

ConDiS – Conducting Digital System

Extended role of the conductor in mixed music performance

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Abstract

This report documents and offers a reflection on my artistic research project “ConDiS – Conducting Digital System: Extended role of the conductor in mixed music performance.” It takes as an example my composition *Kuuki no Sukima - Between the Air*, a through-composed mixed music composition for ensemble and interactive conductor. This composition was created specially as part of this project.

With a custom-made conducting glove – “Con Glove” – the conductor can conduct and control the overall balance, volume, tempo, and synchronization of the electronic sounds written in the musical score.

ConDiS – Conducting Digital System is, in its artistic essence, a tool that brings the electronic aspects of musical expressivity directly under the conductor’s control, and in doing so the conductor is able to rely on this ability the tool affords him. So, in turn, it enables the writing of through-composed mixed music with precision while maintaining a certain amount of flexibility and expressivity.

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Note

An electronic copy of this document and other materials related to the artistic research project, such as blog posts and a diary, can be found on the following web page:

<http://condis.caveproduct.com>

Links to audio and video material referenced in this dissertation can be found on the same web page: <http://condis.caveproduct.com>

Analytical examples left out from this report see: <http://condis.caveproduct.com>

- Sonic analyses
- Use of Electronic Volume Control
- Comparison on Performances
- Use of Synchronization cue marks



Introduction

The ConDiS - Conducting Digital System is a personal artistic research project in which I have tried to solve certain practical and artistic problems through the application of my own artistic vision. This vision is based on the desire to combine electronic sound processing with the conductor's expressive gestures shaping the musical material of the orchestra. This has long been a dream of mine: to find a way to treat the electronics with the same precision and expression as the notes of the written instrumental score. For these reasons, the ConDiS artistic research project has been from the beginning an exciting journey exploring what happens when these tools are put in the “hands” of the conductor.

Narrowed definition of mixed music

In framing my analysis of this project, I have chosen to use the term “mixed music,” which comes from the French “musique mixte” and can be “thought of as being the combination of an acoustic instrument in the presence of electroacoustics.” It is therefore a “crossing point between sound-based and note-based music, inheriting the possibilities and problems of both sound worlds” (Lacroix, 2018). In my work on the ConDiS project and in this discussion of it, I will use a narrow understanding of the term and focus on mixed music as a type of semi- and through-composed concert music that incorporates elements of both art music and acousmatic music.

To better illustrate the difference between classic concert performance and classic mixed music performance I turn to Oliver La Rosa’s definition of composition and performance as being “traditionally conceived as a uni-directional, linear, sequential communication process. The composer gives the music to the performer, and the performer plays it for an audience. Two media are used to enable this process: scores and musical instruments” (Oliver La Rosa, 2011). He calls this *the composer-performer-listener model*. (Fig.1)

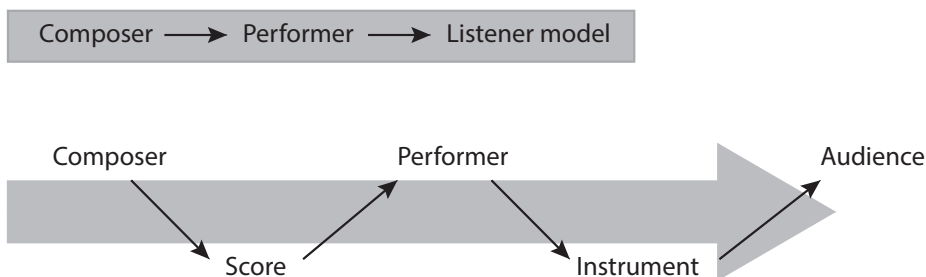


Figure 1. Adapted from Oliver La Rosa drawing of the traditional uni-directional communication process of classical concert performance.

In mixed music¹ this “uni-directional” communication is disturbed to an extent since the addition of live signal processing creates an interaction between the performer and the computer. The composition process has therefore changed into one in which the composer not only has to compose the score for the performer, but also the “score” for the computer. Additionally, the model has changed since the computer can “listen” to the performer and respond in real time to his performance. The responding process, or the electronic score (sonic response), is decided (composed) by the composer during the compositional stage. Various methods can be employed to have the computer “listen” and trigger the sonic response, with the most commonly used ones being pitch following, amplitude following, spectral analyzes, and cero crossing.

Figure 2 shows the “traditional” mixed music communication process.

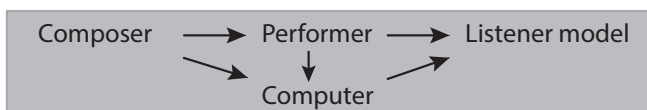


Figure 2. The disturbed uni-directional process of mixed music concert performance.

With the addition of the ConDiS system a conductor is placed between the composer and the performer(s)/computer in the communication process, as shown in Figure 3.



Figure 3. The mixed music communication process including a conductor.

The insertion of a “new member,” the conductor, between the composer and the performer(s)/computer in this model, adds new dimensions to the communication process. In addition to the responsibilities attached to the classic conducting job, namely interpreting the written score and delivering it to the performers, the conductor now has to interpret the “computer” score as well. This opens up a floodgate of new musical interaction, or what I prefer to call musical interplay. This extended role of the conductor provides conductors new means of expression beyond those they would usually have. Using the ConDiS system the conductor can exercise actual sonic influence by controlling the digital signal processing of the performing instruments. This is in contrast to the “suggested” sonic influence, which is produced by the conductor prompting and spurring action from an ensemble that is actually

¹ I am referring to a specific form of mixed music where live processing is used. This discussion therefore excludes the form where the electronic component is fixed.

producing the sound and may or may not follow the conductor's instinct. Depending on the compositional decisions made, the composer can become a co-conductor, or the conductor a co-composer.

Hence even in pursuing the aim of the ConDiS project, *to create a conducting system to use in performance of through-composed mixed music*, the full exploitation of some of these new spaces that have been realized is constrained, and by no means have the boundaries been fully explored. There is an opportunity and a need for further research, additional software and hardware development, and additional experiments with conductors and different styles of compositions and performances.

In *Kuuki no Sukima*, caution is exercised in harnessing the full possibilities of the ConDiS system, with the main focus limited to the traditional function of conducting, interpreting a written score and controlling volume, sonic balance, tempo, and synchronization. This restriction was chosen mainly due to the fact that a through-composed composition does not require other external conducting methods. Furthermore, the fact that this new expanded conducting capability is still very exotic to conductors recommends a more measured adoption. They are not used to using external elements, and "even having to use a baton has [a] sudden amount of limitation" (Halldis Rønning in an interview). Consequently, I felt I needed to be careful and somewhat conservative in my approach.

Figure 4 illustrates the process model used for the performance of *Kuuki no Sukima*. The Composer writes a Score for the Conductor to interpret to the performers who react by making instrumental sounds via their written instrumental parts. At the same time, the Composer writes a timeline-based score in the Digital Audio Workstation (DAW)², where the entirety of the digital sound process is precisely written to accord with the instrumental score. The Score and the DAW score interact since the Score includes graphical information on the digital sound process and other necessary information such as synchronization markers, volume, and tempo.

² An electronic device or application for recording, editing and producing audio. The abbreviation will be used throughout this paper.

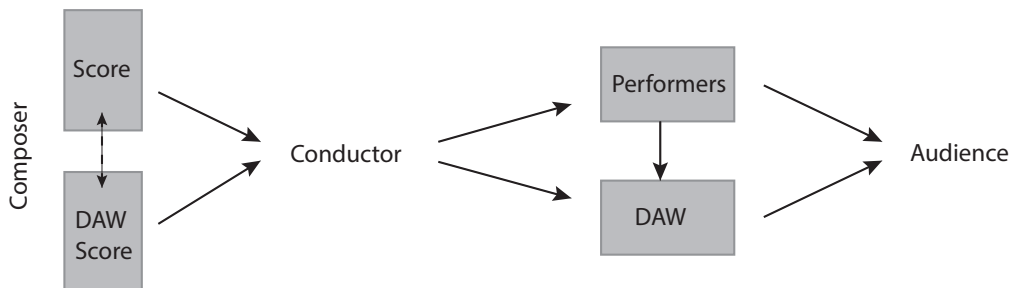


Figure 4. The composer-conductor-performer/computer-listener model used for "Kuuki no Sukima"

Figure 5 shows the processes with reference to Oliver La Rosa's composer-performer-listener model. A third activity category has been added between the categories I prefer to call, Human and Object-oriented activities: Digital activity. The Digital Audio Workstation is situated after the Conductor to emphasize the role of the conductor as the controller, even though the DAW is also a part of the composer's compositional process. Hence the two arrows from the composer to the DAW in the diagram. Similarly, the conductor controls the performer, who reacts to the conductor's gestures by playing the written compositional part, making sound via his instrument.

The instrumental sound then simultaneously travels directly out to the audience and in real time via the signal processing of the DAW. I have chosen to refer to this process as an electronic extension of the instrumental sound.

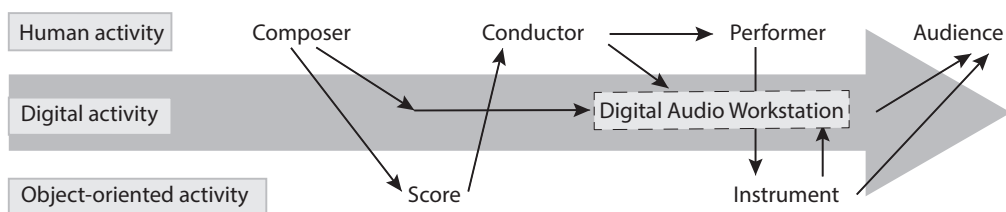


Figure 5. The mixed music model of Kuuki no Sukima showing the process as three forms of activity: Human, Digital and Object-oriented.

Lack of expressive interplay (Synchronization)

During classic acoustic performances, there is an interplay between the written score and the performers as well as between the performers themselves. The performers read the composed score and add expressions, emotion, and dynamics using their musical training, experience, and musicality. In mixed music, electronic sounds are added to the instruments performing the composition and in doing so the interplay gets somewhat lost. Regardless of whether the electronic sounds are played from a pre-recorded audio file or an automated timeline of a digital audio workstation (DAW), they lack comparable expression—they lack

the human touch. What is ultimately missing is synchronization and the crucial musical interplay between the instrumental and the electronic.

Often the solution is to write the composition in either strict metric or free semi-improvisational style. Strict metric style means the performers would have to follow a given tempo quite closely, sometimes wearing headphones playing a click-track in their ears. In the free semi-improvisational style synchronization becomes less critical with performers playing freely in and out of synchrony with the electronics. Writing through-composed music for mixed music media is a challenge especially when writing for larger ensembles. In these cases, synchronization between the acoustic instruments and the electronics becomes critical. This is what spurred the creation of ConDiS – Conducting Digital System.

The lack of expressive interplay has been a continual challenge for contemporary music since the first appearance of electronic music. From the 1980s on, various attempts have been made, including explorative efforts by Michel Waisvisz (Waisvisz, 1985) Philippe Manoury and Miller Puckette (May, 1999), Morton Subotnick and Mark Coniglio (Rowe, 1992), and Tod Machover and Teresa Marrin Nakra (Paradiso, 1999), among others. In these attempts the performer is the source of expressive timing and variation. Less explored is how to allow the conductor to shape the music, as she would do with purely acoustic music.

What turns a written composition into music is the musician's interpretation of the written musical score. It is what is written in-between: the interplay between what is written and what is performed. It has everything to do with the interpretation of music in time and space; hence the need for ConDiS, which allows the conductor to expressively control and synchronize the music produced by the performing instruments and the electronic component of through-composed music.

Compositional Interest

My main compositional interest lies in the field of through-composed contemporary music using live electronic extension of the instrumental sound. Unfortunately, until recently, this style of through-composed mixed music in a larger format (ensemble/orchestra) was not technologically feasible given the precision such a composition method requires. Through-composed music needs this preciseness, it needs to be interpreted in a similar way from one performance to another. This description should not be taken literally, however, as a certain degree of freedom of musical interpretation can certainly be incorporated, as is evident in my own compositional methods.

Faced with a choice between the strict metric or semi-improvised style, the semi-improvised style has been more appealing to me due to its flow and fusion. I am drawn to its ability to flow freely according to the musical interpretation of the performer(s) and the accompanying electronic sounds. This captivation can be traced through my mixed music

compositions: the *Sononymus* sequence for different solo instruments to *Circles I*³ for three instruments, *Hljóðs bið ek* for voices⁴ and *Hljóðs bið ek* for five instruments⁵. In these compositions various experiments are performed, both compositionally and technologically, dedicated to the search for a way to synchronize the written score and electronics. I have found pitch tracking to be the most successful.⁶ This is especially evident in my *Sononymus* sequence for solo instruments and computer-generated sounds, which is not entirely surprising since there is only one instrument interacting with the electronics. Including more instruments complicates the pitch tracking due to sound bleeding between the microphones.

In my composition *Circles I*, I work around the problem by integrating the bleeding into the construction of the composition. *Circles I* is written for three instruments that circle between eight different electronic effects—the circling is based on a set of pitches, which trigger jumps from one setup to another. So bleeding between the microphones causes disturbances which then alter the adaptive effect setup controlled by the pitch parameter. Thus the varying bleeding in the microphones causes variation in the electronic effects. The pitch-tracking disturbances and their consequences are therefore part of the composition. The result is a composition that varies significantly between performances.

In order to reduce these variations and compose music with more precision, as required of through-composed music, I needed to create the ConDiS system; the possibilities bestowed by this system are exemplified in the composition *Kuki no Sukima*.

³ Circles I on YouTube, <https://www.youtube.com/watch?v=Ya0yQF5IREk&t=52s>

⁴ Hljóðs bið ek for voices on YouTube, <https://youtu.be/83yIIKsYdMg>

⁵ Hljóðs bið ek for five instruments on YouTube, <https://www.youtube.com/watch?v=TO8Z0kIMnts&t=346s>

⁶ Pitch tracking means the process of analyzing pitch in an audio signal.



Content and structure

This ConDiS - Conducting Digital System report is divided into seven main chapters in which I reflect on distinct aspects of the project. This traces the process of creation, starting with an unconscious need all the way to the development of a fully-fledged system used for the performance of through-composed mixed music.

The first three chapters provide historical context and are framed by the question: Why ConDiS? The first explores my background and motivation. The second explains the role of the conductor and the third gives a brief historical overview of the technological evolution of gesture-based interfaces.

“Why ConDiS” explores why I felt it desirable and necessary to develop a tool that can, through the conducting gestures performed by the conductor, intertwine acoustic and electronic sounds. It also examines opportunities I see for extending the ConDiS project including compositional possibilities, the role of the conductor, and performance experience. I use selected examples of my compositions to illustrate how my compositional background generated an urge to contribute to the development of and production of more knowledge related to the field of interactive mixed music. In this way I seek to illuminate the long-lasting relationship between concept and technical limitation that has informed my process.

I approach the role of the conductor in the same way, as her role is one of the core focuses of this research. In my conversations with people outside of the field of music, it became clear to me that the majority has little knowledge of the role of the conductor, such as how she uses gestures to control rhythm and volume, among other things. I have therefore devoted space in this paper to explain the importance of the conductor, given this figure’s central place in the research project. This will improve the reader’s understanding of how the role of the conductor is extended through the ConDiS conducting glove, ConGlove.

The third and final chapter of this section gives a brief overview of the technical development of the software and hardware related to my research. I conclude the chapter with an explanation of my decisions regarding the structure of the ConDiS system.

The chapter entitled “ConDiS: Technological Development” reviews a variety of aspects related to the choice of hardware and software. This includes the presentation of results of experimentation with different arm gestures, and the chapter ends with video examples of the practical use of these gestures to control output.

“The Research Process” chronicles the project’s entire process of artistic evaluation, focusing on considerations and needs from an artistic, as opposed to technological, perspective. Particular emphasis is placed on the importance of researching and developing score

instructions for the electronics, since this is one of the most important foundational aspects of unified interplay in mixed music. To this end, I analyze three experimental compositions I wrote with the purpose of trying out various graphics specifically in mind.

Chapter 6 “Performance Reflections” refers to reflections based on:

- Performance preparation;
- Performance analyses;
- Interview with conductor Halldis Rønning;
- Questionnaire sent to members of Trondheim Sinfonietta; and
- Conversations with audiences.

These reflections are made through an analysis of the written musical score in conjunction with audio and video recordings made during the performances. I reflect on the composition as well as the performance, emphasizing both positive and negative aspects. The interview with conductor Halldis Rønning was conducted via Skype shortly after the Nordic Tour and was guided by a questionnaire I sent her in advance. I also used an email questionnaire to survey the members of the Trondheim Sinfonietta who had performed during the Nordic Tour. The email was sent shortly after the tour, but the response rate was rather low, with only three completing the survey. Despite this low response rate, I consider their answers consistent enough for me to draw valid conclusions from the collected information.

The final section of the report— “Conclusion and Future Work”—summarizes the overall results of and experiences during the ConDiS artistic research project. In this I place particular emphasis on the artistic gain realized through “learning by doing.” Finally, I explore concepts for the future development and practical expansion of the project.

The “Epilogue” is based on my reflections following the closing concert of the project. The concert was not originally conceived as an object for reflection, but rather as an endpoint for the project and a result of the analyses themselves. However, I realized that providing thoughts on the closing concert would benefit the reader by providing a better understanding of how the research had progressed and an impression of the last stage of the project in this iteration.

Research and context

The research process can be divided into five main categories in chronological order followed by a conclusion and brief discussion on future developments.

1. **Technology/Technical** - Development of the device itself, i.e. software and hardware. Choosing which software to use and then completing basic programming in Max/MSP constituted an important part of the research. Using a do-it-yourself method meant that I felt more direct contact with the execution of the project. I therefore made do without any external assistance, with just a few exceptions, in cases where functional changes were needed, additional programming was called for.
2. **Graphic Notation and Instructions** – Focusing on developing symbols for the electronic sound processing and related instructions for conducting.
3. **Experimenting** - Using experimental compositions to test the interface to and the functions of the hardware, the conducting glove “ConGlove.” Compositions in the form of solo études provided the opportunity for electronic and aesthetic troubleshooting. I collaborated with individual performers to work out various extended instrumental techniques.
4. **Composition** – Composing a new work *Kuuki no Sukima*, which was purpose-written to demonstrate the advantage of the ConDiS system for through-composed mixed music performances.
5. **Performance** - Collaboration among the composer, the conductor, and performers. Rehearsals and concerts.
6. **Conclusion and future work** – New compositions to further explore the potential of ConDiS and future collaboration between composer and conductor, other conductors, students, ensembles, and developers. Future developments and improvements to the ConDiS system are discussed.

Certain questions accompanied the ConDiS research project throughout. These were kept foremost in mind during the artistic research process:

1. **Why** – Why do I need the ConDiS system? What do I want from the ConDiS system?
2. **Process** – Is there an artistic advantage to this research process?
3. **Composition** – Will the ConDiS system produce a different style of composition?
4. **Conductor** – Does the use of ConDiS maneuver the conductor into a different and more creative role?
5. **Performance** – Will the extended role of the conductor—in which she actively functions as a co-composer or performing member of the ensemble—change our expectations of the concert performance as traditionally understood?

Chapter 1 Why ConDiS

The Initial Approach

“The original remote controller for music is the conductor’s baton”(Roads, 1996).

Whether or not it is accurate, Curtis Roads’ statement prompts the question: What if you do not use a baton? And I found myself asking an additional question: But what if we were to take the remote control and develop it even further? By which I mean develop a system where the conductor can, using physical bodily movements or gestures, remotely control the acoustic sound, the digitally processed timbre of that sound, and the sonic spectrum.

This opens a floodgate of possibilities for integrating the orchestral conductor’s capacity to control the overall flow of the “whole” musical performance. Instead of having a cue-man and/or sound engineer in the middle of the hall triggering and mixing the digital sounds to the analogue sounds of the orchestra, the conductor now has the opportunity to extend her conducting expressions and interpretation in an unmediated way.

The ConDiS project aims to extend compositional possibilities, the role of the conductor, and the performance experience. Emphasis is placed on changing as little as possible of the traditional task of writing on the part of the composer or the conductor’s traditional conducting gestures. Therefore the notes, dynamics, and duration of the instrumental parts are written in the traditional manner in the form of a musical score.

Special notation or instructions are added to provide expanded opportunities for composing the live electronic sounds as if they were an actual extension of the ensemble of instruments. This allows me to treat the sonority and dynamics of the electronic part in a way similar to the traditional written score. It also enables the conductor to interpret the score she reads with more precision while still maintaining the flexibility of live performance, expression, and dynamics, allowing the whole to flow in time and space. In other words, this system creates the opportunity to conduct and control the live electronic sounds and treat them as though they were actual instruments.

Why Interactive Conducting?

The ConDiS concept crystallized during a conversation with conductor Cathrine Winnes following a concert in honor of the 100th birth of composer John Cage. We expressed our

mutual interest in the idea of creating a conducting tool that would enable conductors to conduct electronic sounds. Cathrine was therefore my choice for conductor from the beginning, and this project was initially developed for her specifically. When I started to organize the Nordic Tour dates with Trondheim Sinfonietta, it became clear that Cathrine was fully booked. I therefore asked conductor Halldis Rønning, whom I had seen conducting Trondheim Sinfonietta at a concert in Trondheim, to step in to replace Cathrine.

Conducting is an extraordinary form of conversation in which a person stands in front of a group of people and communicates without producing any sound themselves. Conducting is based on a form of sign language we might refer to as conducting gestures, a language learned through years of practice. In addition to gestures primarily involving the hands, the conductor adds other bodily movements, facial expressions, and eye contact. To characterize this implicit information I will use the term “exformation,” which was introduced by Tor Nørretranders in his book *The User Illusion: Cutting Consciousness Down to Size* (Nørretranders, 1999). It was also later used by composer Jesper Nordin as a title for his mixed music composition, *Exformation Trilogy*. The term is perhaps best described by Baptiste Bacot and François-Xavier Féron in their paper “The Creative Process of Sculpting the Air by Jesper Nordin: Conceiving and Performing a Concerto for Conductor with Live Electronics”:

Exformation relates to the fact that when people are communicating, they are sharing an implicit knowledge, which is taken into consideration tacitly in the comprehension of the words. For instance, facial expressions, tone of voice, and the gestures of each speaker give away a body of information, although it remains implied. Exformation is ‘everything around the information, everything you are not saying’ (PI 2), that is to say an important part of human interaction. (Bacot & Féron, 2016)

Motivation

I have gradually realized over the course of the research process that the motivations and concept behind ConDiS have much deeper roots than I had imagined. This discovery (revelation) has, over time, become an important part of the research process, as there is no progress without background. In other words: “No one escapes his origins.” Familiarity with my background as composer is important in understanding the need and motivation behind the development of ConDiS - Conducting Digital System project. To know and understand where the roots lie and the path the shoots took to the surface.

Turning Point

Attending a lecture given by the American composer and electronic music pioneer Morton Subotnick,⁷ who was speaking about his visions for the future of music and music technology, instantly altered my own vision of future developments in contemporary classical music. I saw how it would fuse and extend its limitless limits with digital technology; how one could see and hear a French horn player play his horn and then how that sound would gradually morph into a totally different sonority that would travel through sonic and physical space. This was in 1988 and these ideas seemed still to be light years away, but it was a vision that had a tremendous impact on me as a then young composer.

A few years later I witnessed Theremin performer Natasha Theremin⁸ and computer pioneer Max Mathews⁹ performing Sergei Rachmaninov's *Vocalise* on the original Theremin and Radio Baton instruments.

This historic concert was held outdoors at Stanford University's Frost Amphitheater on September 27, 1991, as part of Stanford's Centennial Celebrations.

I remember Natasha gracefully moving her arms to create such expressive and wonderful sounds on the legendary Theremin instrument, while Max Mathews played his Radio Baton instrument by drawing various gestures on a relatively small rectangular table. These unforgettable events marked a turning point in my professional career as a composer: preliminary thoughts about interactive performance were born that would later develop into full-fledged multimedia performances including dance and video.¹⁰ Real-time interactive live musical performance was its birthright, with ever faster computers and the introduction of MIDI and Max object-oriented programming.

⁷ A well-known electronic music composer who wrote the first electronic work commissioned by a record company, *Silver Apples of the Moon*.

⁸ Daughter of the legendary inventor Léon Theremin. His Theremin instrument was one of the first electronic musical instruments and the first to be mass produced.

⁹ Pioneer and "grandfather" of Computer Music, known for his GROOVE program, the first fully developed music synthesis system for interactive composition and real-time performance. He later developed the Radio Baton conductor's baton for controlling a computer orchestra.

¹⁰ My first full-scale multimedia work *Goblins from the Land of Ice*, composed in 1992. It included live interactive Japanese Butoh dance and video projection.

Historical path to ConDiS

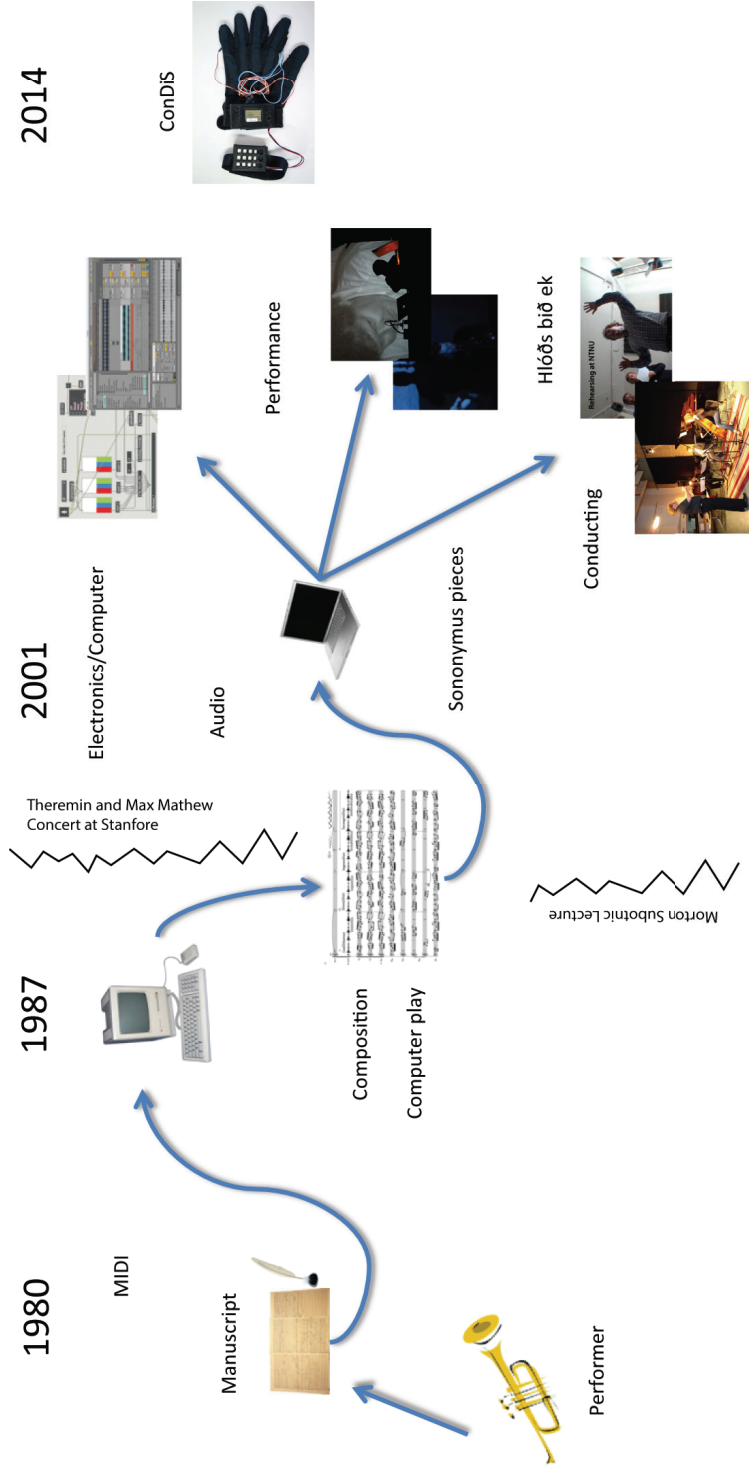


Figure 6. Historical path to ConDiS

The Path to Interactive Conductor

The following is a brief overview of my path to ConDiS, written to clarify how my personal needs and musical interests gradually led to the idea of ConDiS. In this, I use examples from my compositions to explain how the need I experienced revealed itself in parallel with technological developments and, consequently, enhanced possibilities for performing live interactive mixed music. I explore how these increased capabilities result in the need to write mixed music for larger musical groups. This then increases the need for a musical solution to connect and synchronize the control of electronic and acoustic sounds.

Early Interactive Compositions

Computer Play (1988)

In 1988, I wrote my first interactive music, named *Computer Play*, for Viola, Piano and “interactive” computer. At the time, the Macintosh SE system had just been introduced with more horsepower than its predecessor, extending possibilities for interactive performance.

Written using the software “Professional Composer,”¹¹ the computer would play a musical score in real-time with the live instrumental performance. To synchronize the playing of the live performers and the computer, the composer conducted while sitting on a chair on stage, keeping the tempo synchronized with conducting gestures while watching a metric clock on the computer screen.¹²



Figure 7. Program from Reykjavik Art Festival

Experience and Results

The interactivity deployed in the performance of *Computer Play* was somewhat primitive, but the components of future development were already there. The need for interactive conducting was obvious. It was the technology that was limited, or at least too limited for my musical intention.

Although it was possible during the performance to synchronize the performers and the computer by conducting, the conducting process was robotic. The conductor had to follow the computer’s internal clock without any ability to interact with or alter it once the

¹¹ Professional Composer was among the first commercial music notation programs available on Mac and was produced by MOTU (Mark of the Unicorn) in the 1980s.

¹² The performance took place at the Reykjavik Arts Festival, June 10th, 1988, at Kjarvalsstaðir Museum, performed by Svava Bernhardsdóttir on viola, Guðný Guðmundsdóttir on piano, and me conducting.

performance had started. What I had wanted was more musical expression, more rubato,¹³ more on-the-spot reaction, more musical interaction between the acoustic live performance and the digitalized sound and performance of the computer. These interactive performance expressions, however, were not available, or at least not available to me. It was perhaps a bit too early for full real-time interactivity, but one could sense something in the air. It was not until 1992, as a composer-in-residence at CNMAT,¹⁴ that I made my next serious attempt at composing music for live mixed music media.

Crossover Sonic Art

Goblins from the Land of Ice (1993-95)

The multimedia work *Goblins from the Land of Ice* was written for the Japanese/American Butoh¹⁵ dance company Harupin-Ha.¹⁶ It is based on figures from Icelandic folklore, the so-called Yule lads.¹⁷ Here I used, for the first time, interactive media to control and trigger



Figure 8. Poster from *Goblins from the Land of Ice*.

sounds and video. Dancers on stage would trigger light sensors with their body movements, creating a variety of sequences of music and video clips. As their gestures shifted in dance, the rhythm and playback speed would change accordingly. The sonic material was based on recordings from volcanic eruptions and hot springs in Iceland. As the Butoh dancers slowly moved around making their unique body gestures, sounds of running lava, muddy hot springs, and geysers were triggered.

This was an adventure, a new dimension, a crossover between the field of written contemporary music and sonic art. Given my background as a classically trained composer, most of my music had been in the field of experimental instrumental music of the mid-twentieth-century European tradition. But I felt an increased ambition to fulfill my own musical desires. It was in the—at that time—newly developed capabilities of sensor

¹³ In music, the term “rubato” means playing in free rhythm, which means the musician can bend or swing the rhythm.

¹⁴ Composer-in-residence at the CNMAT (Center for New Music and Audio Technology).

¹⁵ Butoh is a form of contemporary Japanese dance that arose in the period following the Second World War. It is known for its slow pace and awkward body postures.

¹⁶ Harupin-Ha on Facebook: <https://www.facebook.com/berkeleybutoh/>

¹⁷ Figures from the Icelandic folklore, traditionally portrayed as mischievous pranksters but who, in modern times, have increasingly taken on a more benevolent role similar to Santa Claus (Father Christmas). https://en.wikipedia.org/wiki/Yule_lads

technology and the possibilities these offered for composing and performing live interactive music¹⁸ that I found my path. Since that time, interactivity between sound, gestures, and live performance have played an important part in my compositional creation and work.

Experience and Results

Goblins from the Land of Ice was an international collaboration that including light sensor technology developed at two research centers: CRIM (Création et Recherche en Informatique Musicale) and CNRS (Le Centre National de la Recherche Scientifique). Creating *Goblins from the Land of Ice* was a very challenging task, not only technically, but also artistically. It was a meeting point of different fields of art and cultures. The experience of staging *Goblins* provided me with a valuable lesson about the danger of giving other art forms an opportunity to play with your music live on stage. Especially if you as a composer intend specific meanings and are not ready to seek musical compromise.

Interactive Compositions for Solo Instruments

Sononymus for Flute (1998-2000)

In my first *Sononymus* piece, “*Sononymus for Flute*,”¹⁹ the electronic part was pre-recorded on a CD as an accompaniment or interplay with the flute. All the electronic sounds were composed beforehand in the music studio using the sound of the flute as the main sonic source. Although it was a successful composition and one of the most frequently played from among the *Sononymus* sequence, I was not fully satisfied. I felt constrained, I felt the musician was constrained, and I felt the music was constrained. Why?

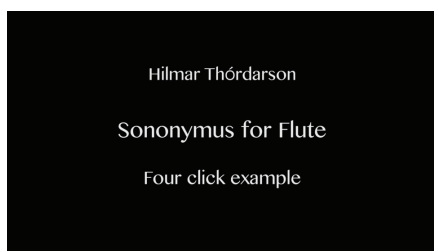


Figure 9. Video example, four clicks.

<http://caveproduct.com/videos/4click.mp4>

I felt constrained because I had no way to synchronize the flute part and the CD-recorded part. In an attempt to keep them in sync, I put a very soft set of four key claps sounds of the flute at the very beginning of the piece. The clap sounds being meant to give the performer information about the tempo or metronome 72. (See sample in Fig. 5). Since there were no other metric indications and no click track, I had to be very careful in my composition to not write anything that might cause a major asynchronous event, such as rubato playing or accelerando/ritardando.

¹⁸ Immediate two-way communication between performer and computer responding to given information.

¹⁹ See YouTube recording at <https://youtu.be/fLx0IOU8wQ>

I felt the performer was constrained since he had to follow the CD player no matter what. Surely by listening to it over and over, the performer learned the electronic part by heart to the point of identifying a few sounds or signals that he could use as milestones to keep in sync with the CD player. I felt the music was constrained because regardless of the venue in which it was performed, the tempo had to stay the same. It is a fact that musical tempo depends largely on the resonance of the music hall in which the performance takes place: the longer the resonance, the slower the tempo.

The duration of reverberations in Gothic churches, therefore, does not permit excessively rapid modulations, and also sets more or less narrow limits on the ability to recognize rapid figures, in spite of the reflections from posts or pillars. The acoustic conditions in these halls are better suited for the slower line sequences of liturgical songs or Gregorian chants. (Meyer & Hansen, 2009)

The musicologist Thurston Dart argues that early composers were very aware of the resonance effects of different performance halls on their music “and that they deliberately shaped their music accordingly” (Dart, 1954). The British architectural theorist and acoustician Hope Bagenal states that without the Reformation, which resulted in reduced reverberation in Lutheran churches, polyphonic music could not have developed beyond a certain point since less resonance led to new possibilities for “more rapid music flow, and true tempo effects in church music” (Bagenal, 1951). I can confirm this from my own experience. One of my pieces, *Concert for Violin and orchestra* (1986), went from an overall duration of approximately 14 minutes when performed in a concert hall to just over 19 minutes when performed in a large cathedral.

Sononymus for Human Body (2005)

In my work *Sononymus for Human Body*,²⁰ I was able for the first time to digitally control sonority and the spatial location of the sound (panning).²¹ Employing the DIEM Digital Dance System,²² I made my first move to use bodily movement as a metaphor. I used environmental sounds from my own recording of a seashore made at one of Iceland’s most magical places, Malarrif on the Snæfellsnes peninsula. Using my own body motion, I was able to control volume by holding my arms tight to my body for minimum volume and then gradually increase the volume by stretching my arms, achieving maximum volume with fully outstretched arms. By moving my arms from left to right, I not only shifted the sound left to right, but I also moved it around the hall using four-channel surround sound. This was a

²⁰ See the YouTube version at <http://www.youtube.com/watch?v=EoObGunr55s>

²¹ Distribution of a sound signal in space giving the impression that sound is moving from one side to another.

²² Gesture controlling system using bending sensors for sending MIDI information. Developed by the Danish Institute of Electronic Music – DIEM.

unique experience for me, standing there on stage with Mother Nature literally in my hands and being able to control its volume and its spatial movement.



Figure 10. Excerpt from *Sononymus for Human Body*.

http://caveproduct.com/videos/Sono_Body.mp4

It was an incredible feeling to be able to exert control with the movement of my body, the sound of the sea waves coming from the back of the hall to the front with increasing velocity, with me making them move to the left and the right, right-to-left and back again with decreasing volume, and so on and so forth. While standing on the stage I felt a kind of God-like sensation of “controlling the forces of nature.” What if a conductor could control electronic music the same way with her body movements?

Experience and Result

Being able to control the volume and spatial location of the sound in real time using the movement of my body was a very promising development in my musical progress. As a composer whose interest lies in interactive media and the classical tradition of composing music on paper, performing *Sononymus for Human Body* was a unique and encouraging experience. It was encouraging because the interactivity was working and unique because the expression and musical feeling were there. But the composition as written, physical object was still missing.

The performance was completely improvised; nothing was written down beforehand. A repository of years of musical training was harvested to create music in structured form. That is to say, the structure was unconsciously formed by my years of musical training.

Extended Interactive Composition

The Hljóðs bið ek (Silence I ask) for Voices (2013)

The *Hljóðs bið ek* composition involved more instruments (voices), making the common challenges associated with real-time polyphonic pitch tracking highly impractical. This therefore called for alternative methods.

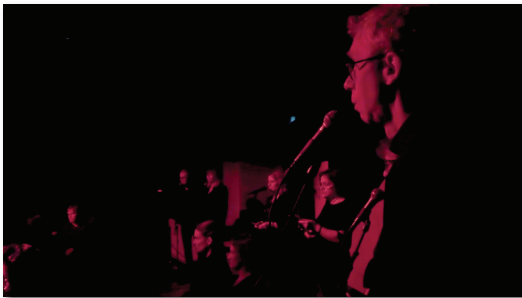
The singers form a circle in groups of two around the audience, with a conductor located in the middle of the audience. The voices of each group of two are transferred via computer to a speaker located behind the group and to a speaker located behind the next group to the right. This thus forms a sense of surround. I ended up using a simple, custom-made amplitude envelope follower for analyzing the vocal volume and controlling the electronics in real time.

Experience and Result

Hljóðs bið ek for Voices was premiered in May 2013 at the Rockheim Museum in Trondheim with me conducting. Standing there conducting on a podium in the middle of the audience made the need for conducting and controlling the electronic sound particularly evident. What if I could mix the sonic balance, bring the electronic volume up and down, change its sonority, and move it around the hall, all with my conducting gestures?

Creating a conducting tool such as ConDiS became an urgent goal.

Five years later at the final Artistic Research concert in November 2018 a revised version of *Hljóðs bið ek* (Silence I Ask) was performed using the ConDiS conducting digital system. During the performance the questions asked before all found their answers.



Excerpt from Hljóðs bið ek (Silence)I Ask in Rockheim 2018.

[http://caveproduct.com/videos/Silence \(ex.4\).mp4](http://caveproduct.com/videos/Silence (ex.4).mp4)

Chapter 2 The Conductor

The Art of Conducting

The conductor is by definition a person who stands center stage in front of performing musicians whose “conducting of musical measures is realized by a flow of organized body movements, usually hand movements that draw specific patterns in a 3D space around the conductor. These movement patterns are periodic and may be grouped into different sets of beats” (Schramm, Jung, & Miranda, 2015)

The conductor’s job is to realize and interpret the music, and to do so he expects “all those before him to be subject and subordinated to him” (Fredman, 2006). Without making any sound, the conductor uses his body language, arm, hand, and finger gestures, facial expressions, anger, smile, eye contact, everything that can be included under musical gestures. The conductor interprets a composition through a written musical score, which includes all necessary information about the performance, pitch, timbre, tempo, rhythm, and volume of any of the performing instruments (Johannsen et al., 2010, p. 268). The ideal conductor must learn the music beforehand, incorporate it into her neurological system, and then she must be able to express this emotion to her performers, first through her words at rehearsals and then through musical gestures at the concert. One can therefore say that “in terms of conducting, as a trained motor skill used for nonverbal communication, effective gestural cues are vital” (Visentin, Staples, Wasiak, & Shan, 2010).

Conducting

From a historical perspective, the role of the conductor has grown through the centuries. The conductor has gone from being one of the performing members of the orchestra conducting from his chair, usually the violin or the harpsichord player, to a figure standing on a podium in front of an orchestra. This change in role goes hand-in-hand with the development in size and instrumental combination of the orchestra from the Renaissance orchestra (about 400 years ago) through the Baroque and Classical orchestras to the Romantic era, which provided us with the size of orchestra we know today.

With the growth of the orchestra, the instrumentation was increasingly organized into sections and composers started to write for the specific instruments they had in mind. The term “orchestration” became important, meaning to arrange or score music for orchestra by writing a musical score. Composers also began to be more adventurous about combining instruments to produce different sounds and colors (Philharmonic., 1999, n.d.). Increased interest in new sonority led to better design and construction of the “old, traditional”

instruments and new instruments, such as the clarinet, saxophone, piccolo flute, and tuba, were introduced.

Musical auxiliary signs, such as tempo signs, also came into play, usually provided in Italian, such as Adagio, Moderato, Presto (slow, moderate, fast) and later more precise metronome indications were utilized, such as quarter note = 60 (quarter note per second). Dynamic signs became prevalent, such as *f* (forte) loud, *p* (piano) soft, crescendo (cresc...) gradually louder, diminuendo (dim...) gradually softer, accelerando (accel...) faster tempo, and ritardando (rit...) gradually slower.

All these developments led to an increased interest in composing music that would enrich the sonic and rhythmical possibilities of the orchestra. It also led to an increased complexity of the orchestral score and expanded the responsibility placed on the conductor and his role as the “leader” of the orchestra. The conductor became the ultimate interpreter of the orchestra; he moved from being one of the performing members to an independent, conducting musician standing on a podium in front of the orchestra.

Conducting Tools

In the eighteenth century, the conductor baton was introduced as a tool to help make gestures clearer and easier for the orchestra to follow. By extending the arm of the conductor, the baton made it easier for the performers to watch for and see the conductor’s gestures. With the establishment of conducting schools in the mid-nineteenth century, gestural patterns or “rules” evolved for all metric indication, such as $\frac{2}{4}$, $\frac{3}{4}$, $\frac{4}{4}$, and $\frac{6}{8}$. Other musical gestures were also accepted and understood more generally and used for musical expression, including small gestures to indicate less volume (pianissimo) or larger gestures for more volume (forte), stiff conducting gestures for strict rhythmic playing (staccato gesture), and more curved or soft gestures for more melodic playing (legato).

The rise in complexity of twentieth-century compositions not only provoked an explosion in the harmonic language of music but also in the orchestra form. Contemporary experimental composers preferred smaller instrumental ensembles and different instrumental combinations, where the tiniest details in the written score could be illustrated through the conductor’s gestures. As a consequence, a growing number of twentieth-century contemporary music conductors preferred to use their hands rather than the baton. This way they had more control in their “fingertips” to implement the smallest details of the music.

With this historic perspective in mind, I have focused on developing a new conducting tool that is in and of itself a consequence of the historical evolution of the art of conducting. This is why the ConDiS system is a glove-based instrument.

No new tools have been developed and applied to the work of conducting over the past 100 years. It is in fact fascinating that the only development made in this time was putting aside the use of the only existing tool, the baton. The most likely explanation for this turn of affairs is that there never has been a need for tools other than the conductor's body. The conductor's body gestures and facial expressions are able to convey any and all information necessary to conduct music.

It is not until the advent of interactive mixed music performance that a new need has arisen for the development of new conducting tools. As will be explained in more detail in the next chapter, technological advances over the past several decades (since around 1980) have opened up new possibilities for developing and designing new musical instruments and conducting tools.

The Extended Conductor

The Best Musical Solution

The idea behind having the conductor conduct the electronics is that I believe it is the best “musical” solution in these cases. As I will demonstrate below, the conductor is the best-qualified person for this task. The conductor is the only person who knows the whole score by heart and is trained to synchronize and control the whole performance. It is the conductor who prepares herself by analyzing the score, and it is through the score that the conductor interprets the composer's intentions and communicates these to the orchestra and the audience. Using the conductor instead of a sound engineer to adjust the mix between the orchestra and the electronics is simply more “natural” since this continues to correspond to the traditional job of the conductor.

One might argue that the sound engineer is better situated than the conductor for hearing the overall mix. I nevertheless believe that regardless of the conductor's location being based on her physical connection with the orchestra rather than a connection to the overall sonic mix, it is better to have the acoustics and electronics mixed from the same point of hearing. I consider it unfortunate to have two people in charge of the overall sonic mix, one on stage front and center mixing the balance of the acoustic instrumental sounds and the other in the middle (or at the back) of the hall mixing the balance of the electronics. In this situation, if the conductor decides that the electronic sound is too loud or too soft, her only option is to adjust the sound level of the orchestra accordingly.

I must confess one oversight that only became apparent later on in this project, namely that most conductors of acoustic music find the electronic sounds to be exotic and, in some ways, disturbing. Halldis Rønning, like the majority of classical conductors, has little experience of mixing instrumental sound and electronic sound. Her experience is therefore considerably

different from my own. I have worked with electronic sounds for decades, and they are a part of my sound world. Halldis, on the other hand, has worked mostly in the world of acoustic instrumental sound. These electronic sounds are consequently not part of her sound world. It was therefore fascinating, if challenging at the same time, to witness the developments that took place over the course of the performances of *Kuuki no Sukima*, from the first concert at Dokkhuset to the last concert at Rockheim. With these developments she became increasingly better at mixing the acoustic instruments and the electronics. This had the additional effect of making the performances more relaxed with a more precise formation of the music.

It was noticeable that Halldis lowered the overall electronic sound levels during concerts where, due to the better location of the speakers, she heard the electronics more clearly. This might be explained straightforwardly with the observation that better hearing caused her to lower the volume. But I nevertheless felt that hearing the electronics more distinctly ended up disturbing her from hearing her familiar “classical” instrumental sound. And this led her unconsciously to lower the electronic volumes.

This discovery was unexpected, but not surprising. It is my opinion that ConDiS is a very exotic tool for the conductor. It is not only an extension of the job of conducting, it is an extension of the conductor’s sonic world. With the electronics so closely related and responding to the conductor’s gestures, the conductor becomes more aware of the electronic sounds. The conductor starts to hear the electronic sounds in a different way than before when they were just an accompaniment to the instrumental performance. The conductor starts to hear the mix of the instrumental sounds and the electronic sounds in a novel way. What is more, the performers share a similar experience. As a result the conductor, the performers, and the electronics become one: they become unified.

It is evident to me now that it will take a long time before ConDiS is regularly integrated into the performance of mixed music. This is not only because it is a new, exotic tool for the conductors, as I already acknowledged at the beginning of my research project, but also because it extends their sonic world. They need time, they need practice, they need more opportunities to use it in performance. That can only come about with the production of new compositions incorporating the results of the ConDiS project.

Chapter 3 Alternative Controlling Systems

Above I presented a brief historical overview to provide a better contextual understand of the choices made with respect to the control devices, design, and technology of the ConDiS system. It presented insight into the relationship between what I want to do with this project and what I set out to do. The following chapter offers reflections on alternative systems and controllers from both a musical and a technological standpoint. Emphasis is placed on sensing devices that can be traced genealogically to conducting gestures.

The birth of MIDI and Digital Technology

The introduction of the silicon microchip and the MIDI protocol in the early 1980s has been called the “technological revolution” by NYU professor Jamie Oliver (Oliver La Rosa, 2011). The silicon microchip enabled the production of faster, smaller, and cheaper computers, while the MIDI protocol promoted the interconnection of various kinds of equipment including computers, interfaces, and synthesizers. These revolutionary milestones mark the beginning of a new era in the history of computer music, the era of interactive music systems.

Interactive Music Systems

Faster, smaller, and cheaper computers and the MIDI protocol opened up various possibilities for using computers in music, as a means of composition, source of new electronic instruments, and in terms of performance. Robert Rowe explains in his book *The Aesthetics of Interactive Music Systems* how computers caused upheaval in the practice of music making, how they opened up new kinds of composition and performance practices, leading to the development of interactive computer music systems. Systems that “explore some highly specific techniques of composition at the same time that they create a novel and engaging form of interaction between humans and computers” (Rowe, 1999), systems “whose behavior changes in response to musical input” (Rowe, 1993). He then classifies these interactive systems into a combination of three distinguishing dimensions:

Classification of Interactive Systems

1. *Distinguishes between Score driven systems and Performance driven systems.*

Score-driven programs use predetermined event collections, or stored music fragments, to match against music arriving at the input. They are

likely to organize events using the traditional categories of beat, meter, and tempo. Such categories allow the composer to preserve and employ familiar ways of thinking about temporal flow, such as specifying some events to occur on the downbeat of the next measure or at the end of every fourth bar.

Performance-driven programs do not anticipate the realization of any particular score. In other words, they do not have a stored representation of the music they expect to find at the input. Further, performance-driven programs tend not to employ traditional metric categories but often use more general parameters, involving perceptual measures such as density and regularity, to describe the temporal behavior of music coming in.

2. Distinguishes of response methods as transformative, generative, or sequenced.

Transformative methods take some existing musical material and apply transformations to it to produce variants. According to the technique, these variants may or may not be recognizably related to the original. For transformative algorithms, the source material is complete musical input. This material need not be stored, however - often such transformations are applied to live input as it arrives.

For generative algorithms, on the other hand, what source material there is will be elementary or fragmentary - for example, stored scales or duration sets. Generative methods use sets of rules to produce complete musical output from the stored fundamental material, taking pitch structures from basic scalar pattern according to random distributions, for instance, or applying serial procedures to sets of allowed duration values.

Sequenced techniques use prerecorded music fragments in response to some real time input. Some aspects of these fragments may be varied in performance, such as the tempo of playback, dynamic shape, slight rhythmic variations, etc.

3. *Distinguishes between the instrument and player paradigms.*

Instrument paradigm systems are concerned with constructing an extended musical instrument: performance gestures from a human player are analyzed by the computer and guide an elaborated output exceeding normal instrumental response. Imagining such a system being played by a single performer, the musical result would be thought of as a solo.

Systems following a player paradigm try to construct an artificial player, a musical presence with a personality and behavior of its own, though it may vary in the degree to which it follows the lead of a human partner. A player paradigm system played by a single human would produce an output more like a duet. (Rowe 1993)

The relevance to ConDiS

Based on Robert Rowe's classification of interactive systems, we can situate the ConDiS system in the following manner:

1. It is a score-driven system since it uses predetermined event collections and a stored representation of the music at its input. This comes in the form of the timeline-based programmed automation of the electronic part that then needs to synchronize with the music arriving at the input. That is to say, the two parts need to match the performance of the written score. Events are organized using the traditional categories of beat, meter, and tempo, allowing the composer to preserve and employ familiar ways of her compositional process.
2. It is transformative since it takes musical material, in this case the live input, an audio signal from each instrument, and applies a transformation in real time to its sound to produce a sonic variant. These variants can be adjusted from being recognizable to nonrecognizable depending on the preprogrammed automation of the electronic part. For the transformative algorithms, the source material is complete live musical input of each of the performing instruments.
Certain functions of the ConDiS system can also be recognized in the description of the sequenced technique since they allow a variation in performance, such as the tempo of playback, dynamic shape, and rhythmic variations.
3. ConDiS is not an instrument but a tool that does nothing more than extend the conductor's job to synchronize and control the electronics. Therefore, the ConDiS

system is a conducting paradigm system that is concerned with constructing an extended musical tool.

Performance gestures from a human conductor are analyzed in real time by the computer and guide an elaborated output exceeding the standard instrumental response.

Score following programs

“Score following was first presented at the 1984 ICMC, independently, by Barry Vercoe and Roger Dannenburg” (Puckette & Lippe, 1992).

Score following is the process of tracking live signals from a live performer to determine where in a score a performer is and synchronize this with its computer accompaniment. By matching the performance score to the score stored in the computer, electronic events are triggered at precise points written in the performance score. The most commonly used score following is pitch tracking, though other parameters can be followed.

The collaboration of composer Philippe Manoury and computer researcher Miller Puckette started in the 1980s when both were working at the IRCAM research center in Paris on a computer program for interactive performances named Score Following. Using the 4X system, developed by Italian physicist Giuseppe Di Giugno,²³ its Synthetic Performer interface was developed by Barry Vercoe²⁴ and the control implementation by Miller Puckette in the form of Music 500 software (Puckette, 1991).

The 4X machine was equipped with the 4X digital signal processor and two boards: one for controls and another for the interface allowing a real-time synthetic analysis and score following performance. Their first use of 4X in a real-life setting was during the performance of the Philippe Manoury composition *Jupiter* (1987) for flute and score following electronics-based pitch tracking. This is now considered to be the first interactive piece in which an acoustic instrument controls electronic music in real time. Further development of the Synthetic Performer and Music 500 led to the birth of Csound²⁵ and Max/MSP (Nunzio, 2013).

Score following is relevant for my project since I need synchronization between the performance of the written score and the programmed automation for the electronic parts. As mentioned above, there has historically been more concern with pitch recognition than with any other parameters, such as amplitude or tempo, the reason being that pitch

²³ Giuseppe Di Giugno is an Italian physicist known for his work at IRCAM and his close collaboration with contemporary composers such as Luciano Berio and Pierre Boulez.

²⁴ Barry Vercoe is a New Zealand-born computer scientist and composer and inventor of Csound.

²⁵ A music synthesis language widely used by composers and performers of computer music.

recognition is a rather predictable and safe method. But I learned while composing *Circles I* (page 7) that pitch recognition is not ideal when dealing with more than one instrument, at least not when they are staged close to each other. The same goes for amplitude recognition due to the exponential complexity of a larger instrumental group. Tempo or meter ($\frac{4}{4}, \frac{3}{4}$) pattern recognition look at other laws where it is possible to draw a connection directly to the conductor's gestures. As shown on page 43-44, attempts were made to connect these gestures through the MuBu.hhmm²⁶ gesture-following program, with unsatisfactory results. This was mainly related to the fact that most conductors prefer to conduct these patterns with great gestural flexibility, which proved too volatile for delivering an acceptable result. Therefore a decision was made, following, among other things, a conversation with my co-supervisor Wayne Siegel, to add buttons to the "ConGlove" design. That way a synchronization message could be sent with the click of a button by the conductor to the DAW with minimum interruption to her "natural" conducting method. This proved to be the simplest while also most reliable solution.

Gesture-based Interfaces

A number of systems and new digital musical instruments have been developed for interactive real-time performance that use performance gestures as musical input/output. At the same time, less emphasis has been placed on developing a tool for classical music conductors that analyzes their conducting gestures for use in mixed music performance. Of those that have been produced, most are related to conducting a virtual orchestra or the musical score of a MIDI-based performance. Although it is quite possible to transform many existing systems and instruments for use in interactive conducting, I decided to build and design such a tool from scratch. Why? Because I wanted to:

- Create a conducting tool that is solely built for and responds to the art of conducting;
- Design the structure and functions of the system from the ground up;
- Ensure familiarity and understanding of the system to allow for future developments;
- Understand the technical function of the tool.

The following is a list of interfaces based on and related to gestural recognition. This list is in no way comprehensive but should give the reader a better overview of the technology, analyzing method, and design that have dominated since the beginnings of interactive performance. For more detailed overview the conference paper by Kyungho Lee, Michael J. Junokas and Guy E. Garnett "A Review of Interactive Conducting Systems 1970-2015" (Kyungho Lee, 2016) is highly recommended.

²⁶ MuBu is a toolbox for multimodal analysis of sound and motion, interactive sound synthesis, and machine learning. hhmm stands for the Hierarchical hidden Markov model often used for pattern recognition.

The first fully functional electronic instrument using hand gestures for music performance was the “Etherphone,” later renamed the “Theremin” after its inventor, Leon Theremin. Originally built in 1920, it first received international attention when Theremin traveled to Europe and the United States in 1927, generating considerable excitement. Its revolutionary design, a box with two antennas played with the hands but without touching the instrument itself, did not resemble any other conventional instrument. The relative proximity of the left and right measured capacitance in an electromagnetic field around the antennas allowed the performer to control pitch through the vertical antenna and amplitude through its relation to the horizontal antenna. With a combination of a variable oscillator and fixed oscillator, it created sound waves that evoked a sensation of angelic voices, hence it was often called the “Thermenvox.”

In the mid-1960s William H. Ninke (Ninke, 1965) developed a light-pen interface called “Graphic 1”²⁷ for the computer music inventor Max Mathews.²⁸ It allowed users to draw figures on a screen and see the graphical result before it was converted into sound. This early attempt at sonic computer interaction led to the birth of a digital-analogue hybrid system called Groove, “A Program to Compose, Store, and Edit Functions of Time” (M. Mathews & Moore, 1970). In collaboration with composer and musician Richard Moore, Max Mathews developed the Groove machine as one of the first performance systems to have a computer controlling an analog synthesizer. The computer receives gestures and consequently produces sound, making the computer an instrument and the gesture-maker a performer. The same performer “commonly had the ability to design the behavior or processing of the control signals, the routing of these signals to analog equipment and the way this configuration would evolve over time. In this sense the user was a composer” (Oliver La Rosa, 2011).

In the 1980s Max Mathews made “The Conductor Program” and its associated device, the “Radio Baton.” The Conductor Program is a type of sequencer that receives triggers and control signals from the radio batons (mallet-shaped tools), sending MIDI commands to a synthesizer. The musical material to be played (pitch and duration) are stored in the computer. The Radio Baton is a controller that uses a coordinate system of radio receivers to detect the three-dimensional position of one or more batons and a table. “The technology and the analysis are straightforward. The capacitance between a transmitting antenna and receiving antenna is inversely related to the distance between them. The radio signal is simply used to measure this capacitance. The position of the transmitter can be deduced from the distances between the transmitter and a suitably chosen set of receivers” (M. V. Mathews, 1991).

²⁷ A YouTube silent video showing use of the Graphic 1 can be viewed at https://www.youtube.com/watch?v=llnzK2H_HZo

²⁸ Max Vernon Mathews (1926 - 2011) was a pioneer of computer music.

Hand-held instruments

The Hands

The Dutch composer, performer, and inventor Michel Waisvisz,²⁹ in conjunction with STEIM engineer Johan den Biggelaar and, later, Wim Rijnsburger, developed a multi-sensor control device named “The Hands.” It consists of three parts: the two “hands” and an analog-to-MIDI-converter. The “hands” are a set of two aluminum, ergonomically shaped plates with sensors, potentiometers, and switches that are strapped under the hands of the performer (Waisvisz, 1985). Finger movements and altering the positions of the hands sends information to a microprocessor with an onboard MIDI-encoding program. Thus codes can be sent to any MIDI device through a standard MIDI cable.

The Strophonion

“The Hands” provided a role model for Alex Novitz’s instrument Strophonion (Novitz, 2019), though the two differed in fundamental ways in spite of similarities in design. The Strophonion is a wireless digital musical instrument that uses sensors that are built into differently shaped cases of two hand controllers. It has 13 push keys, a three-axis accelerometer, and a pressure sensor on the right hand and 8 push keys on the left, with a joystick that is operated by the thumb. An ultrasonic distance sensor, which functions as a receiver, is mounted on a hip belt to measure the distance of the hand from the body. Through the physical movement of his body, in combination with the fingers pressing and releasing the round-shaped keys on both hand controllers, the musician operates the instrument’s functionality and thereby steers the sonic and musical process. Just as with any traditional acoustic instrument, the Strophonion allows the user to control pitch, rhythm, and timbre.

Digital Gloves

Lady’s Glove

In 1991, Laetitia Sonami³⁰ (SONAMI, n.d.) began her work on the Lady’s Glove, which has since gone through a series of radical design changes, most recently with the help of engineer/designer Bert Bongers, with sponsorship from STEIM.

In its present implementation, the Lady’s Glove comes with an accelerometer that measures hand speed, numerous motion and pressure sensors, and ultrasound transmitters and receivers that detect the distance between the glove and the floor. Sonami uses the Lady’s Glove in live performances to control sound, mechanical devices, and lights via MIDI—mostly in solo situations, but also in improvisations with other instrumentalists. Her current setup includes a STEIM SensorLab processor and a Mac laptop running Max/MSP.

²⁹ Michel Waisvisz (1949–2008), Dutch inventor and performer, was Artistic Director of the Studio of Electro-Instrumental Music (STEIM) in Amsterdam 1981-2008.

³⁰ Laetitia Sonami (b. 1957) is a French sound artist, performer, and composer of interactive electronic music.

The “mi.mu” glove³¹ (2015), created by MI.MU gloves limited, is a commercially available glove for both hands used for live composing and performing. It is probably best known for its use by the British innovative recording artist Imogen Heap and the American pop singer Ariana Grande, who uses the mi.mu glove for live processing of the voice. The mi.mu gloves use the x-OSC high performance I/O board as well as the x-IMU Inertial Measurement Unit from x-io Technologies to calculate, control, and trigger sounds through various hand gestures. The x-OSC is the same I/O board that is used in the ConDiS system.

Wireless MIDI Controllers – Rings

Wayne Siegel’s³² attempt to control and perform live music using only hand gestures is a good example of the more recent development of a direct control system. In an introduction to his paper “Conducting Sound in Space,” the composer writes: “The goal of this project was to explore the potential of electronic music that combines production, performance, and diffusion into a single integrated creative process” (Siegel, 2017). Using two rings, a HotHand USB on the middle finger of each hand, and the built-in web camera of his laptop, Siegel performs live using his hand gestures to control sounds and sound diffusions and rotational panning. This method of performing has an obvious parallel to other historical electronic music interfaces such as the Theremin (1920) and The Hands (1984) (Siegel, 2017).

Wave, by Genki Instruments, is a commercially available ring that, similarly to the HotHand, can control sound with motion. It comes with configurable presets and buttons for full control. It senses three different motions, allowing parameter control through the movement of its user’s hands. Three buttons can be clicked to play, stop, or record and by tapping any surface you can trigger any parameter, such as tempo, note, or a sample.

Jackets

A direct continuation of “The Digital Baton” (see below), “**The Conductor’s**” jacket system by the MIT Media Laboratory (Marrin & Picard, 1998) uses different and considerably more complex sensing technology than its predecessor. The device is a custom-made “jacket” that was able to gather and analyze the positional and acceleration data and sense muscle tension in the wearer (the conductor). It was designed to cause no discomfort to the conductor and measured physiological and gestural signals (Teresa Marrin Nakra, Machover, & Picard, 1999).

³¹ See <https://mimugloves.com>

³² Wayne Siegel is an American/Danish composer, performer, inventor, and teacher. He is the founder of DIEM, the Danish Institute of Electronic Music.

The “**Controller Suit**” was developed in 1994 as a collaboration between the Norwegian composer Rolf Wallin and Øyvind Hammer at the Norwegian Center for Technology, Acoustics, and Music (NOTAM). In 2008 the Controller Suit was upgraded by composer and programmer Anders Vinjar and developer (signal processing) Henrik Sundt at NOTAM, with the transmission mechanism made wireless through adding Open System Control (OSC) using Wi-Fi via a normal wireless router (NOTAM, n.d.). Thanks to the NeXT computer, which could handle real-time sound data, the composer was able to create and control live sounds by touching various parts of his body: “I had small hose clamps on my fingers with a small voltage on them (5V). Touching one end of the black strips on my arms, legs, and chest, the full 5 Volt goes back into the central voltage-to-digital translating chip placed on my hip. Then the further away I touch, the smaller the voltage. In this way I had a lot of faders (+ a lot of on/off buttons of course) on my body to control the software” (Wallin, n.d.).

A commercially available MIDI jacket was recently released by MACHINA, a company that specializes in the design and production of wearable technology. **The MIDI jacket DK1** allows music creation through body movements and body sensors. It comes with an accelerometer, a gyroscope, two push buttons, and one piezoelectric transducer. The MIDI jacket DK1 can be configured to an individual’s needs to allow for control through body movements. Arm movements can be used for volume or tempo control, a tap on the chest can trigger events, all depending on one’s personal configuration. Unfortunately, the jacket is no longer available due to manufacturing complications. A new version will be released soon with redesigned hardware and firmware.

Infrared technology – Buchla Lightning

One of the first tools that used infrared light as a means of data transmission was made by the electronic instrument pioneer and inventor Don Buchla.³³ Introduced in 1991 the Buchla Lightning consists of two handheld wands that emit and transmit data about location, acceleration, velocity, and direction to the infrared photo-sensors of the box unit.

Several systems directly related to conducting musical performance have been developed using the Buchla Lightning. One of the earlier attempts to build an interactive conducting system was “**The Digital Baton**” built at the MIT Media Laboratory in 1996. The Digital Baton was designed as a multimodal, handheld input device measuring several types of activity through the use of three different sensor systems (Paradiso, 1999). It was built as part of Tod Machover’s Brain Opera, which is described as an “interactive musical journey into your brain” that premiered in August 1996. Depending on where the conductor points in space,

³³ Donald "Don" Buchla (April 17, 1937 – September 14, 2016) an American inventor of electronic music instruments.

an infrared detector following the tip of the Digital Baton sends information to the Buchla Lightning unit, resulting in the production of different instrumental sounds.

Another system for orchestra conducting using the Buchla Lightning is Jan Borchers' "**Personal Orchestra**." It was created for interactive exhibits featuring footage of the Vienna Philharmonic and is somewhat sensitive to conducting gestures. With one Buchla Lightning wand to measure the exhibit visitor's gestures, the orchestra would reflect the tempo of the "conductor's" beat. If the conductor conducted badly, the orchestra would stand up and insult the "conductor," whereas if he/she did a nice job conducting, they would applaud.

Later Borchers, in collaboration with Teresa Marrin, created the "**You're the Conductor**" based on a similar concept to the "Personal Orchestra" except the orchestra, now the Boston Pops orchestra, would raise their instruments as soon as the conductor raises a wired conducting baton. They would then immediately start to play upon the conductor moving the baton. As soon as the conductor stops playing, the orchestra stops and waits for 30 seconds before rewinding to the beginning of the loop to wait for the next conductor.

The **iSymphony**, "an interactive orchestral conducting system for digital audio and video that adaptively adjusts to the user's conducting style" (Lee et al., 2006), also created by Jan Borchers and his research group, featured an adaptive gesture recognition system that could recognize three types of gestures: a four-beat gesture, up-down, and random. The system uses a digital baton to identify which gesture is being used and then follows in the indicated tempo.

Camera-based systems

There are several systems available that use video images as a means of gesture recognition and analysis. Of the systems that are commercially available, the **Nintendo Wii** motion controller and **Microsoft Kinect** are the two that have been most widely used in research related to gestural recognition and analysis.

Wii control-based systems

The **UBS Virtual Maestro** is a commercially available interactive conducting system. It simulates orchestral conducting to the general public attending a classical music concert. "The system utilizes the Wii Remote, which users move like a conducting baton to affect the tempo and dynamics of an orchestral video/audio recording." The Wii Remote uses the accelerometer data to control playback speed and volume in real time. (Teresa M. Nakra, Ivanov, Smaragdis, & Ault, 2009).

EyesWeb

In 2004 Paul Kolesnik and M. Wanderley of McGill University designed a gesture analysis and performance system for conducting audio and video scores of orchestral performances in real time. It utilized two EyesWeb cameras and Max/MSP/Jitter environments to capture conducting gestures: “Gesture recognition procedure is designed on the basis of Hidden Markov Model (HMM) process. A set of HMM tools are developed for Max/MSP software. Training and recognition procedures are applied toward both right hand beat- and amplitude- indicative gestures, and left hand expressive gestures” (Kolesnik & Wanderley, 2004).

Microsoft Kinect

Gesture recognition systems – Machine learning systems

The Music Technology Group in Barcelona have conducted recent research on capturing the conductor’s gestures using the Kinect³⁴ device. This device enables the design of a system that learns expressive and idiosyncratic gesture variations for gesture-based interaction (Sarasua, Caramiaux, & Tanaka, 2016). Another research project based on the conductor metaphor analyzes the performance of a conductor in a concert, identifying descriptors and adapting personal nuances “that can be automatically computed from spontaneous conducting movements.” The idea “is to turn the computer into an orchestra that the user conducts with movements” resembling those a real orchestra conductor would make (Sarasúa Berodia, 2017).

The Norwegian researcher and university teacher Andreas Bergsland at NTNU, in collaboration with choreographer Robert Wechsler and others, has led the development of the **MotionComposer**. This is described as “a therapy device for persons with different abilities that turns the movement into music using video-based motion tracking” (Bergsland & Wechsler, 2017). Using stereo-vision technology (two video cameras), which mimics two eyes, the MotionComposer can recognize the human body and then, with the use of motion tracking software, interpret expressive gestures, shapes, and movements, converting these into musical sounds in real time. The MotionComposer has been successfully used in interactive dance performances and as a musical tool for “otherly-abled persons including artists” (Wechsler, n.d).

Of the many other research projects and papers I consulted while working on the ConDiS research project that focuses on the conductor’s musical gestures, I would like to highlight several in particular: “Gestural control of sound synthesis” (Halmrast, Guettler, Bader, & R.I.Godøy, 2010), “Gesture and timbre” (Halmrast et al., 2010), “Tracking Conductors Hand Movements Using Multiple Wii motes” (Bradshaw & Ng, 2008), “Body Movements for

³⁴ <https://dev.windows.com/en-us/kinect>

Affective Expression: A Survey of Automatic Recognition and Generation” (Karg et al., 2013), “Gyroscope-Based Conducting Gesture Recognition” (Höfer, Hadjakos, & Mühlhäuser, 2009), “A computer music system that follows a human conductor” (Morita, Hashimoto, & Ohteru, 1991), “A Wii-based gestural interface for computer-based conducting systems” (Peng & Gerhard, 2009), and “A Customizable Recognizer for Orchestral Conducting Gestures Based on Neural Networks” (De Prisco, Sabatino, Zaccagnino, & Zaccagnino, 2011).

Assessments of gesture-based technologies in the context of ConDiS

Handheld instruments

In spite of their wonderful design, both of the handheld instruments detailed above are not feasible as tools for conducting since they rely on a physical mechanism that is not comfortable for conductors. They are designed as electronic instruments attached to the hands of a performer and, as such, are rather bulky. They therefore fail to provide the “natural” conducting extension tool I was aiming for.

Gloves

The design of the “Glove” interfaces mentioned above looks very similar to the ConDiS system. The fundamental difference lies in these “other” gloves having been designed as digital musical instrument-based systems. They were developed for improvisational performance where their main purpose is to manipulate electronic sounds in real time. Therefore, gloves are not that easily adjusted for the need of ConDiS.

Technologically the “mi.mu.” glove is the most closely related instrument to the “ConGlove,” since both use the same type of I/O board—the x-OSC from x-io Technologies—and bending sensor for each finger. Soon after starting the ConDiS research project, I took a close look at the “mi.mu” glove, which was not commercially available at that time, and gave it serious consideration to using it in my project.

After the release of the mi.mu. in 2015, I decided that it was too expensive and was missing fundamental functions needed for my conducting system, including the button-pressing function. It therefore seemed inadvisable to spend a significant amount of money to redesign an already made glove, to say nothing of the fact that I wanted to make my own glove from the bottom up.

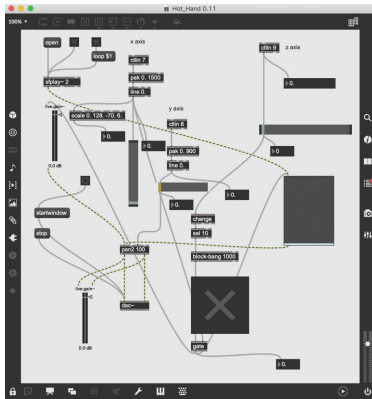


Figure 11. HotHand USB Max/MSP test patch

Ring-designed interfaces

One of the first interfaces I looked into at the early stages of my research was the HotHand USB wireless controller ring. I introduced it to my co-supervisor Wayne Siegel, and we agreed that the ring provided many options that could be utilized in the ConDiS system. After some tests (Fig. 13) it became clear, however, that the HotHand USB receiving ring did not meet my requirements. By that point I had tried it out several times and was convinced that the technology I needed should be based on the OSC protocol and Wi-Fi for its flexibility and accuracy.

The Wave ring from Genki Instruments was not available until late in the ConDiS research project and was therefore not an option when deciding what interface to use for the ConDiS system. It does come with 3 button functions, a function that is lacking in most other interfaces, but it also uses Bluetooth technology for wireless communication and therefore, for same reason as the HotHand, did not meet my requirements.

Jackets

At the beginning of the ConDiS research project, I gave consideration to designing a jacket for the conductor not very dissimilar from The Conductor's Jacket created at MIT. The idea was dropped based on the fact that having the conductor wearing a special jacket was onerous both in terms of size and comfort. The fact that neither the Conductor's Jacket nor the Controller Suit are commercially available was also a negative factor. The MIDI jacket DK1 was not available at the beginning of the research project and therefore was not a choice.

Infrared devices

None of these systems are expressly made to conduct a live orchestra. They are all designed to be a tool to conduct a prerecorded (sampled) sounds or performance reacting to the conductor's gestures. While it is possible to modify these systems to control and conduct live music, it is my personal experience, having used Buchla Lightning, that it is not a suitable tool for use. The infrared photosensors of the box are divided into eight zones and the conductor needs to be very careful about what zone she occupies at any moment. This zone issue significantly reduces the conductor's concentration and restricts movement and is therefore not well suited to use.

Camera-based interfaces

Knowing the importance of eye contact and other facial expressions on the part of the conductor, I originally intended to implement these exformations into my toolbox of

recognizable conducting gestures using camera-based technology. Numerous attempts were made to connect the Kinect2 system to the Macintosh computer used for the research, without success. Too late for the ConDiS research project, NI Mate released software that supports the Kinect 2.0 for MacOS. This opens up all kinds of possibilities for having a physical object (a black box) watching the conductor's exformative gestures.

Composer and conductor Oliver Knussen (Knussen, 1994), in an interview about a film showing conducting by Arthur Nikisch, considered by many to be the father of modern conducting, notes: "What you actually see on that film is a very disciplined and elegant classical, if you like, conducting technique where everything is here (Knussen shows hand gestures). You can see how for example, people said his eyes were mesmerizing because as a result of him conducting up there the player is forced to look at his eyes and every conductor virtually that one talk to, would tell you that half of what you do is done with your eyes" (Bambarger, 2003). Thinking ahead to the future development of ConDiS, implementing facial recognition could be a significant advance since, as stated above, "half of what you do is done with your eyes" (Bambarger, 2003), and that half is still missing in the ConDiS conducting digital system.

Related Compositions

The composition that comes the closest to my idea of ConDiS is the system the Swedish composer Jesper Nordin uses in his research and an artistic project developed at IRCAM. The *Exformation Trilogy*, a concerto for conductor with live electronics is a mixed music triptych, in which, in the first piece of the cycle "Sculpting the air" (2015), he "employs two motion sensors, allowing the conductor to trigger sound files or to process (sculpt) instrumental sounds gesturally" (Bacot & Féron, 2016). In his work Nordin uses the conductor's gestures in a rather unconventional way, developing strategies that deal with various aspects of music creation and performance. In this way, it circumvents certain difficulties that are involved in conducting in a "traditional" way. It gives the conductor more time and more space to focus on shaping and interpreting the electronic sounds, not having to conduct and sculpt at the same time. This solution leads to a very satisfactory result and is extremely well suited for this kind of composition, namely a composition that is a concert for conductor and therefore features a greater emphasis on "sculpting the air" with theatrical conducting gestures.

Although not based on live interactive technology, there are other works in a similar vein, such as *The Black Box Music* (2012)³⁵ by Simon Steen-Andersen, where he uses an on-stage, real-time video display of hands inside a black box to conduct performers displayed around the auditorium, thus emphasizing the dialogue between gestures and sound.

³⁵ Video recording available on YouTube: <https://www.youtube.com/watch?v=UEInFQWgcNw>

Alexander Schubert in his composition *Point – Ones*³⁶ for sensor-augmented conductor and small ensemble approaches the problem in a manner somewhat similar to my own, in that sound reacts to the conductor's gestures. His use of this technique and purpose behind it are nevertheless very different.

These compositions differ fundamentally from the ConDiS project, the aim of which is to make a system that is as unobtrusive as possible. The ConDiS system strives to achieve the most accurate performance of through-composed music with respect to both instrumental and electronic sound. That is to say, nothing is left to uncertainty, nothing is left in the air, rather it is left between the air. Of course the conductor is responsible for the interpretation and shaping of the music, working out the sonic spectra, extracting everything that makes the composed interplay into music. But it all takes place within a specific framework based on the conductor's traditional conducting: this is the key challenge in ConDiS. It was therefore very gratifying when after a performance of *Kuuki no Sukima* I got questions like "What did she do with the Glove?"

National relevance - Norwegian inventors

Most of the research and development in the field of music technology and gestural interfaces takes place in conjunction with the Norwegian Center for Technology, Acoustics, and Music (NOTAM), a center that focuses on the development and innovative use of technology in music and the arts, RITMO, Centre for Interdisciplinary Studies in Rhythm, Time and Motion, a division at the University of Oslo (UiO), and the music technology group at the Department of Music, Norwegian University of science and technology (NTNU). As described above two of these institutions were involved in developing the MotionComposer of the NTNU-based Andreas Bergsland and Rolf Wallin's Controller Suite, developed at NOTAM. The Norwegian musician and researcher Alexander Refsum Jensenius, currently a deputy director of RITMO, is internationally recognized for his contribution in the field of music and gestures. His systematic analysis of body motion has been widely cited in music research as well as in psychological research (Jensenius, 2014).

Similar to the Controller Suit is the Multisensorial Environment designed by Stahle Stenslie, a bodysuit to control sound and graphics used in his multisensorial installation "Erotogod." (Stenslie, n.d.)

The composer and instrument builder Koka Nicoladze displays great innovation in his instrument construction, in which the main material is always what he describes as an "everyday object that [he] find[s] at random places" (Nicoladze, 2018). Others individuals who merit mention are the NOTAM-based composer, musician, and sound artist Åsbjørn Blockum Flø, known for his installations, including the "Doppelgänger," a site-specific installation made for the Art exhibition hall in Bergen (Flø, 2014), and musician and

³⁶ Video recording available on YouTube: <https://www.youtube.com/watch?v=CN-r1IuyNbY>

researcher Øyvind Brandtsegg at the NTNU, who used a special sensor jacket with the group Krøyt. His jacket was embedded with EMG sensors, which convert muscle activity to MIDI signals via a BodySynth system made by Ed Severinghaus. Brandtsegg's jacket is exhibited at Rockheim, the national museum for pop music.



Figure 12. ConDiS - Lecture at the Iceland Academy of the Arts.

Chapter 4 ConDiS: Technological Development

The ConDiS project is an artistic research project, not a technical research or engineering project. The following chapter focuses therefore on a practical exploration of why the x-OSC was chosen and how the sensor can be used to capture conducting gestures, as is appropriate for my application.

Choice of Sensors

The types of sensors available now is more varied than ever before, and they are becoming more affordable. Given this fast-evolving technology, one must keep in mind that what is news today may be yesterday's news tomorrow.

To select the type of sensor best suited to the idea behind the Conducting Digital System, the following criteria were proposed:

- Wireless technology;
- High speed and versatile communication —> OSC protocol for accuracy and flexibility;
- Simple and small enough to use but sophisticated enough to fulfill the needs;
- Reliable and not affected by external interference, such as stage lights or human sweat;
- Comfortable/natural for the conductor to wear;
- Low-cost technology.

The following sensors were tested: The Leap Motion Controller, Myo Gesture Control Armband, HotHand, Qualisys Motion Capture Systems, Xbox One Kinect 2.0 Sensor, and x-io Technologies' x-OSC sensor.

Brand	Tech. type	Simple/Complex	Reliability	Comfort	Price
Leap Motion	USB	-	-	+	+
Myo Armband	Infrared	+	-	+	+
Hot Hand	USB	-	+	+	+
Qualisys	Infrared	-	+	-	-
Kinect 2.0	Infrared	+	? Not enough time to test	+	+
x-OSC	OSC	+	+	+	+

Table 1. Evaluation of sensors. + means positive result, - means negative result.

I decided to use the x-OSC for the ConDiS Conducting Digital System for the following reasons:

- **Simple** to use – The OSC offers various implementations, including real-time sound and media processing environments, web interactivity tools, a large variety of programming languages and hardware devices for sensor measurement.
- **Reliability** – It uses the Open Sound Control (OSC) protocol for communication between the sensor and the computer. The advantages of using OSC include interoperability, accuracy, and flexibility.
- **Comfort** – The x-OSC is a relatively small Wi-Fi I/O board that fits comfortably in the hand.
- **Price** – The x-OSC wireless I/O board is priced within the limits initially set out for creating an inexpensive, fully functional system.

Exploration of the sensor in terms of the project’s practical applications

As stated in the previous chapter, there are numerous existing studies on conductors' movements. Nevertheless, it was very important for me at the start of this research to better understand in a physical way the response of the x-OSC I/O board to different conducting gestures. The best means of doing this was to physically conduct the electronic sounds myself and explore responses based on various (traditional, non-traditional) conducting gestures. By taking a “snapshot” of these gestures, I could better understand and feel the relevance and robustness of the gestures in conjunction with their conducting function. I was thus in a position to judge their potential for use.

Traditional conducting gestures

The basic traditional conducting gestures are gestures indicating the desired volume, meter, and tempo. With hand gestures, the conductor traditionally indicates an increase or decrease in volume by lifting her arm(s) or making larger (for louder) and smaller (for softer) gestures. The conductor uses different arm gesture patterns to indicate the written time signature—e.g., $\frac{4}{4}$, $\frac{3}{4}$ —and variable speeds of the arm gestures to indicate the written tempo or metronome. In the next section I describe the test used to find out if it would be possible to use the x-OSC sensor to recognize and learn various traditional conducting gestures.

Up/down motion

Holding a hand open and raising an arm up and down (palm facing the ceiling on the way up and the floor on the way down) produced the following patterns:

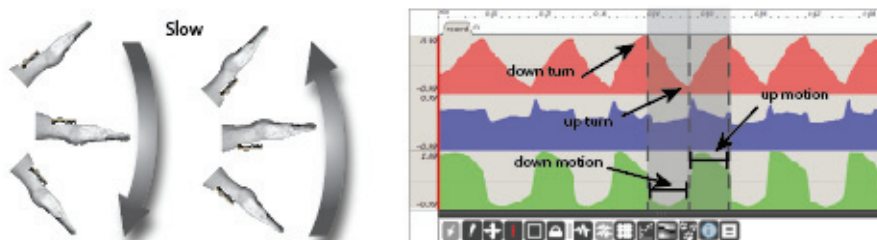


Figure 13. Arm slowly up/down. X-axis peaks at turning points

Raising a hand slowly, as shown in Figure 13 the X-axis (red) indicator showed a gradual move in the direction of the arm, moving up and down. Turning points are also traceable in the form of high and low points. The Y-axis (blue) showed a small but gradual movement in the direction of the arm but apparent peaks at turning points. The Z axis (green) showed an up/down movement when the arm was raised slowly and a down/up motion when lowering the arm. Fast moves up or down were shown at the turning points.

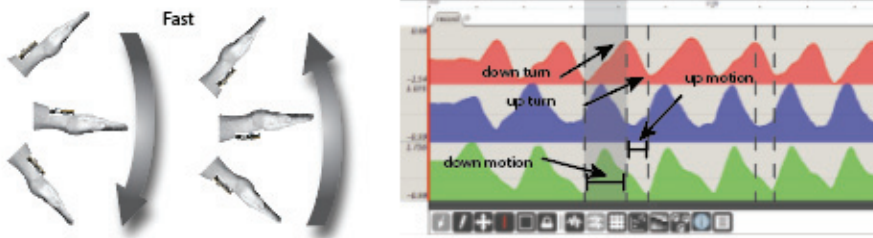


Figure 14. Arm fast up/down. X-axis peaks at turning points

When the arm was raised quickly up and down (Figure 14), a slightly different picture was revealed, especially at the Y- and Z-axes, whereas the X-axis was mostly identical to the case for slow movement. The only notable difference was a minor deviation especially at high points, which was probably caused by computer latency. The Y-axis showed an up/down motion when the arm was raised and a down/up motion when lowering the arm with no peaks at turning points. The Z-axis showed up/down motion on the way up and down/up motion on the way down with no peaks or change of direction at turning points.

Assessment of sensor to capture up/down motion

The accelerometer worked extremely well for measuring the down motion of the hand. The result was very stable with respect to whether the arm was moved, especially the X-axis movement. This provided good enough resolution for use in calculating the arm position in space. Therefore, a decision was made to use the up/down gesture recognition for Volume and Effect control.

4/4 beat conducting gesture – Beat/Tempo

Conducting standard 4/4 beat gestures in two different tempos—fast and slow (metronome 60 for slow and 120 for fast)—resulted in the following patterns:

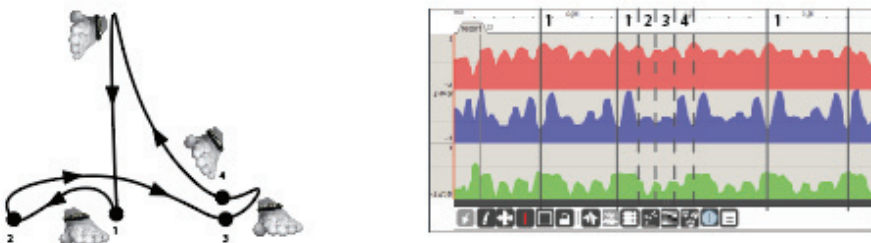


Figure 15. Metronome 60. Counting clear 4/4 pattern

As shown in Figure 15, all the axes X, Y, Z showed traceable patterns when conducting a precise 4/4 beat pattern at a relatively slow tempo, 60 bpm. The X-axis was peaking at every

beat (1, 2, 3, 4) while the Y-axis showed reverse motion. The X-axis shows each beat as clear peak points. The Y-axis shows reverse motion with peak points at upbeat to first, second, third, and fourth beat and a definite low point on the first beat. The Z-axis is moderately clear, showing peak points at every beat, although the first and second beats are not especially clear.

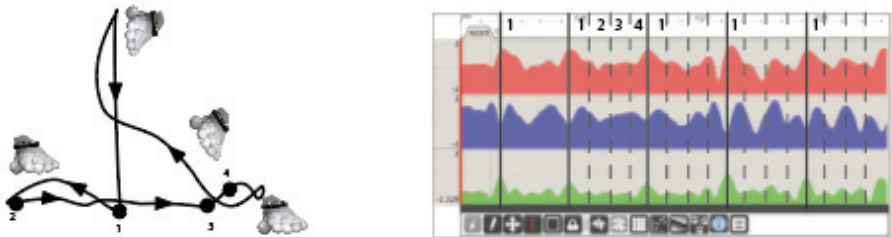


Figure 16. Metronome 60. Counting less clear pattern

When conducting the same tempo with a bit more of a “natural” style (Figure 16), i.e. a very clear downbeat with the remaining second, third, and fourth beats not as strict or more flowing in style than in the first example, the patterns became less clear. The first beat in particular could easily be confused with the fourth beat.

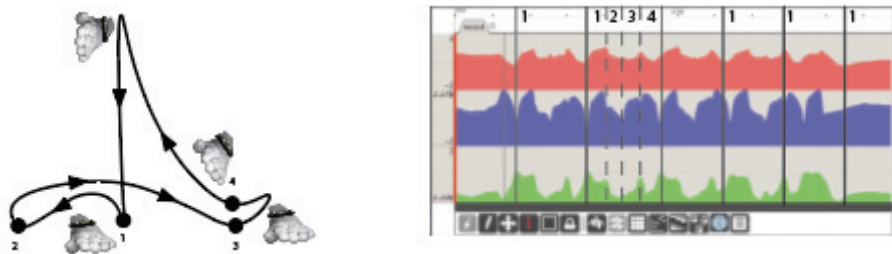


Figure 17. Metronome 120. Counting clear 4/4 patterns

When conducting clear beats in a relatively fast tempo of 120 bpm, the patterns became much more blurred, as illustrated in figure 17. The upbeat to first beat was still evident, especially on the Y-axis. As before, the X-axis showed peak points at first and second beat, though these were much blurrier than before. Also as before, the Z-axis was somewhat obscure and irregular.

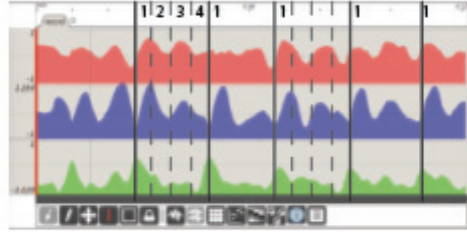


Figure 18. Metronome 120. Counting unclear 4/4 patterns

When conducting in more fluid gestures but still with strict upbeat and downbeat to the first beat, the first beat was clearer, but the whole pattern became blurrier (Figure 18). This happened since the up/down beat to the first beat was accented while the other beats (second, third, and fourth) were less accented or even not at all.

Assessment of sensor ability to capture metric motion

As expected, conducting a straight and clear 4/4 pattern provided acceptable results in the form of repeated patterns with peaks on each beat. When conducting more freely, the patterns started to get blurry. The same happened with increased tempo, with a faster tempo resulting in less predictable patterns. Using the MuBuForMax-hhmm program learn the conducting patterns resulted in precision rates between 50% and 80%, an unsatisfactory result in light of the artistic goal of the ConDiS system.

It is simply a fact that conductors like to use expressive conducting gestures for conducting tempo, meaning they insist on being able to use patterns that go beyond the strict metric gestures. They are musicians too and they need to express themselves freely, as conductor Haldis Rønning clearly states in the interview appended to this dissertation. For this reason, the results when conducting a 4/4 beat revealed that it would be impossible to use the MuBuForMax-hhmm learning feature. Another solution would have to be found that would allow the conductor to conduct tempo as freely and musically as possible.

Circular motion (non-traditional gesture)

Although circular motion is not a part of the conductor's vocabulary in the way the up/down motion and metric patterns are, it was necessary to ascertain if this type of motion would be useful in realizing the original idea of having the conductor control the panning of the electronic sound. The notion was that if the conductor made a gesture significantly different from any traditional ones, there would be no confusion between the conductor and the performers. Circular motion probably best satisfied this requirement since it is hardly used as a traditional conducting gesture. One potential use for circular motion was to control spectral location of a sound.

The objective was to detect circular motion with the arm held up above the head and moving clockwise around the head.

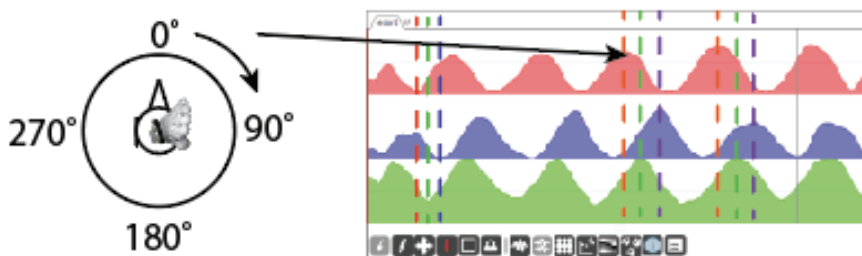
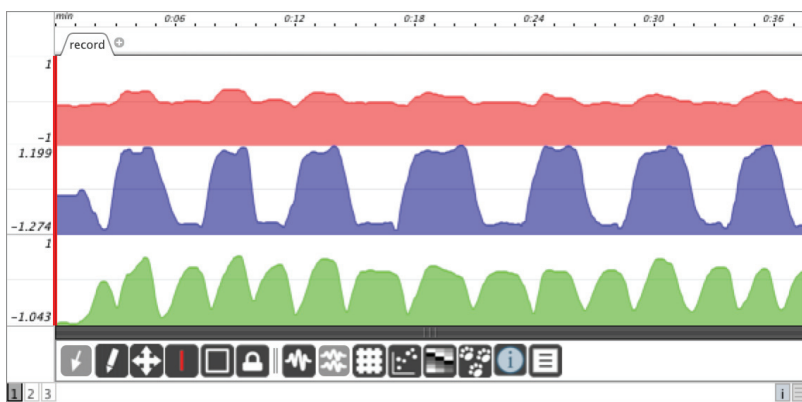


Figure 19. Left arm overhead moving 90° per sec.

Circular motion with the left hand over the head, the palm facing right and moving one circle 360° per 4 sec. or 90° per 1 sec., or the equivalent of a tempo of 60 bpm. As can be seen in figure 19 the pattern is very clear and linear on all the axes. The X-axis shows the high point at 0° and the low point at 180°. The Y-axis has a high point at 180° and a low one at 0°, or a phase of 180° from the X-axis. The Z-axis point is in a +- 90° phase from the other axes with high points at 90° and low points at 270°.

Assessment of sensor ability to capture circular motion

Moving the arm in a circular motion provided a clear and reliable result, certainly good enough to be used in the early development stages of the ConDIS system. It was used, for instance, when Arne Johansen conducted the Jonsvatnet Brass (p. 74). Later I decided not to use it for the final version for aesthetic reasons. Having the conductor moving his arm in circles proved to be a very distracting gesture that seemed to have more to do visually with the rodeo than contemporary music performance. I later determined that holding the arm straight out and twisting it from left to right gave a similar result.



Circular motion with the left hand 90° out from the body moving left-right, right-left.

The ConDiS system and its Graphical Interface

The ConDiS Graphical interface

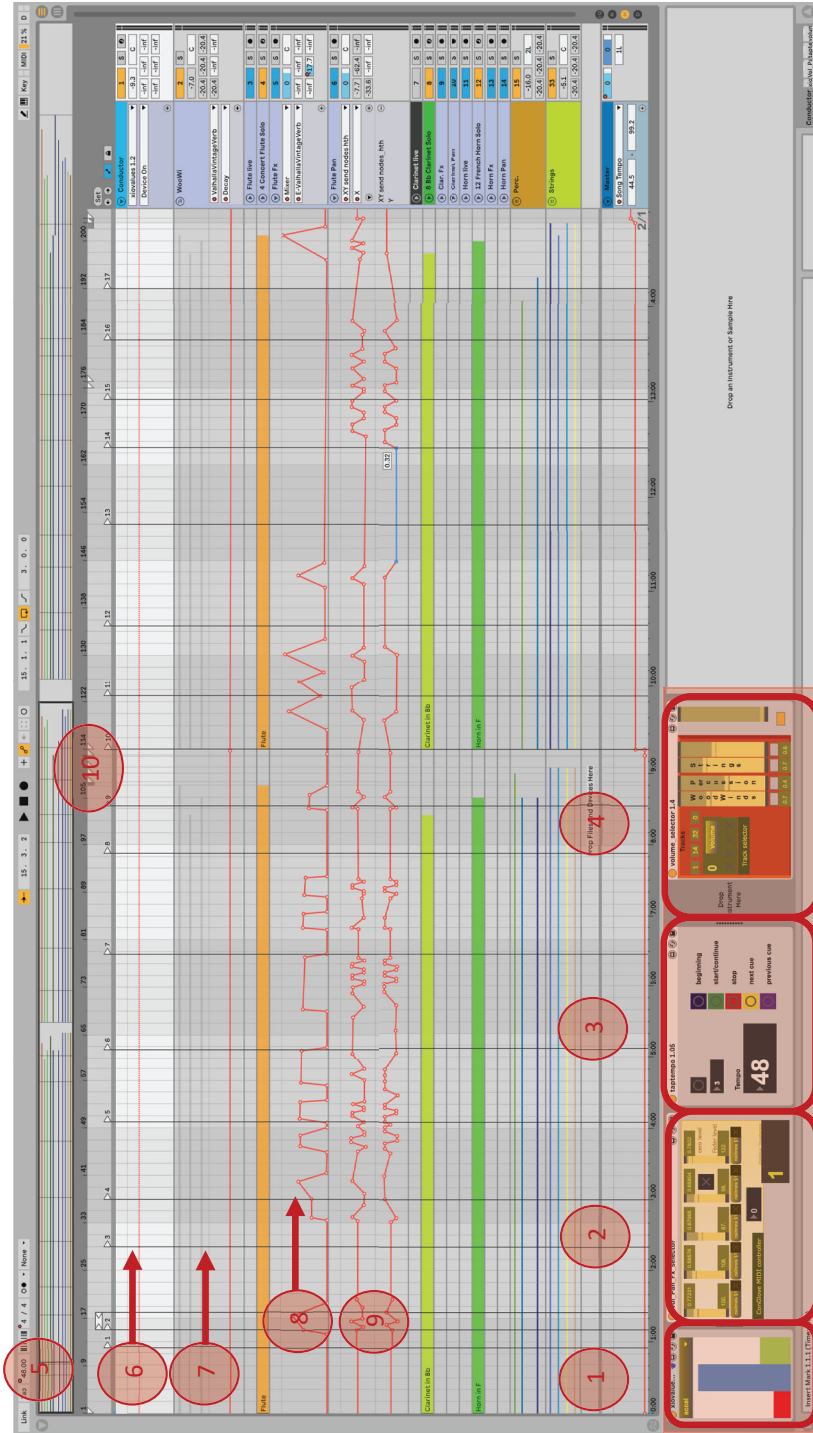


Figure 20. The ConDiS Graphical Interface

Figure 20 shows the graphical interface of the ConDiS system (red highlighted squares) as used in conjunction with the Ableton Live digital audio workstation (DAW). The system is originally written in Max/MSP and Max for Live.

1. The accelerometer of the x-OSC sensor. The blue column (Y-axis) is used to sense the position of the conductor's left arm, which is in a high position in this illustration.
2. The "ConGlove" finger bending device. Senses finger signs to activate various functions of the system.
3. The synchronization and metronome device. Senses the button-clicking function of the "ConGlove."
4. The volume control device. Senses the arm position of the conductor. If the arm position is high, the sliders are high. Conductor can select which instrumental group she activates by straightening out her finger or closing her hand to activate all.
5. The metronome of the DAW related to the metronome button function of the ConDiS system.
6. The Conducting track. If selected (as it is in the picture), the ConDiS device board is visible.
7. The instrument tracks showing instruments either as groups, e.g., woodwind, percussion, and strings, or as individual instruments. Fig. 20 shows the flute.
8. The "automated" effect track of the flute. It is showing the automated reverberation of the flute track.
9. The "automated" surround track of the flute. Showing how the flute sounds move in space.
10. The "markers" written in the DAW that relate to the same markers (numbers) written in the score. This is the backbone of the ConDiS synchronization function, as pressing the jump forward button would move the play head of the DAW to the next marker while jump backward takes it back to the previous marker.

The ConDiS Software

ConDiS is intended to be accessible to others without the presence or involvement of the developer. It is intended to be flexible and open for personal adjustments and/or individual experimental development, an essential component in the artistic philosophy behind the ConDiS project. Therefore the decision was made to use Max/MSP, Max for Live, and Ableton Live, a commercially available software that is user-friendly and yet flexible enough to fulfill the artistic needs of the project. This software is commonly used by composers, performers, software designers, researchers, and artists to create various forms of artistic performances and installations. This is an important factor in choosing appropriate software. The following is a brief description of the ConDiS system, its interface, and the Max/MSP graphical programming as it appears when used in conjunction with the Ableton Live digital audio workstation (DAW). For more detailed instructions on the practical use of the interface, see Chapter 6, Performance Preparation.



Figure 21. The ConDiS systems graphical interface

Figure 21 shows the graphical interface of the ConDiS system. The following uses the first device, the “xiovalue,” as an illustration of the Max software programming that lies behind the system.

A closer look at the ConDiS system

Figures 22 and 23 provide a more detailed view of the receiving messages of the “xiovalue” or the x-OSC device as it is implemented in Max for Live.

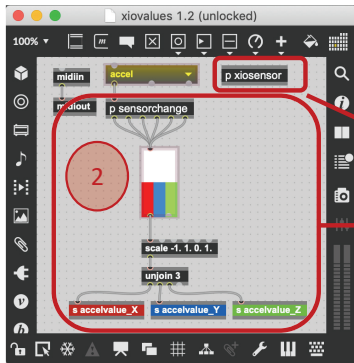
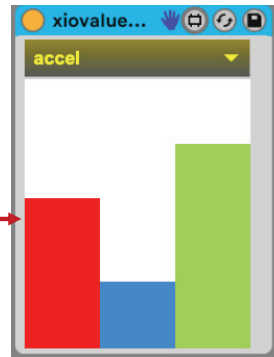


Figure 22. Max for live patch of x-OSC values



The x-OSC sensor value interface

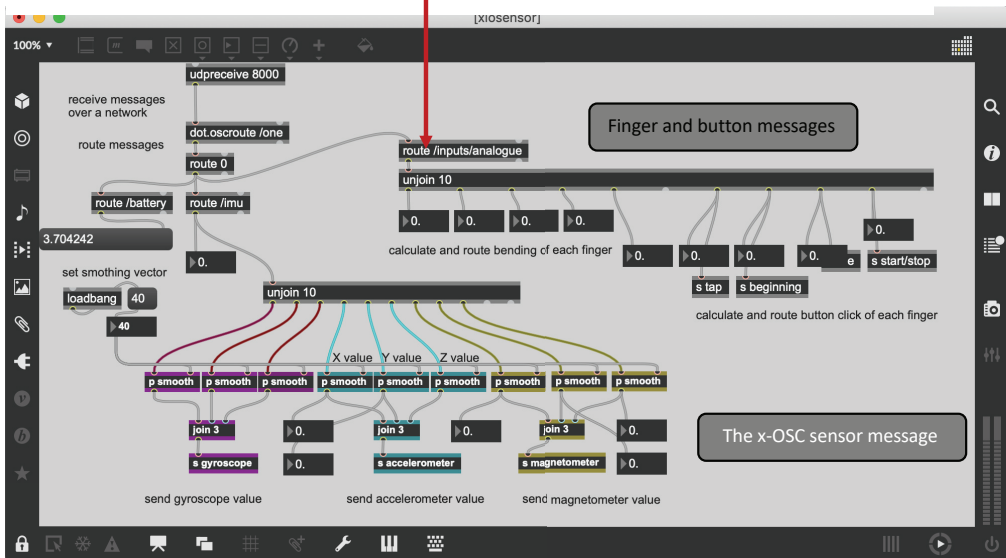


Figure 23. The receive message and routing patch of the ConDiS system

1. The patch “p xiosensor” receives messages over a network and routes to various functions of the system. Messages are sent from the on-board sensors (gyroscope, accelerometer, magnetometer) alongside an analogue signal from the bending sensors on each finger as well as the glove’s four buttons.
2. The patch “p sensorchange” selects the sensor (gyroscope, accelerometer, magnetometer) to be activated.

DAW and Digital Sound Processing (DSP)

The signal chain of the DSP is one of the crucial parts of the electronic sound. It is “the thing” that happens in the middle, thus the DSP chaining setup determines the *sonic outcome* of the electronics. Figures 25-26 shows the DSP in conjunction with the DAW. At this point it will be helpful to take a closer look at the mixed music model that was introduced above on page 4.

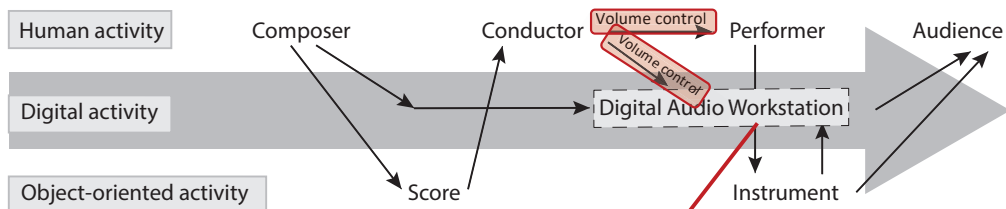


Figure 24. The mixed music model of *Kuuki no Sukima* showing the process as three forms of activity: Human, Digital, and Object-oriented. Here the conductor's volume control is added to the process.



Figure 25. The digital signal processing chain of the violin. From left to right: high pass filter, granular synthesis, procrastinate feedback delay, and tap delay.

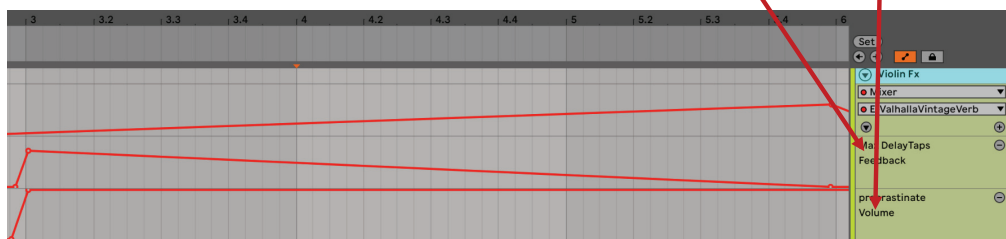


Figure 26. Measures 3 – 6. The automated "score" of the DSP chain.

As shown above, the DAW sound processing in *Kuuki no Sukima* is entirely automated, meaning the conductor has no control over the electronic signal other than adjusting sound volume output.

Conducting Gestures and Signs

Controllers and signs.

Controlling electronics using Conducting Gestures

Testing various conducting gestures to activate, control, and conduct the electronics, has been a crucial part of the research. Seeking for answers to questions like how to add these controls to the conductor's gestural library? Is it possible to use classical conducting gestures only, or do I need to invent new gestures?

The professional orchestral conductor has trained for years her musical gestures, and it may be difficult to ask her to learn new, let alone many new ones. Why not use the same gestures since the conductor is conducting very similar elements in the electronic as for the acoustic instruments? Therefore, making the use of ConDiS less noticeable or invisible. The following is a short introduction to the gestural solutions used for controlling various parameters of the digital workstation.

Gestural Functions

The controllers (parameters) that originally were thought to be controlled by the conductor were grouped into the following categorization:

1. Overall volume (amplitude).
2. Spatial location (pan).
3. Sonority and spectral timbre (effect).
4. Conducting tempo (tap tempo)
5. Synchronization between conducting score and electronic score.

To signal the computer with parameters should be controlled a use of sign language turned out to be the simplest solution. Using sign language is nothing new for conductors, as this solution proved to be very good.

For the conductor to activate the controlling features the following action had to be taken:

Close fist to signal the computer DAW that control action is about to be executed.

1. Make an OK sign to activate volume control, then move arm up or down to adjust volume level.
2. Make a thumb up sign to activate spatial location (pan), then twist arm to move the sound in space.
3. Make a little finger sign to activate effect control, then move arm up or down to adjust the effect volume.

Open hand to deactivate all control features and therefore being able to conduct freely without affecting the electronic sound.

4. To control tempo (tap tempo) the conductor has to press a button on second finger four times in the suggested tempo.
5. To synchronize the written score and the electronics of the digital workstation the conductor has to press the following buttons:
Third finger button to stop and start the DAW
Fourth finger button to jump forward to the next marker of the DAW
Fifth finger button to jump backward to the previous marker of the DAW
Multi click the fifth finger button to jump to the beginning of the piece.



Figure 27. Sign language to signal various control features to the computer DAW

As mentioned earlier the panning and the effect control functions were left out for the final version of the ConDiS system. Keep in mind that the fundamental idea of ConDiS was to extend the traditional job of a conductor allowing her to conduct and control the electronic sounds as she does with the instrumental sounds. Therefore, in its basics, the conductor's job is not to conduct and control the spatial location of the sound nor to control the sonic timbre. These instructions are all written in the score beforehand. Still, these functions were realized, and it turned out to be a too complicated task. To have the conductor doing his traditional job of interpreting the written score, controlling the volume and tempo, cueing and synchronizing while simultaneously moving and panning the electronic sound turned out to be too extensive for our multitasking abilities.

All these factors have been realized and do function as shown in the following video examples.

1. Volume control (Overall volume).

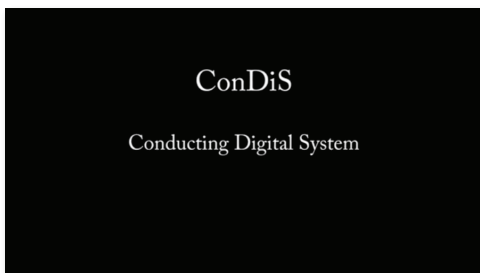


Figure 28. Video example. Volume control (video demo)

<http://caveproduct.com/videos/Vol.-control.mp4>

The conductor can raise or lower the overall volume of the electronic sound. With simple finger gesture, an OK sign, the conductor can trigger the volume control feature “on” and then by lifting left arm raise the sound. When the volume level is at “right” level, the volume control is triggered “off” by closing the hand. Same goes for lowering the sound except the arm must be lowered. (See Figure 28).

The use of a traditional up/down arm gesture to indicate increase or decrease of sound levels gave a positive artistic result. It was well suited to the traditional conducting gestures for

2. Pan control (spatial location).



Figure 29. Video example. Pan Control (video demo)

http://caveproduct.com/videos/Pan_control.mp4

The conductor can move sound in space. He can with finger gesture (thumb up) trigger the pan control feature and then by tilting the hand move the location of the sound. As with volume control, the pan control function is deactivated (turned off) by closing the hand. (See Figure 29).

3. Effect control. (sonority and spectral timbre)

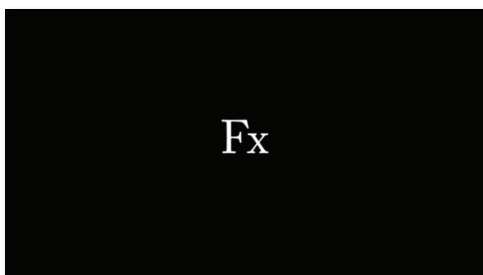


Figure 30. Video example. Effect control (video demo)

http://caveproduct.com/videos/Fx_control.mp4

The conductor can raise or lower the overall effect volume. He can with finger gesture (little finger out) trigger the effect control feature and then by lifting or lowering left arm raise or lower the sound. The effect control function is turned off by closing the hand. (See Figure 30).

4. Conducting tempo (tap tempo)



Figure 31. Video example. Tempo control (video demo).

http://caveproduct.com/videos/Tempo_Control.mp4

The conductor changes tempo by clicking a button on the middle finger accordingly to a written tempo. The tempo controller can be set to calculate the average time between any number of clicks. That means it can calculate the time between two clicks minimum to an infinite number. If the score is in 4/4 a calculation setting of 4 would be the most natural setting although a setting of 2 can efficiently work. For pieces with frequent meter changes a setting of 2 seems to give the best result. (See Figure 31).

5. Cue control. (Synchronization of conducting score and electronic score)



Figure 32. Video example. Cue control (video demo)

http://caveproduct.com/videos/Jump_to_cue.mp4

The conductor can, by clicking buttons on the ring finger and little finger move the electronic score back and forth to selected numbers (rehearsal numbers) written in the score.

Expressions and “natural” emotions

As can be seen clearly in the above videos, the emphasis was on making use of the conducting glove as normal to the conductor’s gestures as possible. With this, the conductor could focus on his traditional way of conducting with the same natural emotion and expression to which she is accustomed. It can easily be argued that pushing buttons is not a conducting tradition or a very expressive way of conducting. These arguments can surely be accepted, but this was the simplest solution in the situation where gesture recognition technology was not reliable enough. During the development period, attempts were made to use “force sensitive resistors” to give the conductor a better feel using her fingertips. Unfortunately, that experiment did not give as good result as the buttons due to instability and complications related to accidental touches such as when opening and closing hand. One of the future goals of the ConDiS system is finding a genuine solution to get rid of all buttons since they are not in parallel of the philosophy of the ConDiS system. A philosophy of making a conducting tool that is a “natural” extension of the conductor’s conducting tradition.

Making the conducting tool.

Designing the hardware

One of the first ideas of the ConDiS hardware or tool was to extend the use of the conductor's baton by making a digital pole/baton. A prototype of a baton was made, and various gestures recorded to find what kind of patterns it would make.

To measure the conducting gestures, the MuBu multi-buffer program from IRCAM running Max/MSP on OSX was used. (Ircam, n.d.) The type used for the ConDiS motion analysis was; mubu.hhmm (Hierarchical Hidden Markov Models) based on the hhmm_leapmotion_recognition program by Masayuki Akamatsu (Akamatsu, n.d.) and slightly modified for the use of x-OSC Wi-Fi board.

The ConBat (Conducting Baton)

The first idea was, not to surprise, to think historically. What of making a baton that could be used similarly to Lully's conducting baton?³⁷ A romantic and interesting idea, but much too



Figure 33. First prototype of ConDiS

limiting and unnatural for the conductor. The second idea was more practical and more in the spirit of Curtis Road's idea quoted earlier of the conductor's baton to be the original remote. A prototype was made of a conducting baton that contained a sensor in the shaft. Admittedly, it would be great if just a technological upgrade of the traditional baton would be the answer. After testing the baton, reading out various gestural patterns, I concluded that to use a baton was too limiting for the conductor and for confusing for the performers. Through the baton I realized that using design of a conducting tool that was based on the classical conductor's baton was probably not a good idea. The main reason being that the conductor holds the baton in her right hand which is the hand that is used to give the basic tempo and volume indications to the orchestra. Tempo given with clear metric signs and volume with smaller or bigger gestures. To have this also linked to the electronics made it difficult for the conductor to

divide her conducting between the performers and the electronics. It also made it difficult for the performers to distinguish when the conductor was conducting the orchestra or the electronics. Another important part of orchestral conducting is the conductor contact to individual performing groups. If she needs to get the message to the Brass section to play softer than he does so by looking at them, usually gets eye contact, and signals less volume. That signal is usually given raising the left arm and then lowering it. Action that would be impossible to do with the sensor in the right hand. There it was judged as the best alternative to put the ConDiS conducting tool to the conductor's "fingertips" or even better in the hands of the conductor, hence the conducting glove the "ConGlove."

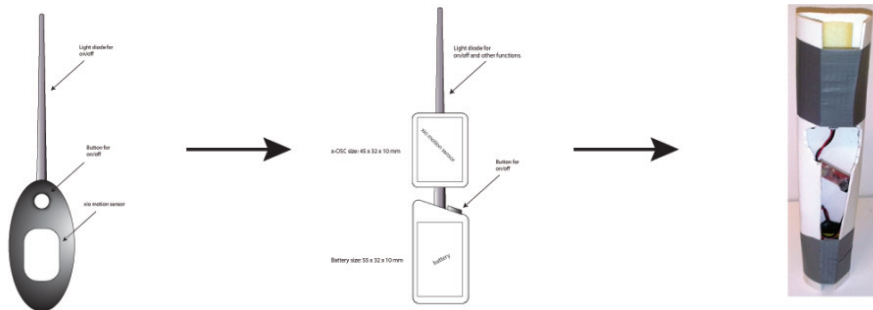
³⁷ Jean-Baptiste Lully (1632-1687) was a French composer that used a long conducting staff during a performance.

The ConDiS Conducting Glove (ConGlove)

The decision to make the conducting tool in the hands of the conductor was somewhat disappointing but logical. It was disappointing because I had hopes of inventing something totally new and original. Thus, making a digital glove was far from that dream. There are so many gloves out there. Although most of them used in virtual reality environments and video there are also to directly control audio like the Imogen Heap’s “mi.mu” Glove.(mi.mu, n.d.) mentioned earlier (p.44) The main difference though, being the aim of the ConDiS project to create conducting tool for music conductor that is based on and adds on to the tradition of classical conducting.

The conducting glove is designed to enable a conductor not only to control the overall mix of the performing musicians and the electronics but also to synchronize the performers and associated DAW. In other words, conducting the overall balance/volume, tempo and synchronize written score and DAW. ConDiS is directed toward new possibilities in musical composition and the interaction, the expressions, the musical gestures and movements of the classical conductor.

The following section is written to give a better understanding of the functions of the conducting glove (hereafter, referred to as the ConGlove). This writing is by no means a complete explanation but as an introduction providing an overview of the ConGlove's usability with regard to "Kuuki no Sukima."



First draft of conducting baton

Second draft of conducting baton

First prototype of conducting baton

The development process of conducting baton (ConBat)

The ConGlove

Steinar Brandslet writes in an article published in Gemini, Research News from NTNU and SINTEF:

The composer Hilmar Thordarson found this glove on the street, and decided it deserved a new life — as a tool for conductors. The glove now has wires, buttons and sensors that can sense different movements and send the information to a computer. (Brandslet, 2019)

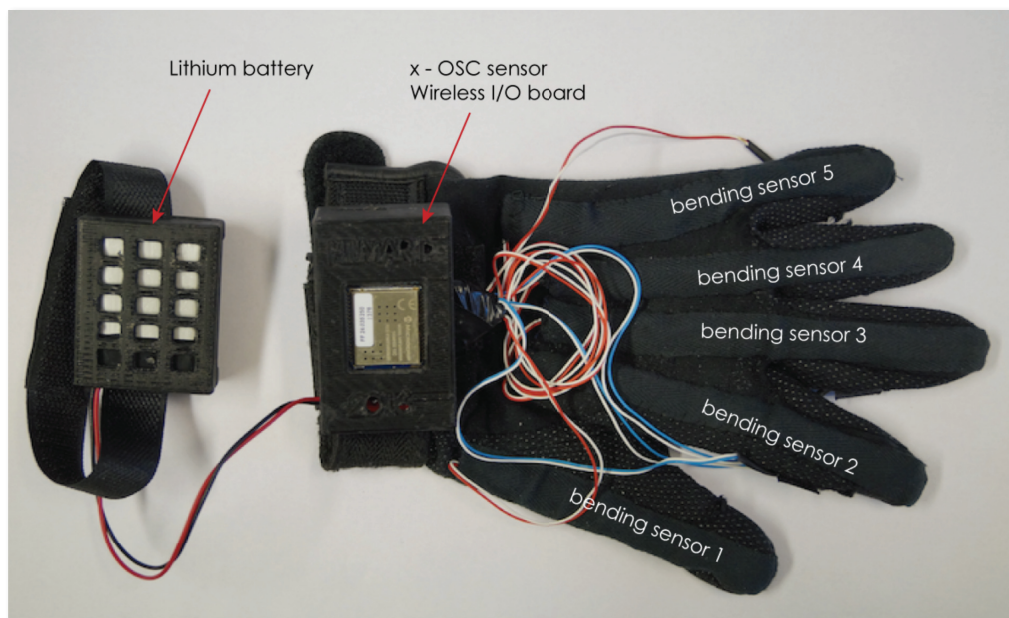


Figure 34. The Conducting Glove "ConGlove". Showing the five bending sensors, the x-OSC I/O board and battery.

ConDiS - Conducting Digital System consists of a glove controlled by x-OSC wireless I/O board that communicates over Wi-Fi using open sound control³⁸ (OSC). Software based on Max / MSP sends information from glove through Max4Live to Ableton Live digital audio workstation. The conducting glove is designed to enable a conductor not only to control the overall mix of the performing musicians and electronics but also to synchronize the performers and associated DAW.

In other words, conducting the overall balance/volume, tempo and synchronize written score and DAW at selected cue-points written in the score. ConDiS is directed toward new

³⁸ Open Sound Control (OSC) is a communication protocol for networking computers, sound, and other multimedia devices.

possibilities in musical composition and the interaction, the expressions, the musical gestures and movements of the classical conductor.

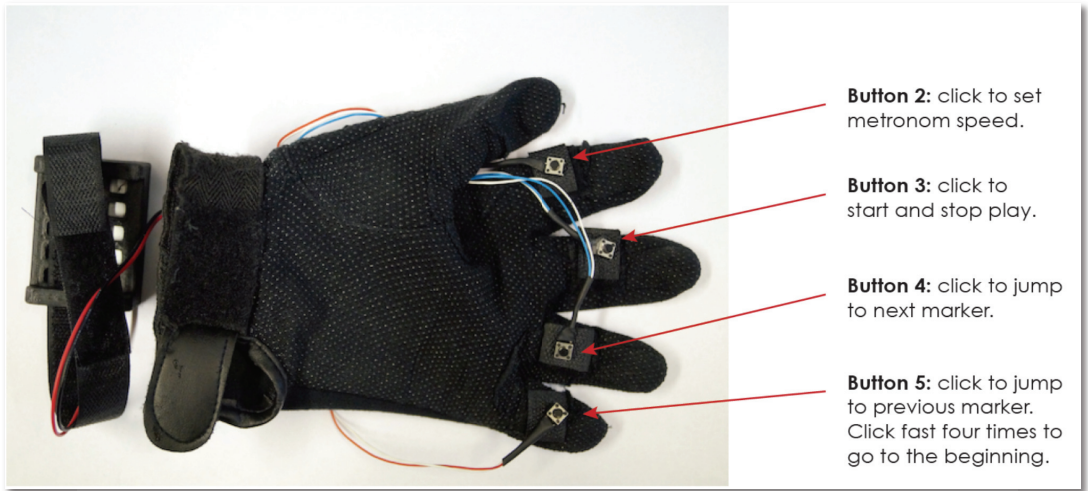


Figure 35. There are four buttons on the inside of the ConGlove, each with a designated function.

Functions of the ConGlove

Bending sensors

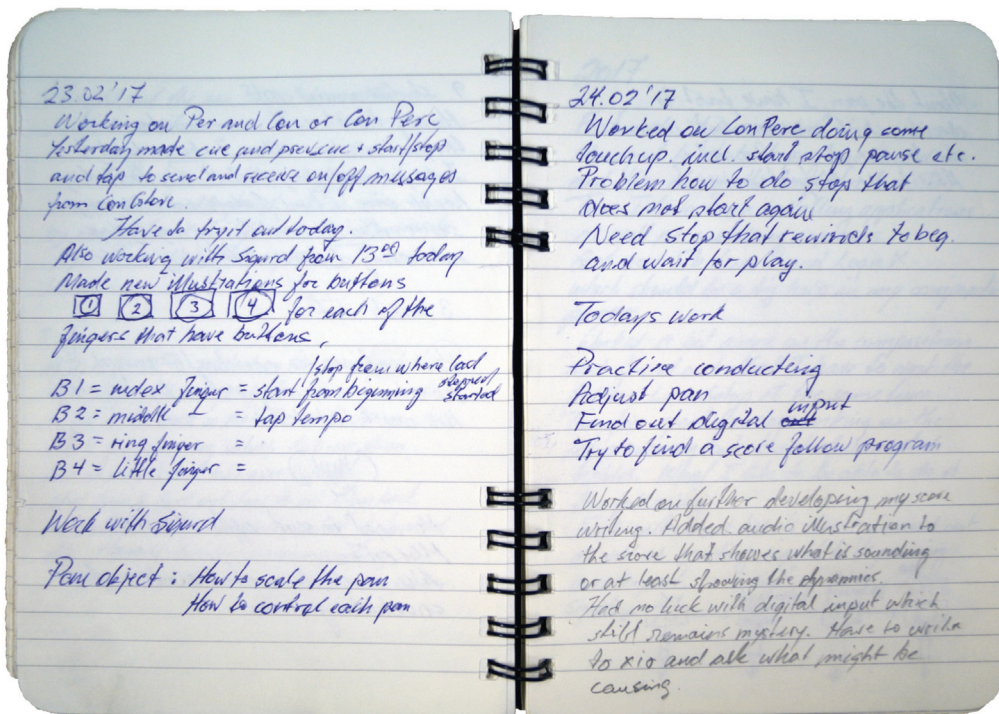
There are five bending sensors “built in” the conducting glove. One for each finger allowing use of sign language to send messages to the DAW. For instance, by sending out message holding out the thumb the DAW reads the message as value of one (1), holding out index finger as value of two (2) holding out middle finger as value of four (4), ring finger as value of 8 and little finger as value of 16. Any combination of fingers would then be the sum of the fingers for example holding out thumb and index finger would give a value of $1+2 = 3$ or combination of index and middle finger (a peace sign) would give a value of $2+4 = 6$. The bending sensors are then scaled to give a value from 0 - 127. 0 indicating fully bend finger and 127 for fully stretch out finger.

OSC x-IO Wireless Sensor

The conducting glove comes with x-OSC wireless I / O board that communicates over Wi-Fi using OSC. It provides up to 32 analogue / digital channels and equipment with three onboard sensors; gyroscope, accelerometer and magnetometer. For the ConDiS system I decided to use the accelerometer to measure the movement of the conductor’s arm from 0 as the lowest possible position and 127 the max.

Buttons

There are four buttons on the conducting glove, one for each finger except the thumb. It being excluded since the thumb needs to trigger the other buttons. Each button triggers an on/off message with 0 as the "on" value and 1 for "off" value. These buttons are used to synchronize and indicate tempo and cue-points between the DAW and written score.



Notebook February 2017.

Chapter 5 The Research Process

Experiments via Trial Compositions

Early in the research process it became apparent that it would be necessary to study practical and artistic intentions of the research.

Practical factors with specific focus on:

1. Develop conducting instrumental tool. A conducting glove adapted to the conductors traditional conducting movements.
2. Develop a method for synchronizing the interaction of live instruments and live computer-generated sounds (DAW).
3. Develop a musical notation (graphics) method for communicating visual and audible information i.e., musical score.

Artistic factors with specific focus on:

1. Musical interaction between the conductor conducting gestures and audible reaction.
2. Musical interaction between the conductor and the performers (ensemble).
3. Extended instrumental sonority through the use the ConDiS system and sonic changes through instrumental notation and digital audio workstation (DAW).

To conduct my research, I found it necessary to write experimental music pieces that I choose to call Etudes. The intention with these experiments was to develop and create notated instructions of an expanded sonority. The fact that they were not composed for public performance gave freedom necessary to stretch the limits and go beyond classical boundaries. These experiments enabled me to intertwine acoustic and electronic sounds parallel to my compositional methods.

Notation, Symbols and Signs

As a classically trained composer my interest lies in the field of writing down my compositions. I like the process of playing with my kids called notes³⁹, select carefully which of them I am going to introduce in my composition. I like to make decisions, how I tread them, give instructions, how to play with them, decide what is the flourishing tempo for them, decide what are the flourishing dynamics for them etc. I like to wonder and figure out the fundamental question in music composition, how can I give them their moment to express them self and shine? All this I like to do through the magical transformation from being dots on a piece of paper placed carefully by the composer to divergent soundwaves created through and interpreted by the musical performer.

Music notation is for me a collection of letters where I can write my own personal language when trying to gain a more organized and coherent idea of what I want to create.

Similarly, it is no less critical for me to treat the electronic sounds, therefore I needed an electronic notation dictionary. A collection of signs and symbols that I can understand and somewhat hear, touch and feel. Yet understandable for the conductor and performers to follow.

A relationship between what is "heard" and what is "seen" in the score is a fundamental issue. Therefore, it was important to come up with graphics for the electronic effects that are related to well-known notational graphical signs. Being in harmony with own theory to re-use and adjust already accepted signs instead of innovating.

How can I interpret the electronic sounds making it easy for the performer and conductor to follow and understand? In my search for an answer, various experiments were made including testing out the graphics (fonts) from Lasse Thoresen's system "Aural Sonology"⁴⁰ (Music, 2018, n.d.). Since Thoresen's system is more a pedagogical tool used to describe the analysis of sonic and structural aspects of music-as-heard, it shows little detail as to what those sounds really are. Therefore, turning to be impractical for my purpose.

³⁹ An indirect quotation to the American composer Morton Feldman who liked to compare his selection and treatment of notes to care of children.

⁴⁰ Aural Sonology (auralsonology.com) is an approach to the analysis of sonic and structural aspects of music-as-heard, developed at the Norwegian Academy of Music.

Practical and Artistic Aspects

The following writings concentrate on the graphic notation research. This being an essential part of the pre-compositional preparation. Important part of the process for the realization of ConDiS, its use and possibilities.

Compositions Experimenting with Notation

To realize these additional instructional features, experimental pieces or studies were written. Focusing on a specific factor of primary control, i.e., volume, spatial location, and sonority. Various “new” graphics for compositional and conducting instructions needed to be developed. These graphics were later tested via live performance. In that manner, I could better realize their clarity, practicality, and accuracy.

Etude for Voice and ConDiS

Etude for Voice and ConDiS version 1.0

The first attempt to develop and extend personal style of mixed electronic and traditional notation was realized through an experimental composition named Etude I for Voice and ConDiS. Voice was chosen since I could easily use my own voice and therefore did not need to rely on external assistance. Using wireless headset, I was able to move freely use my voice as instrument and work on live control of volume, pan and sound effects using early version of ConDiS.

Etude I - Volume

Strá í fuglsgoggi
regnið léysir af hólmi
snæ yfir jörðu.

Hilmar Thordarson 2015

The score is written in 4/4 time with a tempo of quarter note = 48. It features a bass clef staff with various dynamic markings (*ppp*, *p*, *pp*) and volume control symbols. The score includes a series of notes with 'á' above them, a section of notes with 'Strá í fuglsgoggi' above them, and a section of notes with 'whispering without voice sound' below them. A wavy line at the bottom represents a volume or amplitude waveform.

Figure 36. Etude for Voice and ConDIS first version.

Figure 36 shows the opening of the first version of Etude I with a subtitle Volume indicating that this exercise is focusing on live interactive controlling of the volume of the electronics. A Haiku style poem by the Icelandic poet Pjetur Hafstein Lárusson, "Strá í fuglsgoggi" is chosen since the form of Haiku, and the phonetic transcription of Icelandic gave a sudden degree of freedom and inspiration.

The score is written in Adobe Illustrator since all of the commercially available music notation software such as Sibelius and Finale are not flexible enough to meet the needs for this kind of experimental composition.

Notation Analyzes.

At the very beginning the performer makes a very soft *ppp* Ssss..... sound on any low pitch and holds that sound for some time (fermata sign) while making a *crescendo* to *p* and then *diminuendo* back to very soft *ppp* before making the Strrrrrrr..... sound with similar *crescendo and diminuendo*. Thereafter, the performer sings a given note C (or a note close to that C) and then a note a pure 5th higher on the letter "á". After that there is an un-timed pause (fermata), before singing the next phrase beginning with a very deep pitch, followed with short jumping notes, moving upwards in pitch, all based on the letter "á".

In the second line the vocalist sings a very high long note on the letter "á" before whispering the words "Strá í fuglsgoggi-" using duration of the diamond shaped notes (half-note,

quarter-notes and eight-notes). The following diamond notes are all whispered with the use of spatial notation to indicate pitch and density. This phrase is repeated as often as needed.

Volume Control Analyzes

Before starting the performance, the vocalist needs to activate the ConDiS volume control by making an OK sign with the conducting glove (ConGlove). Then he needs to gradually move the left arm upwards to follow the written crescendo and then a decrescendo of the electronic volume. That way the voice and the electronics have a parallel volume change. The next phrase has written crescendos and diminuendos for various time duration ranging from soft volume level *p* up to unspecified volume (left to the performer to decide).

Next line begins with a long high note that starts with the volume level *p* diminishing to silence before an extremely soft whisper of “Strá í fugls-gogg-i”. During the final phrase of this page the volume ranges from very soft up to unspecified volume indicating space between volume signs as stable points.

Pan Control Analyzes

To activate the pan control, function the conductor needs to give a thumb up sign and then move arm or wrist in circles accordingly to written indications in the music score. The little squares with dot and arrows are written to indicate the sonic location (pan) of the sound, meaning that at the very beginning the sound starts in the left front loudspeaker and moves linearly clockwise in a circle until it stops in the middle at the “Strá” singing. During the next phrase ááááá... the sound continues to move in a circle, but its process is interfered with left/right up/down motion of the wrist making the sound move in non-linear motion. The non-linear motion is indicated with lines simulating the motion. During the very high pitch in on the long-held note “á” the sound location is in the middle. The open diamond note in “strá” the electronic sound appears in the front right speaker moving linearly clockwise until it appears without a move in the left rear in “fugls” and left front in “gogg-i”. The last phrase is similar to the last phrase of the first line except the sound move is denser with short break points where the hand motion stops for a short period before continuing.

Etude for Voice and ConDiS version 1.1

The next figure shows the same score with minor changes. The most noticeable is that a box has been drawn around the electronics sound signs and a “Timbre” has been added to the electronic score. Volume sign has changed, and more details added to the pan graphics. Using box around the electronic sound made the score much clearer for the performer to read still keeping the close relationship between the electronics and the instrumental score. To simplify the score even further decision was made to leave out the black triangular volume indicators and use traditional hairpins notation. There was no need for specific electronic volume sign since the volume of the electronics followed or were parallel to the volume of the voice. With further developments of the ConDiS system, timbre control became available and had to be integrated into the score. Use of linear motion inside a box

was chosen especially because it was different from other signs (symbols) and was thought to give a correct visual image.

Etude I - Volume

Strá í fuglsgoggi
regnið leysir af hólmi
snæ yfir jörðu.

Hilmar Thordarson 2015

Pjetur Hafstein

Tempo ♩ = 48

Volume *ppp* < *p* > *ppp* < >

Pan

Timbre

p > < *pp* > <

whispering without voice sound

Figure 37. Etude for Voice and ConDiS Version 1.1

Etude I for Voice and ConDiS was an important experiment especially since it, literally speaking, allowed me to use my own voice to test and discover the possibilities I had in my hand. It helped me to understand and get a feel for what would happen with many different actions.

Experiences and Results

Experimenting and performing Etude for Voice was an important step towards the development of the ConDiS system. Learning to use the “ConGlove” to control various parameters with sign language based on finger combination as well as moving the sound levels and location with left arm was a thrilling experience. Hours were spent in the studio improvising using own voice mixed with electronic sound effects controlled with the conducting glove. The sound moved accordingly to wrist movement from one speaker to another although if moved too fast a little spike or click sound appeared. Its volume level went up and down accordingly to the arm movement. Timbre or sonic changes were made

using the Hadron Particle Synthesizer⁴¹ providing control of various synthesis parameters. It was a fun to play with, it gave me the touch and feel of its potentials. But I was not able to follow the instructions of the notated score. It turned out to be too complicated, I was unable to do all these various arm, hand and finger gestures while simultaneously reading the score.

I was unable to control at the same time volume and sonic changes; how would I increase volume and decrease sonic changes with my arm movement since I only could do one gesture at a time? How could I move the sound location in space with my wrist movement without moving the volume level or sonic changes? I was unable to synchronize the “score” and the computer sounds since there was no way to send a “score following” information to the computer or to turn on/off any of the controllers. Therefore, new methods and simplifications were needed.

Etude for Percussion and ConDiS

Although the first experiment to write instructions for the conductor to conduct her own performance was partially unsuccessful, I decided to move to the next experiment. To write a piece for one performer and a conductor wearing a new version of the “ConGlove.” The outcome was Etude for Percussion and ConDiS illustrated below.

Buttons Signs in the Musical Score

Many changes made from the notation of Etude for Voice and ConDiS. Adding button function to the “ConGlove” being the largest breakthrough. Now I was able to notate where the conductor starts and stops the performance, where to synchronize playback of the DAW and the live performer all with click of various buttons. With more than one clicks I was able to set the metronome (tempo) of the piece and jump back and forth between queue numbers. The button icon, black square with number surrounded by a white circle was a clear design easily understood by the conductor.

Visual Audio Files in the Musical Score

Another change was to write a copy of a recorded audio file of the electronics so that the performer could visually follow the audio of the electronics. Adding a picture of the electronic audio, I believed would help the performer to see and feel the accompanied electronics. Putting the audio files behind the staves, I considered both easier for the performer to read and at the same time save considerable space on the manuscript paper.

⁴¹ Synth, sampler and effects processor developed by Øyvind Brandtsegg at Norwegian University for Science and Technology (NTNU).

Etude for Percussion and Conductor

Hilmar Thórhásson

Figure 38 shows the first page of the score for 'Etude for Percussion and Conductor'. It features three systems of music. The first system is for Bass Drum, with a tempo of 96 and a 4/4 time signature. It includes a 'Click to start' button, a 'Bass drum' icon with the instruction 'rol with finger 5 cm from the edge', and a 'Computer' control panel with 'Feedback' and 'Reverb' sliders at 0%. The second system is for B. D. (Bass Drum) and Cpt. (Conductor), with a 'Click to pause' and 'Click to start' button, and a 'Delay' effect. The third system is for B. D. and Cpt., with an 'activate volume control volume slider one' button, a 'rubberstick' icon, and an 'arm movement ad lib.' instruction. The score includes musical notation, waveforms, and hairpin dynamics (p, mp, pp).

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Figure 38. Page 1. from *Etude for Percussion and ConDiS*

Sonic Changes

Although the sonic signs i.e. volume, pan and timbre used in *Etude for Voice and ConDiS* were quite clear and usable a totally new version was not needed. The “new” design being much closer to a traditional notation. Another important facture is the sonic changes are notated for the performer and conductor as indications of what is written as automation in the computer part. They are not written in the score as instructions for the conductor to raise or lower her arm or any other interaction with the performance. In *Etude for Percussion and ConDiS* three fundamental effect units are used, delay, reverb, and procrastinate an audio effect that creates cascading pitch and delay effect, here named feedback since it has a feel of feedback. The “hairpin” shaped icons are used to indicate how much of the effect is used, spanning from 0% to 100%. In the case of a delay effect the 0 to 100% would indicate the level of dry/wet and feedback added to the effect. For Reverb it indicates the decay time of the reverb or in other words how long time it takes the reverb to fade out and for the procrastinate the hairpin indicates the volume of the effect or how loud it can be heard.

Many composers including composer Kaija Saariaho indicate the use of electronic effect with a hairpin indicating the effect at the beginning and then draw a hairpin indicating the volume.⁴²

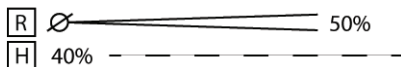


Figure 39. Effect notation used by Kaija Saariaho

In Etude for Percussion the design is taking a step further and try to indicate the effects by using a designated pattern for each effect. The intention is to make a bit clearer distinction between the various sound changes.

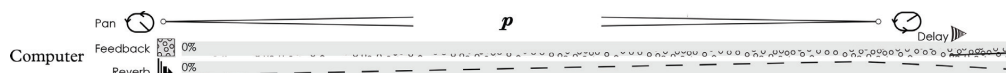


Figure 40. Notation of electronic sound effects in Etude for Percussion and ConDiS.

That way giving the performer and conductor a better visual feeling for the sound they were hearing.

Visual Audio

To add a copy of a recorded audio file was an attempt to make it easier for the conductor and the performer to connect ear and eyes, giving a picture of the sound and sound value as they perform. The image is placed behind the notes to save space and to make it easier to connect the written notes and their sonic outcome.

Sonic Location (panning)

Slight changes were made for the sonic location or the panning sign. These changes were made to simplify the graphics as well as moving closer to commercially used graphics in the world of DAW showing a button formed icon with a line for pan location.

The square shape sign has changed to more oval sign with arrows on the edge lines to indicate pan motion. A sign moving from left to right indicates move to left and right and wise versa.

⁴² It should be noted that these indications are from the dates when it had to be done manually on hardware. When using Max/MSP patches for performance Kaija Saariaho has said to disregard them as it is irrelevant and in some cases contradictory to what is happening.

Sign Language

The introduction of sign language instructions for the conductor is another addition to the score writing. These can be seen as an OK sign, thumb up sign, fist sign, little finger and index finger up signs. For more detailed writing on the use of sign language, (see Gestural Function p. 52).

The image shows a musical score for 'Etude for Percussion and ConDiS page 2'. It features three main parts: Vibraphone (Vib.), Bass Drum (B.D.), and Finger Bass Drum (Finger B.D.). The score is annotated with sign language instructions for the conductor, indicated by red circles and arrows. Key annotations include:

- Measure 26:** 'turn off volume control' (OK sign), 'Bass Drum' (drum icon), 'ppp' dynamic.
- Measure 33:** 'Bow Vib' (vibraphone icon), 'select effect' (fist sign, red arrow), 'activate arm motion' (little finger sign, red arrow), 'turn on effect control' (thumb up sign).
- Measure 40:** 'de activate arm motion' (fist sign), 'Bass Drum' (drum icon), 'select volume' (thumb up sign), 'turn on volume control' (little finger sign), 'activate arm motion' (thumb up sign), 'ad lib.' (wavy line), 'ppp' dynamic.
- Measure 53:** 'turn off volume control' (OK sign), 'Finger B.D. move back and forth from edge to center' (drum icon), 'turn on effect control' (thumb up sign), 'ppp' dynamic.
- Measure 57:** 'turn on volume control' (little finger sign), 'ppp' dynamic.

The score also includes conductor parts (Cpt.) and dynamic markings (ppp, p) throughout.

Figure 41. Etude for Percussion and ConDiS page 2. Red circles around various graphical sign language functions.

These different finger signs are all written for the conductor to “tell” the DAW which controller to be activated and when. For instance, in measure 33 when the bowed Vibraphone enters (red arrow), the conductor has to give a little finger sign to tell the DAW that she is going to control the effect unit. The conductor then has to give an index finger sign to activate level changes and then move her arm up for crescendo and then down for diminuendo, following the drawn line before deactivating the control by closing her hand shown with fist sign. The closing hand function to turn off activation was later reversed to turn on an activation. The OK sign activates the volume control while a thumb up sign activates a pan control.

Experience and Results

The notation used for Etude for Percussion and ConDiS was quite successful, for conducting, all was clear and simple to follow. The performer did not complain but felt that the recorded audio files could either be placed below the notes or not used at all. He felt that it was difficult to read the notes and preferred regular use of volume expressions such as *p* and *f*. The sign language worked fine although I started to realize the limits of conducting information. It took time to get used to the sign language and to remember the various functions. I also felt the graphics were too busy, they did work fine but this was a piece for solo instrument what if they were more?

Etude for Flute and ConDiS

The third and last piece in the sequence of experimental pieces for the ConDiS system was an exercise for Flute and ConDiS. There are less changes in the score writing graphics due to experience and praxis from previous experiments.

ConFlute
for flute and conductor

Hilmar Thórdarson

♩ = 72

press button to start

1 breath sound with little flute sound inbetween
poco a poco accel to ♩=72 then play very rhythmic until rit...

prepare by activating Volume control and close hand

Flute

pp poco a poco cresc... (R.D.Fb.)

Figure 42. Etude for Flute and ConDiS beginning

Sonic Notation

As can be seen slight changes have been made for the sonic notation. The icons are unchanged but the way of using it is now closer to the use of hairpins as in classical notation and classical volume expression signs are now (*p*, *mp*, *f*) are introduced.

For me to use % to indicate sonic changes was not satisfactory since it did not look of feel very musical. Why not use the same language for these indicators as we use in traditional music notation? Therefore, I decided to indicate the volume of the effects with musical signs such as *p*, *mf*, *f*, etc. that could easily be transcribed to % as *ppp* could be less than 10% and *fff* between 90 and 100%. I still use the number one (1) icon to indicate the first button which is located on the index finger of the conducting glove. This was later to change deciding to use same button numbering for the buttons as used in traditional piano fingering with thumb as the first finger and index finger number two. Hence a different numbering appearing first in *Kuuki no Sukima*.

Extended Instrumental Notation

In this work *Etude for Flute and ConDiS*, more emphasis was placed on extended notation than in previous works. I was looking very closely at extended notation of Luciano Berio⁴³ and Kaija Saariaho⁴⁴, as well as Robert Dick's⁴⁵ book *The Other Flute* (Dick, 1975).

It was important to exercise my own language to get the feel for the blending of various flute sounds and electronics.

Fl. 3

raise/lower arm if volume adjustment is needed

pp

6

7:4

5:4

Hold till electronics fade out.

2

pp

moto

sfz

sfz

f

Figure 43. Extended notation, sonic indicators.

Con Flute

5

Fl. 77

D

R

Fb

Figure 44. Another example of extended notation from measure 77 in *Etude for Flute and ConDiS*.

Making a virtual computer version of the piece, I managed to do experiments with mix of the flute and electronics as well as practice conducting the score. Flutist Trine Knutsen, gave me very important feedback about notation and clarity, as well as instructions of physical limitations of the instrument and its performer.

⁴³ Luciano Berio (1925-2003) Italian composer known for his compositional experimentations.

⁴⁴ Kaija Saariaho (1952) Finnish composer known for her mixed music compositions.

⁴⁵ Robert Dick (1950) American flutist, composer, improviser and inventor, known for his writings on extended flute technique.

Video example #1: Etude for flute video simulation (mockup) with score follow animation.
http://caveproduct.com/videos/CF_p1.mp4

Learning by Doing

Experimenting with various form of electronic and extended notations through the “Etude” compositions gave me a good feel for my extended musical language. I felt as I had gained enough practice to keep on moving forward and start pre-compositional work for *Kuuki no Sukima* my main composition using the ConDiS system. Although still having few unanswered questions concerning extended string writing it was too time assuming to write more Etudes. These experiments had to be done through the pre-compositional process.

Thanks to double bassist Michael Francis Duch⁴⁶ who’s advice and instructions performing sounds unknown to me was an eye-opener. Through our meetings I got introduced to other composers including double bassist Stefano Scodanibbio⁴⁷ who’s extended notation for double bass had a deep and lasting impact on my choice of extended string notation. Especially Stefano’s notation used in “E/Statico con contrabasso solo”.



⁴⁶ Michael Francis Duch (1978) an experimental composer and improviser.

⁴⁷ Stefano Scodanibbio (1956-1912) Italian double bassist and composer known for his use and notation of external Double bass technique.

Experiments and Practical Studies

Working with Conductor Arne Johansen

A series of practical studies, first based on my own conducting practice and then involving conductors Arne Johansen (Jonsvatnet Brass) and Halldis Rønning (Trondheim Sinfonietta), led to the conclusion that there are limitations on how much information the conductor can deliver to the performers (including the computer) during a performance.

The work with Arne Johansen involved him conducting a five-minute “conventional” composition adding real-time control of volume and panning. We met three times at my office where I explained the functions of ConDiS. Then we would practice with computer simulation for about an hour each time. The first objective was for him to learn the four basic signs for volume and pan control. There was initial confusion, however, when it came to conducting controlling signs. Arne tended to give an OK sign (which is used to activating volume control) by using his thumb and middle finger, while I use my thumb and index finger. When shifting between volume control and pan control, i.e., between the OK and thumbs up signs, there was sometimes confusion such that the computer would not deactivate one while shifting to the other, or it would activate both. That had not happened during my own trial conducting and it ultimately had to do with the difference in the way we moved our fingers from one sign to another. It so happened that Arne was preferred being able to control both—volume and pan—at the same time, therefore a decision was made to allow him to do so. Arne was quick to learn the sign combination and add it to his conducting technique. He managed to practice individual control of two separate groups, which was done by using the index finger for group one and combined index/middle finger for group two.

Stage setup

Jonsvatnet Brass was staged center stage and divided into two groups using two overhead microphones, one for each group. One microphone faced to the left for group one, and the other faced to the right for group two. The conductor would then activate either microphone, that for group one (left side) or that for group 2 (right side), using the finger gesture with just one or two combined fingers. There was substantial leakage between the groups due to the close proximity of the microphones. The microphone input level had to be adjusted to very low to prevent unwanted feedback. There was subsequently not much room for electronic output.

Preparation and practice time with the Jonsvatnet Brass was limited, as is too often the case in the mixed media situation. Two rehearsals plus a concert was not enough time to perfect the quality of the sound and the mix of the acoustic and electronic sounds. Nor did this provide enough time to explore sufficiently the potential inherent in the ConDiS technology.

Nevertheless, the concert performance was an essential milestone in the research process as it demonstrated the system's constraints and potential.

Experience and Results

Although the concert went fine, meaning there was no technical breakdown, the artistic result was far from satisfactory. Having the brass band split into two groups and using one microphone for each group proved totally unacceptable:

- It was difficult to hear and differentiate the electronic sound of the two groups.
- The electronic sound level was too soft due to feedback problems probably caused by microphone and speaker placement.
- The electronic sounds were too complicated and too processed, and their appearance too random. It was therefore difficult to hear them and understand the relationship between the instruments and the electronics.
- Moving the sound around in space with the conductor making a circular motion while holding up his left arm sounded good but looked awkward and made the conductor look more like a cowboy waving a lasso than a conductor.

One valuable outcome from this study was undoubtedly the reassessment it prompted of the realistic use for ConDiS and of the classic role of the conductor. Another valuable lesson was the improved understanding of the importance of a clearer relationship between the sound source (instrument) and the electronic sound (digital sound process of the instrument). This lesson is most directly applied to the placement and use of microphones and loudspeakers.

Arne did well, activating the control of the two groups, adjusting the volume level, and moving the sound around. However, the ConDiS software made too many mistakes shifting between the volume, pan, and group 1 and 2. These mistakes did not harm the performance since I could correct them manually, but it became clear that revision was necessary. In this instance Arne was conducting a short, simple, straightforward composition that left him ample time to concentrate on conducting the electronics. Nevertheless, it turned out to be plenty of work for him.

The experiment with the Jonsvatnet Brass and conductor Arne Johansen was an invaluable experience in the development of ConDiS. It made it absolutely evident that future use would depend on simplifying the conductor's control of the electronic parameters.

Experimental Work with Trumpetist Erik Kimestad

Collaboration with Erik Kimestad was conducted through Internet-based communication. He would send me audio files of various sounds he created with his trumpet. I then experimented with the sound using various gestures and button clicks of the conducting

glove, reporting back to him which sounds worked better than others. That way we could



Figure 45. Facebook ad for the Research days in Kristiansand.

prepare for the concert to be held at the “Research Days” festival at the University of Agder in Kristiansand, Norway. Having a few hours to rehearse in person before the concert provided us with enough time to construct the performance. With Eric standing on stage and me in the audience facing him, we improvised performance of around 30 minutes. Erik blew his horn while I sculpted the sound in real time with finger signs, arm gestures, and button clicking.

Experience and Results

It was a unique experience to be able to “grab” the sound from the trumpet, sculpt it, and move the sound in space using the “ConGlove” conducting glove. At the same time, through this experience I became ever more convinced that having a conductor doing all those things for my composition *Kuuki no Sukima* (then in the making) was not what I wanted. Doing everything I was doing before and during this performance was a full-time occupation and there was not even a written score to worry about. Even though it was evidently possible to add these features for the conductor, it was visually disturbing. The effect would be too disturbing of the atmosphere I hoped to create with *Kuuki no Sukima*, and it would have ended up looking more like a circus act than an example of serious conducting.

Working with Conductor Halldis Rønning

Leaving out Pan and Effect Control

Work with conductor Halldis Rønning started in early October 2017. I was soon able to confirm my suspicion. My expectation that the conductor could “grab” the sound, throw it into the air, and make live sonic modulations was unrealistic. Although I had proven it to be technically possible (see a demo video of pan control and Fx control), it was not the job of the conductor. Therefore, after a Skype meeting with Halldis, the panning and effect control functions of the interface were disabled.



Figure 46. The conductor interface before October 2017 with pan and FX control.



Figure 47. The conductor interface after October 2017 without pan and Fx control.

In the subsequent weeks of our collaboration, Halldis was given more and more detailed versions of the score of *Kuuki no Sukima*, leading up to the point where we were ready to schedule a meeting in Trondheim on October 31st for an intensive workshop. That included reading through the composition with playback from a mock-up⁴⁸ version. This would allow Halldis to rehearse conducting the performance while following written instructions on when to start and stop, when to change tempo, and how to change the overall volume value when needed.

The workshop with Halldis that day involved more than rehearsing, conducting, and talking through the functions of the ConDIS system. It also meant walking through the notation and graphics used for electronic sound indication and extending instrumental technique. In *Kuuki no Sukima* there is substantially extended instrumental technique. Therefore, in the pre-compositional process, there was an urgent need to explore new lands of instrumental sonority and experiment and explore the possibilities of various types of sonority. Hence the title *Kuuki no Sukima - Between the Air*.

To get a better grasp of the extended notation used in sonic experiments, three performers with the Trondheim Sinfonietta, flutist Trine Knutsen, double bassist Michael Francis Duch, and percussionist Espen Aalberg, were asked to be available that day to explore this issue

⁴⁸ Mock-up is a term normally used when playing MIDI simulation of a performance via computer.

through discussion and performance of some of the extended notation used in *Kuuki no Sukima*. The following videos provide examples from the workshop:

Sonic experimentation with flutist Trine Knutsen.

Video example #2: http://caveproduct.com/videos/Flute_2M_B62.mov

Sonic experimentation with double bassist Michael Francis Duch.

Video example #3: http://caveproduct.com/videos/DB_2M_B86.mov

Sonic experimentation with percussionist Espen Aalberg.

Video example #4: http://caveproduct.com/videos/KnoS_ext_perc.mp4

Much to our significant relief, the conducting rehearsals and sonic experiments went very well. Halldis felt quite comfortable using the conducting glove while conducting a mock-up simulation of *Kuuki no Sukima*. Unfortunately, there was not enough time to rehearse and experiment with the electronic sound extensions of those instruments, with the negative repercussions having too little rehearsal time with the electronic sounds before the first concert.

Experience and Results

In addition to confirming my suspicions about restrictions placed on conducting, our workshop revealed a few other things that needed to change. One was swapping the signs used for the activation and de-activation of the Volume Value Control. Originally the conductor opening up her hand to activate and closed the hand (fist sign) to deactivate. This turned out to be uncomfortable (unnatural) for Halldis and they had to be reversed.

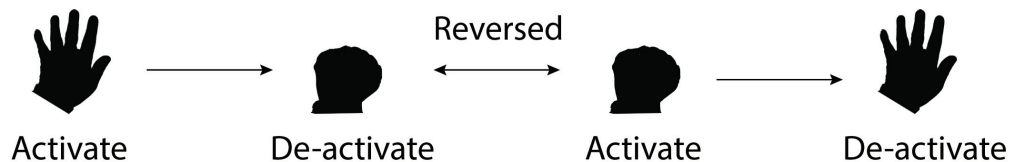


Figure 48. The on/off function reversed.

Another discovery that was a bit disappointing was that my use of altered hairpin signs to indicate effects was not very meaningful to her. She was not familiar with reading a musical score with increased delay or decreased feedback graphics.

Effect volume values

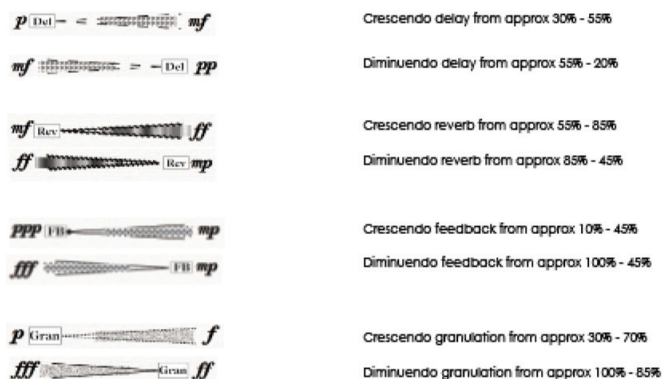


Figure 49. Hairpins designed for various effects.

Halldis felt this information made the musical score more complicated to read. Instead she recommended a simple way to indicate the overall loudness of the electronics, hence audio wave graphics were written into the musical score to indicate the overall audio level.



Figure 50. Graphical illustration of overall audio level

This was an unexpected discovery and led to the conclusion that two kinds of scores were needed.

Two Printed Versions of a Musical Score and a Book of Instructions

Conductor Halldis Rønning and I decided to print two versions of the score for *Kuuki no Sukima*. One contains all the electronic graphics and the other features none aside from the audio graphics indicating the overall volume. The score including all the electronic graphics is named “Composer-Conductor” and the other is the “Performance Score.” Instead of adding all instructions to the score as is traditional, i.e., instrumentation, notation, and instructions, a decision was made to present these as a separate file (book). The reason behind this decision was that the score itself is already quite a few pages in length and if everything else were included, it would be too long and bulky. It also helps to have the instructions in a separate book since it adds to the clarity of the work. In other words, there is aesthetic value in keeping the music and the technical/technological information separate.

This was a somewhat disappointing conclusion, since I really thought that I had come up with a simple solution to extend the classic notation vocabulary. It was my belief that using similar signs to express changes in electronic effect values would be the perfect solution. This still is my belief. One likely explanation for its not working in this particular context is the fact that the altered hairpin signs were too alien to Halldis and making them a part of her score reading practice would have required more time than we had.

Over the course of this period of research, I have developed a system for writing that I understand and can use to express my compositional needs. I have also created a means to extend my own compositional aim. That is, I have found a way to write the electronic effects with the same precision as the instrumental notes—a way to have them conducted and performed with the same expression.

Therefore, having to write two versions of the same score was a small price to pay and a solution that I am able to accept, at least for the time being.

Expanding Artistic Need

Musical Intention

Looking at the way in which the *Kuuki no Sukima* is written, it appears at first glance to be traditional. Standard staves for each instrument, which are then sorted conventionally with relevant information about speed and volume. The notation is somewhat traditional, although with exceptions where it uses extended notation. What then makes this score different? What makes the score different from most other scores written for mixed music is how I have chosen to write electronics into the score.

The way I write has much to do with my method of composing mixed music: The fact that I like live, real-time sound processing of each instrument in the ensemble; the fact that I like to process the instrumental sounds and the electronics with as much precision as possible. It all feeds into my intention to find a way to compose and perform mixed music in a larger format while maintaining a level of precision that fulfills my musical aspirations.

I do not look at the electronics as separate instruments. I choose instead to look at them and treat them as extensions of typical instruments, i.e., extended instruments or hyper-instruments. Their sonic material is constructed on top of their instrumental sound, for instance, the electronic sound source associated with the flute is the sound of the flute processed in real time. A sound that starts as a voiced flute sound and then gradually changes its sonority would be written as such:

Figure 51. *Kuuki no Sukima* 1st movement. m.50-54.

Figure 51 shows the flute playing a harmonic overtone while simultaneously singing the tone C. At the beginning, there is a pure flute and voice sound that gradually changes sonority; its sonority is extended as the electronic effects fade in (out).

To be able to hear these electronically processed sounds in my head the same way I hear the written pitches of the instruments, I need to write them down parallel to the instrument notes. I therefore write all sonic changes right below the respective instrument. That way I can see just by looking at the musical score how the sound progresses through time both with respect to both the given instrument and the whole instrumental group. This need for connectedness explains why I do not write these changes on a separate electronic line, as is often done in mixed music.

It may be somewhat confusing that I express my need to treat the electronic sounds as if they were individual instruments while at the same time talking about the electronics as a sonic extension of the instrumental sound. I use this expression in relation to how I perceive the interplay between the instrumental and electronic sounds. I hear the electronic sound as an offspring of the instrument, closely related but, at the same time, able to maintain its independence with respect to time, space, and volume. That is why, when looking at the score, all electronic effects, their location in space (pan), and volume are written on each instrument staff.

My intention in the ConDiS project is to capture the interplay that happens in a mixed music composition and performance. The interplay between the written instrumental instructions and their associated electronic sounds. The interplay between the written score and the performer. The interplay between the performer and conductor, and even the interplay between the performers and audience.

Testing Sonic Relation

Instrumental and Electronic Sound

During the composition process, interesting complications arose when testing out the sonic relation between the acoustic instruments and the electronics.

Firstly, there was the unfortunate reality of working in the media of mixed music, where there is often very limited time available to work on the electronics with the performers. Although I did meet with most of the players on an individual basis, there was little time to adjust the electronic sound effects. The reason? Too much time had to be spent experimenting with the extended instrument technique, the physical, notational, and sonic aspects. This meant testing out how this or that concept sounded in practice. These experiments and adjustments are very time-consuming and left no extra time for adding additional experiments with the electronics. Therefore, all of the experiments involving the electronic extension of the instrumental sounds were done with mock-up. This method is far from perfect especially because most samples libraries have very few extended techniques, which typically leads to relatively poor results.

Secondly, conducting mixed sonic experiments and tests requires studio time and studio preparation. In my case, it meant moving personal gear to the studio, including loudspeakers, to set up a quadraphonic audio system. This type of mixed sonic studio trial was done with the percussionist performing Etude for Percussion and ConDiS, but it turned out not to be worth the time spent. There was feedback trouble, and watching the computer while wearing the conducting glove to be able to conduct the sound proved complicated. Cueing up the score and the DAW was particularly troublesome, especially since I had not yet developed the use of buttons to jump back and forth. Therefore, I decided to do most of the sonic experiments and tests using computer simulation or mock-up at my office desk.

Video example #5: Extended violin test.

http://caveproduct.com/videos/Vln_verttrem.mp4

Chapter 6 Performance Reflections

In this chapter, I present an analysis of the written musical score in conjunction with audio and video recordings made during the Nordic Tour. I reflect on the technical implementation of the ConDiS system with regard to its use for musical performance. I explain the performance preparation, the connection between the written score and the DAW, and the conductor's use of ConDiS during a performance—paying due attention to both the positive and negative experiences and discoveries.

In an effort to simplify descriptions and facilitate understanding of the process and outcome, I will use video examples from concerts, video clips from an interview with conductor Halldis Rønning, and questionnaires sent to members of the Trondheim Sinfonietta to supplement the text provided here.

Performance preparation

Score and DAW Synchronization

In order to better the functionality of the ConDiS system, both for practical and artistic use, we need to take a closer look at the score and DAW synchronization. I will start by examining the performance preparation for the first version of *Kuuki no Sukima* used at the trial performance at Dokkhuset and then compare that to the later version of the score, which will provide excellent insight into the process that took place during the ongoing development of the project. A sequence of short videos is used to illustrate and enhance the discussion presented here.

Kuuki no Sukima – The Dokkhuset concert

Performance Preparation

Before entering the stage, the conductor needed to prepare the performance by carrying out the following actions:

1. Activate the x-OSC sensor by turning on the on/off switch located on the wrist of the conducting glove.
2. Press the 3rd finger button once to stop the playback function that starts when the sensor is turned on.
3. Press the 5th finger button twice to set the DAW play-head to the beginning.
4. Select the OSC network on the laptop.
5. Activate the calibration toggle on the ConDiS interface. Open and close hand three times for finger recognition. Deactivate calibration toggle.

Now everything is set for the conductor to walk onto the stage.

Figure 52 shows the opening page of the first version of *Kuuki no Sukima - Between the Air*. Instructions are provided in writing that indicate what the conductor needs to do in the opening measures of the piece.

Figure 52. The opening page of *Kuuki no Sukima* 1st movement. First version of the composition as performed at Dokkhuset.

When on stage the conductor needs to complete the following actions to start the performance:

1. OK sign to activate the volume interface of DAW.
2. Click the 2nd finger button three times to set the tempo.
3. Click the 3rd finger button to activate play-head button of the DAW.
4. Close her hand to activate the Volume Value Control.
5. Move arm up or down to set the Volume Value.



Figure 53. Ok sign

First, the conductor needs to give an OK sign with her left hand, on which she is wearing the ConGlove. This tells the DAW to activate the Volume Control Unit of the ConDiS interface.

After activating the volume (OK sign), the conductor has to give the written tempo by clicking her index finger (finger no. 2) three times in tempo. As indicated on the page by:



Figure 54. Button 2 = set metronome. Click the second button three times in given tempo.

That sets the metronome of the DAW somewhere close to the given tempo (metronome

♩ = 48), depending on the conductor's accuracy.

Now the conductor is ready to start the performance by pressing button three.



Figure 55. Start performance

Press button three to start the performance.



Figure 56. Closed hand

The conductor needs to close her hand into a fist to activate the volume control levels and raise her arm a bit. That will set the volume level of the electronics.

The Responding Graphical Interface

Figures 57 and 58 illustrate the operation of the ConDiS digital interface when activated.

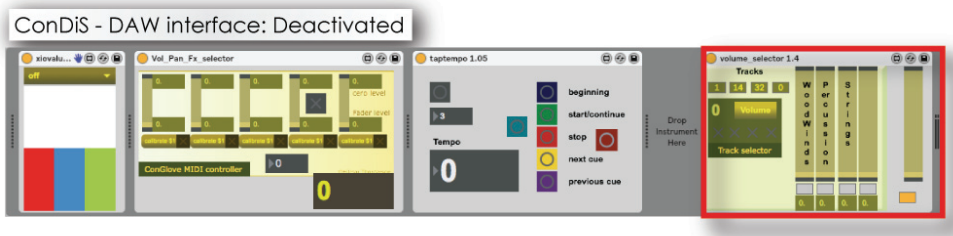


Figure 57. The ConDiS system de-activated. Red frame showing the volume selector with sliders at volume 0.



Figure 58. The ConDiS system activated. The accelerometer activated, finger calibration on, tap tempo and metronome set, and volume levels up (turned red).

From left to right:

1. Accelerometer, to calculate arm position.
2. Vol_Pan_Fx_selector, which indicates finger positions from little finger to the left to thumb far right.
3. Tap Tempo – Calculates the average time between 2nd finger button clicks. In this example, number 3 is selected for average metronome of four clicks (0-3). Any number can be set for tempo calculation.

This process of preparation turned out to be complex and confusing for the conductor. She felt there were too many actions in preparation for starting the conducting. As a result, a change was made before the first performance at Dokkhuset in which the volume control and metronome were to be manually activated, thereby eliminating the need to make the OK sign and press the metronome button. That way, she only needed to press the third button once to start the piece.

That was a last-minute compromise and needed fine-tuning before the next performance. The tight synchronization expected between the played instrumental sound and the live electronic sound suffered since her conducting beat was significantly faster than the manually set metronome for the DAW. Since there are markers in the written score (marked with button sign 4) that assist the conductor in synchronizing the score and electronics, the performance never veered far off course. Nevertheless the performance was negatively affected.

How to Start Performing - Instruction Videos

Links are provided below for seven short instruction videos that were made to illustrate the processes described in the section above. They are based on an earlier version of the musical score and are meant to give insight into the complications involved in starting the performance. Because they focus on the opening measures, the video clips give a good overview of the conductor's job and should improve the reader's understanding of the functionality of the ConDiS system.

The reader should be aware that the musical score used in these videos is from an older version of *Kuuki no Sukima* and therefore looks slightly different than the final version. The main difference is that in the newer version less information is provided for the conductor.

Instructions for the conductor:

Video example #6: http://caveproduct.com/videos/KnS_Cond_ins_part....mp4

A closer look at the instructions:

Video example #7: http://caveproduct.com/videos/KnS_Cond_ins_part....mp4

After the conductor has activated the volume control, she can adjust the volume value of the electronic sound by moving her arm up and/or down.

Moving arm up and down, opening hand for control deactivation:

Video example #8: http://caveproduct.com/videos/KnS_Cond_ins_part....mp4

There are several other extra things the conductor needs to do before starting the piece. She has to set the metronome for the piece, which in this case is metronome 48. To do so, she needs to press the index finger button four times in the tempo of the written metronome.

As with the videos above, the instructional video below uses an old version of the musical score. Therefore the narrative description provided above and the musical score do not always coincide.

Setting the metronome:

Video example #9: http://caveproduct.com/videos/KnS_Cond_ins_part....mp4

After setting the metronome, the conductor has to press the 3rd button to tell the computer that she has set the metronome.

The following video demonstrates in more detail what the conductor has to do in the opening measures of *Kuuki no Sukima*.

Opening measures of *Kuuki no Sukima* at the Dokkhuset concert:

Video example #10: http://caveproduct.com/videos/KnS_ConBeg.mp4

The aim of the project, however, is to create a system simple enough for conductors to use as a “natural” extension of their conducting tradition. Therefore, simplification was needed before the next scheduled concert, The Nordic Tour.

Kuuki no Sukima, the Nordic Tour Version

Pre-performance Preparation

The following pre-performance preparation needs to occur before the conductor enters the stage (this remains unchanged from the Dokkhuset performance):

1. Turn the sensor on by clicking the on/off button attached to the sensor.
2. Press the 5th button two times to move the play-head back to the beginning and stop playing. (When turned on the network sends a start signal to the DAW.)
3. The conductor has to press the 3rd button once to stop the rewind function of button five.
4. Select the OSC network on the laptop.
5. Activate the calibration toggle on the ConDiS interface. Open and close hand three times for finger recognition. Deactivate the calibration toggle.

The performers and the audience do not see any of this preparation since these actions are all done before the conductor enters the stage. Nevertheless they are a hassle and stressful for the conductor.

Changes were made from the first performance:



Activating the volume control unit is no longer necessary since there are no other units to activate after the pan and effect control were left out.

Figure 59 shows the opening page of the second version of *Kuuki no Sukima - Between the Air*. Instructions are written out to indicate what the conductor needs to do in the opening measures of the piece.

Full Score

Kuuki no Sukima
Niður/Murmur

Hilmar Thórðarson (2017)

♩ = 48

1 → use OK sign to select volume control

2 → on first downbeat press middle finger button to start computer play

3 → $\times 4$ on 2,3,4 and 1st beat of measure 2 press index finger button 4 times to set the metronome

3 → use flat sign to activate control volume of all instruments groups

5 → move arm up to set volume value

6 → use five fingers sign to de-activate control volume of all instruments groups

Clarinet in B \flat

Violin

Viola

Violoncello

Double Bass

Electronics

Cl.

B. D.

Vin. I

Via.

Vc.

Db.

Electr.

Figure 59. The opening page of *Kuuki no Sukima* 1st movement. Second version of the composition as performed during the Nordic Tour.

The order of tasks to start the performance was changed:

1. The conductor gives a sign to start playing by clicking the 3rd button on the first downbeat, not the upbeat as in the earlier performance.

This solution worked very well and produced no problems in ensuring the performance is synchronized right at the beginning.

2. The conductor gives the metronome speed *after* starting the performance instead of *before*, as in the earlier performance.

This change worked out very well since it is a natural extension to her conducting technique.

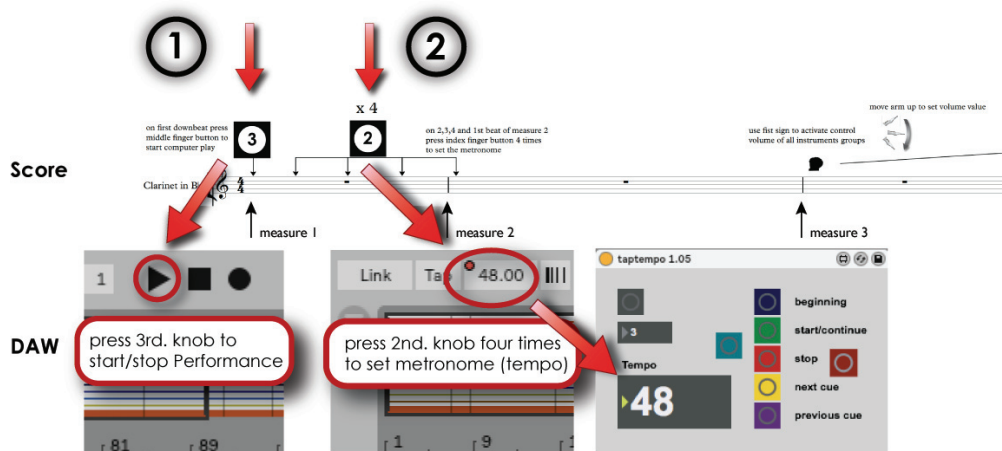


Figure 60. Press 3rd button to start performance. Press 2nd button to set metronome (tempo 48). This illustrates the relationship between the musical score and DAW.

3. The conductor closes her fist and raises the electronic volume level in measure three instead of doing it at the very beginning, as she did in the first version.

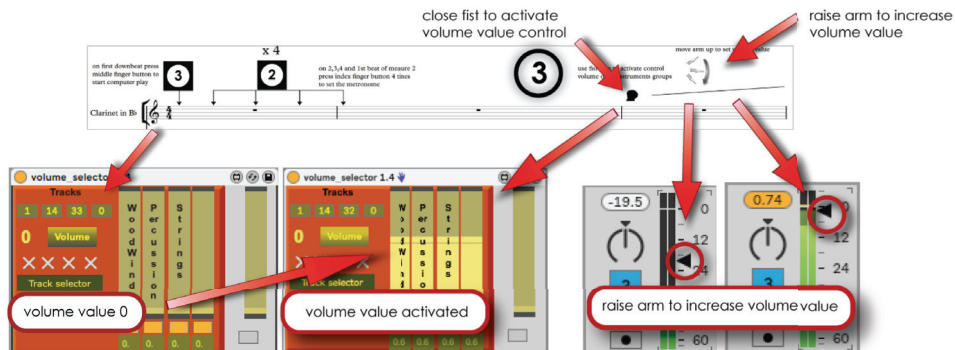


Figure 61. Start performance, set metronome, adjust volume.

4. When the electronic volume value has been set, the conductor deactivates her control by opening up her fist as shown in the next example:

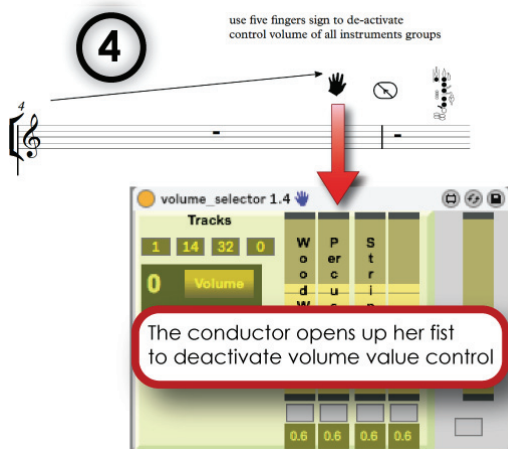


Figure 62. Control of volume value deactivated

The computer recognized the close/open fist gesture faultlessly, and there was an audible increase in volume when the conductor raised her arm.

This solution worked very well since it:

- a. gave the conductor more confidence in adjusting the electronic volume;
- b. gave the opening a bit more breathing room;
- c. illustrated the intended use of ConDiS in a clear way; and
- d. resulted in a more graceful opening aesthetically speaking.

Issue: Volume Value Not Clear

Conversations with Halldis after the concert in Harpa, however, revealed that she was not entirely confident with respect to knowing how much she had increased the volume. She found it especially uncomfortable not knowing how much headroom was left, i.e., whether she could increase the volume even further. This is easier to understand with reference to the interface:

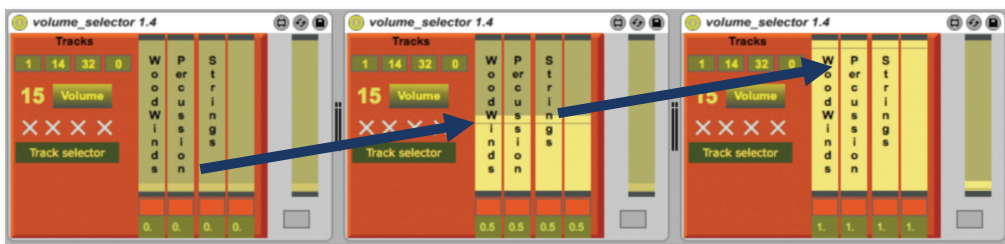


Figure 63. Volume selecting interface. 0 = no volume; 0.5 = half the min/max volume value; 1 = max volume value

The first volume selector (at the left) shows the volume value at zero points; the next one shows the volume value at half point, 0.5; and the last one shows the volume value at its maximum point of 1.0.

I suggested placing this visual information on the stand next to the score with use of an iPad or iPhone. After giving it some thought, the conductor decided that while this was a good idea in theory, it might prove too distracting for her ability to concentrate on conducting the score.

With the experience we gained during the Nordic Tour, we discovered that it was essential to adjust monitoring so she could hear the electronics and the ensemble equally clearly. That way she could rely on her hearing and would not need to see the volume value interface.

Kuuki no Sukima - Sonic Analyses

In this section I will focus on the sonic part of the concert, how the sound of the instruments interacts with the electronic sound effects of the DAW, to showcase the relationship between the written notation and sonic output. I will explain how I use traditional notation in conjunction with the “traditional” graphical interface of music software applications. Attention will also be paid to the feature commonly called “automation,” which refers to a control whose value changes over the course of a timeline that is automated.

Sonic Analyses

Figure 64 shows the opening measures of *Kuuki no Sukima*.

Full Score

Kuuki no Sukima
Niður - Murmur - せせらぎ

Hilmar Thórdarson (2017)

♩ = 48

use OK sign to select volume control

on first downbeat press middle finger button to start computer play

3

x 4

2

on 2,3,4 and 1st beat of measure 2 press index finger button 4 times to set the metronome

use fist sign to activate control volume of all instruments groups

move arm up to set volume value

Clarinet in Bb

Violin

Viola

Violoncello

Double Bass

Electronics

Figure 64. The opening measures of *Kuuki no Sukima*. The first effects are not audible, hence an electronic volume level of zero.

Figure 65 shows the revised version of the opening measures of *Kuuki no Sukima*.

The image displays a musical score for the piece "Kuuki no Sukima" by Niður - Murmur - せせらぎ, composed by Hilmar Thórdarson in 2017. The score is for a full ensemble including Clarinet in Bb, Violin, Viola, Violoncello, Double Bass, and Electronics. The tempo is marked as ♩ = 48. The score begins with a conductor's actions: a fist sign to select volume control, followed by a middle finger button press to start computer play. The conductor then raises her arm to set the metronome on measures 2, 3, 4, and the first beat of measure 2. A volume control sign is used to activate control volume for all instrument groups. The score shows the instruments playing in 4/4 time. The violin part starts with a piano (*p*) dynamic and arco playing. The viola and double bass parts start with a piano (*p*) dynamic and pizzicato (*pizz.*) playing. The electronics part starts with a piano (*p*) dynamic and pizzicato (*pizz.*) playing. The score includes various performance markings such as *arco*, *pizz.*, *mf*, *ff*, and *f*. The conductor's actions are indicated by icons and text above the score.

Figure 65. Revised version of *Kuuki no Sukima* with electronic effects removed.

The opening measures of *Kuuki no Sukima*:

Audio example #1: http://caveproduct.com/audio/Harp_1st.m.1-5.2.wav

In the opening measures there is no use of electronics to interfere with the clear, dry sound of the instruments until the conductor activates the volume control by closing her fist and then raises her arm. At that point, the beginning of measure three, the conductor increases the volume of the electronic sounds from none to the desired level. This beginning is a slight change from the original concept, in which the electronics were supposed to be active from the beginning. Why did I make these changes? As mentioned above, this revision simplified the actions the conductor had to perform in preparation for the performance. This way the conductor did not have to raise her arm before starting the performance to a volume of no responding sound. It is undoubtedly possible to have the volume adjusted beforehand in the DAW, but that solution would not have resolved the issue to my artistic satisfaction. Aesthetically the solution of having her raise her arm later in the piece worked out to produce a stronger beginning. It gave the composition a more dramatic opening, with the electronics entering with the visual and sonic effects of the conductor raising her arm.

Graphical Notation of the Digital Signal Processing (electronic sound)

Figure 66 shows the relationship between the notated score and the DAW. This selection focuses on the violin part, the sound of which starts to change in the third measure or as soon as the conductor raises her hand, thereby increasing the volume of the DSP or the electronic sound.

A closer look at the score and the electronic score will illustrate how these aspects are connected or related.

Figure 66. *Kuuki no Sukima* measures 3-6. The connection between notated score and the graphical interface of the DAW.

The score and the graphical notation of the electronic effects that are added to the high opening note of the violin (E) reveal several effects with respect to the volume:

1. **Delay** with diminuendo (decreasing volume) from approximately *mf* to silence.
2. **Reverb** fades in with increasing volume to approximately *mp* (relatively little reverb).
3. **Granulation** starts with *ff* (very strong) and stays unchanged.
4. **Feedback** starts with *ff* (very strong) and stays unchanged.

I consider it very important to be able to notate the electronic sounds in the score in synchronization with the graphical interface of the DAW. That way, when composing, I can write on the manuscript paper both the instrumental sonic idea (notes) and the electronic extensions of the DAW (effects). Having been trained to read musical scores, this helps me to hear and feel the music by looking at the score. In the example above, I can easily imagine how the sound of the violin gradually changes with decreasing delay and increasing reverb, granulation, and feedback. I can hear how the electronic effect gradually comes in with the

conductor lifting her arm, although I can see that this will never be too strong given the *mp* volume sign written in the score.

The following example illustrates the opening eleven measures of *Kuuki no Sukima* and shows the close relationship among the score, the DAW, and the conductor's gestures.

Kuuki no Sukima measures 1 – 11:

Video example #11: http://caveproduct.com/videos/H_KnS_1st_m_1-11.mp4

Measures 11 - 14

In measure 11 there is a general pause where the conductor stops the playback of the electronics by pressing the 3rd button on the glove. After the pause, the conductor continues by pressing the 4th button, which jumps the playback-head of the DAW precisely to the beginning of measure 12. That synchronizes the DAW and the notated score so that the bass drum and piano duo are in sync with the written effects of the electronics.

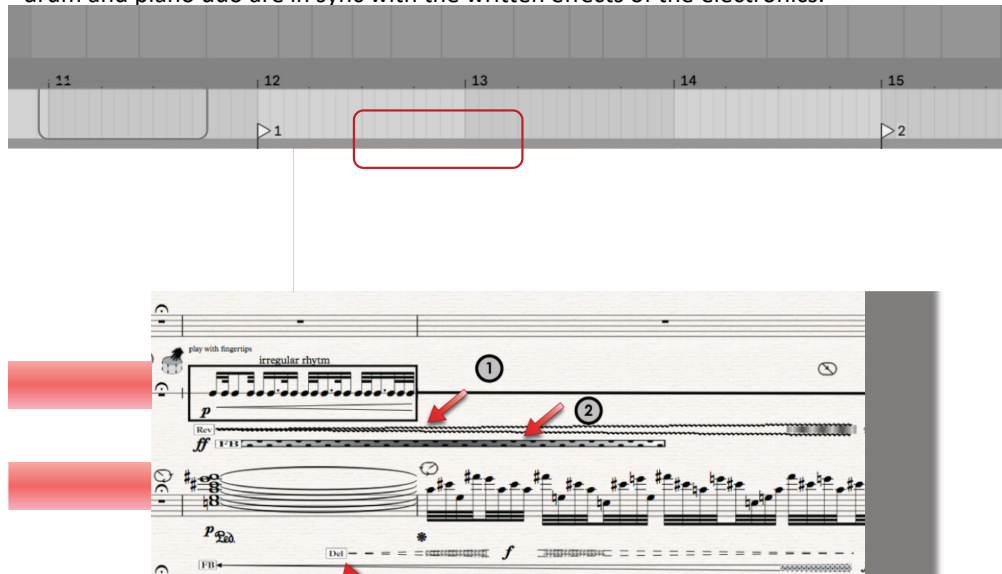


Figure 67. *Kuuki no Sukima* measures 11-14. Percussion and piano entrance showing first synchronization point.

As shown in the figure above, the bass drum comes in with increased reverb and strong feedback effect while the piano has increased feedback as well as increased ---> decreased delay.

Bass Drum

1. Reverb crescendo to *mf* (mezzoforte) medium loud.
2. Feedback with unchanged *ff* (fortissimo) strong effect.

Piano

1. Delay crescendo to *f* (forte) ---> diminuendo to zero.
2. Feedback from zero to *ff* (fortissimo/very strong).

The next illustration is of the automation for the same measures as written in the DAW.

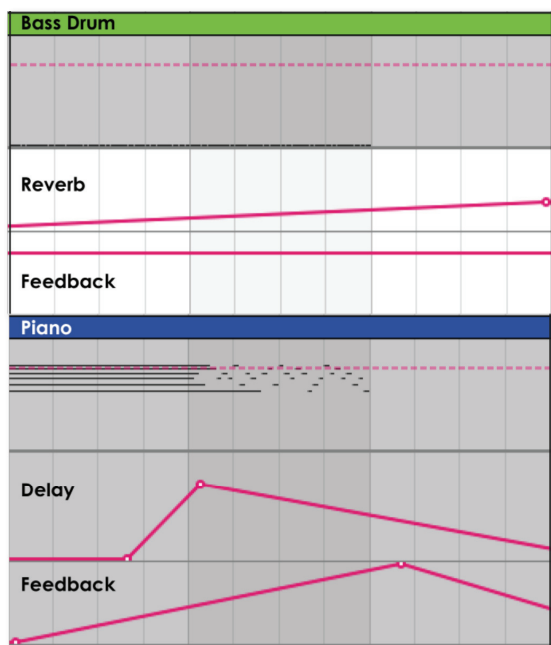


Figure 68. The automation window of the DAW.

The above figure shows the automation for the electronics that should be in precise synchronization with the written score. It means that when the bass drum starts playing its rhythm pattern, there is an increasing reverb coming in and very strong feedback. At the same time, the piano plays a chord that should, at the beginning, have very little electronics, with increasing delay and feedback as the chord dissolves in single notes.

This is exactly what I was aiming for with the development of ConDiS. I sought to create a tool that would allow the conductor to conduct with all the expressions (rubato, etc.) necessary in her interpretation of the music while also synchronizing the score and DAW.

The following example, taken from the closing concert performance of *Kuuki no Sukima*, shows how the conductor stops the DAW in measure 11 (pressing button 3) and continues in perfect synchronization with the score in measure 12 (pressing button 4). It also provides a very good example of how the conductor decides to increase the electronics volume level by raising her arm even when this is not written in the score. After she has adjusted the level,

she presses the third button in measure 14 to stop the DAW. Then she waits until the sound is about to fade out before synchronizing and starting the flute entrance in measure 15.

The image displays a musical score for measures 11 through 16. It consists of five staves. The top two staves show a sequence of notes with circled numbers 3 and 4 above them, indicating specific actions: 'press middle finger button to jump forward and start computer play'. The third staff shows a piano part starting in measure 12 with a dynamic marking of *p* and a note indicating to 'Play with fingertips'. The fourth staff shows a bass drum part with a dynamic marking of *ff* and a note to 'irregular rhythm'. The fifth staff shows a flute part starting in measure 15 with a dynamic marking of *f*. A red box labeled 'piano' is positioned over the piano part in measure 12. The score includes various musical notations such as notes, rests, and dynamic markings.

Figure 69. Measures 11-16, with percussion and piano entrance in measure 12 and flute entrance in measure 15.

Bass drum and piano duo in measures 11 – 14:

Video example #12: http://caveproduct.com/videos/R_1st.m.11-16.mp4

Measures 37 - 49

After the fermata in measure 36, the score and the DAW are synchronized before the flute comes in. Here we can easily hear the electronic effects of delay and reverb as the flute continues to play (and sing). The electronic effects become even more audible as the strings and the clarinet enter with an increasing delay, reverb, and granulation. This part is one of my favorites since it sounds very close to the sonority that I had in mind and it adds a very elaborate sonic cloud to the chord progression.

The image displays a musical score for measures 37 to 49 of the piece 'Kuuki no Sukima'. The score includes staves for Flute (Fl.), Clarinet (Cl.), Violin I (V. I.), Violin II (V. II.), Viola (Va.), and Double Bass (Db.). Each instrument's part is accompanied by a Digital Audio Workstation (DAW) hairpin plot, which is a line graph showing the level of an electronic effect over time. The hairpins are color-coded: orange for Flute, green for Clarinet, purple for Violin I, blue for Violin II, yellow for Viola, and brown for Double Bass. Red arrows point from text annotations to specific points on the hairpins and the musical notation, indicating where the effects are being adjusted. The annotations include: 'Increased value of delay and reverb' (pointing to the Flute hairpin), 'Increased value of delay, reverb and granulation' (pointing to the Clarinet hairpin), 'Increased value of delay, reverb and granulation' (pointing to the Violin I hairpin), 'Increased value of granulation' (pointing to the Violin II hairpin), 'Increased value of delay and granulation' (pointing to the Viola hairpin), and 'Increased value of delay and granulation' (pointing to the Double Bass hairpin). The score also includes performance instructions such as 'p' (piano), 'mf' (mezzo-forte), 'f' (forte), 'ppp' (pianissimo), 'arco' (arco), 'molto sul pont.' (molto sul ponticello), and 'liberamente'.

Figure 70. *Kuuki no Sukima* measures 37 – 49, showing various electronic Fx hairpins in conjunction with the DAW.

Figure 70 shows measures 37 - 49 and the connection of the score to the DAW. As can be seen, the volume of the electronic effects increases significantly after the multiphonics begin. The effect can be heard clearly in the video recordings below.

Volume of Electronic Effects:

Video example #13:

http://caveproduct.com/videos/R_1st.m.37-49.mp4

http://caveproduct.com/videos/Cph_M4.mp4

It is particularly interesting that the electronic sounds are very clear even though the volume of the instruments, which is the power source for the electronic sounds, is very weak. The main reason is that the effects are very open or strong f (about 85%). It is therefore not necessary to increase electronic volume if the acoustics are soft.

The following is an illustrated video example that shows the opening measures (measures 1 – 23) of *Kuuki no Sukima*:

Video example #14: <https://www.youtube.com/watch?v=NwxfjLoe9Ek&t=74s>

Reflections

The synchronization solution, whereby markers are placed in the DAW that aligns with the button sign on the score, was the simplest and most reliable solution that I could find. It is far from perfect since it relies entirely on the conductor not only remembering to press the button, but to press the right button—in this case button four—and to press it correctly. For this reason, a backup or emergency setup was placed in the DAW graphical interface so that an additional party (the composer) could “correct” the synchronization function if something went wrong. Most of the mistakes that did happen occurred during the first concert, but they became fewer in number as the conductor gained more experience. The last two concerts in Schæffergården and Rockheim witnessed none of the button-pressing mistakes that happened in earlier performances. It should be acknowledged, however, that I would have liked to have found—and continue to hope to find—a better solution to this because one of my primary aims was and still is to completely eliminate the “middleman.”

Figure 71 shows the security buttons of the DAW.

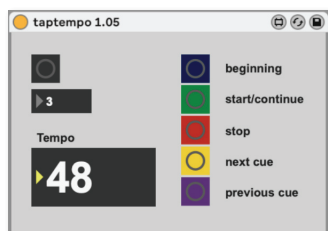


Figure 71. The synchronization unit of the ConDiS system

It should also be noted that the synchronization unit of the ConDiS system turned out to be very useful during rehearsals as it allows the conductor to manually jump forward or backward between the markers in the DAW. Thus, if the conductor needed to play from a given marker in the score, she could align it to the marker in the DAW. This saved a lot of time and frustration as this kind of flexibility is a key factor in keeping the flow that is necessary during rehearsals.

The Conductor’s Relationship to the Conducting Tool

There are a few instances in the score where an arm movement is written to indicate live variations in the instrumental and electronic mix. The following section focuses on the conductor’s use of her arm to control the overall volume of the electronics. Attention is paid to how she follows the written arm movement indications while adding her own sense of volume control based on her musical sensitivity.

The Conductor following Electronic Volume Control instructions

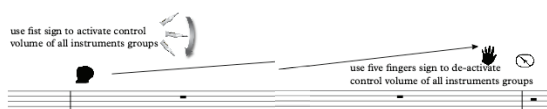
1st Movement

During the first movement of *Kuuki no Sukima* there are four events where the conductor has written instructions to activate volume control. Two of these volume control events occur at logical points when the conductor needs to raise and lower the electronic volume: at the beginning and the end of the movement. The other two have been inserted at places where I felt it necessary for the conductor to control the volume.

Figure 72 shows the four places in the first movement of *Kuuki no Sukima* where volume control is written in the score.

Example 1

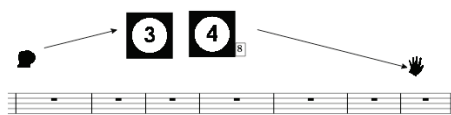
Measure 3



Measure 85



Measure 91



Measure 105

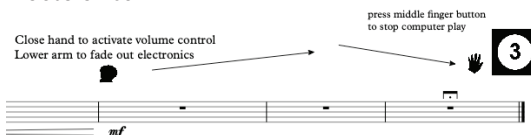


Figure 72. The four volume activation points written in the score of the first movement of *Kuuki no Sukima*

The accompanying video is a collage of these four written volume control spots. They were all recorded at the ConDiS closing concert in Rockheim and show how the conductor follows

the written instructions. As can be seen in the accompanying video, the conductor follows the given instructions entirely. This is exactly what took place at all six concerts. This provides definitive proof that writing instructions for volume control is not only feasible, but also reliable.

The Conductor following Electronic Volume Control instructions:

Video example #15: http://caveproduct.com/videos/R_Vol.ctrl_cue.mp4

Even more interesting is an analysis of when the conductor activates volume control when it has not been written in the score. These occasions of instant decisions being made in the middle of a performance reveal the crucial benefits of putting this form of control into the hands of the conductor. These are the very moments, after all, that are so important in performing music. And it is these moments that provide the underlying impetus behind creating ConDiS: to put all the conducting into the hands of the conductor. These moments reinforce my conviction that the conductor is best suited to control all elements of the music performance. To demonstrate this, I will refer to examples from several places in *Kuuki no Sukima* and compare various instances of its performance. These performance examples are taken from the concerts in Harpa Concert House in Reykjavik, Schæffergården in Copenhagen, and Rockheim in Trondheim.

The Conductor controlling Electronic Volume Control

Example 2

The image shows a musical score for measures 18-23 of 'Kuuki no Sukima'. The score is written for Flute (Fl.), Bass Clarinet (Cl.), and Horn (Hn.). The flute part has a mordent and is marked with dynamics *pp* and *mp*. The bass clarinet part has dynamics *p*, *mp*, and *f*. The horn part has dynamics *p* and *f*. A conductor's hand is visible at the top, with a black box containing the number 4 indicating a specific gesture. A red box highlights a section of the conductor's hand.

Figure 73. *Kuuki no Sukima* measures 18 – 23.

After the flute mordent notes, the bass clarinet enters with a continuous irregular slap and trill and soon thereafter the horn plays a note that has a crescendo from *p* (soft) to *f* (loud). At the same time, the conductor decides to give the horn a bit more electronic support, as can be heard in the video clip below.

Measures 18 – 23. Video example #16 - 18:

Harpa: http://caveproduct.com/videos/H_1st.m.15-23.mp4

Schæffergården: http://caveproduct.com/videos/S_1st.m.15-23.mp4

Rockheim: http://caveproduct.com/videos/R_1st.m.18-23.mp4

The electronic effect is easily audible as the conductor raises her hand, providing a clear indication that she is affecting the overall value of the electronic sound. Since the conductor opens her hand when her arm is in the uppermost natural position, the electronic value stays at a high value until she makes the next adjustment. Though there are slight variations among the performances, the conductor always activates the electronic volume control in roughly the same place. This demonstrates that the conductor has studied the whole composition, the instrumental score and the electronics, and is adding her own interpretation to the performance.

The image shows a page of a musical score for measures 63-68. The instruments listed are Flute (Fl.), Bass Clarinet (B. Cl.), Horn (Hn.), Bass Drum (B. D.), Violin 1 (Vln. 1), Viola (Vla.), Violoncello (Vc.), and Double Bass (Db.).

- Flute (Fl.):** Starts at measure 57 with a dynamic marking of *p* and the instruction "ooh". A red box labeled "Clarinet" is positioned above the staff. Two black boxes with the numbers "3" and "4" are placed above the staff, indicating specific moments.
- Bass Clarinet (B. Cl.):** Features a complex texture with dynamic markings ranging from *ff* to *pp*. It includes performance instructions such as "play with voice overtones arip" and "play with voice overtones afip".
- Horn (Hn.):** Also includes the instruction "play with voice overtones arip".
- Other Instruments:** The Violin 1, Viola, Violoncello, and Double Bass parts are shown with various dynamic markings and performance instructions.

Video example #19 - 21: Measures 63 – 68.

Harpa: http://caveproduct.com/videos/H_1st.m.57-68.mp4

Schæffergården: http://caveproduct.com/videos/S_1st.m.57-68.mp4

Rockheim: http://caveproduct.com/videos/R_1st.m.57-68.mp4

Example 3 shows another instance where the conductor activates the volume control at a similar place in the music (score). This time she handles the control quite differently between performances. At Harpa she raises the volume value close to where the strings enter, while at Schæffergården she decides to lower the electronic sound of the strings before the clarinet enters. After the clarinet has entered the conductor plays with the capabilities of CONDIS by increasing and decreasing the electronic volume or, in musical terms, the conductor makes a crescendo and diminuendo at the beginning and end of each sustained multiphonics of the clarinet. This playfulness is even more noticeable in the Rockheim performance, where she brings the volume up and down in a very musical and playful way. It is clear that at the Rockheim performance, which was the last performance, the conductor has become so familiar with her “extended” conducting job that her conducting gestures are much more relaxed or what I would prefer to call “poetic.”

These measures provide a perfect example of a very positive and musical use of the ConDiS technology. Here the conductor is molding the sonority of the instruments and electronics in a slightly different way, using her musical talent to create a live “conversation” that would be impossible without the live interactivity that is available through ConDiS.



2nd Movement

The second movement has more complexity and musical action. This means there is less time for the conductor to adjust the ConDiS system. It is deliberately composed that way to experiment and discover where the boundaries of conducting information lie.

Example 4

Example 4 comes from measures 16 – 21, where the left-hand pizzicato motive from measure 11 is repeated. Again, nothing is written in the score indicating that the conductor should adjust the electronic volume value. It is therefore an exercise of her own musical judgment to add more electronics to the pizzicato. By doing so, the conductor brings out slightly varied repetition, producing an interesting effect and making the repetition much more effective.

Figure 75. *Kuuki no Sukima* 2nd movement. Measures 16 -21

The conductor adds electronic volume to the pizzicato motive of the double bass:

Video example #22 - 24: Measures 14 – 21.

http://caveproduct.com/videos/H_2nd.m.14-21.mp4

http://caveproduct.com/videos/R_2nd.m.14-21.mp4

http://caveproduct.com/videos/S_2nd.m.14-21.mp4

Example 5

Another example of the conductor using the ConDiS to insert spontaneous volume control occurs in measure 46. When the horn enters (grey arrow), the conductor immediately brings down the volume value and keeps it low until measure 49. Then, as the cello enters with its pizzicato, a knock-on body, vertical bowing tremolo and glissando (grey arrow), she increases the volume. By doing so, the conductor makes sure that the sonic effect of the cello is evident before adding the electronics.

The image shows a musical score for measures 45 to 55, featuring staves for B. Cl., Hn., Vib., Vln., Vla., Vc., Db., and Electro. The score includes various musical notations such as dynamics (p, mp, mf, ff), articulations (trills, gliss., pizz.), and performance instructions (e.g., "Glissando with the tip of the bow", "Hit the body with the pizz left hand thumb"). A red rectangular box is overlaid on the bottom right of the score, labeled "Cello entrance", indicating the point where the cello enters with its pizzicato, knock-on body, vertical bowing tremolo, and glissando.

Once again, the conductor uses musical intuition in keeping the horn electronic levels all the way down to emphasize the cello electronics with the pizzicato, knock, and glissando sounds.

Video example #25 - 27: Measures 45 – 55:

http://caveproduct.com/videos/H_2nd.m.45-55.mp4

http://caveproduct.com/videos/R_2nd.m.45-55.mp4

http://caveproduct.com/videos/S_2nd.m.45-55.mp4

3rd Movement

Example 6

The following example, which shows measures 54-63, is a good illustration of the use of the ConDiS system, as the conductor needs to stop the DAW and synchronize and then set a new tempo (metronome 92). She immediately decides to activate a volume value control to reduce electronic sounds, though this is not written in the score.

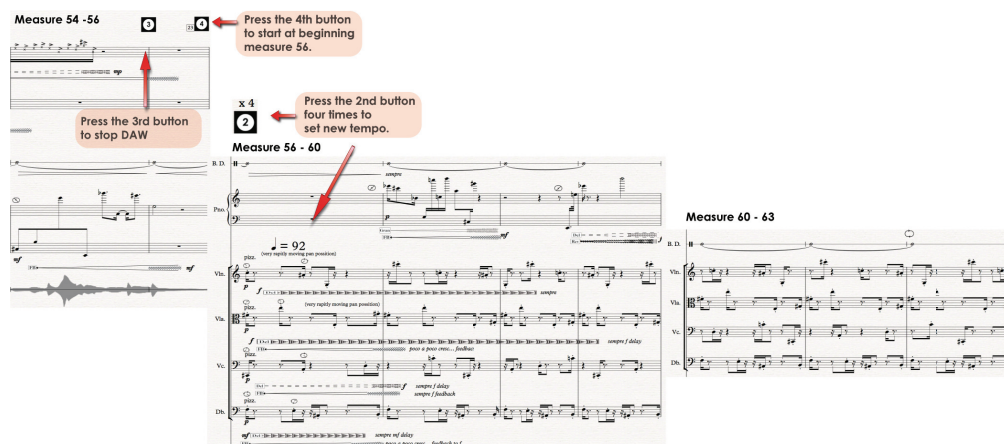


Figure 77. *Kuuki no Sukima* 3rd movement. Measures 54 – 63.

The accompanying video is of the performance of these measures. It shows clearly how the conductor, without visible difficulties, changes tempo from being around metronome $\text{♩} = 64$ to $\text{♩} = 92$. At the same time, she reduces the volume value of the electronics, probably because she has found the echo effects following the pizzicato (plucked strings) to be too loud. She then relatively quickly decides to increase the volume so that the echo comes in. It is a perfect example of how the conductor herself determines the balance between the sound and electronics. Her intention is to keep the echo effect strong at the beginning of this pizzicato section. The conductor's interpretation is excellent and gives the music more life. Again it comes down to the conductor's role in the music performance. Even though it is generally accepted that the conductor's job is to put themselves into the mind of the composer and interpret the music from that starting point, it is inevitable that the conductor stamps her own mark on the performance. The fact that the conductor puts her character into the composition is very important to me as a composer. It is in this way that the music comes to life, from being black dots on the manuscript page to a sea of sounds, tones, and chords.

Video example #28 - 30: Measures 54 – 64.

Harpa: http://caveproduct.com/videos/H_3rd.m.56-64.mp4

Schæffergården: http://caveproduct.com/videos/S_3rd.m.56-64.mp4

Rockheim: http://caveproduct.com/videos/R_3rd.m.56-64.mp4



Figure 78. Conductor Halldis Rønning conducting at Schæffergården in Copenhagen.

Reflections Based on an Interview with Halldis Rønning

Having the opportunity to work with conductor Halldis Rønning was an experience to treasure. From the very first moment I could feel her genuine interest in and commitment to the ConDiS project. It is not easy to work closely with a composer in the process of interpreting a new composition. And that is to say nothing about a composer who has added a digital glove to expand the conductor's field of work. Halldis Rønning showed admirable confidence, was positive all the time, and never questioned the musical usefulness of this experimental project. As was stated in the interview I conducted with her soon after the Nordic Tour, it became clear that she became more and more confident using the ConDiS technology after each concert, meaning she was able to play more with her musical and extended conducting abilities. Her only source of anxiety was receiving an overload of feedback through the speaker system, which occurred several times in the practice process. In the preliminary interview, Halldis suggested making slight changes to the design of the conducting glove to make it easier to turn pages while conducting. This was absolutely an oversight on my part because I am left-handed and usually use my right hand to turn pages.

The Fragility of the ConDiS System During Performance

As clearly stated in the interview with Halldis (see Appendix A), there were some difficulties using the ConDiS during the performances. The primary problem, especially during the early concerts, was that she did not sense much sonic response when using the conducting glove. She had difficulties in knowing how much volume to add and even how much the electronic volume would respond to her gesture. A feedback problem during rehearsals and the first performance at the Dokkhuset in November caused her to become nervous and cautious about using the ConDiS system's volume function. This fear about getting a feedback loop into the system also seems to have affected the performers, whose responses to my questioning⁴⁹ indicate that their knowing that conducting the electronics could go wrong had negatively affected their concentration.

Although for me the ConDiS conducting system was a successful outcome of the research project, I am aware that there are many things that can be improved. Mixed music performance of this kind, where there is a live real-time sound processing, is fragile in its nature. Feedback is a problem that increases proportionally with the size of the group of performers. On the other hand, the fact that the feedback "problem" disappeared at later stages was a good sign. It showed that additional experience helped to produce a better solution with respect to the microphone and speaker setup. It proved that as the conductor accumulated more experience she got more used to the functioning of the ConDiS and was therefore able to keep the feedback under control.

⁴⁹ See the "Reflections from the Performers" section.

Volume Level “Headroom”

Steering the overall volume of the electronic sounds is a complicated task and still a problem. The reason is that the conductor has a very little volume to control if and when the instruments are playing a soft passage. This is due to the fact that the source for all of the electronic sounds is the performing instruments themselves. If the instruments play softly, a very low sound level feeds into the audio system, producing a very soft electronic response. When the conductor tries to raise the volume level of a very soft sound source, there is a very subtle change that can lead to feedback. If, on the other hand, the volume level of the instruments is very loud, the conductor has much more “headroom,” meaning the conductor can change the volume level of the electronics much more drastically. To put this into more musical terms: If the instruments are playing very softly or *ppp*, the audio level of the electronics can vary from silence (volume 0 or 0%) to max *p* (30%); if the instruments are playing very loud *fff*, the audio level of the electronics can vary from silence (0%) to *fff* (100%). This difference in response was a bit problematic for the conductor and made it more difficult for her to get a “feel” for the volume control function.

While composing *Kuuki no Sukima* I was fully aware that writing a very soft-sounding piece would cause more problems than writing a composition with a louder sonic level. But that was part of the research process: I really wanted to create a composition where the sounds were soft and one would have to listen carefully to each sound to hear the slightest change. Perhaps it was a failure on my part not to have written a composition that included more volume changes or at least one moment with more loudness to demonstrate the use of ConDiS. Perhaps I should have written a composition giving the conductor more time to explore and play with the volume control. What would happen if there were a section where the strings play long sustained notes and the conductor can play with the volume or mix between the instrumental and electronic sounds? What would happen with a composition in which...? These questions can only be answered with new compositions.

I later realized that there are a number of ways to solve this “headroom”—or dynamic—problem. An altered DSP chain placing dynamic range compressions such as a limiter or compressor, for example, would make it possible to increase the electronic intensity of the incoming signal. These experiments are yet to come and will undoubtedly be a part of future projects.

One important factor in the conductor being able to control the overall volume is how evenly she hears the acoustic and electronic sounds. And this is a direct consequence of the stage setup, namely the microphone and loudspeaker locations. At the Harpa concert the loudspeakers were located in front of the ensemble, so neither the conductor nor the performers could clearly hear the electronics (see Appendix E). Cellist Marianne Baudouin Lie wrote in her answer to the survey question of whether a different positioning of the

ensemble would have made a difference, with reference to the location of the ensemble behind the front speakers at the Harpa concert:

Here I could hardly hear the electronics and it felt a bit like not being part of the work, like just being “the ensemble” and not inside the music. I was also uncertain as to whether the audience were hearing enough electronics.

From an aesthetic point of view, this problem, which is practical in part and technical in part, did affect the overall artistic outcome of the performances. It caused variations in the sonic outcome that were too drastically different from one performance to another.

This inability to hear the electronics at Harpa caused the ensemble to play louder and the conductor to use more volume control. At the concert in Schæffergården, the front loudspeakers were located behind the ensemble and the back speakers behind the audience. That resulted in a much softer performance, where the conductor kept the overall volume of the electronics much quieter. At the closing concert in Rockheim, monitors were placed behind the stage while the main loudspeakers were placed at front of the stage and the back speakers to the rear of the audience (see Appendix E). This loudspeaker setup proved to be the most satisfactory in the attempts to produce a complete mix of the overall sound for all parties: the performers, the conductor, and the audience.

Reflections from the Performers

Shortly after the Nordic Tour a questionnaire was sent to the members of the Sinfonietta. The following are my reflections on answers submitted by three members of the Trondheim Sinfonietta: the French hornist Peter Hatfield, cellist Marianne Baudouin Lie, and flutist Trine Knutsen.

- What is your opinion about the idea of expanding the conductor role by conducting the electronic sounds rather than a sound engineer? Is there an artistic gain?

They shared the belief that the idea of expanding the conductor’s role is a positive development. Marianne felt it made it more a part of the performance, adding extra tension to the electronics, regardless of whether everything works. Peter mentioned the possibility that the conductor (any conductor) wearing the glove “would become more creative with it,” while Trine pointed out that it made the performance unique from time to time.

Their answers reinforce my view that ConDiS is a step in the right direction. The fact that musicians experience each performance differently, that they feel the electronics to be more a part of the whole, and that they paid more attention to the electronics is positive. This

completely corresponds to the ConDiS conceptual charge to expand the possibilities of live concert performances. The project aimed to open the door to new possibilities for inspiring creativity that is unique to the performing artist on stage.

- With the conductor being able to control the electronic sound as well as the acoustic: Does that change your perception of the conductor's role?

Marianne mentioned that it made her "pay more attention to the things she does with the glove." Peter wrote that the role of the actual "conducting" needed to be more complicated, and especially when it comes to metric changes, "it might change rather more." Trine, on the other hand, noted that when the conductor has to keep track of the extended opportunities to "make mistakes etc.," that this might not be a positive additional role.

The extended role of the conductor through enabling control of the electronic sound did not change their perception of the conductor's role. This finding shows that the aim of the ConDiS project to develop a system that is a direct continuation of the conductor's classic conducting gestures has—in some ways—succeeded. That is also important from an artistic point of view since music performance is about the music, not about any extended role of a conductor or about technical solutions to technological problems.

What Peter said when talking about the complexity of the actual "conducting," meaning the traditional conducting without the extension of ConDiS, is true. This was a compromise I made at the beginning, writing the whole piece in 4/4 with no metric changes. I was afraid that if I went too far in that direction, the whole project would become much too complex. And this would, as Trine remarked, produce extended opportunities for mistakes. While mistakes are an important part of live musical performance, whether their outcome is positive or negative, I was afraid that if the conducting job became too complicated, the music would become more about technical experiments than artistic (musical) quality. I do agree with Marianne when she writes, "I'm impressed that she has learned to use it as well as concentrating on everything else in the score." I felt as though I needed to give the conductor a break. Perhaps I was wrong, perhaps I should have added metric changes into the composition. These questions can only be answered by writing a new piece of music.

- How does it feel watching the conductor using the ConDiS? Is it "natural", confusing or distracting when she moves the conducting glove?

Answers to this question were quite emphatic in the sense that they all found it quite disturbing to see the conductor use the ConDiS conducting glove. Trine was very straight forward, writing that it was "Most disturbing." She did not necessarily mean this in the sense of a visual distu

rbance, but was drawing more on a comment made by the conductor complaining about problems controlling volume and electronics. Marianne's response was not too dissimilar from Trine's, that she was "wondering if anything is going to go wrong." Marianne mentioned the accident at the Harpa performance in which the battery fell off. Peter reflected on the possibility of "mistaking an expressive gesture in the left hand for something to do with the electronics and vice versa."

It was surprising that what distracts the performers in watching the conductor is more their fear of hardware problems that the conductor cannot fix rather than any diversion created by her wearing the glove. I had imagined that the design of the glove or the object itself would be a visual distraction, but given their answers, it clearly is not. The fear of mistakes or failure is not new to performers, and it is interesting to see that crystalize in a fear of technical mistakes.

Only Peter mentioned the possibility that there would be confusion between conducting electronics and instruments in the expressive gestures in the left hand. This is a very valuable point, something that had me worried during the development process. When I made the decision to extend the conductor's job by using gestures as close to her traditional conducting gestures as possible, I was fully aware that the "electronic" expressive conducting could be confused with the instrumental. I am therefore pleased to a certain extent that Peter added: "in 'Kuuki' it wasn't really a problem, but I can imagine it might be in a different piece." What Peter is saying is that in my composition I consciously avoided the danger of confusion between the electronic and instrumental expressive conducting gestures. Perhaps I did so unconsciously or, more likely, Halldis solved that problem herself with her conducting experience.

With the exception of the fear about technical problems and the battery falling off at the Harpa performance, the use of ConDiS was not distracting or confusing for the performers. I had the feeling that as the tour went on, they paid less and less attention to the fact that Halldis was wearing a digital glove and that "the object" became less a part of the performance.

- Should additional information about the electronics be written in your musical part, such as reverb and delay? Is less more? Anything else?

Both Marianne and Peter were aware that too much information can be dangerous. Marianne did not think it was important since she was "not in charge of steering anything." Peter had a similar opinion based on the fact that he did not "hear anything." Trine, on the other hand, had a slightly different opinion, stating that it would have been nice to know what kind of effect had been intended. More importantly she added her view that the performer should be able to "optimize the effects."

Creating an equilibrium of information in a written instrumental score is an eternal problem. When is enough enough? In the original instrumental parts given to the performers, all information, meaning all electronic signs, were left in the parts. Like Trine commented, it was my opinion that it helps the performer to “optimize the effects.” I happened to be wrong; most of the performers got confused and asked for these signs to be left out in future versions.

Writing electronic signs into the instrumental score happened to be unnecessary. Why? First of all, the electronic signs have limited meaning for them since they are not used to these types of marks in a traditional score. In addition, classical musicians (like classical conductors) are not experienced in listening to their instruments extended with electronic sounds. Even if they did hear the extended electronic sound of their instrument, it might not help them much since they do not have the experience of linking their instrument to its electronic counterpart. Mixed music, or instrumental performance using digital sound processing, is still not part of their educational curriculum. Therefore, the notation of electronic information might be distracting or even confusing, like it could be for the conductor.

The other explanation might have to do with the difficulties in preserving a clear, audible relationship between their instrumental performative action and the electronic reaction, meaning the interplay between an individual instrument and its electronic counterpart would be recognizable. The performers complained when asked (not during rehearsal) that they did not hear clearly how the electronics responded to what they played. Marianne mentioned that the electronic signs were not needed since she was not in “charge of anything,” and Peter did not care since he could not “hear anything.” The reason Marianne felt as though she were not in “charge of anything” is, I believe, largely due to the fact that she could not hear very clearly the electronic response to her musical instrument.

I am convinced that if the response of the electronics had been more closely linked to their playing, and therefore more easily audible, they would have found a way to link the electronic signs to the instrumental score. Therefore, a good solution would have to be in the form of improved onstage monitoring. I thought of using headphones but gave it up, fearing it would cause even more trouble. Another plausible solution was to have a single monitor per musician. This proved to be too complex. There is a lot of work to be done, work I would love to tackle in the near future.

Reaction from the Audience

The following is a summary based on conversations I had with audience members right after each performance of *Kuuki no Sukima*. These conversations were guided by the following questions:

- What is your opinion of the idea of expanding the conductor role by conducting the electronic sounds?
- Is there an artistic gain?
- Can you describe your personal experience during the concert performance?

The most common answer to the expanded conductor's role was: What did the conductor do with the glove? This was exactly the type of reaction I was hoping for since it proved to me that I had succeeded in one of my primary goals. Throughout the entire development and research process, my main goal was to expand the conductor's ability to control the electronics, in as "natural" a way as possible, without any extra-musical gestures or other show-off gimmicks. These responses also reflect an indirect answer that could be interpreted as a positive reaction.

Regarding artistic gain, the audience members' responses were generally that they needed better insight and knowledge of the subject to be able to answer the question clearly. However, they agreed that they had experienced an exciting sonic world that was very exotic to them. They had experienced a performance that definitely contained artistic gain. The fact that the composition is more an abstract sonic art than a tonal composition already makes it difficult for the audience to exactly pinpoint the artistic gain. For me there is an obvious answer: there is substantial artistic gain—I have extended my musical language and my musical sonic world through the Bridging the Gap - ConDiS project.

The overall expression of the audience when asked about their personal experience of the performance was that it was a wonderful piece, a dreamy piece, meditative, ritual, one in which electronics strongly supported that experience without any interference from the technical implementation. I especially recall the words of composer Sunleif Rasmussen when he described the work as a spiritual experience that would be exceptionally well at home performed in cathedrals or churches. Recorder player Michala Petri believed she had rarely experienced such an equally good balance between electronics and acoustics. She considered the idea of leaving the total sound control in the hands of the conductor to be great. Electronic composer Rikhardur H. Fridriksson was less convinced and thought the idea of having the conductor in charge of the electronics was dangerous. He felt the electronics were way too soft and he was generally disturbed by watching the conductor in charge of the electronic sounds.

Finally, I would like to quote Eiríkur Pálsson, trumpeter with the Iceland Symphony Orchestra, who wrote to me: *Minnistætt hvað verkið var notalegt áheyrnar og svolítið draumkennt. Tækni þín, eða elektróníkin gaf því aukna dýpt eða kannski svona þrívídd sem undirstrikaði stemminguna í verkinu án þess að vera áberandi eða þannig að hún væri aðalatriðið eða eitthvað sem ætti að taka sérstaklega eftir.*

Roughly translated:

My recollection of the work was pleasant and somewhat dreamy. Your technology, or the electronics, gave it a greater depth, or perhaps a three-dimensional perspective that underlined the mood of the work. All without the technology being prominent or being the main thing or something that should be specifically noticed.



Chapter 7 Conclusion and Future Work

This dissertation has examined multiple aspects of the project from a variety of perspectives. My background and my motivation in creating ConDiS, the role of the conductor, and the evolution of gestural interfaces are all addressed in a historical context. Practical exercises and experiments conducted throughout the research process are explained. This is followed by an analysis of the conductor's use of her new tool, the conducting glove "ConGlove." This revolves around her musical interpretation of a written musical score during live performances.

The whole ConDiS process was a unique experience from beginning to end. From the first stage of fleshing out an idea for developing a tool to be used in a performance of one's own compositions. Then composing a new piece specifically written for the use of the new tool "ConGlove." Working with a conductor who practiced using this new device. Through to the final stage of performing *Kuuki no Sukima* on six occasions. Each stage was a unique experience in and of itself. When looking back on the process as a whole, it is therefore natural to ask: What (generalizable) conclusions can be drawn from this process?

Musical Expectations and Physical Constraints

In my application to the Norwegian Artistic Research Program I wrote the following:

The expected result is that through musical material of a composer and the conductor's musical gestures controlling digital technology, new sound worlds, new ways, new possibilities for musical performance will be explored. Practices that digital technology has to offer will be used to create a unique musical experience.

Expectations were high but not unrealistic. The ConDiS process addressed all of these factors, all of which were explored. Results have shown that the ConDiS system has:

- Opened up a new sonic world with unprecedented possibilities through composing, conducting, and performing interactive mixed music.
- Created new possibilities for composers through electronic notation and immediate synchronization of acoustic and electronics.
- Opened up new capabilities in the form of an extended role of the conductor.
- Created new possibilities through an uninterrupted interplay between the performers, the electronics, and the conductor.

Through ConDiS the composer can write the electronic part of a through-composed mixed music (ensemble music) composition with a precision and accuracy similar to that used in the notated instrumental score. This allows him better control of the expected sonic outcome. In spite of the fact that the ConDiS hardware—the ConGlove—affects and can limit the conductor’s natural conducting gestures, the conductor is in direct contact with the performers. Simultaneously, there is a direct connection with the electronics using conducting gestures and clicks of buttons on the glove. With the use of ConDiS, the “middleman” is cut out. There is no need for an additional “cue man.”

With ConDiS the performance, the interplay of instrumental and electronic sounds, gains additional musical meaning through the musicianship and musical interpretation on the part of the conductor. With the use of ConDiS the coexistence between the composer’s score of electronic and acoustic sounds flows through the conductor’s musical gestures.

Experiments made during the development phase of the ConDiS research project proved that the desired outcome was achievable. Sound can be successfully and dynamically altered in an expressive way. Sound can convincingly be moved and conducting gestures can change tempo and sonority. There are limitations, however, and these limitations coalesce around the human ability to learn and memorize. How many different pieces of information can we process at once? Where are the boundaries? Was the volume control turned on or not; did I push the 2nd button or was it the 3rd or...?

With ConDiS the conductor not only has to deal with all the traditional information written in the score, but she must additionally learn and remember various instructions for controlling the new member of the band, the live electronics. With more practice, the human limitations will decrease, and this will be reflected in an increased control of the electronics. The ConDiS artistic research project has proven that ConDiS can successfully be built around traditional conducting gestures. I do not foresee a need to introduce any major changes in the way this style of music (through-composed) is conducted, though I am fully aware that more improvised styles would introduce entirely new and different scenarios.

Physical Consequences of the ConGlove

Using a device attached to the conductor's body raises questions about physical consequences. It is evident that a supplement such as the ConGlove, despite being conceived as an extension to enhance the role of the conductor, is in some ways limiting and demanding. It limits the intuitive gestures of the conductor’s left hand, bringing with it not only physical consequences, but exercising a psychological impact on her concentration.

Closed/Open Hand for the on/off Function

When designing the ConDiS, it was fundamentally important to create a device that would have as little physical impact as possible. Thus various options were tested, including a baton, a glove with sensors that measured motion, and infrared technology (see table on page 41). For more on the results of these tests specifically, refer to the discussion above (See chapter 4). Based on the results of these tests I chose what I thought to be the most prudent direction. Using an x-OSC sensor enabled me to use a combination of high-performance analog/digital channels and onboard sensors (gyroscope, accelerometer, magnetometer) via OSC messages over Wi-Fi. This allowed me to use both gestures and physical touch-sensitive tools like bending sensors and buttons.

To minimize the constraints imposed by the ConGlove, the system is built to allow the conductor to turn the electronic control functions on and off by opening or closing her hand. That way when no action is required, the conductor does not affect the playback of the electronic sounds and can move her hand undisturbed, as long as she does not close her hand. Therefore, when the function is turned off, the conductor can use her left hand freely and in precisely the same way she does without ConDiS. Thus, there should not be any obstruction of conducting gestures involving the left hand.

In a conversation after the closing concert in Rockheim Halldis and I discussed, among other things, the success of this decision to allow an on/off function. It turned out that she felt that it was disturbing. The reason was that when she was able to conduct normally, her mind was still focused on remembering when to reconnect the system.

I had not considered this point of view and had actually believed that I had come up with a great solution. Following this conversation, I can better understand her perspective, and future work will involve finding a better solution, the specifics of which I will discuss below.

Use of Buttons

When the conductor needs to change the tempo or stop and synchronize playback, she needs to press different finger buttons. Pressing these buttons entails movements that are not natural to the conductor and, in that respect, new and initially unpleasant. I was aware of all of this from the very beginning and tried to find ways to mitigate or avoid these problems. Having the conductor push buttons was a simple, functional solution, but not 100% foolproof. What if the conductor forgets to press a button, or what if she does not push them properly? During the six performances of *Kuuki no Sukima* there were few incidents where pressing a button failed and the ConDiS system needed manual intervention and correction. Most of these incidents occurred during the first few performances, but they became less frequent, and during the final concert, only one incident took place which required manual assistance.

All of the failures are traceable to human error. The conductor forgot to press a button or failed to push firmly enough. At the Nordic Tour's last concert in Copenhagen, the metronome key (second finger) began to emit incomprehensible tempo changes, and it was revealed after the concert that the soldering of the wire was broken.

Using buttons is therefore not a perfect solution, but it proved to be the most reliable. Other solutions tested were gesture recognition and learning (MuBuForMax - hhmm) and a means of measuring directional change, registering turning points (zero points) in vertical and lower movements of the right or left hands (Max/MSP). For further details on these, see Appendix A. They all proved to be less reliable than buttons due to the complexity of the conductor's gestures.

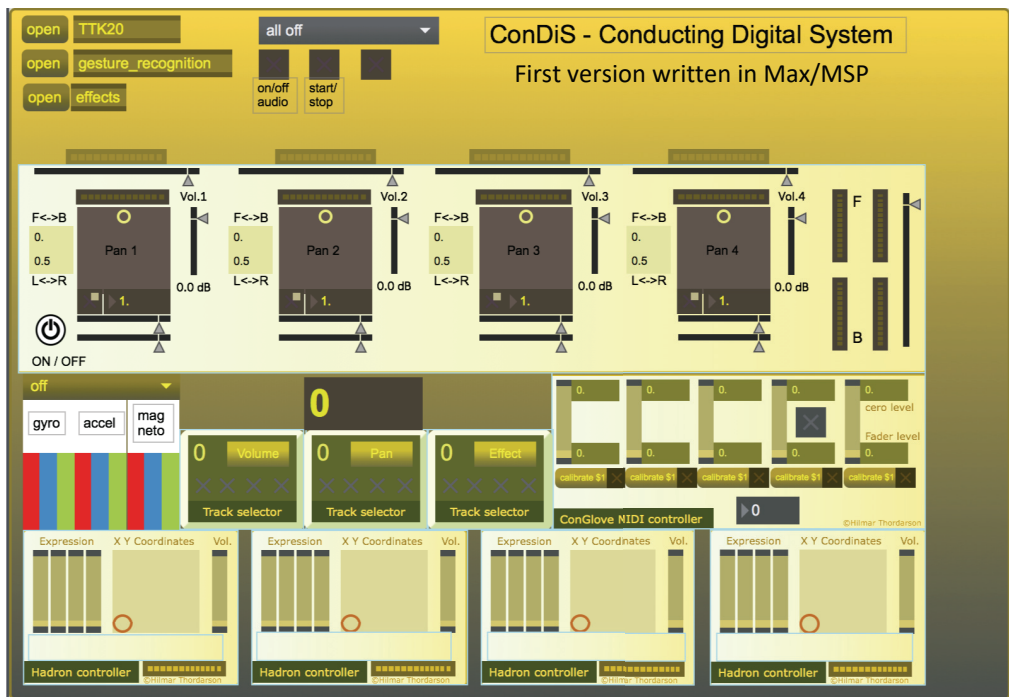
When asked Halldis for her opinion on my solution using buttons, her answers were straight forward. Her experience was negative and she found it disturbing to have to press buttons that weren't protected from accidentally being pushed. She also mentioned the difficulty involved in remembering which buttons to press and which buttons she pressed that would interfere with the operator. She suggested that I find a solution that reflects the reality of conducting practice, for example, having the conductor cue off or give a cue signal by pushing a pressure sensor with her fingertips.

Controlling Volume Value with Arm Movements

From the start I believed the solution of having the conductor activate the volume level control by closing her fist and adjust the level with her arm was the best and simplest one. It is a well-known practice that conductors use their left arm to indicate volume changes—an upward motion for increased volume and a downward one for decreasing volume. This method proved satisfactory but, as Halldis stated in our conversation, the main drawback was that she could never be sure when she had reached the maximum or minimum level. The ultimate solution would be to build a system such that the maximum volume level is when the conductor has a maximum arm position—that is, the conductor's arm held straight up—and minimum volume with the arm straight down.

Keep in mind that the position of the arm and volume value can vary. It is all based on the relative position of the arm meaning that the calculation relates to the latest arm position value. This relative arm position means that if the conductor deactivates volume control with 75% of its maximum volume value, it will stay at 75% when activated again — no matter [the] arm position. When the conductor activates the volume value control again, the arm is most likely not going to be in the same volume position as the last time the conductor deactivated the control. To have the computer remember the previous position is done to avoid an audible jump in the volume level.

The ultimate solution would be to build a system in which the maximum volume level is when the conductor has a maximum arm position, that is, the conductor's arm is held straight up from body or (0°), and minimum volume with the arm straight down (180°).



The Weaknesses of the ConDiS system

Although the ConDiS system proved to be successful in that it fulfills my basic needs for expanding my compositional methods, it is far from being a perfect system. The following section provides my assessment of the factors that weaken the system and that need to be fixed in future updates.

The weaknesses of the ConDiS system can be summarized as follows:

- It is an object that needs to be attached to the conductor.
- It needs too many pre-performance operations, including turning on the system, calibrating fingers, and pressing buttons.
- It requires conducting actions that are disturbing and unpleasant for the conductor.
- It needs an additional inspector who manually intervenes if something goes wrong.

Having a hardware device that must be attached to the conductor is not a perfect solution. When asked after the final concert about her experience using the ConGlove, Halldis openly expressed her opinion that the ConGlove was too bulky, used material that was too thick, and therefore hindered her conducting. She recommended a much thinner material be used that would include holes for the fingertips, which would make it easier to turn pages. She was also concerned about the size and weight of the battery. It interfered with and disturbed the way she naturally moved her arm.

The pre-performance operations that need to be completed before walking on the stage are disruptive and should be minimized. These operations include turning on the system, calibrating the fingers, and pressing various buttons. The perfect solution would be one that did not need any preparation and would turn on with an upbeat motion from the conductor at the very beginning of the performance. As mentioned above in the “Performance Preparation” section (p. 90), I managed to simplify these actions, but further development is needed.

The ConGlove requires specific actions during a performance that are not related to physical gestures intuitively used by a conductor. These actions include pressing buttons with different functions. Although the button solution was the most simple and reliable one that I could come up with, it is not ideal. It requires a certain amount of thought and abnormal motion. In my conversation with Halldis she mentioned the button functions and recommended other solutions, such as pressing sensors (see “Use of Buttons” p. 120).

The ability of the conductor to synchronize the system by jumping to markers written in the DAW beforehand is not a perfect solution even if it worked well for this project. The best solution would be to synchronize the whole score according to the conductor’s movements. Another solution would be to have the conductor synchronize the music when she feels it necessary. Unfortunately, my attempts to implement these types of resolutions turned out

to be too complicated or too unreliable to be of use in the ConDiS system. Despite its weaknesses, the ConDiS system did not prove to be too complicated, and Halldis and Arne Johansen (p. 74), who also experimented with the system, managed to use it after only relatively short periods of practice.

Conductors normally spend a substantial amount of time preparing with new compositions and in that context, the addition of ConDiS is less than ideal. The addition of ConDiS means they need to conduct an additional member of the ensemble, “the electronic sound extension,” or the DAW. They do so by following additional information written in the score. Preparation therefore mostly takes the form of practicing when to press which buttons and controlling the overall volume. They can easily incorporate this practice into their “traditional” preparation routine.

This does not mean that a conductor who is not familiar with the use of the ConDiS system would not need both instructions and practice before using it. But this process of preparation and practice is shorter than one might think. This of course depends on the musical style that is to be conducted since more improvised styles in which the conductor becomes a performer would allow or even require an entirely different way of conducting. Since the aim of the ConDiS research project focuses on through-composed mixed music, I will not explore that subject any further.

According to Halldis, she did not spend too much time practicing the functions, “perhaps a week or so,” with additional practice and learning taking place during rehearsals and concert performances. When asked about her preparation for the closing concert, held nine months after the five consecutive concerts of the Nordic Tour, she responded by saying that there had been no preparation time: “I was so used to the ConGlove that I just needed to put it on and start using it.”

The fact that the ConDiS system is not 100% reliable means that an additional person has to be available to manually “correct” any faults. This is mainly needed when the conductor forgets to press a button or does not press a button hard enough (see chapter 6). Then the “inspector” has to intervene and click the button manually via the DAW. This is a weakness of the system that needs to be solved in future updates.

One of the most critical challenges in the preparation of the ConDiS research project was to expand my compositional methods. Extended instrumental and electronic notation played a significant role in the process. I was fully aware that without expanding my notation language, my sonic world could not expand.

However, it is not enough to expand one’s collection of extended notation technique; one has to learn how to use it. I would need to be able to use it as clearly and fluidly as possible

and use it often to make it second nature. This development can only be accomplished by exercising the musical language through music composition.

ConDiS and its electronic notation graphics opens up new possibilities for composers to write with more precision the interplay between live instruments and their accompanying electronics. That way the composer becomes more aware, more conscious of the electronic writing in the whole compositional process. In other words, the writing of electronic sound becomes a part of the whole or an integrated part of the orchestration. That integration by itself leads to new methods, opening up novel possibilities for written compositions as well as musical performances.

Kuuki no Sukima went further sonically than anything else I have done so far. My constant search for altered sounds, different sonic combinations, and ways to compose and perform mixed music gained a new dimension. In composing *Kuuki no Sukima* I felt I was getting closer to discovering the sonic gap that I believe is there somewhere “In Between the Air.” I realize that even though I have gained a lot from the success of the ConDiS artistic research project, there is much to be discovered still. Therefore, it is so important to continue my journey through the valleys of the endless spectrum of music. And it is so important that I continue my research into varieties of musical harmony. I know I have just opened up a new door and now I am eager to discover and further explore the musical spectrum of the valleys behind or “in between.”

Because the ConDiS project aimed to develop conducting tools for the performance of through-composed mixed music, I must emphasize here that all of the research work associated with the project was confined to that particular type of music. Other forms such as improvised or even semi-improvised music were not included. Different forms reveal different potentials for using ConDiS, as shown through my conducting of “Silence I Ask” at the closing concert in Rockheim. There I conducted a semi-improvised performance which does not require the accuracy of through-composed music. I was therefore able to freely improvise my interpretation of the electronic sounds that extended the performing voices. This kind of performance (use of ConDiS) is by all means more entertaining and to some extend more interesting for the audience. It has more of a visual relationship to what you are hearing, and it is definitely fun to conduct since you are also performing an instrument. Nevertheless, this type of performance was not what the ConDiS research project is about. “Silence I Ask” was added to the program in historical context to the first performance of the work in Rockheim 2013, and to show the potential of ConDiS

I believe that the ConDiS system has contributed in important ways to my artistic position at the national and international levels. This is particularly evident in the results of my research process, including my composition "Kuuki no Sukima" and its performances, and now this dissertation in textual form and its publicly available video components. The ConDiS

system has broadened my composition potential. It has demonstrated new possibilities for music performance and it has proved it possible to extend the role of the conductor. The future development of the ConDiS system needs to be put in the hands of others—other composers, conductors, and performers. That way the ConDiS project will continue to contribute to the professional development of all types of mixed music performance, thus elevating new ideas and artistic innovation. I also foresee the ConDiS concept easily expanding its reach to cross over to other artistic fields, especially the field of multimedia.

While composing *Kuuki no Sukima* and again when listening to the performances of the work, I constantly asked myself if I was exploiting the full potential of ConDiS. I can confidently say that I did. This is not to say that the end results exactly met my expectations at the beginning of the project, but the project was successful to the extent that it fully satisfied my intent to produce a compelling performance of my composition.

The ConDiS research project aimed to make a tool for use in conducting through-composed mixed music, meaning the conductor has to follow instructions provided in a written score. That alone significantly constrains other possibilities inherent in potential uses for the ConDiS system. This is especially evident in the fact that certain capabilities that I initially intended the conductor to have, such as pan and effects control, had to be eliminated for practical reasons.

As stated in the introduction, I am interested in writing through-composed mixed music, and so it was necessary for me to focus on that subject. The end effect of this is that the ConDiS research limited itself to the potential of the system within that specific framework. Hence the study did not address the full range of the possibilities for using the ConDiS system. As demonstrated at the closing concert in Rockheim during the performance of “Silence I Ask” for Voices, the possibilities for using the system are many and inspiring. And it is my hope and intent that all of these will be explored in future compositions.

At the beginning of the ConDiS project I was aware of the fact that the potential capabilities of ConDiS could affect or change my compositional writing practices. I could even go so far as to expect a change in my compositional method. Early in the compositional process it became clear to me that there was little need to change my style, I felt no obligation or desire to write a composition only to demonstrate the possible use of ConDiS. Instead, I felt I had a tool that was useful for fulfilling my “desire” to expand my sonic world. Therefore, *Kuuki no Sukima* was primarily written to fulfill my artistic ambition. *Kuuki no Sukima* is by no means a demonstrative composition; it is a serious composition fulfilling my artistic needs. This is in and of itself a successful result.

Achievements

Experiments made through various short compositions—“Etudes”—during the development phase of the ConDiS research project proved that it would be possible to achieve the desired results. There are several options for incorporating the electronic sound extension of the acoustic instruments graphically into the traditional musical score. Sonic changes can be written successfully into the musical score as graphical symbols similar to other traditional symbols such as volume change indications (crescendo/diminuendo *p* or *f*). Button-pushing symbols are easily understood, as are the panning symbols.

During a performance, sound can be successfully and expressively dynamically altered. Sound can be moved in a convincing manner and conducting gestures can change tempo and sonority. However, there are limitations in the form of the human ability to learn and memorize, the limits of the human brain. How many different types of information can we process at once? Where are the boundaries? How can the conductor avoid a rush of questions in her mind during the performance: Was the volume control turned on or not? Did I push the 2nd button or was it the 3rd, or...?

A variety of experiments and practical performance exercises provided invaluable information regarding these questions that informed the research and development process. They resulted in changes that were driven by technical limitations, human psychological congestion thresholds, and aesthetics. The project was partially reconstructed and simplified.

Due to technical limitations, indented features such as facial recognition and other gestural recognition features had to be left out. Given human limitations and the tradition of conducting, the final version of ConDiS eliminated the conductor’s control of both panning and effects. Even though I accept that these functions are not part of the conductor’s conventional job, my imagination is still tickled by the possibility of offering the conductor those capabilities. Another decision was made to exclude all innovative and exotic conducting gestures, this time for aesthetic reasons. This decision demonstrates to me that ConDiS can be built successfully within the limits of traditional conducting. Similarly, but for musical reasons, a decision was made not to include any extra-musical conducting show-off gestures.

When using the ConDiS system, the conductor not only has to deal with all the traditional information written in the score, but she must additionally learn and remember various symbols and graphic representations to lead the new member of the band, the live electronics. With more practice, the human limitations threshold will become lower, reflecting an increased control of the electronics, as was demonstrated during the five concerts of the Nordic Tour. With more practice, the conductor’s job can expand even further.

I am fully aware that ConDiS is not a complete system for live digital conducting of mixed media performance. I am also aware that ConDiS might never—perhaps should never—become a complete system due to the fact that constant technological innovation offers endless new developments and changes. But it is an important step to unify the interplay needed for mixed music performances. It is an important step to add the DAW as a new member of the orchestra.

With time the conductor becomes a part of the whole: the musical score, electronics, and the ensemble. With time, conducting electronics becomes as natural to the conductor as conducting the “other” instruments.

Future work

Cooperative Development

Further development of the ConDiS system is already planned, including a new design of the ConGlove. This will be based on the experience gathered over the course of the ConDiS project and the suggestions provided by conductor Halldis Rønning. Towards that end, I have already had meetings and correspondence on artistic and technical cooperation with persons related to innovation in the arts. In these we have focused on our mutual interest in expanding the abilities of the glove technology in multimedia performances, including the visual arts and dance.

Cooperative Artistic Work

Not only will further development of ConDiS continue, so will the ongoing development of electronic notation and conducting instructions. The potential inherent in notation and instructional techniques will enhance and expand ConDiS’ potential, from writing ensemble works to use in multimedia performances. These developments will together reveal the capabilities or limitations of the conductor to control individual sonic groups of performers at a single time.

Thanks to a grant from the Norwegian-Icelandic Cultural Cooperation Fund, preparatory work on a new cooperative multimedia production (working title “Black Obsidian”) has already begun with conductor Halldis Rønning. In our application to the fund the project is described as a “cooperative multimedia production of composer/conductor Hilmar Thordarson and conductor/composer Halldis Rønning. They will create a work together and

cooperate with two excellent ensembles, the Icelandic Caput Ensemble⁵⁰ and the Norwegian IMNO ensemble to realize the end project “Sort Glimmer.” They will make use of the ConDiS technology glove to create and manipulate the electronic sounds and visual art design. The cooperation will consist of workshops with the two ensembles in both countries and eventually performances in both countries to be held at art festivals in 2020.”

The composition will be written in a more open form: a through-composed composition, semi-improvised and improvised. Workshops will be used to engage in experimentation with mixing the tradition of written composed music with improvisational instructions. This will further enhance and expand the potential of ConDiS, giving the conductor an excellent opportunity to test her ability and limitations. In this process the conductor will be more involved in making her own artistic decisions. She will be able to “exform” them with a clear sense of perception or interpretation and creatively apply and sculpt real-time DSP to what is being played. This will allow the conductor not only to conduct the written instructions, but also to sculpt the performance and, by doing so, function as a co-composer and performer as well.

In order to further develop the ConDiS concept, i.e. to extend the conductor’s traditional conducting responsibility, it is necessary to involve more composers and conductors. Without this, a project such as this will end up like so many others have, fading away gradually or limited in its use to its creator alone. To avoid such a fate, workshops are scheduled in collaboration with ensembles and academic art institutions to offer young, talented composers the opportunity to compose and conduct music for the ConDiS system. The likelihood that the ConDiS concept and tools will be able to put down firm roots is significantly improved when it can be used and experimented with by the youngest generation of musicians.

⁵⁰ <http://caput.is>

Epilogue

ConDiS - The Final Artistic Research Concert



The final Artistic Research Program concert took place on November 3, 2018, at Dokkhuset in Trondheim under the name “Bridging the Gap.” The program consisted of three compositions by the author: *Silence I Ask* (2013) for 14 voices and live computer-generated sounds, *Sononymus for Flute* (1998-2000) for flute and computer-generated sounds, and finally *Kuuki no Sukima* (2017/18) for 9 instruments, interactive conductor, and live computer-generated sounds.

A video recording of the whole concert can be found at:

<https://vimeo.com/300730209/8577fb29d9>

Two of these works—*Silence I Ask* and *Kuuki no Sukima*—were selected as they clearly illustrate two different functionalities of the ConDiS system. The first shows a possible use of ConDiS for conducting and performing a semi-improvised work. The latter demonstrates a possible use for the system in conducting a performance of a through-composed concert work. The third piece, *Sononymus for Flute*, was chosen to provide a historical perspective as it presents the oldest synchronization method of mixed music performance: the fixed media/playback where the performer follows a written score of a fixed prerecorded audio file(s). I consider it to be a good example of the problem I have solved with the design of the ConDiS system.

Silence / Ask

The first work featured on the program was a revised version of *Silence / Ask* for voices, interactive conductor, and live electronics. Originally written in 2013 and premiered that same year at the Rockheim museum in Trondheim, the new version included an interactive conductor using the ConDiS system.

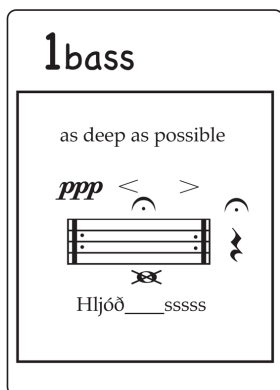


Figure 79. *Silence / Ask*. First card for bass.

The stage setup is such that the singers form a circle around the audience in groups of two with a conductor located in the middle of the audience. With one microphone per voice, the voices are transformed using a custom-made amplitude envelope follower. It analyzes the vocal loudness and feeds them using real-time digital signal processing (DSP) to a surround loudspeaker arrangement.

The written score consists of fifty-two cards divided into four voice groups, soprano, alto, tenor, bass, with each voice of a group holding a stack of thirteen cards numbered from 1 to 13—each card containing written information conveying musical ideas that performers follow or improvise around. The conductor's job in the original version is then to signal (cue) when to move from

one card to the next and to adjust the volume of the voices and live electronics through conducting exformation. In this, the electronic sound level is a direct consequence of the volume of the voices.

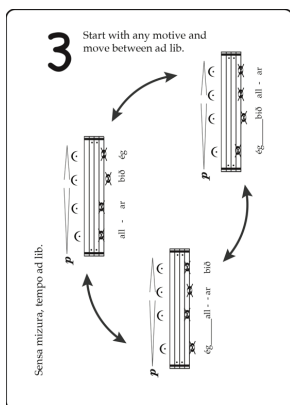


Figure 80. *Silence / Ask*. Third card for Alto.

As I stood there during the performance in 2013, conducting on a podium in the middle of the audience, the need for the ability to conduct and control the electronics became evident. What if I could use my conducting gestures to mix the sonic balance, bring the electronic volume up and down, change its timbre, and move it around the hall? I felt an urgent need to create a conducting tool such as would become ConDiS.

The revised version of *Silence / Ask* did precisely that. Using the ConDiS system, I managed to add those features that I so urgently wanted during the 2013 performance. Using a mixture of sign language and arm gestures I was able to affect and control the computer-generated sound while conducting the performing voices. Making an OK sign activated volume control

and moving my left arm up increased the volume, while a downward motion would decrease the volume. A thumbs up signal followed by a twist of the arm activated and enabled the panning function allowing control of the spatial location of the computer sound. A little-finger up sign along with different finger combinations then allowed the selection of

different sound effects. This sound effect could then be controlled by different left-hand movements.

An example of an effect control could be as follows: Begin pointing the little finger of the left hand (the hand wearing the glove) straight out, and then extend a three-finger combination (index, middle, and ring finger) to activate the low pass filter effect. Then open the filter by turning the hand to the right, and close it by turning the hand to the left. To control the amplitude of the effect, an up/down motion of the left arm is needed.

Reflections

Reflecting on the performance, I felt quite pleased; technologically it went well, and aesthetically I was satisfied. I really could feel how my conducting gestures controlled the overall interplay of the voices and the electronics. The feeling of being able to mold and sculpt the electronic sounds and at the same time conduct the performing voices was unexplainable. After a rather cautious start, I grew more enthusiastic and enjoyed improvising with a variety of gesture variations as I began to feel as though I were part of the whole.

Although the ConDiS system successfully met my expectations, it is far from being flawless. The fact that I was conducting a semi-improvised performance meant I did not have to follow a through-composed score, which gave me a lot of freedom. It allowed me to concentrate more on the sound-sculpting factor. By this I mean I was able to play with the sound on the spot, unbound by tight synchronization with the composed score. However, there are many things I would have liked to be simpler and somewhat more musical. I found the need for a computer screen to “see” what action/actions were active was a disturbance that needed eliminating or at least minimizing. Having to use a special sign language in the form of finger combinations to activate/deactivate certain features can also be rather complicated. As mentioned on page. 126, it can become confusing keeping track of which controller you have activated or deactivated, which effect type you have increased/decreased in volume, etc. Although the freedom of improvisation means these moments of confusion are hardly audible or recognizable to the audience, a better solution would certainly be a benefit to the ConDiS system.

Stage Setup

The stage setup, with the singers located around the hall and the conductor located in the center, had a considerable impact on the audience’s musical experience. It greatly improved the audience’s ability to follow the interaction between the conductor’s gestures and the apparent outcome from the speakers located around the hall. Although the singers did complain about not hearing the overall outcome, namely what the other groups of singers were singing, they quickly got used to it during the few rehearsals they did have in the hall.

Once again, we were confronted with the issue of limited rehearsal time for mixed music performance.

Although the conductor cannot face all the performers at the same time because they are situated all around him, it did not seem to cause any confusion, as the conductor turns to the group he needs to instruct. When the conductor needs to make contact with all the performers at once, such as when there is a change of performance cards, he raises his arms, makes a sign (finger sign), and turns in place, making sure that all performers are in contact.

I must underline that even though I consider the first performance of *Silence I Ask* in 2013 to have been an important stepping stone toward the idea of ConDiS, the ConDiS research project has not been built with an emphasis on this type of performance. The ConDiS system is built for conducting through-composed mixed music, although it has proven to be very useful for semi-improvised or improvised performances as well. As such, the premiere of *Silence I Ask* using ConDiS for interactive conducting proved to be an experience of a certain significance, an experience that sparked ideas for future development and compositions.

Sononymus for Flute

Sononymus for flute and electronics represents one of my earliest works in the field of mixed music. I decided to place it on the program for two main reasons. The first is purely aesthetic, since it is a work of personal significance, having been written for and dedicated to the birth of my first child. The second reason was its historical significance since it uses the earliest type of synchronization strategy in mixed music, the fixed media/playback. In writing about the piece on page 16, I mention the constraint presented by having the performer following a fixed playback: "I felt the performer was constrained since he had to follow the CD player no matter what." I explain how players develop their own ways of finding sounds or signals to use as cues to keep in sync with the CD player. My decision to present this work was motivated by a desire to give the audience an opportunity to listen to the "old," constrained synchronization method. Surprisingly the musician had not only learned and marked some cues, but also had them timed. By using a stopwatch on a mobile phone, the synchronization remained fairly accurate, hence the constraints of fixed playback were hardly noticeable.

Kuuki no Sukima

The final work of the concert, *Kuuki no Sukima*, was being performed for the sixth time by Trondheim Sinfonietta under conductor Haldis Rønning. The last previous performance of the work was in Copenhagen at the beginning of February, which was about 9 months after the performance before that. Initially, I had asked for three days in advance to prepare and rehearse for the final concert, but for various reasons it had not been possible. As previously discussed, mixed music's Achilles heel is the difficulty associated with getting enough rehearsal time, plus the expenses of adequate setup for more than one day. We had to face

that fact that we had to prepare as well as possible with very little time. This by itself was an opportunity to prove that the ConDiS system is sufficiently simple and stable to use, which was the initial aim of the ConDiS project.

Several performers from the Nordic Tour were not available and had to be replaced. For that reason, a great part of the rehearsal time involved achieving the right sonority and incorporating these new players into the artistic interpretation of the work. The whole ConDiS system was working well during the rehearsal and I found it noteworthy how skilled and confident in using it the conductor had become. Therefore, it was possible to practice the work without any interference from technical or technological problems. That way we were able to place the main emphasis on artistic progress and interpretation. However, this did not allow for the time for the careful monitoring setup that I was originally hoping for with the aim of improving the relationship between instruments and electronics. The same was also true for the conductor, who did not have access to the monitor setup I was hoping for. I had asked for a monitor located at her feet but had to settle with monitors placed behind and above the ensemble which faced downwards onto the stage. Thus, the performers and the conductor were better able to hear the overall electronic sounds than they had been before.

Reflections

Besides not getting the rehearsal time that I was expecting, this sixth performance exceeded all the other performances in both sonic quality and aesthetic interpretation. From the beginning it was obvious that the conductor was in full control, she was relaxed yet focused on her conducting of both the instrumental and electronic sounds. The fact that the piece had had time to settle definitely had a positive effect. This was reflected in a more playful approach from the performers. The result was a performance where the music enjoyed the space, the breathing room, so to speak, that was necessary for it to flourish. The overall sound quality was better than before due to changes made both in microphone setup and in the form of a software upgrade, including a totally new plugin for surround mixing. Finally, the Rockheim music hall, with its square shape, high ceiling, and dark, raw concrete, was a perfect setting for this type of musical performance. This is something I knew beforehand, hence the choice of location.

In spite of the excellent performance, some things could have gone better. With respect to my artistic tastes, I would have preferred more variation in the volume levels of the electronics. The conductor chose to keep the volume somewhat loud all the time, which sometimes caused the details of the sonic environment to disappear. But this experience is precisely what the ConDiS system allows: the conductor is able to make decisions and interpret the written composition herself. It is precisely these aspects that fascinate me, these humanistic variants that arise from the interpretation of the music performance from one person to another. As a composer, I find this exceptionally fascinating because I am not

interested in carving my composition in stone. This statement may sound like a contradiction since, on the other hand, I want to write through-composed compositions. But as I have emphasized before, I enjoy writing musical ideas as accurately as I want, keeping in mind that inaccuracies can be a matter of accuracy, and then allowing the performer to add his musical interpretation. That is what makes for the interesting musical interplay between the composer's score and the performer. It is exactly this personal interaction that turns music into a musical adventure.

Stage Setup

Having performed two works with totally different setups, one with performers surrounding the audience and the other staged in the classic performance style on stage, prompted me to think about the importance of the stage setup. Surely the intention behind the creation of ConDiS and therefore the composition *Kuuki no Sukima* was solely to experiment with the new conducting tool, the ConDiS, in a very narrow way. This more limited framework would test if it was possible to use ConDiS in the "classic" stage setup.

In my opinion, this experiment was successful, and I believe I achieved acceptable results. But I have experienced a strong desire to expand the horizon. What if the ensemble is staged differently? What if the musicians are located further apart from each other? What if they are staged all over the hall, like in *Silence I Ask*? What if...? These are all questions that challenge my thinking following the experience of the ConDiS closing concert. These are all questions for which I will have to find answers in future compositions.



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Appendix A

Interview with Conductor Halldis Rønning

The following are reflections based on an interview with conductor Halldis Rønning conducted shortly after the Trondheim Sinfonietta's Nordic Tour.

Halldis conducted all the performances of *Kuuki no Sukima* at concerts in Harpa in Reykjavik, Iceland, Nordic House in Torshavn and Christian's Church in Klaksvik, Faroe Islands, and Schæffergården in Copenhagen, Denmark.

The conductor's art of conducting is one of the main focal points of the ConDiS project. Therefore, the interview with Halldis is a critical component in the ConDiS artistic research process and in prompting reflections on the project.

Video recordings are used since transcribing these dynamic interviews in writing would not capture them sufficiently or do them justice.

What is your opinion about the idea of expanding the conductor role by conducting the electronic sounds?

Video example #31: <http://caveproduct.com/videos/1.idea-of-ConDiS.mp4>

Is there an artistic need?

Video example #32: <http://caveproduct.com/videos/2.artistic-need.mp4>

Controlling more than sound?

Video example #33: <http://caveproduct.com/videos/3.adding-video.mp4>

The threshold of complexity?

Video example #34: <http://caveproduct.com/videos/4.too-much-info.mp4>

What does the conductor do differently with the music when able to conduct the electronic sound as well as conducting the traditional way? Is there a feeling of fusion of the roles of the conductor and performer?

Video example #35: <http://caveproduct.com/videos/5.What-C-do-dif.mp4>

How does the conductor feel using the ConDiS, does it feel natural toward her way of conducting?

Video example #36: <http://caveproduct.com/videos/6b.feel-of-tact.mp4>

Did a different location of the loudspeakers make a difference?

During the “Nordic Tour,” performances took place in different “concert” halls with different placements of the ensemble.

1. Did a different location of the loudspeakers make a difference?
2. Did a differently resonating hall make a difference in the performance?
3. Ensemble located on stage behind the front speakers. (Harpa)
4. Ensemble located on stage with front speakers on their sides. (Nordic House and Christian’s Church, Klaksvik)
5. Ensemble located on stage with front speakers behind. (Copenhagen)

Video example #37: <http://caveproduct.com/videos/7.0.Loc-of-spker.mp4>

Video example #38: <http://caveproduct.com/videos/7.II.res-diff-loc....mp4>

Did a different resonating hall make a difference in the performance?

Probably the piece benefits from some space.

Video example #39: <http://caveproduct.com/videos/7.I.res-diff-hall....mp4>

How can I improve the Conducting Glove "ConGlove"?

Page turning!

Video example #40: <http://caveproduct.com/videos/9.Pturn-and-Glove....mp4>

What musical parameters should the conductor be conducting? Volume, tempo, spatial sound location etc....

Adjusting the parameters?

Video example #41: <http://caveproduct.com/videos/9.II.adj-param.mp4>

About adding new parameters: Panning control?

Video example #42: <http://caveproduct.com/videos/9.III.pan-ctrl.mp4>

Leave it for the next piece: A concert for conductor, video, and orchestra.

Video example #43: <http://caveproduct.com/videos/9.IV.next-piece.mp4>

The written musical score?

The complexity of the score and writing of electronic sound information?

Video example #44: <http://caveproduct.com/videos/10.I.cplex-score.mp4>

Is there a need for visual aid such as iPad screen etc.?

Video example #45: <http://caveproduct.com/videos/10.IV.screen-aid.mp4>

The anxiety of receiving an overload of feedback.

The danger of Feedback.

Video example #46: http://caveproduct.com/videos/11.fbck_dngr.mp4

The danger of Feedback, part 2

Video example #47: http://caveproduct.com/videos/11.II.fbck_dngr2.mp4

Appendix B

Questions and answers – Performers

Marianne Baudouin Lie, cellist:

- What is your opinion about the idea of expanding the conductor role by conducting the electronic sounds rather than a sound engineer? Is there an Artistic gain?

I think that it feels more like the electronics are also a part of the performance within the ensemble, maybe more than if it was steered from outside. It also gives an extra tension as to whether or not everything works, and I find myself listening to hear if the electronics are there. I do get a bit distracted by the glove and worrying about it working, but that might be because this is a prototype and things have in some instances not been working, or the levels seem uncontrollable. It is almost so I would have wished for the composer to have a small console to see how the levels were behaving. But at the same time, I didn't think the distraction made the performance less concentrated, it was more like an observation.

- With the conductor being able of controlling the electronic sound as well as the acoustic. Does that change your perception of the conductor's role?

Well it makes me pay attention to the things she does with the glove and I'm impressed that she has learnt to use it as well as concentrating on everything else in the score.

- How does it feel watching the conductor using the ConDiS? Is it "natural", confusing or distracting when she moves the conducting glove?

It is somehow a bit distracting with the glove because I keep wondering if anything is going to go wrong, or if she will push the right button. Or what happens if the battery actually falls off etc. I'm also very aware that she has to change her main conducting hand, but this does not bother me.

- Should additional information about the electronics be written in your musical part such as reverb and delay? Is less more? Anything else?

I do not feel that I need more information about the electronics as long as I'm not in charge of steering anything.

- During the “Nordic Tour” performance took place in different “concert” halls with different placements of the ensemble.

I. Did a different resonating hall make difference of the performance?

Yes I think so, or maybe it was that the electronics were given more reverb. I felt like a room with more reverb created a better unity of the acoustic and the electric sounds.

II. Did a different location of the ensemble make difference for you? Can you describe the difference?

a) Ensemble located on stage behind the front speakers. (Harpa)

Here I could hardly hear the electronics and it felt a bit like not being part of the work, like just being “the ensemble” and not inside the music. I was also uncertain as to whether the audience were hearing enough electronics.

b) Ensemble located on stage with front speakers on their sides. (Nordic House and Christians Church, Klaksvik)

This worked better, but I still felt that either the levels were a bit low or that I just couldn’t hear the electronic part. But I know Rasmussen was very happy with the work in Klaksvik and thought the acoustic in the hall and the electronics created a good unity.

c) Ensemble located on stage with front speakers behind. (Copenhagen)

Here we felt like a part of the entire work, and I think this affects the way we play and the way we imagine the music. So, I think this is the best location of the speakers – keeping both the ensemble and the audience inside the circle of sound. I think it is then also easier to give more as a performer.

- Can you describe your personal experience during the concert performance?

I had difficulty trusting the sound I was hearing, which is difficult being an acoustic musician used to orientate everything from what I hear around me. This felt better when the ensemble was within the circle of sound. I could also not let go of worrying about something not working, but maybe it is always like that with acousmatic/ mixed music? I enjoyed playing when I could hear the effect the music was creating, feeling like a small part in a big mix.

Peter Hatfield, French Horn player:

- What is your opinion about the idea of expanding the conductor role by conducting the electronic sounds rather than a sound engineer. Is there an Artistic gain?

I think it has possibilities. We talked about Boulez “Répons”, but I’ve only heard that on TV or on CD, never live, so I’m not sure how reliant Boulez was on his sound man. As Halldis, or any conductor did this or any other piece involving the glove, I guess they would become more creative with it.

- With the conductor being able of controlling the electronic sound as well as the acoustic. Does that change your perception of the conductor’s role?

Not really. The actual “Conducting” part of the job was relatively simple: If one found a way to use the glove in Répons, which I far more complicated, with many fast time changes (5/16 - 7/16 - 3/8 etc.) it might change rather more.

- How does it feel watching the conductor using the ConDIS? Is it “natural”, confusing or distracting when she moves the conducting glove.

This is a continuation of the previous question. There is a danger of mistaking an expressive gesture in the left hand for something to do with the electronics and vice versa. In “Kuuki” it wasn’t really a problem, but I can imagine it might be in a different piece.

- Should additional information about the electronics be written in your musical part such as reverb and delay? Is less more? Anything else?

On stage I didn’t hear the electronics as much as I expected to (at least in comparison to the Harpa performance on You Tube. I was pleasantly surprised when I heard anything, so I don’t think for myself I need more information than I had. There is a danger of “Too Much Information”.

- During the “Nordic Tour” performance took place in different “concert” halls with different placements of the ensemble.

I. Did a different resonating hall make difference of the performance?

I became less and less aware of the electronics as the tour went on. Even more than most performances, the stage is not always the best place to judge the overall effect of a

performance. I got the impression that you and Halldis were more careful with the volume levels in the smaller halls due to the danger of feedback, so the overall effect seemed to be less integrated.

- II. Did a different location of the ensemble make difference for you? Can you describe the difference?
 - a) Ensemble located on stage behind the front speakers. (Harpa)

 - b) Ensemble located on stage with front speakers on their sides. (Nordic House and Christians Church, Klaksvik)

 - c) Ensemble located on stage with front speakers behind. (Copenhagen)

One would have expected to hear more of the electronics with the speakers behind the ensemble, but I hardly noticed it at all there (volume levels too low?)

- Can you describe your personal experience during the concert performance?

As I mentioned it was difficult to get the whole picture from where I was sat. For myself I was pre-occupied with what I had to do personally and was pleasantly surprised (but I hope not distracted...) when I became aware for the electronics, especially when they were generated by something I had played.

Trine Knutsen, Flute player

- What is your opinion about the idea of expanding the conductor role by conducting the electronic sounds rather than a sound engineer. Is there an Artistic gain?

Spennende tilleggfunksjon for en dirigent. Bidrar til at framførelsen blir unik fra gang til gang.

Translation:

Exciting additionality for a conductor. Continues to make the performance unique from time to time.

- With the conductor being able of controlling the electronic sound as well as the acoustic. Does that change your perception of the conductor's role?

Hun får mer å holde styr på, flere muligheter til å gjøre feil osv. Dvs ikke nødvendigvis en positiv tilleggsrolle.

Translation:

She gets more to keep track of, more opportunities to make mistakes, etc. That is not necessarily a positive additional role.

- How does it feel watching the conductor using the ConDiS? Is it “natural”, confusing or distracting when she moves the conducting glove.

Mest forstyrrende egentlig. Særlig fordi hun stadig kommenterte at hun egentlig ikke hadde kontroll på volumet, dvs ikke følte at hun faktisk hadde kontroll på effektene når hun brukte hansken.

Translation:

Most disturbing really. Especially because she constantly commented that she did not really control the volume, meaning she did not actually control the effects when she used her glove.

- Should additional information about the electronics be written in your musical part such as reverb and delay? Is less more? Anything else?

Ja gjerne, fint å vite hvilken effekt som er tilsiktet. Slik kan musikeren også bidra til å optimalisere effektene.

Translation:

Oh, yes, it’s nice to know what effect is intended. This way the musician can also help optimize the effects.

- During the “Nordic Tour” performance took place in different “concert” halls with different placements of the ensemble.
 - I. Did a different resonating hall make difference of the performance?
 - Absolutt. Først og fremst fordi man tilpasser seg akustikken ift egen dynamikk, artikulasjon osv.
Translation: Absolutely. First and foremost because you adapt to acoustics in your own dynamics, articulation, etc.
 - II. Did a different location of the ensemble make difference for you? Can you describe the difference?
 - a) Ensemble located on stage behind the front speakers. (Harpa)

Opplevdes som at man spilte mer separert, alene. Akustikken i denne salen var "sterk", dvs at man kunne spille veldig svak dynamikk og effekter og at det fortsatt bar godt til publikum i salen.

Translation:

Experienced as playing more separated, alone. The acoustics in this hall were "strong," meaning that you could play very weak dynamics and effects and it still benefited the audience in the hall.

- b) Ensemble located on stage with front speakers on their sides. (Nordic House and Christians Church, Klaksvik)

Denne løsningen kjentes best ut for meg som musiker. Hørte elektronikken og de andre i ensemblet best.

Translation:

This solution felt best to me as a musician. Heard the electronics and the others in the ensemble best.

- c) Ensemble located on stage with front speakers behind. (Copenhagen)
Også ok.

Translation:

Also ok.

- Can you describe your personal experience during the concert performance?

Spennende klanger. Litt rart å gi fra seg "kontrollen" over en klang eller en effekt, siden den blir bearbeidet og «fordreid».

Translation:

Exciting sounds. A little odd to give away "control" over a sound or effect since it is being processed and "distorted."

Appendix C

Comparison of Performances

Using examples from the first two movements of *Kuuki no Sukima*, I will compare the conductor's use of ConDiS across several of the performances. The Harpa (Reykjavik) and Schæffergården (Copenhagen) concerts have been chosen since they were the first and last performances of the Trondheim Sinfonietta Nordic Tour and should therefore provide a good cross-section of performance variance.

1st movement

Example 8

Conducting instructions from measure three of the opening of the 1st movement.

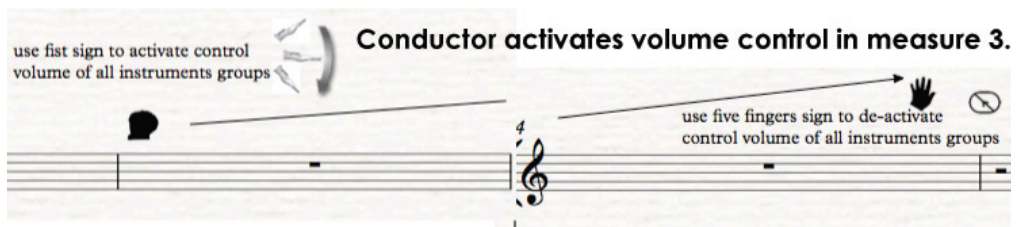


Figure 81. *Kuuki no Sukima* 1st movement. Measures 3 - 4.

First I examine the conducting gestures from the concerts at Harpa and Schæffergården:

Conducting at Harpa:

Video example #48: http://caveproduct.com/videos/H_Vol.ctrl_1.mp4

Conducting at Schæffergården:

Video example #49: http://caveproduct.com/videos/Cph_Vol.ctrl1.mp4

The opening measures of the 1st movement show that the conductor has an identical way of conducting in each case. This is not a surprise since the use of ConDiS is precisely written in the score.

Example 9

Now let us compare the following section:

Bass Clarinet
in B \flat
irregular quarter tone trill w. key slap

p *mp* *f*

Del — — — — — Del

Gran ————— *f* ————— Gran

FB ← ————— *f* ————— FB

F1 slide out (for Pax 23)

p *f*

Del — — — — —

Gran —————

FB ← ————— *f*

Figure 82. *Kuuki no Sukima* 1st movement. Measures 18 – 23.

Conducting at Harpa:

Video example #50: http://caveproduct.com/videos/H_Vol.ctrl_2.mp4

Conducting at Schæffergården:

Video example #51: http://caveproduct.com/videos/Cph_Vol.ctrl2_2.mp4

Although it is not written in the score, the conductor in this excerpt activates the volume value control at a very similar point in each performance. At the Harpa concert, the conductor activates the volume value control a bit earlier then decides to wait till after the flute has ended. Then similarly to the Schæffergården concert, she activates it again just before the horn but deactivates it sooner in Harpa. Recall that the Harpa concert was the first of four concerts and Schæffergården the last. It is obvious that when conducting the last performance, the conductor has become much more comfortable and familiar with the use of the ConDiS conducting system.

Example 10

Again, the conductor follows the instructions written in the score.

The image shows a musical score for three instruments: Flute (Fl.), Bass Clarinet (B. Cl.), and Bass Drum (B. D.). The score is for measures 83 to 90. The Flute part starts with a *pp* dynamic and a *mp* dynamic. The Bass Clarinet part starts with a *p* dynamic and a *mp* dynamic. The Bass Drum part starts with a *pp* dynamic and a *ff* dynamic. The score includes various musical notations such as notes, rests, and dynamic markings. There are also conductor's instructions and hand gestures shown above the staves. The conductor's instructions include "strike with finger" and "triple quarter note roll w key flap". The hand gestures include a hand with fingers spread and a hand with fingers curled.

Figure 83. *Kuuki no Sukima* 1st movement. Measures 83 - 90.

Conducting at Harpa:

Video example #52: http://caveproduct.com/videos/H_Vol.ctrl_3.mp4

Conducting at Schæffergården:

Video example #53: http://caveproduct.com/videos/Cph_Vol.ctrl3.mp4

The conductor perfectly follows the lines drawn in the instructions.

Example 11

Finally, the closing measures of the 1st movement. The conductor follows the written instructions identically.

Close hand to activate volume control
Lower arm to fade out electronics

press middle finger button to stop computer play

3

pp mf ff f

Del Rev Gran FB

normal ---> sul pont --->

normal ---> sul pont --->

sul tasto ---> normal ---> sul pont --->

sul tasto ---> normal ---> sul pont --->

Gran FB

Figure 84. *Kuuki no Sukima* 1st movement. Measures 104 – end.

Conducting at Harpa:

Video example #54: http://caveproduct.com/videos/H_Vol.ctrl_6.mp4

Conducting at Schæffergården:

Video example #55: http://caveproduct.com/videos/Cph_Vol.ctrl7.mp4

Appendix D

List of Performances

The following is a list of performances and lectures given during the research period.

Research Concert at Dokkhuset, Trondheim

An hour-and-a-half-long video from a lecture/concert given in Dokkhuset April 21, 2018. Through documented examples as well as live music performances it gives a good insight into the ConDiS concept.

Video example #56: <https://vimeo.com/266997352/6cc5700384>

Research Concert at the Organ Room, Olavshallen, Trondheim

An eight-voice version of the *Hljóðs bið ek* for 14 voices was performed at the Olavshallen Organ Room in Olavshallen on June 24, 2015. It inspired some early thinking about the importance of a simple graphical interface. Forgetting to press an on/off button had me conducting without any response from the system. I realized this very late in the performance, too late to make it a successful demonstration. Still it was a valuable lesson for me as I moved forward in the process.

Video example #57: <https://www.youtube.com/watch?v=SNPb1lcddnE>

Test Concert at Dokkhuset, Trondheim, Norway

Performed at the Virtuoso Listener Festival in Trondheim, November 24, 2017

The Dokkhuset concert was a typical trial concert testing out various technical and practical elements. This was partly the case since I was still looking for the right sonority based on my extended notation experimentation. During the rehearsal period, substantial time was therefore spent rehearsing the ensemble without the electronics. For that reason, the electronics did not come into the rehearsal process until the last day of rehearsal. This did not leave enough time for the performers to digest the sonic extension to their instruments or the overall sound of the ensemble. Nor did it give Halldis enough time to study the possibilities and musical advantages of the conducting system. The rehearsal time that I thought would be plenty turned out to be not enough.

The concert at Dokkhuset was unsatisfactory, not in a performance sense, but rather in terms of overall sound quality.

Kuuki no Sukima 1st movement:

Video example #58: https://www.youtube.com/watch?v=V_03oqu0kpU

Kuuki no Sukima 2nd movement:

Video example #59: <https://www.youtube.com/watch?v=UM2ULIQixNw>

Kuuki no Sukima 3rd movement:

Video example #60: https://www.youtube.com/watch?v=dvqH_ATZkaQ

Trondheim Sinfonietta - Nordic Tour

Video Recordings

The following web addresses are for video recordings from the Trondheim Sinfonietta - Nordic Tour. Four concerts in six days: in Harpa Music Hall, Reykjavik, Iceland; Nordic House, Torshavn and Christian's Church, Klaksvik, in the Faeroe Islands; and a final concert at Schæffergården, Copenhagen.

Concert in Harpa, Reykjavik, Iceland

Trondheim Sinfonietta's first concert during the Nordic Tour. Recorded at the Harpa Music Hall in Reykjavik.

January 27. Myrkir Musikkdagar Festival (Dark Music Days), Reykjavik, Iceland

Kuuki no Sukima 1st movement:

Video example #61: https://youtu.be/xIU_911lLko

Kuuki no Sukima 2nd movement:

Video example #62: <https://youtu.be/QbD7eqD4MiQ>

Kuuki no Sukima 3rd movement:

Video example #63: <https://www.youtube.com/watch?v=JWomugiE74c>

Concert at the Nordic House, Torshavn, Faroe Islands

January 30th. Nordic House, Torshavn, Faroe Islands

Kuuki no Sukima 1st movement:

Video example #64: <https://youtu.be/8MS6FtIDxys>

Kuuki no Sukima 2nd movement:

Video example #65: <https://youtu.be/kyWiOhQANnk>

Kuuki no Sukima 3rd movement:

Video example #66: <https://youtu.be/waZfIAFWb0>

Concert at the Christian's Church, Klaksvik, Faroe Islands

January 31. Christians church, Klaksvik, Faroe Islands

Kuuki no Sukima 3rd movement:

Video example #67: <https://www.youtube.com/watch?v=KgA8gGaMzzg>

Concert at Schæffergården, Copenhagen, Denmark

February 1. Schæffergården, Copenhagen

Kuuki no Sukima 1st movement:

Video example #68: <https://youtu.be/UTjQRJqEqzk>

Kuuki no Sukima 2nd movement:

Video example #69: <https://youtu.be/RA9aagwcUB4>

Kuuki no Sukima 3rd movement:

Video example #70: <https://youtu.be/2RD0mnb6o7E>

Concert at the Rockheim museum, Trondheim, Norway

November 3. Rockheim museum, Trondheim

Kuuki no Sukima 1st movement:

Video example #68: <https://www.youtube.com/watch?v=T2JXfuTEghg>

Kuuki no Sukima 2nd movement:

Video example #69: <https://www.youtube.com/watch?v=AXy4os9eZ2Q>

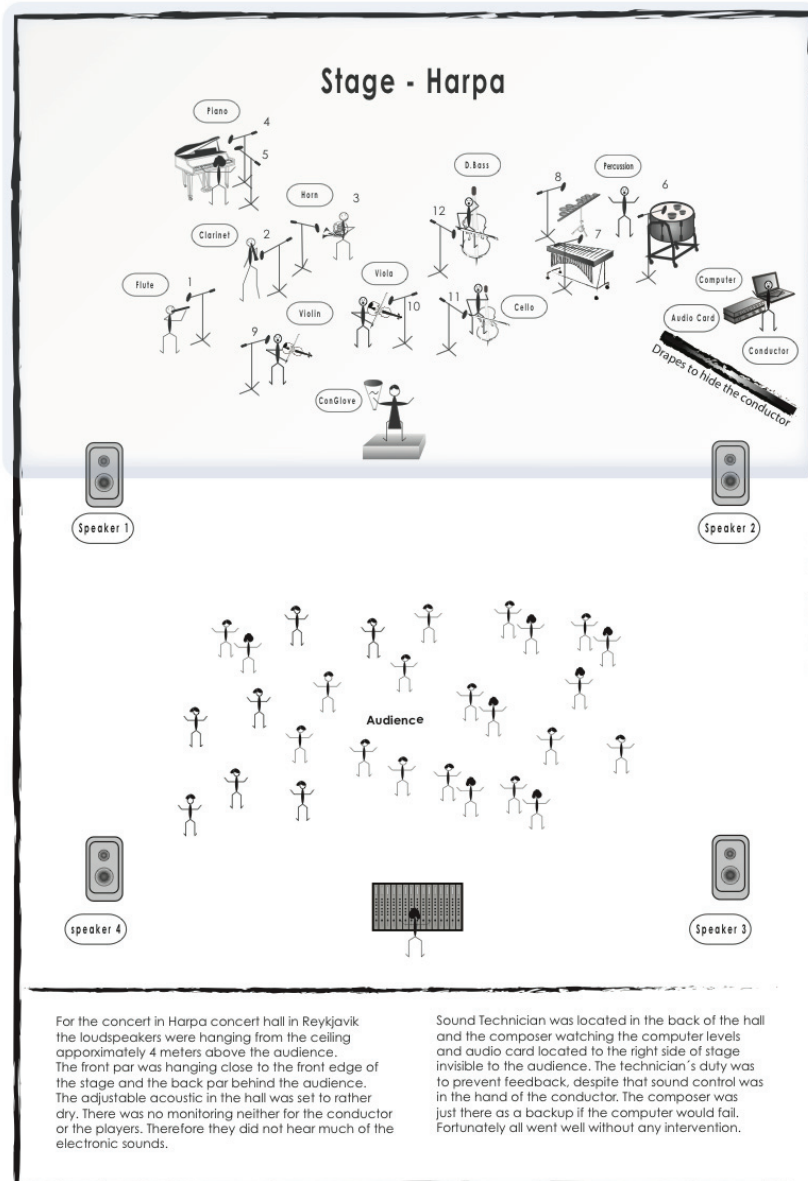
Kuuki no Sukima 3rd movement:

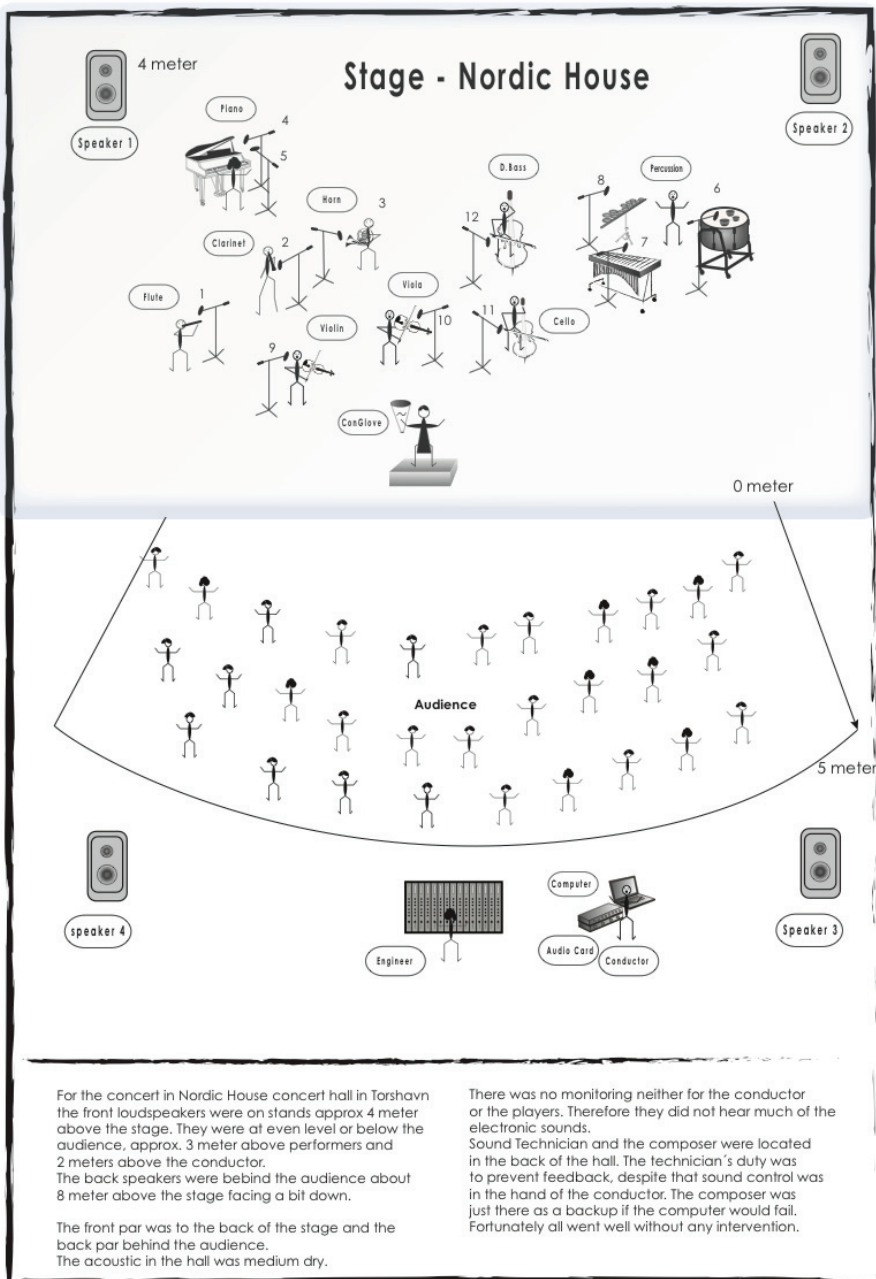
Video example #70: <https://www.youtube.com/watch?v=RM0j3hsge-o>

Appendix E

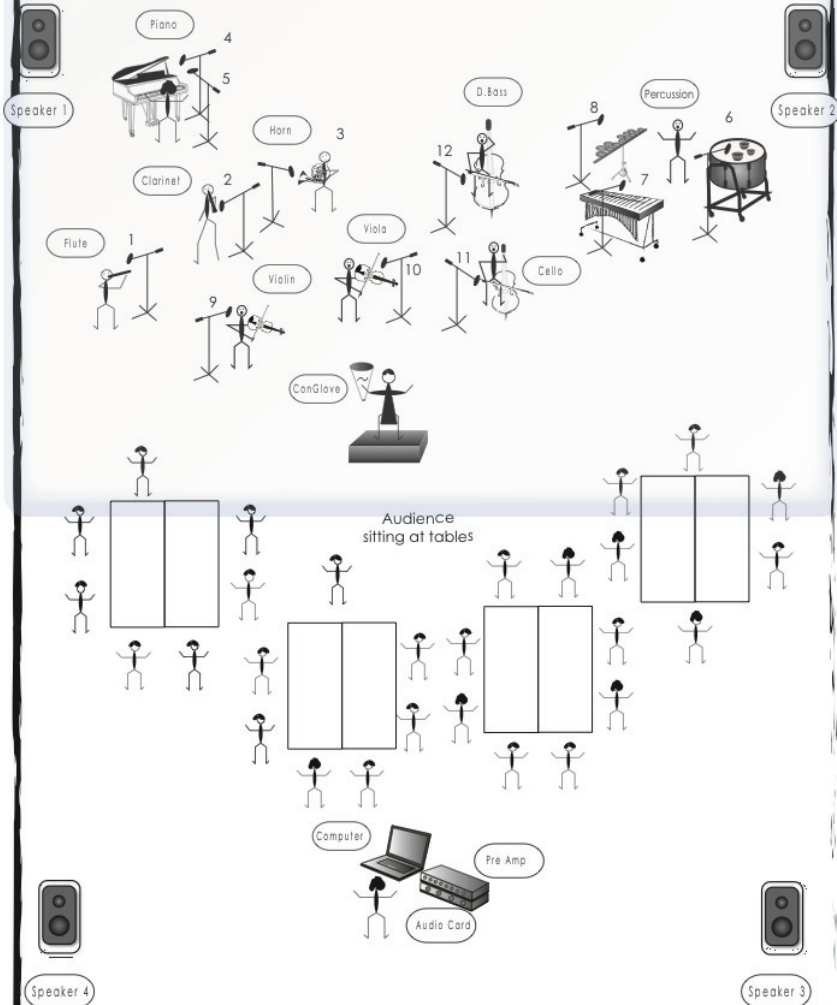
Stage Setup

Stage setup during performances in Harpa (Reykjavik), Nordic House (Torshavn) and Schæffergården (Copenhagen).





Stage - Copenhagen

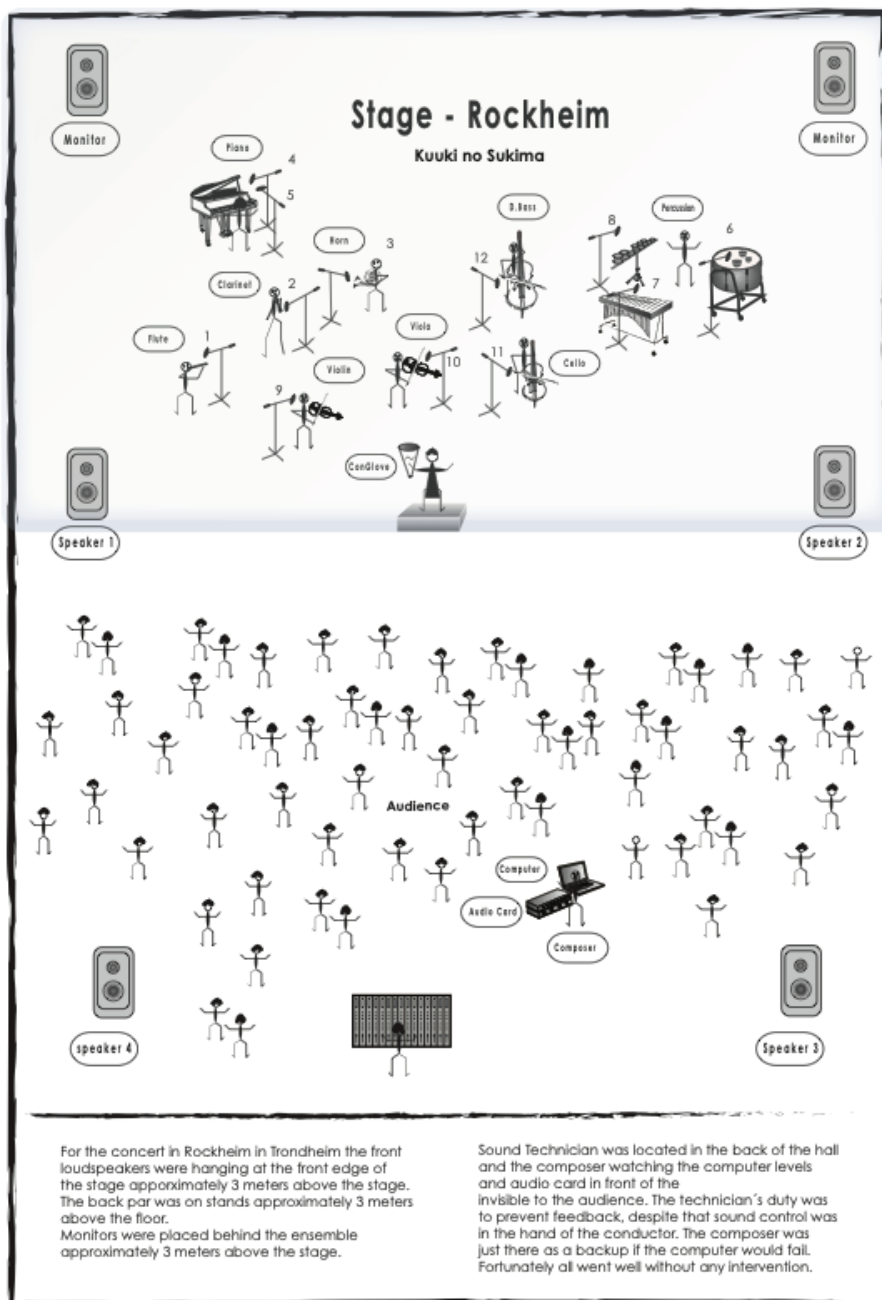


For the concert in Schæffergården in Copenhagen the front loudspeakers were on stands approx 3 meter above the stage and 2 meters above the audience/performers and just above the conductors height. The back speakers were behind the audience in same height as the front speakers.

The front par was behind the players and a bit to the side of the stage. The back par was behind the audience. The acoustic in the hall was dry.

There was no monitoring neither for the conductor or the players. Still they heard much of the electronic sounds due to speaker location and height. The composer was also sound technician and located in the back of the hall. His duty was to prevent feedback and be a backup if the computer would fail.

Fortunately all went well without any intervention.



Hilmar Thórdarson

Kuuki no Sukima

Between the air

For interactive conducting,
nine instruments and live electronics

Instructions

Submitted as Fulfilment of the Requirements for the:

Norwegian Artistic Research Program
at
NTNU - Norwegian University of Science and Technology
Department of Music

Commisioned by Trondheim Sinfonietta with support from Norwegian Cultural Fund



NORSK
KULTURFOND
Kulturrådet



CAVE
©2017 Cave Production/
Hilmar Thórdarson

Prologue

Kuuki no Sukima

ConDiS - Conducting Digital System

Kuuki no Sukima is written explicitly for the ConDiS system. This system gives conductors the ability to control in realtime, electronically generated sounds. The sounds are governed in the same way as a conductor directs performers in an ensemble. With a special conducting glove, ConGlove, the conductor interacts with a computer that receives directions about tempo, volume and score following.

The conductor can, by closing the ConGlove or showing the fist indicate that the volume is about to change. By lifting or lowering his/her arm, the volume gets louder or softer. Once reaching the correct volume, the conductor opens the hand (the glove) and disconnects the interaction with the computer.

Although Kuuki no Sukima is composed with the intention of demonstrating the usefulness of these new possibilities for conductors in controlling electronic sound live on stage with real-time interaction, it is by no means written as a "Demo piece." There are no compromises or showcases to demonstrate or illustrate the features of ConDiS project. Its emphasis concentrates upon the composer's artistic goal of composing music. The music itself is the priority, while the use of technology is secondary. The aim was to make the latter as normal and unobtrusive, or as invisible as possible. With this in mind, the conductor is given a musical tool which expands and explores new possibilities of conducting live electronics most simply and naturally. A goal achieved in performance without the constraint of technology.

Kuuki no Sukima is an uncompromising composition which makes great demands upon the conductor and performers through its endless search for new sonorities and a new sonic spectrum. Now realized vis-a-vis the controlling features of ConDiS. The title can be transcribed literally as "the gap of the air" or even, "in between the air." Both these phrases reflect the composer's vision of creating a sonic landscape of sounds that lie somewhere out "there," or "in-between" the gap of a sound or pitched note. If sonority is a vibration of traveling air pressure, could such a gap exist? Could such a sonic world exist somewhere out "there" or "in-between" the air?

The conducting glove "ConGlove" buttons, the musical score, and the automated electronic effects written by the computer digital audio workstation (DAW) can be synchronized with precision. With the use of new musical graphics, the composer can indicate precisely on the score and DAW where he wants to increase or decrease the intensity of different effects.

With use of the "ConGlove" metronome (tempo) button the conductor can synchronize the score and the DAW tempo.

With the use of the "ConGlove" acceleration meter the conductor can adjust the overall volume of the electronic and acoustic mix. The composer can take advantage of the new opportunities which ConDiS offers.

Through ConGlove synchronization the composer can also express him/herself in a personal way through synchronization and precision, free from the constraint of technology. The composer can also explore possibilities for innovative external use of live electronics through the conductor. In this way, Kuuki no Sukima can be realized.

With support from the Norwegian Culture Fond the Norwegian Artistic Research Program and Norwegian University of Science and Technology (NTNU), Kuuki no Sukima was composed during the autumn of 2016 to winter of 2017 for the Trondheim Sinfonietta and conductor Halldis Rønning.

After a work in progress performance at the Virtuoso Listener Festival in Trondheim, November 2017 a revised version was premiered during Trondheim Sinfonietta's Nordic Tour of Iceland, Faeroe Islands and Denmark in January/February 2018.

My sincere thanks to the Trondheim Sinfonietta and conductor Halldis Rønning; without your extremely positive and professional approach, the unique sonority and musical expressions of Kuuki no Sukima would never have been crystallized.

Trondheim 23. April. 2018

Hilmar Thordarson, composer.

Kuuki no Sukima Movements

Kuuki no Sukima - Between the air/The gap in the air

The title can be transcribed literally as "the gap of the air" or even "in between the air" both very suitable for the composer's vision of creating a sonic landscape of sounds that are somewhere there, in-between or in the gap of being a sound or a pitched note. If sonority is a vibration of a traveling air pressure, could there be a gap? Could there be a sonic world somewhere there in-between the air?

1st. movement

Niður - Murmur - せせらぎ

Duration c.a. 9'00''

A soft, indistinct sound made by a person or group of people speaking quietly or at a distance. Could also be linked to nature sounds such as a low continuous sound of the wind murmuring through the trees or an atmospheric sound of a river.

2nd. movement

Hviss - Hiss - ビュービュー

Duration c.a. 5'30''

A soft but still loud gust of wind hissing over the rooftops. Could also be a sound of an object passing by with a sharp short hissing sound. According to English dictionary it means as a noun: "a sharp sibilant sound" or as a verb: "make a sharp sibilant sound as of the letter S"

3rd. movement

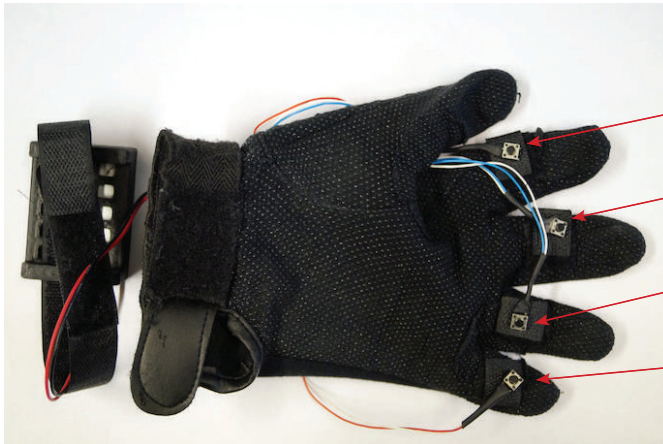
Suð - Buzz - ハミング

Duration c.a. 8'45''

A very soft sound like a buzzing sound from an electronic hardware like refrigerator or from electric light-bulb. English dictionary mention "the buzz of the bees" which is not quite the right explanation since the bee-buzz is in this case too loud and variant. Here the buzzing sound has more a humming sonority.

Total duration c.a. 23'15

Condis Glove - ConGlove



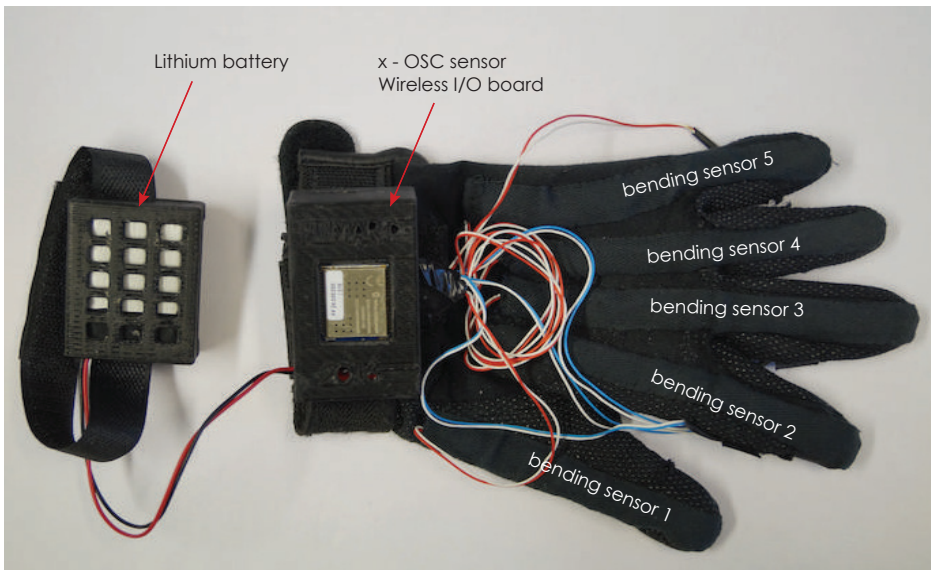
Button 2: click to set metronom speed.

Button 3: click to start and stop play.

Button 4: click to jump to next marker.

Button 5: click to jump to previous marker. Click fast four times to go to the beginning.

There are four buttons on the inside of the ConGlove, each with a designated function shown to the right.



There are five bending sensors on the outside of the ConGlove, each with a designated function. Different combination of finger signs is used to activate various conducting control. The x-OSC is a wireless I/O board that communicates through Open Cound Control (OSC) protocol. It has three onboard inertial sensors; gyroscope, accelerometer, magnetometer and provides acces to 32 high-performance analouge/digital channels.

Conducting instruction I



Ok sign for activate Volume control

To activate the Volume control feature the conductor has to make an OK sign by bending thumb and index finger.



Closed fist to activate all control

To adjust the Volume level the conductor has to close his/her fist.



All fingers to deactivate all control

To deactivate the Volume level adjustment feature the conductor has to open his/her fist.

**Finger numbering the same as for piano.
Thumb = 1, Index finger = 2 etc.**



Click button on Middle finger.
Set metronome.

Click the button on the Middle finger to set the tempo of the computer DAW. Needs to be clicked more than once to set the tempo.



Click button on Index finger.
Start and Stop button

Click button on the Index finger to start and stop the computer DAW play.



Click button on Ring finger.
Jump forward


Click button on the Ring finger to jump forward to next marker on computer DAW.



Click button on Little finger.
Jump Backward

Click button on Little finger to jump back to next previous marker on computer DAW. Click fast 4 times to jump to the beginning.



 Jump to marker number 3 and start play at measure 29.

Click button on the Ring finger to jump forward to marker number 3 on computer DAW.



Click button on Middle finger.
Three times to set the average metronome

Click button on Middle finger. X 4 means that button should be clicked four times in given tempo to set the metronome speed.

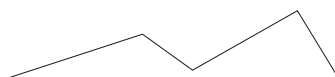


Spatial motion. Sound moving from left back to right front.

Spatial motion or panning of the sound is indicated with circular signs arrowheads and lines.



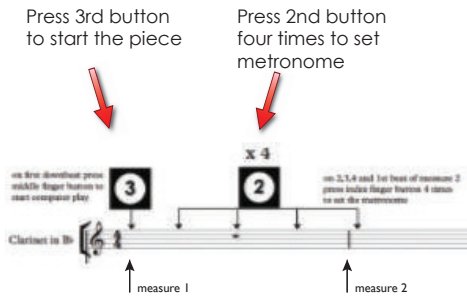
Spatial motion. Sound moving counterclockwise from right front to left front.



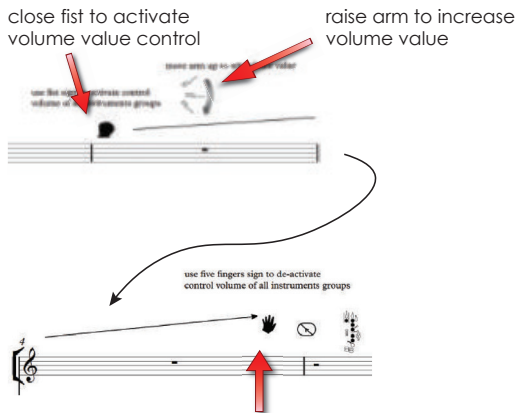
With Volume level control activated (closed fist) raise or lower the arm according to the line contour.

With Volume level control activated (closed fist) raise or lower the arm according to the line contour.

Conducting instruction II



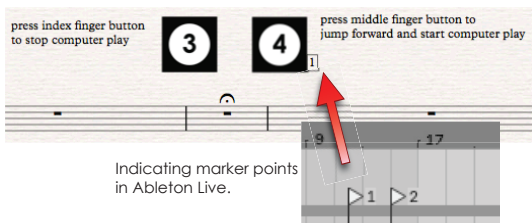
Conductor starts the piece by clicking 3rd button on the first downbeat before clicking the 2nd button four times to set the metronome speed.



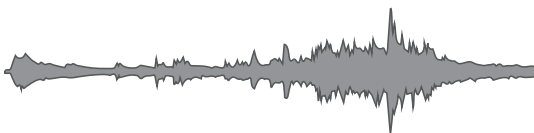
Conductor increases the electronic sound level (volume) by closing his/her fist and raise her arm till she has reached the desired electronic volume value.

The conductor opens up her fist to deactivate volume value control

When the electronic volume value has been set the conductor deactivates her control by open up her fist.



At given points the conductor presses the third button to stop the computer DAW play. Thereafter she presses the fourth button to jump forward and start the computer at a written marker point written in the DAW. In this example the playhead jumps to "Marker 1" and starts playing from there when button 4 is pressed. That way the computer and the written score are synchronized.



Graphic layout of the audio levels is written in the score. It indicates the overall volume of both the instruments and electronics.

Electronic notation

Pan - Spatial location



Spatial motion or panning of the sound is indicated with circular signs arrowheads and lines.



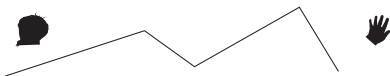
Spatial motion. Sound moving counterclockwise from right front to left front.



Spatial motion. Sound moving from back right to left front.

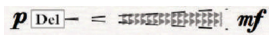


Volume control

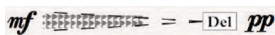


With Volume level control activated (closed fist) raise or lower the arm according to the line contour. Deactivate (open fist) when done.

Effect volume



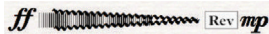
Crescendo delay from approx 30% - 55%



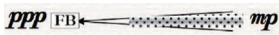
Diminuendo delay from approx 55% - 20%



Crescendo reverb from approx 55% - 85%



Diminuendo reverb from approx 85% - 45%



Crescendo feedback from approx 10% - 45%



Diminuendo feedback from approx 100% - 45%

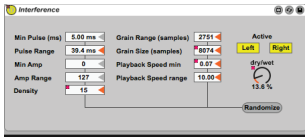


Crescendo granulation from approx 30% - 70%

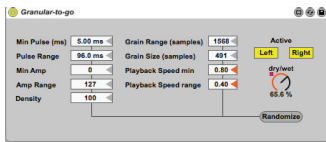
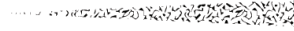


Diminuendo granulation from approx 100% - 85%

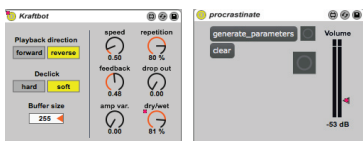
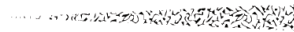
Effect plugins in Kuki no Sukima



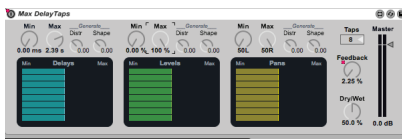
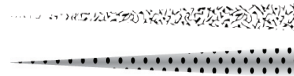
Granular effect



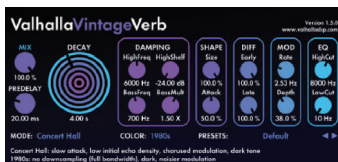
Granular effect



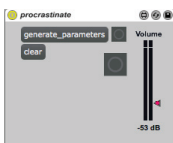
Granular effect w. feedback



Delay effect



Reverb effect



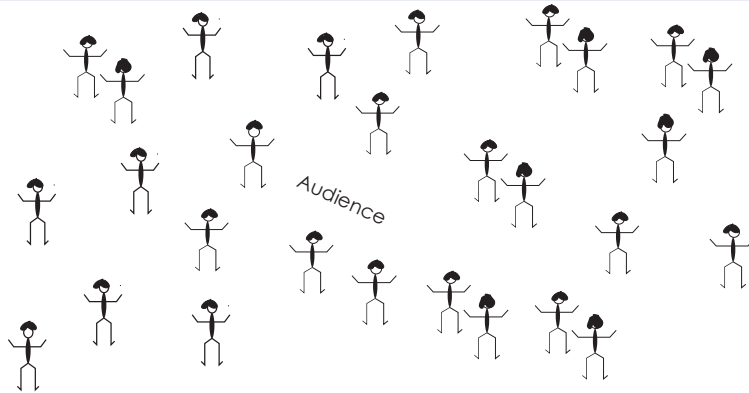
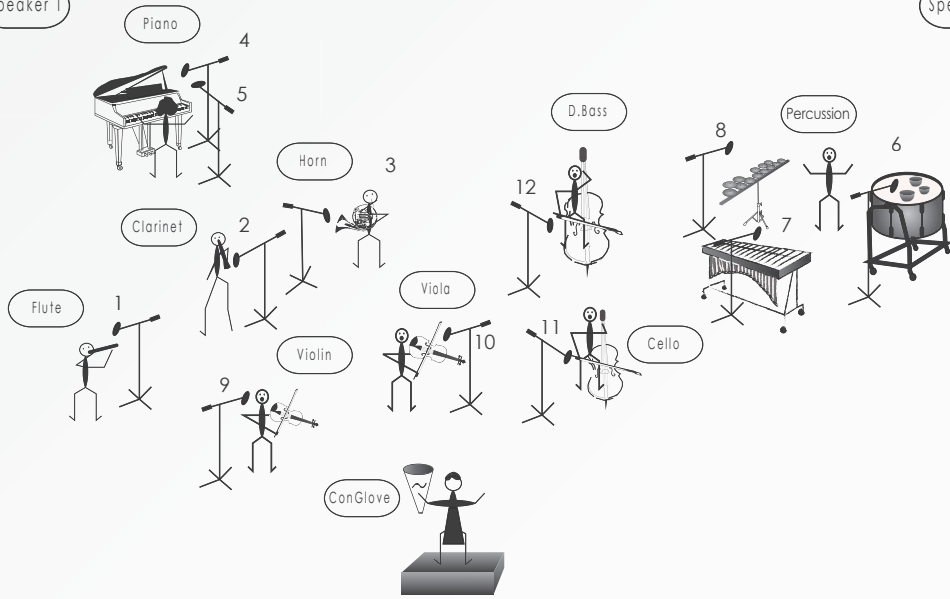
Feedback/Delay + Pitch Shift effect



Stage

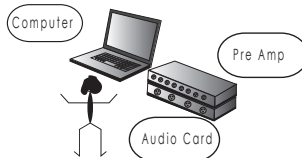
Speaker 1

Speaker 2



Speaker 4

Speaker 3

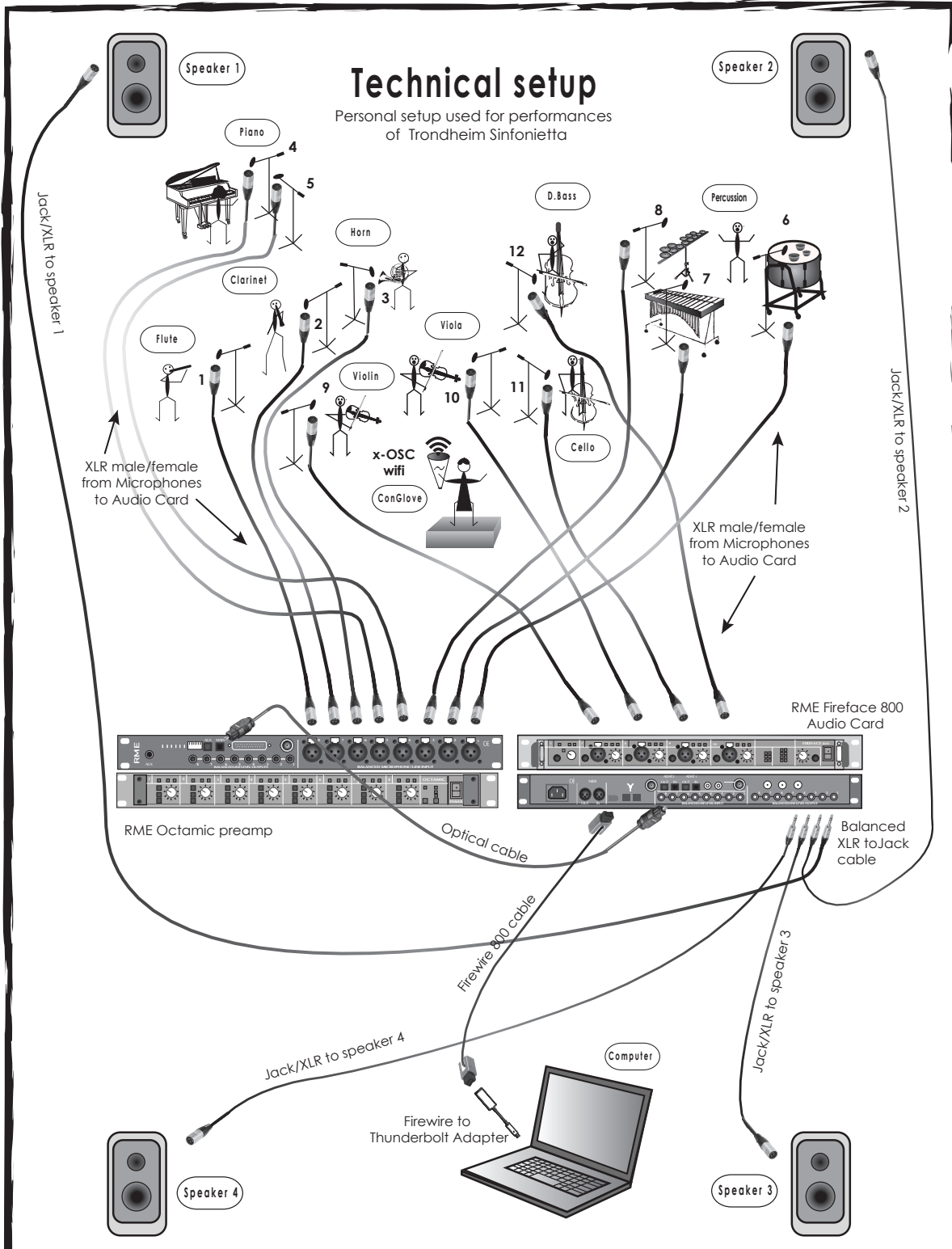


For the best result, the front loudspeakers should be located behind the ensemble and the back speakers behind the audience. The conductor should be as close to the middle as possible although the back speakers will always be in more distance.

Technician (composer) watching the computer and the audio card can be located anywhere in the hall but should be as invisible to the audience as possible. The computer screen should not distract the audience from listening to the performance.

Technical setup

Personal setup used for performances of Trondheim Sinfonietta



There are 12 microphones that need to be plugged into the audio card and preamp. 1-8 are connected to RME-Octamic preamp and 9-12 to RME 800 Fireface (mic input 7-10).

Octamic and 800 Fireface are connected via optical cable so that Fireface is a slave to Octamic.

Audio goes out to the speakers from the Fireface 800 balanced line outputs 1-4.

Technical Instruction II

Computer			Any type of computer can be used although Mac Book Pro laptop is preferred. It should be able to run Ableton Live digital audio workstation (DAW) and fast enough to do multichannel live sound processing.
Software	Ableton Live/Max4Live		Version 9.7 or later is preferred.
	ConDIS		Conduction Digital System comes as separate bundle with the Kuuki no Sukima score.
Audio Card(s)	12 mic/line inputs		There might be a need for more than one audio cards to get the 12 inputs.
	4 outputs		
	12 condenser microphones		Preferred to have clip on mics for the String and wind instruments. DPA Microphones d:vote 4099 instrument microphones work very well with their superior gain-before-feedback. They also ensure superior isolation when used on stage.
Loudspeakers	4 positive speakers preferred		
Monitors	? depending		Depending on individual needs.
Cables	12 suitable cables for the microphones		Depending on the type of audio inputs of the audio card. The plugs could be XLR or Jack even Tulip (RCA).
	4 suitable cables for the loudspeakers		
	1 Cable from computer to audio card		Depending on the inputs and outputs of the computer and audio card.

Instrumentation

Flute

Clarinet in Bb - Bass Clarinet in Bb

French Horn in F - Paxman model 23 preferred

Percussion:

Bass Drum

Vibraphone

Crotales

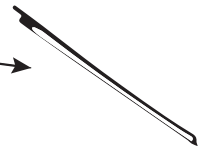
3 - large, medium and small

Tibetan Temple Bowls or Japanese Temple Bowls

Temple Bowls
placed on top of
Bass Drum



Double Bass Bow
for bowing Temple Bowls



Grand Piano

Violin

Viola

Violoncello

Double Bass

Flute - Notation



key slap



key slap with sound



breath and sound



only breath sound



tongue pizzicato



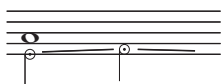
tongue pizz. and key slap



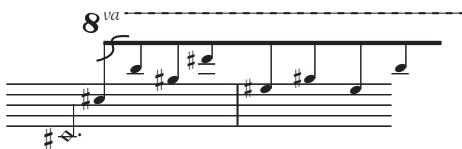
Given notes played in rhythm.
As fast as possible.



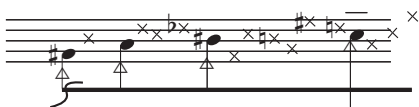
Given notes played with irregular rhythm.
As fast as possible.



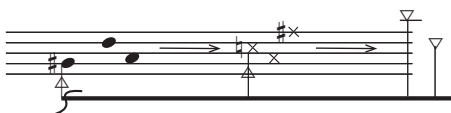
Play the whole note while singing the
half notes with glissando. Sing sound as
written for female voice an octave lower
for a male voice.



Whistle tones overtones from given note.
played ad lib. Irregular (free) rhythm.



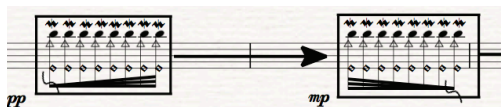
Combination of breath and sound notes
and key slap. Irregular (free) rhythm.



Gradually moving from one way of
playing to next. Irregular (free) rhythm.

Flute - Instruction I

1st. movement



Play "mordent" or rapid alternation of a note with the note immediately below or above it. The note should be the "harmonic" B played from E with a sound combination of breath and sound.

(might have to find other fingerings for multiphonics)

37 *p* ooh
sing very soft "g" while playing multiphonics
(as soft as possible)

While singing the note "G" play the following multiphonics. Use different fingering if necessary.

liberamente

p ooo
(as soft as possible)

While singing the note "G" play the following overtones (g# and d#).

p ooh

While playing the note "c" sing with glissando notes between c and d.

2nd. movement

p *mf*

Key slap with sound to breath sound.

Open claps.

brusco "abrupt" (choose ad lib. pitches that cover the open claps for strongest sonority)

Possible finger combinations for pitches that cover the open claps.

Play abruptly or with irregular rhythm. Keep the approx. tone grouping

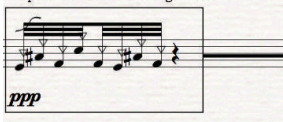
Key slap with sound. abrupt and irregular rhythm with short rests of varying length between notes or note groups. Red circles showing one possible interpretation. Feel free to make your own.

Key slap + tongue slap pitches. Abrupt and irregular rhythm with rests of varying length between notes or note groups.

Flute - Instruction II

3rd. movement

Repeat with short var. length rests



Play the motive with irregular rhythm and various length of rests between repetition. Combination of breath and sound.

air sound with flutter



Breath into the instrument while playing given pitch g# with flutter tongue.

irregular rhythm, molto airy (mye luft)



Written out an irregular rhythm with a combination of key slap + sound notes and key + tongue slap notes. Play as written.

breath and rests ad. libitum



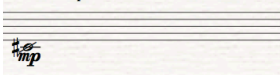
Written out an irregular rhythm with a combination of breath + sound and key slap + sound notes. Play as written.

Use various fingerings to play microtones between Bb and A and sing with glissando between 3rd to 6th below.



Play microtones between Bb and A with breath + sound. while singing with glissando pitches between 3rd. and 6th. below played pitch.

wind pitch --> sound --> whistle tones



Gradually go from very airy sound to more pitched sound to whistle tone sound.

play harmonics ad lib.



Play harmonics from the note c#. Tempo floating or ad libitum.

Notation

Clarinet in Bb/Bass Clarinet



key slap



key slap with sound



breath and sound



only breath sound



tongue slap



tongue slap and key slap



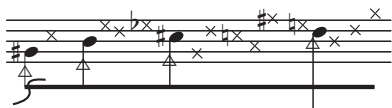
Given notes played in rhythm.
As fast as possible.



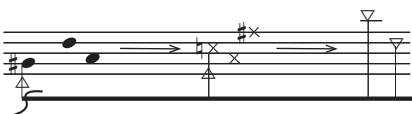
Given notes played with irregular rhythm.
As fast as possible.



Singing a different pitch
from the one played.



Combination of breath and sound notes
and key slap. Irregular (free) rhythm.

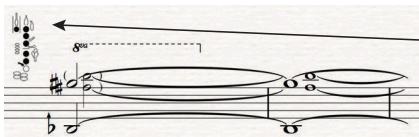


Gradually moving from one way of
playing to next. Irregular (free) rhythm.

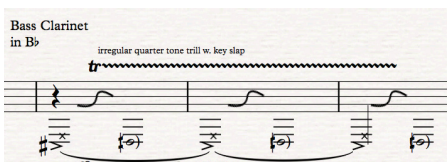
Instruction I

Clarinet in Bb/Bass Clarinet

1st. movement



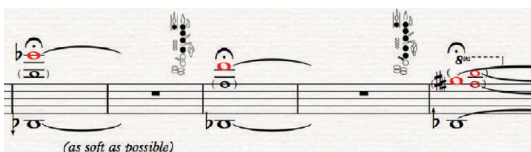
Play multiphonics using the given grip.
Feel free to use alternate grip if necessary.



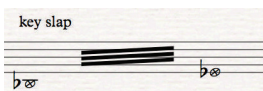
Play irregular quarter tone trill and make as loud key slap sound as possible.



Repeat given multiphonics for the length of the arrow.
Duration of each multiphonic can slightly vary.



Play this multiphonics using given grips.
Alternate if necessary.
Duration of each multiphonic and rests can slightly vary.

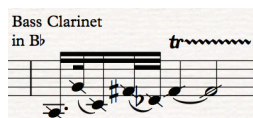


Play tremolo like with as much key slap sound as possible.

Instruction II

Clarinet in Bb/Bass Clarinet

2nd. movement



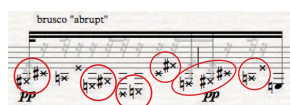
Play key slap with sound. Make as much key sound as possible during the trill.



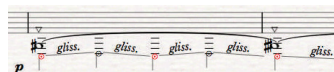
Gradually move from one harmonic overtone to another in the harmonic series starting on low G. Duration of each harmonic can vary.



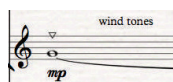
Gradually move from one harmonic overtone to another in the harmonic series from C. Duration of each harmonic can vary.



Play abruptly or with an irregular rhythm. Keep the approx. visual tone grouping.



Use various fingerings to play breath sounding microtones between G# and B. At the same time and sing with glissando notes between 3rd and 6th below. Free in duration and breath when needed.



Blow air through instrument with no valves down (as when playing G).



Key slap with sound. While playing, try to make as much key slap sound as possible.

Instruction III

Clarinet in Bb/Bass Clarinet

3rd. movement

Repeat with short var. length rests

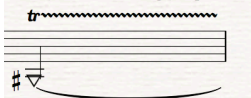


Key slap + tongue slap pitches.
Abrupt and irregular rhythm with rests of varying duration between note groups.

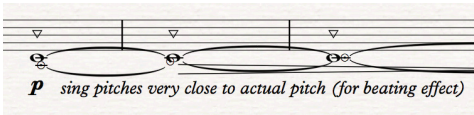


Key slap with sound. Abrupt and irregular rhythm with rests of varying length.

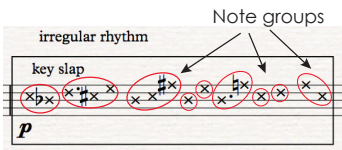
Breath and trill on given pitch



Breath into the instrument and same time make a trill on g#.



Play C with very breathy sound and simultaneously sing a pitch very close to the actual pitch. Not the same but close for a beating sounding effect.

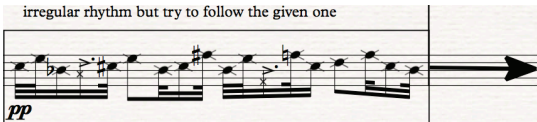


Key slap with sound. Abrupt and irregular rhythm with short rests of varying length between notes or note groups. Red circles showing one possible interpretation. Feel free to make your own.



Combination of key slap and tongue slap pitches with key slap and sound in between. Abrupt and irregular rhythm with rests of a varying length between note groups. Red circles showing one possible interpretation. Feel free to make your own.

irregular rhythm but try to follow the given one



Written out irregular rhythm with a combination of key slap + sound notes and key + tongue slap notes. Play as written.



Written out irregular rhythm with a combination of breath + sound notes and key slap + sound notes. Play as written.

Horn in F - Notation I



key slap



key slap with sound



breath and sound



only breath sound



tongue slap



tongue slap and key slap

mouthpiece backwards

Take mouthpiece out turn it backward and blow air through to get max airy sound.



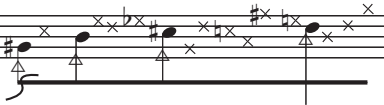
Given notes played in rhythm.
As fast as possible.



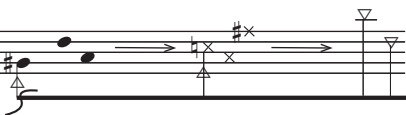
Given notes played with irregular rhythm.
As fast as possible.



Sing a different pitch
from the one played.



Combination of breath and sound notes
and key slap. Irregular (free) rhythm.

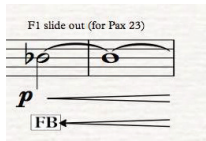


Gradually moving from one way of
playing to next. Irregular (free) rhythm.

Horn in F - Instruction I

1st. movement

F1 slide out (for Pax 23)



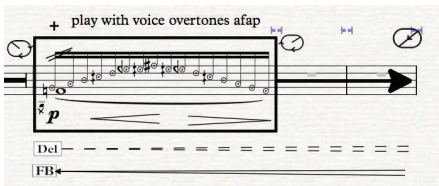
p

FB

Feedback added to instrumental sound.

Take out the F1 slide and play a note that sends air out the open slide hole. To get an airy sounding pitch. Pitch does not need to be exact.

+ play with voice overtones afap



p

Del

FB

Feedback and Delay added to the instrumental sound.

Play overtones based on the 1st valve so that airy overtone gliss is recognized.

2nd. movement



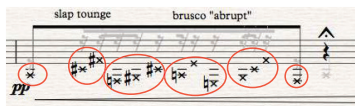
mf

Del

FB

Play airy sounding notes (breath+sound). Probably use loose embouchure.

slap tongue brusco "abrupt"



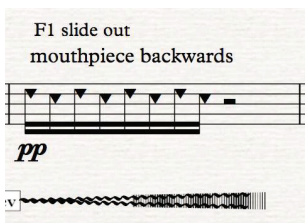
pp

FB

Play abruptly with slap tongue. Irregular rhythm but group notes according to visual spacing of notes.

3rd. movement

F1 slide out
mouthpiece backwards



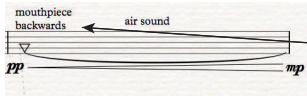
pp

FB

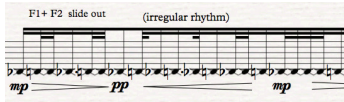
Reverb added to the instrumental sound.

Take out the mouthpiece and turn it upside down. Then play airy sound pulling down first and no claps.

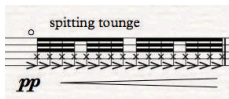
Horn in F - Instruction II



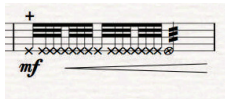
Take out the mouthpiece and turn it upside down. Then play airy sound by breathing through the instrument.



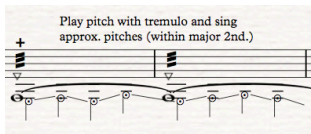
F1 and F2 slide out (probably all slide out?). Play notes with a little bit of slapped tongue like a mixture of a slapped tongue and normal note.



Play spitting tongue with an open bell. No exact pitch more the effect of the short attack of the tongue.



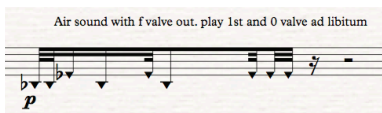
Play slap tongue with a closed bell. No exact pitch more the effect of the short attack of the tongue.



Play with flutter tongue a very airy sustained C while singing right above or below it. Gliss between the singing notes.



Play a very airy sustained C while singing right above or below it. Gliss between the singing notes.

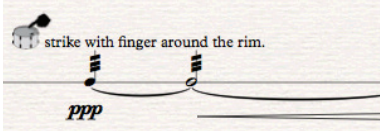


Very airy sound with all valves out. Play irregular rhythm ad libitum.

Percussion - Instruction I

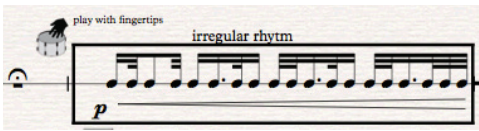
1st. movement

Bass Drum



Use finger, index or thumb to strike the surface of the Bass Drum.
Move in circle about 5 cm. from the rim.

Bass Drum



Play with fingers on the Bass Drum.
Written rhythm is there to indicate irregular and abrupt rhythm and should be played freely as long as the arrow indicates.

2nd. movement.

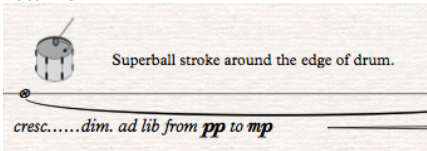
Vibraphone



Repeat the written phrase as long as the arrow indicates.

3rd. movement.

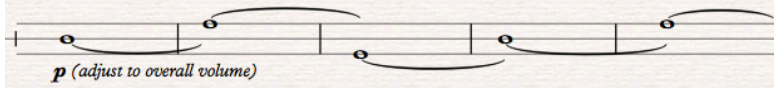
Bass Drum



Use a superball stick to strike around the rim of the Bass Drum.

Percussion - Instruction II

Any type of Temple Bowls for low, medium, high pitches (Tibetan bowls, Japanese Cup Bells etc.), placed Bass Drum (make a slight glissando with timpani pedal) Use appropriate mallet for best sounding solution.



Use three different size bowls for low, medium and high pitches. Preferred bowls would be either Tibetan Temple bowls or Japanese Cup Bells. They should be placed on top of the Bass Drum and a bit of pitch bend should be made by gently pull the bowls down while playing. Use appropriate mallet or bow for the best sounding solution.

Temple Bowls

Bowed bowls placed on a Timpani



Bow the Temple bowls placed on top of the Bass Drum. Let them vibrate.

Temple Bowls

play with chopsticks or thin metal stick



Play with hard mallet.

Temple Bowls



Play with a stick of a small wooden mallet for less resonant sound. Chopsticks could also be used.

Piano - Instruction

A musical score for piano, consisting of a grand staff with a treble clef on the upper staff and a bass clef on the lower staff. The music is written in a key signature of one sharp (F#) and a common time signature (C). The piece begins with a *pp* (pianissimo) dynamic marking. The melody in the treble staff is a sequence of eighth notes, starting on G4 and moving through various intervals, including half steps and whole steps. The bass staff provides a simple accompaniment with a few notes, including a bass line starting on G2. The notation is enclosed in a rectangular box.

Phrase to be repeated as long as the arrow indicates.

Strings notation instructions I



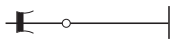
Arco normale - Plain bowing - at the frog, at the tip.



Arco al ponte - Bowing on the bridge or very close to the bridge if more sound needed.



Bow beneath the strings. Hair on the I and IV string. Put the bow underneath the strings and play the I and IV string accordingly.



Bow midway between the bridge and the fingerboard. Finger position above the bow very close to the bridge. Finger position needs to be adjusted to get a sound rich in overtones.



Move the bow in a circular movement, tempo and diameter ad lib.



Keeping the bow horizontal, hair on the string, move it up vertically from the bridge to the fingerboard.



Keep the bow horizontal, wood on the string, move it up vertically from the bridge to the fingerboard.



Keep the bow horizontal, half hair and half wood, move it up vertically from the bridge to the fingerboard.



Keep the bow horizontal, hair on the string, move it fast up and down vertically from the bridge to the fingerboard. Very much like a vertical tremolo.



Keep the bow horizontal, wood on the string, move it fast up and down vertically from the bridge to the fingerboard. Very much like a vertical tremolo.



Keep the bow horizontal, half hair and half wood on the string, move it fast up and down vertically from the bridge to the fingerboard. Very much like a vertical tremolo.



Holding the position with the right hand thumb, do pizzicato with the nail of the middle finger.



Bartók pizzicato

Strings notation instructions II



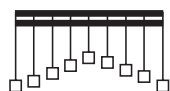
Right hand pizzicato on the bridge wood with the nail of the middle finger.



Use the frog of the bow. Usually used to scratch (gliss) the frog on a given string.
If written with sul A, meaning the frog should be scratched on the A string.
Use vertical movement in either direction (or both) between bridge and fingerboard.



Glissando with the thumb nail (right hand or left hand) on the string.
Positions are indicated in brackets. Very similar to the use of the frog.
Use of plectrum can be substituted with use of fingernail.



"Flautando notes". Perform the gesture, scarcely skimming the strings.
Very soft and airy sound.



Behind the bridge.



Natural harmonic.



Artificial harmonic.



Open string.



The small notes in brackets indicate on which string the sound will be entablatured.



Vibrato.

Sul G

Indicates the string the given notes should be played.



Vertical tremolo moving the bow ad lib. between the bridge and the fingerboard.



Tremolo and glissando with vertical motion while doing glissando

Violin - Instruction I

1st. movement



Play G# on E string

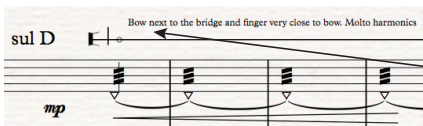


Artificial harmonics on the 3rd string.
Sounding D two octaves and a third above.

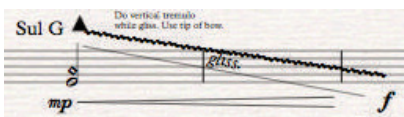
2nd. movement



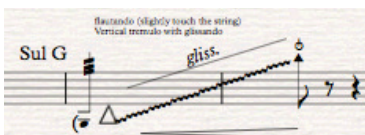
While playing battuto move the bow slightly touching the strings.
Sound should be very airy and rich of overtones (sul pont).
Phrase repeated as long as the arrow indicates.



On A string put finger as close to the bridge as possible and then do bowing very close to the finger.
Might have to adjust position accordingly to get the best sound.
Sound should be very bright and rich in overtones.
The triangle shape notes indicate that the sound is very airy.

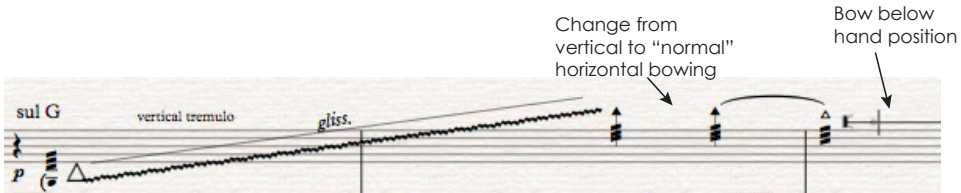


Harmonics on G strings then vertical tremolo on G string using the wood and little bit of the hair of the bow.
Slightly touch the string and make a glissando + tremolo from fingerboard (sul tasto) to the bridge.



Vertical tremolo on G string using the hair of the bow (col legno tratto). Slightly touch the string and make a glissando + tremolo from fingerboard (sul tasto) to the bridge.
Bartok pizzicato at the end below position.

Violin - Instruction II

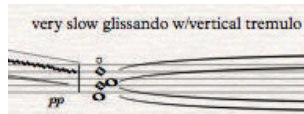
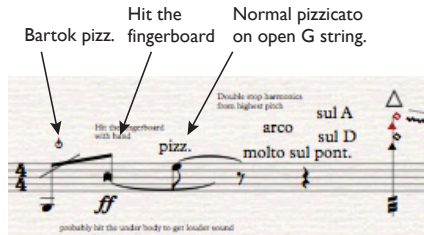


Vertical tremolo on G string with hair on the string. Starting at fingerboard up to the bridge. At the top note change to "normal" horizontal tremolo while changing bow and hand position such as the bow is below the hand position.

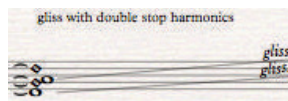


Finger position as close to the bridge as possible bowing the G string very close to the finger. Use normal horizontal tremolo bowing. Then shift the bow to the other side of the grip and do a vertical glissando from that highest pitch down the string to the fingerboard.

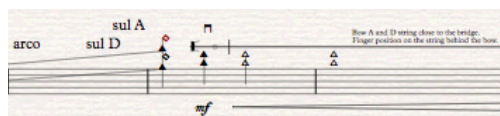
2nd. movement



Play harmonic doublestopp on highest notes of the D and A string. With hair on the string (Arco) gradually do a vertical tremolo with glissandi holding finger position. Molto sul pont. for rich sonority.

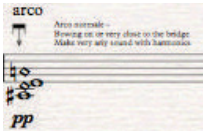


While holding the position for double stop harmonics do glissando to the highest note.

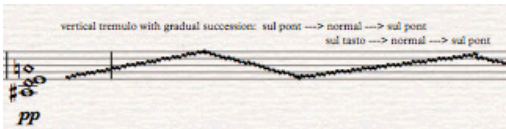


While playing the highest possible notes on A and D string change finger and bow position so that the finger is as close to the bridge as possible and the bow below very close to the finger.

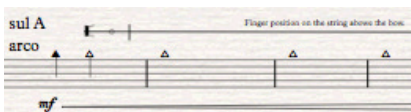
Violin - Instruction III



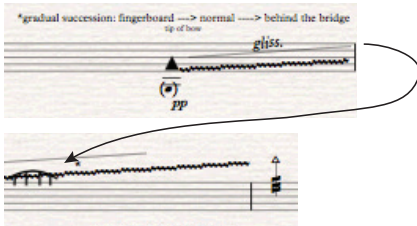
Play double harmonics with the very tip of the bow. Place the bow on top of the bridge or very close to the bridge for more airy sounding effect.



Play double harmonics and move the bow up and down (sul pont - normal - tastu) while doing vertical tremolo.



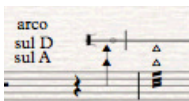
On A string put finger as close to the bridge as possible. Then do bowing very close to the finger. Might have to adjust position accordingly to get the best sound. Sound should be very bright and rich of overtones. The triangle shape notes indicate very airy sound.



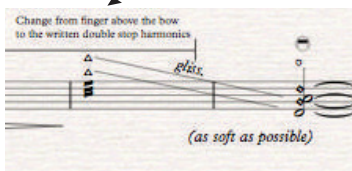
Vertical tremolo on G string with glissando from the fingerboard to up towards the bridge. Use a combination of wood and hair at the tip of the bow.

Continuation of vertical tremolo on G string with glissando going behind the bridge still playing the G string behind the bridge.

At the end of the measure go back over the bridge and play highest possible note with reversed finger and bow position. The finger is as close to the bridge as possible and the bow very closet to the finger. Change bowing tremolo from vertical to horizontal (normal) arco bowing.



Double stop at the highest possible note with changed finger and bow position so that the finger is as close to the bridge as possible and the bow very closet to the finger. Use "normal" bowed tremolo.



Start to gliss down from the double stop at highest possible note using vertical tremolo to the written doublestop harmonics.

When reached the harmonics do circular bowing.

Violin - Instruction IV

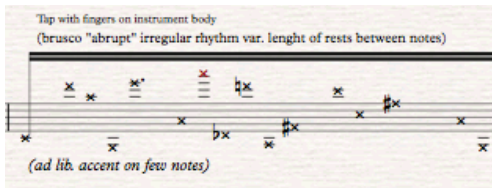


(pizz. like) R.H./fingers slap on strings

pp

The image shows a musical staff with a treble clef. Above the staff, there is a hand icon with fingers spread, labeled "(pizz. like)", and a circular icon with a hand, labeled "R.H./fingers slap on strings". The staff contains a sequence of notes: a quarter note G4, a quarter note A4, a quarter note B4, a quarter note C5, a quarter note B4, a quarter note A4, and a quarter note G4. Below the staff, the dynamic marking *pp* is written.

Slap with right-hand fingers on the strings in circular motion while playing given pitches. Make short rests either at the end of the phrase or between notes ad libitum.



Tap with fingers on instrument body
(brusco "abrupt" irregular rhythm var. length of rests between notes)

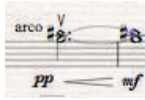
(ad lib. accent on few notes)

The image shows a musical staff with a treble clef. Above the staff, there is text: "Tap with fingers on instrument body" and "(brusco 'abrupt' irregular rhythm var. length of rests between notes)". The staff contains a sequence of notes: a quarter note G4, a quarter note A4, a quarter note B4, a quarter note C5, a quarter note B4, a quarter note A4, and a quarter note G4. Above each note, there is an 'x' mark. Below the staff, the instruction *(ad lib. accent on few notes)* is written.

Hold the Violin in an upright position on your lap. Tap with fingers on instrument body. Higher written pitch should be tapped close or on the edge of the body or where higher pitched sound occur. Lower pitches are closer to the middle of the body etc.

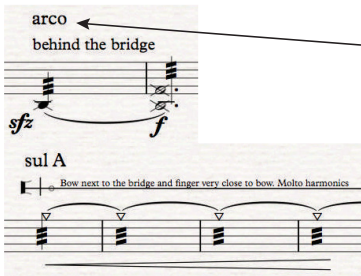
Viola - Instruction I

1st. movement.



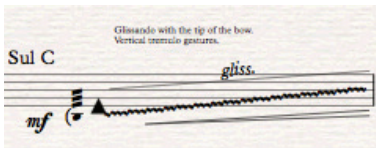
Harmonics, sounding C# two octaves above.

2nd. movement.

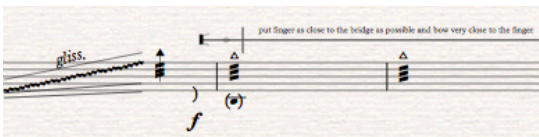


Play arco with tremolo on C string behind the bridge then add tremolo on G string behind the bridge.

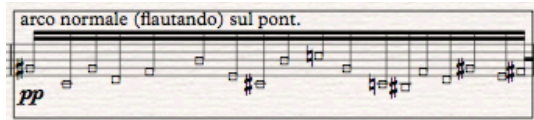
On A string put finger as close to the bridge as possible and then do bowing very close to the finger. Might have to adjust position accordingly to get the best sound. Sound should be bright and rich in overtones. The triangle shape notes indicate airy sound.



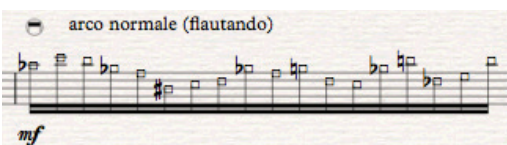
Vertical tremolo on C string using the wood of the bow (col legno tratto). Slightly touch the string with a finger and make a glissando + tremolo from fingerboard (sul tasto) to the bridge. Might have to use a little bit of hair to get a richer sound.



Same as before except the final note is the highest pitch possible on C string. Then change bow position from being below the grip (normal position) to be above the grip with finger next to the bow.



While playing arco normale move the bow slightly touching the strings. Sound should be very airy and rich of overtones (sul pont). The phrase repeated as long as the arrow indicates



Move the bow in circles slightly touching the strings. Sound should be very airy, alternating from dry a sound (sul tasto) to sound rich of overtones (sul pont).

Viola - Instruction II

3rd. movement.

Bartok pizz. Hit the fingerboard Normal pizzicato on open G string. Hit the fingerboard with hand pizz. arco molto sul pont. sul D sul G Double stop harmonics from highest pitch

Play harmonic double stops on highest notes of the D and A string. With hair on string (Arco) gradually do a vertical tremolo with glissandi holding finger position. Molto sul pont. for rich sonority.

glissando w/vertical tremolo

With the same finger position as in the double-stop do a very slow glissando to the given double-stop harmonics.

gliss with double stop harmonics

With the same finger position as in the double-stop do a very slow glissando up to the highest possible note.

sul D sul G Bow A and D string close to the bridge. Finger position on the string behind the bow.

While playing the highest possible notes on A and D string change finger and bow position so that the finger is as close to the bridge as possible and the bow very closet to the finger.

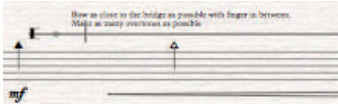
arco bowing on or very close to the bridge make very airy sound with harmonics

Play double harmonics with the very tip of the bow. Place the bow on top of the bridge or very close to the bridge for more airy sounding effect.

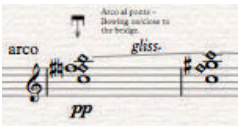
vertical tremolo with gradual succession: sul pont -> normal -> sul tasto sul tasto -> normal -> sul pont

Play double harmonics and move the bow up and down (sul pont - normal - tasto) while doing vertical tremolo.

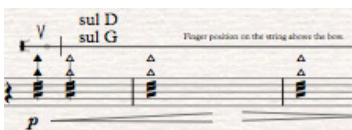
Viola - Instruction III



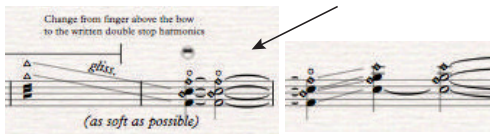
Doublestop at highest possible note with changed finger and bow position so that the finger is as close to the bridge as possible and the bow very closet to the finger. Use "normal" bowed tremolo.



Play double harmonics with the very tip of the bow. Place the bow on top of the bridge or very close to the bridge for more airy sounding effect.

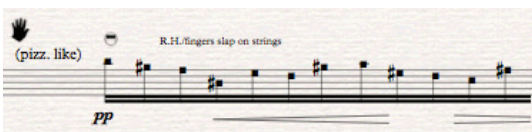


Doublestop at highest possible note with changed finger and bow position so that the finger is as close to the bridge as possible and the bow very closet to the finger. Use "normal" bowed tremolo.

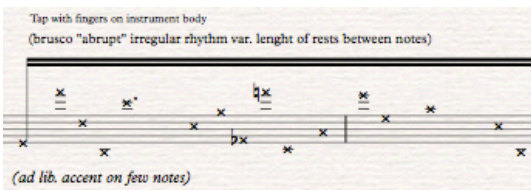


Start to gliss down from the double-stop at highest possible note using vertical tremolo to the written double-stop harmonics. When reaching the harmonics do circular bowing.

Start to gliss up using vertical tremolo to the written double-stop harmonics using circular bowing.



Slap with right-hand fingers on the strings in circular motion while playing given pitches. Make short rests either at the end of the phrase or between notes ad libitum.



Hold the Viola in an upright position on your lap. Tap with fingers on instrument body. Higher written pitches should be tapped close or on the edge of the body or where higher pitched sound occurs. Lower pitches are closer to the middle of the body etc.

Cello - Instruction I

1st. movement.

Move the bow and hand gradually from being close to the bridge (*sul pont*) to fingerboard (*sul tasto*).

Gradually change from bowing at the tip of the bow to bowing closer to the center. At the same time turn the bow so that it goes from the hair of the bow to half hair and *col legno*.

Tip of the bow

arco
sul. D
III
bowing at tip
col legno tratto with hair of the bow.
make vertical tremolo so that the bow moves up/down. first small waves then poco bigger.
gliss.
molto cresc...
Gran
pizz.
sul. G
pp
pizzicato on open G string.

While moving bow and hand make a vertical tremolo. The bow goes up/down instead of the "normal" sideways.

Play the harmonic note arco with the tip of the bow and at the same time pizz. on open G string. Might have to adjust the "tip" accordingly to sound quality.

2nd. movement.

flautando for airy sound

arco
flautando for airy sound

Bow very lightly (flautando) over the strings, except the open C note that should sound out. Tremolo should also be very lightly bowed.

R.H. pizz.(finger slap)

pizz.
p

Slap with fingers of the right-hand while playing given pitches

Right hand pizzicato on the bridge wood with the nail of the middle finger.

Hit the body with the left hand thumb.

pizz.
p

Bartok pizzicato.
Hit the body of the instrument with the fist.

Pizzicato on the wood of the bridge. Probably use the middle finger to get the best sound

Cello - Instruction II

Pizzicco on C string making artificial harmonic (sounding B).

Hair on string.

On C string put the finger as close to the bridge as possible and then do bowing very close to the finger. Might have to adjust position accordingly to get the best sound. Sound should be very bright and rich of overtones. The triangle shape notes indicate that the sound is very airy.

This pizzicato should be made with the right hand such that the thumb of the right hand is used to make the harmonics while the middle finger of right-hand does the pizz.

Vertical tremolo on C string using the wood of the bow (col legno tratto). Slightly touch the string with finger and make a glissando + tremolo from fingerboard (sul tasto) to the bridge.

Cello - Instruction III

arco battuto (flautando) sul pont.

pp

While playing battuto move the bow slightly touching the strings.
Sound should be very airy and rich of overtones (sul pont).
The phrase repeated as long as the arrow indicates.

Circular bowing.

arco normale (flautando) sul pont.

pp

Very lightly touch the strings while bowing in a circular motion.

3rd. movement.

Bartok pizz. Knock on instrument. Normal pizzicato on open G string.

Hit the body with fist.

pizz.

arco molto sul pont.

sul D sul G

ff

Play harmonic double stop on highest notes of the D and A string. Gradually do a vertical tremolo with glissandi holding finger position. Use wood with a bit of hair. Has to be adjusted for rich sonority.

gliss. gliss.

Play doublestop harmonics on A and D sting.

Holding the position of the double stop harmonics gliss to the highest note on A and D string.

sul D sul A

Bow A and D string close to the bridge. Finger position on the string behind the bow.

ff

Finger position as close to the bridge as possible bowing the A and D strings very close to the fingers. Might have to adjust to get a rich harmonic spectrum.

41 arco

Punta dell'arco - tip of bow
Bowling on or very close to the bridge
Make very airy sound with harmonics

ff

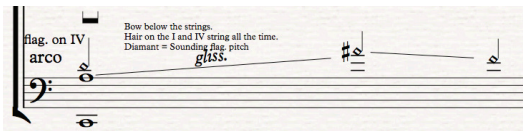
Play double harmonics with the very tip of the bow. Place the bow on top of the bridge or very close to the bridge for more airy sounding effect.

vertical tremolo with gradual succession: sul pont -> normal -> sul pont -> sul tasto -> normal -> sul pont -> behind bridge

ff

Play double harmonics and move the bow up and down (sul pont - normal - tasto) while doing vertical tremolo.

Cello - Instruction IV



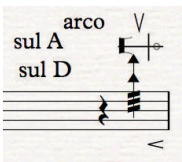
Play with the bow underneath the strings touching strings I and IV.
The diamond-shaped note should be performed on I string (A string) with glissando between given harmonic sounding pitch while IV string (C string) is sounding like a drone.



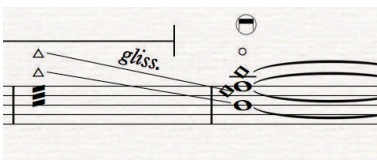
Play with the bow underneath the strings touching strings I and IV. Play the given diamond-shaped notes on I string (A string) while IV string (C string) is sounding like a drone.



Play with the bow underneath the strings touching strings I and IV. Play the given diamond-shaped notes on IV string (C string) while I string (A string) is sounding like a drone.



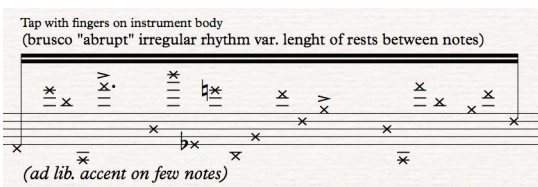
Play with finger as close to the bridge as possible and bow next to the finger touching A and D strings. Keep the bow as close to the finger as possible.



Play with finger as close to the bridge as possible and bow regular tremolo next to the finger touching A and D strings. Then start to gliss towards the given double harmonics. When reaching the double harmonics start to move the baton in circular motion.



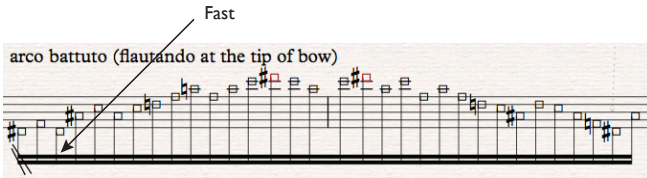
Slap with right hand fingers on the strings in circular motion while playing given pitches. Make short rests either at the end of phrase or between notes ad libitum.



Tap with fingers on instrument body. Higher written pitches should be tapped on the edge of the body or where higher pitched sound occur. Lower pitches are closer to the middle of the body etc.

Double Bass - Instruction I

1st movement



Play relatively fast and very lightly over the notes using the tip of the bow. Should give a airy sounding effect. Might even need a little bit of the bow plastic end to get the right sound.

sul A arco
Pizzicato behind the bridge on A string.

sul pont.
Pizzicato on open A string.

pizz. sul A
Move the bow and hand gradually from being close to the bridge (sul pont) to fingerboard (sul tasto).

gliss
While moving bow and hand make a vertical tremolo. The bow goes up/down instead of the "normal" sideways

Play pizzicato behind the bridge and then arco a natural harmonic on A string. While holding the natural harmonic play pizzicato on open A string. At the black triangle, use the wood of bow with very little hair to make a vertical glissando.

pizz. sul. E
on the bridge wood with the nail of the middle finger.

Pizzicato on the bridge wood. Use the nail of middle finger to get the best sonic result.

Knock on the body of instrument. Choose deep and resonant placement of instrument.

Pizzicato on E string behind the bridge.

Pizzicato on E string behind the bridge. Start slow and accelerate and back to slow again.
accelerando -> ritardando -> accelerando

sul E

Play natural harmonic A on E string. Then change to a artificial harmonic getting sounding E two octaves and a fifth above.

sempre

Play artificial harmonic getting sounding D, two octaves and a major 3rd above.

Double Bass - Instruction II

2nd movement

pizz.

L.H. pizz.

Holding the position with the right hand thumb, do pizzicato with the nail of the middle finger.

This pizzicato should be made with the right hand such that the thumb of right hand is used to make the harmonics while the middle finger of right-hand does the pizz.

Hit the body of the instrument with fist. Bartok pizzicato.

Sul E

f

Pluck the wood of the Bridge

Artificial harmonics on E string. Should create a note two octaves higher.

vertical tremolo

gliss.

Gradually start to make vertical tremolo with the bow and at the same time gliss with finger position of the harmonics. Use hair of the bow.

sul A

arco

sul pont.

gliss.

pizz.

sul E

sfz

Play highest possible pitch on A string and make slow glissando with the finger down to fingerboard. Kepp bow position at sul pont.

Sfortzando pizzicato on open E string. Let vibrate.

arco (above the left hand)

sul G

Play tremolo on G string with the bow above the left hand. Left-hand plays the given pitches that should give sound mirroring the written notes.

Last note should be played as high as possible with the finger as close to the bridge as possible and the bow close to the finger.

Might have to adjust the bow for rich overtone sonority.

Circular bowing.

arco battuto (flautando) sul pont.

pp

While playing battuto move the bow in circular motion slightly touching the strings.

Double Bass - Instruction III

3rd movement.

Knock on instrument. Normal pizzicato on open G string.
Bartol pizz. Hit the body with fist.

Play harmonic double stop on highest notes of the D and A string. Gradually do a vertical tremolo with glissandi holding finger position. Use wood with a bit of hair. Has to be adjusted for rich sonority.

Play double stop harmonics on A and D string.

Play double harmonics with the very tip of the bow. Place the bow on top of the bridge or very close to the bridge for more airy sounding effect.

Play with the bow underneath the strings touching strings I and IV. The diamond-shaped note should indicate harmonic sounding pitch.

Play with the bow underneath the strings touching strings I and IV. Play the given diamond-shaped notes on I string (G string) while IV string (E string) is sounding like a drone.

Play with the bow underneath the strings touching strings I and IV. Play the given diamond-shaped notes on IV string (E string) with glissando while I string (G string) is sounding like a drone. Make a vertical tremolo from last note lowest possible note on E string with the bow underneath the string.

Play with bow underneath the strings touching strings I and IV. Play the given diamond-shaped notes on IV string (E string) with glissando while I string (E string) is sounding like a drone. Make a vertical tremolo from last note lowest possible note on E string with bow underneath the string.

Double Bass - Instruction IV

3rd movement.

Slap with right-hand fingers on the strings in a circular motion while playing given pitches. Make short rests either at the end of the phrase or between notes ad libitum.

(pizz. like)

R.H./fingers slap on strings

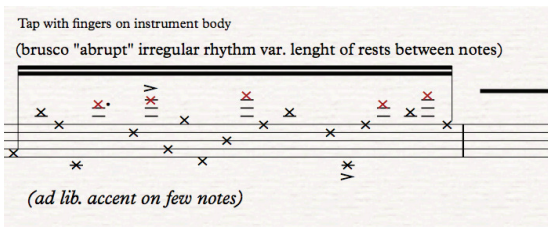
make short brakes (rests) ad libitum



A musical staff in bass clef showing a sequence of notes. Above the staff, a hand icon indicates a slapping motion. The notes are marked with a 'pizz.' symbol and a circular arrow. The text 'R.H./fingers slap on strings' is written above the staff, and 'make short brakes (rests) ad libitum' is written below the staff.

Tap with fingers on instrument body

(brusco "abrupt" irregular rhythm var. length of rests between notes)



A musical staff showing a sequence of notes. Above the staff, a hand icon indicates a tapping motion. The notes are marked with an 'x' and a 'v' symbol. The text 'Tap with fingers on instrument body' is written above the staff, and '(brusco "abrupt" irregular rhythm var. length of rests between notes)' is written below the staff. Below the staff, there are several 'x' and 'v' symbols indicating the placement of the notes.

(ad lib. accent on few notes)

Tap with fingers on instrument body. Higher written pitches should be tapped on the edge of the body or where higher pitched sound occur. Lower pitches are closer to the middle of the body etc.

Hilmar Thórdarson

Kuuki no Sukima

Between the air

For interactive conducting,
nine instruments and live electronics

Conductor - Composer

Submitted as Fulfilment of the Requirements for the:

Norwegian Artistic Research Program
at
NTNU - Norwegian University of Science and Technology
Department of Music

Commisioned by Trondheim Sinfonietta with support from Norwegian Cultural Fund



NORSK
KULTURFOND
Kulturrådet



CAVE
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Hilmar Thórdarson

Prologue

Kuuki no Sukima

ConDiS - Conducting Digital System

ConDiS - Conducting Digital System Kuuki no Sukima is specifically written for the ConDiS system. This system gives conductors the ability to control in realtime, electronically generated sounds. The sounds are governed in the same way as a conductor directs performers in an ensemble. With a special conducting glove, ConGlove, the conductor interacts with a computer that receives directions about tempo, volume and score following.

The conductor can, by closing the ConGlove or showing the fist indicate that the volume is about to change. By lifting or lowering his/her arm the volume gets louder or softer. Once the correct volume is reached, the conductor opens the hand (the glove) and disconnects the interaction with the computer.

Although Kuuki no Sukima is composed with the intention of demonstrating the usefulness of these new possibilities for conductors in controlling electronic sound live on stage with realtime interaction, it is by no means written as a "Demo piece". There are no compromises, or showcases to demonstrate or illustrate what ConDiS is doing. From the very beginning of the ConDiS artistic research project emphasis was placed upon the composer's artistic goal of composing music. The music itself is the priority, whilst the use of technology is secondary. The aim was to make the latter as normal and unobtrusive, or invisible as possible. With this goal in mind, the conductor is given a musical tool which expands and explores new possibilities of conducting live electronics in the simplest and most natural manner. A goal achieved in performance without the constraint of technology.

Kuuki no Sukima is an uncompromising composition which makes great demands upon the conductor and performers through its endless search for new sonorities and a new sonic spectrum which can now be realised via the controlling features of ConDiS. The title can be transcribed literally as "the gap of the air" or even "in between the air". Both these phrases reflect the composer's vision of creating a sonic landscape of sounds that lie somewhere out "there", or "in-between" the gap of a sound or pitched note. If sonority is a vibration of traveling air pressure, could such a gap exist? Could such a sonic world exist somewhere out "there" or "in-between" the air?

The conducting glove "ConGlove" buttons, the musical score, and the automated electronic effects written by the computer digital audio workstation (DAW) can be synchronized with precision. With the use of new musical graphics the composer can indicate precisely on the score and DAW where he wants to increase, or decrease the intensity of different effects. With use of the "ConGlove" metronome (tempo) button the conductor can synchronize the score and the DAW tempo. With the use of the "ConGlove" acceleration meter the conductor can adjust the overall volume of the electronic and acoustic mix. The composer can take advantage of the new opportunities which ConDiS offers. Through ConGlove synchronization the composer can also express him/herself in a personal way through synchronization and precision, free from the constraint of technology. The composer can also explore possibilities for innovative external use of live electronics through the conductor. In this way, Kuuki no Sukima can be realised.

With support from the Norwegian Culture Fond the Norwegian Artistic Research Program and Norwegian University of Science and Technology (NTNU), Kuuki no Sukima was composed during the autumn of 2016 to winter of 2017 for the Trondheim Sinfonietta and conductor Halldis Rønning.

After a work in progress performance at the Virtuoso Listener Festival in Trondheim, November 2017 a revised version was premiered during Trondheim Sinfonietta's Nordic Tour of Iceland, Faroe Islands and Denmark in January/February 2018.

My sincere thanks to the Trondheim Sinfonietta and conductor Halldis Rønning; without your extremely positive and professional approach, the unique sonority and musical expressions of Kuuki no Sukima would never have been crystallized.

Trondheim 23. April. 2018

Hilmar Thordarson, composer.

Kuuki no Sukima Movements

Kuuki no Sukima - Between the air/The gap in the air

The title can be transcribed literally as "the gap of the air" or even "in between the air" both very suitable for the composer's vision of creating a sonic landscape of sounds that are somewhere there, in-between or in the gap of being a sound or a pitched note. If sonority is a vibration of a traveling air pressure, could there be a gap? Could there be a sonic world somewhere there in-between the air?

1st. movement

Niōur - Murmur - せせらぎ

Duration c.a. 9'00''

Lorem ipsum

A soft, indistinct sound made by a person or group of people speaking quietly or at a distance. Could also be linked to nature sounds such as a low continuous sound of the wind murmuring through the trees or an atmospheric sound of a river.

2nd. movement

Hviss - Hiss - ビュービュー

Duration c.a. 5'30''

A soft but still loud gust of wind hissing over the rooftops. Could also be a sound of an object passing by with a sharp short hissing sound. According to English dictionary it means as a noun: "a sharp sibilant sound" or as a verb: "make a sharp sibilant sound as of the letter S"

3rd. movement

Suō - Buzz - ハミング

Duration c.a. 8'45''

A very soft sound like a buzzing sound from an electronic hardware like refrigerator or from electric light-bulb. English dictionary mention "the buzz of the bees" which is not quite the right explanation since the bee-buzz is in this case too loud and variant. Here the buzzing sound has more a humming sonority.

Total duration c.a. 23'15

Kuuki no Sukima

1st. movement

Niōur - Murmur - せせらぎ

A soft, indistinct sound made by a person or group of people speaking quietly or at a distance. Could also be linked to nature sounds such as a low continuous sound of the wind murmuring through the trees or an atmospheric sound of a river.

Duration c.a. 9'00''

Full Score

Kuuki no Sukima

Niður - Murmur - せせらぎ

Hilmar Thórdarson (2017)
move arm up to set volume value

use OK sign to select volume control

♩ = 48

x 4

on first downbeat press middle finger button to start computer play

3

2

on 2,3,4 and 1st beat of measure 2 press index finger button 4 times to set the metronome

use fist sign to activate control volume of all instruments groups



Clarinet in B \flat

Violin

Viola

Violoncello

Double Bass

Electronics

arco

pizz.

Behind the bridge.

mf

ff

Del

Rev

Gran

FB

Cl.

B. D.

Vln. I

Vla.

Vc.

Db.

Electr.

use five fingers sign to de-activate control volume of all instruments groups

strike with finger around the rim.

ppp

ff

Rev

FB

mp

pizz.

p

mf

FB

sul. D

arco

col legno tratto with hair of the bow.

make vertical tremolo so that the bow moves up/down. first small waves then poco bigger.

pp

gliss.

multo cresc...

sul. G

pizz.

pp

Del

Gran

mf

arco battuto (flautando at the tip of bow)

sul. E

pizz.

on the bridge wood with the nail of the middle finger.

f

press index finger button to stop computer play



press middle finger button to jump forward and start computer play



10

Fl.

B. D.

Pno.

Vln. I

Vc.

Db.

Electr.

play with fingertips

irregular rhythm

p

Rev

ff FB

mf

p *ff*

Del

f

ff

f

Gran

FB

Del

Electr.

14

Fl.

Cl.

Hn.

Vln. I

Vla.

Db.

Electr.

pp

Gran

Rev

mp

mp

Bass Clarinet in B \flat

irregular quarter tone trill w. key slap

p

mp

f

Del

Gran

FB

f

Gran

FB

F1 slide out (for Pix 23)

p

Del

Gran

FB

f

pp

Del

mf

mf

Gran

Rev

arco

sul A

sul pont.

pizz.

sul A

mf

Rev

Rev

Rev

Electr.

23

Fl.

B. Cl.

Pno.

Vln. I

Electr.

3

4

p *mp* *pp*

mp *Rev* *mp* *FB* *Del* *Gran* *mp*

p *Del* *ff*

mf *f* *mf* *FB*

31

Fl.

B. Cl.

Hn.

Pno.

Vln. I

Electr.

3

quarter tone trill

play with voice overtones afap

pp *p*

pp *Gran* *f* *Gran*

pp *p* *pp* *p*

Del *Gran* *ff* *p* *Rev* *ff*

ff *Del* *Rev* *ff*

Gran *ff* *FB* *ff*

4



(might have to find other fingerings for multiphonics)

sing very soft "g" while playing multiphonics

liberamente

3

Fl. 37

p ooh (as soft as possible) Del Gran *mf*

p ooo (as soft as possible) Rev Gran *mf*

B. Cl.

ppp (as soft as possible) Del Rev Gran *f* Gran *f* Gran *f* *p* Gran *pp*

Vln. 1

arco molto sul pont. play very close to the bridge for airy and flagolet type sound

pp Del Gran FB

Vla.

arco molto sul pont. play very close to the bridge for airy and flagolet type sound

ppp Gran *pp* Gran

Vc.

arco molto sul pont. play very close to the bridge for airy and flagolet type sound

ppp Del Gran *f* *ppp* Del Gran *f*

Db.

arco molto sul pont. play very close to the bridge for airy and flagolet type sound

sul E

ppp Del Gran *ppp* Del Gran

Electr.

49

4

Fl.

pp

Rev

mf

Gran

FB

B. Cl.

f

pp

key slap

p

f

Gran

Rev

ff

FB

Hn.

+

play with voice overtones afap

p

Rev

Gran

ff

ff

B. D.

play with fingertips

irregular rhythm

p

ff

FB

Vln. 1

molto sul pont.

p

Vla.

molto sul pont.

p

Vc.

pp

Gran

f

p

molto sul pont.

Db.

pp

f

Gran

Electr.

57

Fl.

3 4

p ooh

Rev

ff *f*

B. Cl.

pp

f

Rev

mf Gran

FB

Hn.

+

play with voice overtones afap

p

Rev

Del

ff

FB

B. D.

FB

Vln. 1

Gran

pp Del

FB

Vla.

pp

pp

Vc.

pp

Db.

Electr.

68

Fl. *pp* *mf* Rev Gran

B. Cl. Rev FB

Hn. *p* tr Fl. slide over (for Pic. 23)

Vib. *mp* *poco a poco dim...* Del Gran *f* FB

Pno.

Vla.

Vc. *pp* Del *mf*

Db. *pp* Del *mf*

Electr.

71

Fl. *mf* Del

Hn. *p* Rev Gran FB *mp* *f*

Vib. *p* *mf* Del *p* Gran FB *f* *pp* *poco a poco al niente* Del

Pno. *mp* *pp* Del Gran FB *ff*

Electr.

73 2 3 4 7

Fl. *oooh* *pp* Del *mp* *mp* Del *f*

Rev *pp* *f* *mp* Del *mf* *f*

Gran *mf* *f*

FB *pp* *f*

B. Cl. *pp* *f* *mp* Del *mf* *f*

Hn. *tr* *mp* Rev *p* *ff* *f* FB

B. D. *pp* *ff* FB

Pno. Gran *pp* Gran *pp* FB

Vln. I *ppp* sul tasto --> sul pont

Vla. *ppp* sul tasto --> sul pont

Vc. *ppp* sul tasto --> sul pont

Db. *ppp* sul tasto --> sul pont

Electr. *pp* Del FB

Annotations:
 - sing very soft "F" while playing multiphonics
 - play with voice overtones afap
 - strike with finger
 - Del (Delay)
 - Rev (Reverse)
 - Gran (Granulation)
 - FB (Formant Bandwidth)

83

Fl.

pp

mp Del --- Rev --- Gran ---

B. Cl.

Bass Clarinet in B \flat irregular quarter tone trill in key slip

p

Del --- Rev --- Gran --- *mp*

B. D.

strike with finger

pp

ff FB ---

Pno.

p

Del --- Gran --- FB --- *ff*

Vln. I

pp

Del --- Gran --- FB ---

Vla.

pp

Del --- Gran ---

Vc.

mp

pp

Del --- Gran --- *mf*

Db.

pp

Del --- Gran --- FB --- *mf*

Electr.

Del --- Gran --- FB ---

pp *mp* *p* *ff* *mf*

molto sul tasto

pp *mp* *p* *ff* *mf*

Diagram illustrating the hand position for the Flute and Bass Clarinet parts, showing the placement of the fingers and the direction of the air stream.



89 (2)

Fl.

B. Cl.

B. D.

Pno.

Vln. I

Vla.

Vc.

Db.

Electr.

Gran

Rev

fb

fb

Gran

fb

fb

Gran

Del

Gran

Del

Gran

p

mp

pp

mf

ff

p

p

p

p

p

f

mp

f

irregular rhythm

molto sul pont.

molto sul pont.

molto sul pont.

molto sul pont.

Del

Del

Del

Del

Del

Del

Del

Del

3

98

Fl.

B. Cl.

mf Rev Gran FB

+ play with voice overtones afap

Hn.

ppp

mp Rev Gran FB *mf* Del

B. D.

Vib.

p

mp Del FB

Pno.

p

f Del

Vln. 1

Db.

ad lib. sul tasto --> sul pont <-- sul tasto -->

p

Del FB

Electr.

4

Close hand to activate volume control
Lower arm to fade out electronics

press middle finger button to stop computer play

3

The score is divided into systems for Flute (Fl.), Horn (Hn.), Bass Drum (B. D.), Vibraphone (Vib.), Piano (Pno.), Violin I (Vln. 1), Viola (Vla.), Violoncello (Vc.), Double Bass (Db.), and Electronics (Electr.).

- Flute (Fl.):** Starts at measure 102. Dynamics range from *pp* to *mf*. Includes a section with *ff* dynamics.
- Horn (Hn.):** Features a *ff* dynamic section.
- Bass Drum (B. D.):** Dynamics range from *p* to *mf*. Includes a *ff* section.
- Vibraphone (Vib.):** Starts with a *ff* dynamic.
- Piano (Pno.):** Remains silent throughout the score.
- Violin I (Vln. 1):** Dynamics range from *p* to *f*. Includes markings for *sul tasto*, *normal*, and *sul pont*.
- Viola (Vla.):** Dynamics range from *p* to *ff*. Includes markings for *sul tasto*, *normal*, and *sul pont*.
- Violoncello (Vc.):** Dynamics range from *p* to *ff*. Includes markings for *sul tasto*, *normal*, and *sul pont*.
- Double Bass (Db.):** Dynamics range from *p* to *ff*. Includes markings for *sul tasto*, *normal*, and *sul pont*.
- Electronics (Electr.):** Represented by a waveform at the bottom of the page.

Technical markings include *Del*, *Rev*, *Gran*, and *FB* across various instruments. A hand icon at the top right indicates the location of the middle finger button.

Kuuki no Sukima

2nd. movement

Hviss - Hiss - ヒューヒュー

A soft but still loud gust of wind hissing over the rooftops. Could also be a sound of an object passing by with a sharp short hissing sound.

According to English dictionary it means as a noun: "a sharp sibilant sound"
or as a verb: "make a sharp sibilant sound as of the letter S"

Duration c.a. 5'30''

Kuki no Sukima

Hviss - Hiss - ビュービュー

2nd movement

Hilmar Thordarson

♩ = 64

x 4 (set metronome)

4 2

Horn in F

Violin

Violoncello

Electronic

arco spiccato/battuto (flautando) sul pont.

continue cresc...dim...cresc...without rest

flautando for airy sound

R.H. pizz. (finger slap)

Del Rev FB Gran

Fl.

Cl.

Hn.

Vib.

Vln.

Vc.

Db.

Electro

3 4

Bass Clarinet in Bb

Holding the position with the right hand thumb, the rest with the nail of the middle finger.

Del Rev FB Gran

Fl. ¹⁴

p *mf*

Del *p* *mf* *f*

Rev *f*

Gran *mf*

FB *mf*

Vib.

p *mf*

Del *mp* *f*

Gran *mf*

FB *mf*

Pno.

p *mf*

Del *f*

Gran *mf*

Vln. [Ⓢ] sul D Bow next to the bridge and finger very close to bow. Molto harmonics

mp *mf* *ff*

Rev *mp* *ff*

FB *ff*

Vla. [Ⓢ] sul A Bow next to the bridge and finger very close to bow. Molto harmonics

mp *mf* *ff*

Del *mp* *ff*

Rev *mp* *ff*

FB *ff*

Db.

ff *mf*

Del *ff* *mf*

Gran *ff* *mf*

FB *ff* *mf*

pizz. *mf*

L.H. pizz.

Electro

3 4 12

21

Hn. *p* *mp* *mf* *f*

Del

Gran

FB

Vib. *p* *mf* *f*

Gran

FB

Pno. *mf*

Gran

Vln. *mp* *f* *mf*

Vla. *mp* *f* *mf*

Del

Rev

Db. *mp* *f* *mf*

Electro

24

Pno. *mf*

Vln. *sfz* *f* *ff*

Vla. *sfz* *f* *ff*

Vc. *f* *sfz* *gliss.*

Sul C *pizz.*

Sul E *gliss.*

Db. *f* *mf* *Del*

Electro

Hit the body with the left hand thumb.

Right hand pizzicato on the bridge wood with the nail of the middle finger.

behind the bridge

Spicato like skin over strings very airy around then gradually do vertical tremolo while gliss down.

vertical tremolo

Conductor raise volume



27

Fl. *mp* *molto crescendo* *f*

B. Cl. *mp* *molto crescendo* *f*

Pno. *niente* *Gran ff* *mp* *molto* *f*

Vc. *mp* *molto* *f*

Db. *sfz* *f* *sfz*

Electro

Del - - - - - *f*

Rev - - - - - *f*

Gran - - - - - *f*

FB - - - - - *f*

FB

L.H. pizz

R.H. pizz. (behind the bridge)

Del - - - - - *f*

Gran - - - - - *f*

FB - - - - - *f*

32

B. Cl. *poco*

Hn. *mf* *poco*

Vib. *mf* *poco rit...* *mf*

Vln. *mp* *f* *Sul G* *gliss.*

Vc. *mf* *pizz.* *mf* *Gran*

Electro

Del - - - - - *f*

Rev - - - - - *f*

FB - - - - - *f*

Del - - - - - *f*

Rev - - - - - *f*

Gran - - - - - *f*

FB - - - - - *f*

Del - - - - - *f*

Rev - - - - - *f*

Gran - - - - - *f*

FB - - - - - *f*

Del - - - - - *f*

Rev - - - - - *f*

Gran - - - - - *f*

FB - - - - - *f*

Do vertical tremolo while gliss. Use the tip of bow.

Surando (slightly touch the string) Vertical tremolo with glissando.

3

grad. to multiphonics

4 13 solo

39

Pno.

pp

mf

mf

f

Gran

EB

Electro



42

B. Cl.

mp

mf

mf

f

Del

Rev

EB

Del

Vib.

mf

f

Gran

Pno.

Gran

Vla.

Sul C

mf

Glissando with the tip of the bow.
Vertical tremolo gestures.

gliss.

Gran

arco

sul pont.

gliss.

Db.

pizz.

sul E

fz

Gran

Electro

45

B. Cl. *(tr)*

Hn. *p* *mp* *mf* *f*

Vib.

Vln. *p* *f* *ff* *gliss.*

Vla. *f* *FB* *pp* *gliss.*

Vc. *mf* *sfz* *f*

Db. *mf* *f*

Electro

Gran

Del

FB

par finger as close to the bridge as possible and bow very close to the finger

Gliando with the tip of the bow. Vertical tremolo gestures.

Hit the body with the hand drums.

4

51

Fl. *pp* *mf* *poco mf*

B. Cl.

Hn. *pp* *f*

Vib.

Vc. *mf* *mf* *f* *p* *f*

Db. *p* *f* *f*

Electro

Gran

Del

FB

pizz.

sul C

put finger as close to the bridge as possible and bow very close to the finger

behind the bridge.

vertical tremolo

gliss.

3

55

Fl.

Musical score for Flute (Fl.) in treble clef. The staff contains a melodic line starting at measure 55. Dynamics include *p* (piano), *mf* (mezzo-forte), and *mp* (mezzo-piano). A *Gran* (Grand) dynamic marking is present at the beginning and end of the phrase. A circled '3' is in a box in the upper right corner.

B. Cl.

Musical score for Bass Clarinet (B. Cl.) in treble clef. The staff contains a melodic line with many slurs and ties. Dynamics include *pp* (pianissimo), *f* (forte), and *mp* (mezzo-piano). A *Gran* dynamic marking is present at the end of the phrase. A circled '3' is in a box in the upper right corner.

Hn.

Musical score for Horn (Hn.) in treble clef. The staff contains a melodic line with many slurs and ties. Dynamics include *mf* (mezzo-forte), *f* (forte), and *ff* (fortissimo). A *Gran* dynamic marking is present at the end of the phrase. A circled '3' is in a box in the upper right corner.

Vib.

Musical score for Vibraphone (Vib.) in treble clef. The staff contains a melodic line with many slurs and ties. A *Gran* dynamic marking is present at the end of the phrase. A circled '3' is in a box in the upper right corner.

Vc.

Musical score for Violin (Vc.) in bass clef. The staff contains a melodic line with many slurs and ties. A *f* (forte) dynamic marking is present. A *Gran* dynamic marking is present at the end of the phrase.

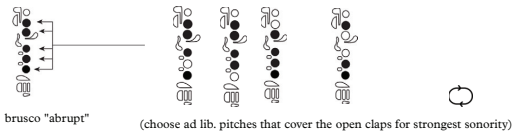
Db.

Musical score for Double Bass (Db.) in bass clef. The staff contains a melodic line with many slurs and ties. Dynamics include *niente* (nothing) and *ff* (fortissimo). A *Gran* dynamic marking is present at the end of the phrase.

Electro



4 15



60

Fl.

pp
f

Gran

B. Cl.

brusco "abrupt"

pp *pp* *mf* *pp*

Gran

FB

Hn.

slap tongue brusco "abrupt"

pp

Gran

Pno.

pp

Gran

FB

Vln.

sul G vertical tremolo gliss.

put finger as close to the bridge as possible and bow very close to the finger

p *mf* *f*

Gran

FB

Vla.

arco normale (hautando) sul pont.

pp

Del

FB

Electro

63

Fl.

B. Cl.

Hn.

Pno.

Vln.

Vla.

Db.

Electro

mf *mp* *p* *mp* *f* *ff* *mp* *mf*

Del - - - - -

Gran

Gran

arco battuto (flautando) sul pont.

p *FB*

sempre delay crescendo

pizz. *ff* *Gran*

66

Fl.

Hn.

Vib.

Vln.

Vla.

Electro

mf *mp* *mf* *f* *mp* *mf* *mp* *mf* *f* *ff* *ff*

Rev

Gran

Rev

gradually gliss from highest note to lowest on g string with vertical tremolo

gliss.

3

4
16

70

Fl. *p* Gran FB *mf* *mf* *f*

B. Cl. *mp* *mf* *mp* *mf*
Dcl *ff*
FB *mf*

Hn. *mp* *mf* *f* *mp*
Dcl *mp*
Rev *mp*
Gran *mp*
FB *mf*

Vib. *mp* *mf* *mp* *f*
Gran FB *f*

Vin. *sul G*
niente poco a poco cresc

Vla. *pizz.*
f *mf* *f* *f* *ff*
FB

Vc. *mf* *f* *f* *f* *mf* *f* *f* *f*
Dcl *f*
Rev *mf*
FB

Db. *arco battuto (flautando) sul pont.*
p *f*
Dcl *f*
FB *sempre feedback cresc... to ff*

Electro

Annotations:
 (dampen pitch with hand for more muffled sound)
 Holding the position with the right hand thumb, do pizzicato with the nail of the middle finger.
 Right hand pizzicato on the bridge wood with the nail of the middle finger.
 Behind the bridge.
poco a poco accel...

3

73

B. Cl. *mp*

Hn. (unis w. vibraphone) *mf*
pp Del
mp Rev *mf*
mf Gran *f*

Vib. *pp* *mf* Del Gran
f FB

Pno. *mp* *pp* *pp*

Vln. *f* Gran *mf* *f*
 gradually gliss from highest note to lowest on g string with vertical tremolo

Vc. vertical tremolo with wood (not legno) sul G *p* *mf* Gran
gliss.

Db. arco (above the left hand) sul G *p* *f* *mf* Del Gran
 Gran *ff* FB

Electro

4 17

79

Pno.

Via.

Vc.

Db.

Electro

pp Del | *mf* Rev | *ff* Gran | *f* FB ← *ff*

arco battuto (flautando) sul pont.

pp arco battuto (flautando) sul pont. *f*

pp arco battuto (flautando) sul pont. *f*

Del | *mf* FB ← *f*

82

B. Cl.

Hn.

Vln.

Via.

Vc.

Db.

Electro

p Del | *ff* Rev | *ff* Gran | *f* FB ← *f*

p arco battuto (flautando) sul pont. *mp*

arco normale (flautando) sul pont. *pp* *f*

ppp arco battuto (flautando) sul pont. *f* Del

Row midway between the bridge and the fingerboard. Position midway between the bow and the bridge.

Close hand to activate volume control
Raise arm to increase electronics

Open hand to deactivate control
Lower arm to fade out electronics

85

Fl.

p *f*

Del
Rev
FB

B. Cl.

Hn.

f
f
ff
f

Rev

Vln.

poco a poco cresc...

repeat ad lib. fade out

Vla.

arco normale (flautando) sul pont.

mf *f*

repeat ad lib. fade out

Vc.

poco a poco cresc...

Del
mf FB

repeat ad lib. fade out

Db.

arco normale (flautando) sul pont.

mp *f*

repeat ad lib. fade out

Del
FB

Electro

Kuuki no Sukima

3rd. movement

SUǒ - BUZZ - ハミング

A very soft sound like a buzzing sound from an electronic hardware like refrigerator or from electric light-bulb. English dictionary mention "the buzz of the bees" which is not quite the right explanation since the bee-buzz is in this case too loud and variant. Here the buzzing sound has more a humming sonority.

Duration c.a. 8'45''

Kuki no Sukima

Suð - Buzz - ハミング

3rd. movement

♩ = 72

x 4

4 2 18

Hilmar Thórdarson

Horn in F
mouthpiece backwards F1 slide out
pp [Del] ----- *f*

Bass Drum
Superball stroke around the edge of drum.
cresc.....dim. ad lib from pp to mp

Violin
Hit the fingerboard with hand
probably hit the under body to get louder sound
ff [Del] ----- *ff* -----
Double stop harmonics from highest pitch
arco sul D
sul D
molto sul pont.
gliss.
very slow glissando w/vertical tremulo
pp [Rev] [Rev]

Viola
Hit the fingerboard with hand
ff [Del] ----- *ff* -----
Double stop harmonics from highest pitch
arco sul D
sul D
sul G
molto sul pont.
gliss.
glissando w/vertical tremulo
mf [Rev] [Rev] *pp*

Violoncello
Hit the body with fist.
ff [Del] ----- *ff* -----
arco sul D
sul D
sul G
molto sul pont.
gliss.
glissando w/vertical tremulo
p [Rev] [Rev] *pp*

Double Bass
Hit the body with fist.
ff [Del] ----- *ff* -----
arco sul D
sul D
sul A
sul pont.
gliss.
glissando w/vertical tremulo
f [Del] ----- *f* ----- *mp* [Rev] [Rev] *sempre poco cresc... delay pp*

Electronic
4/4

Repeat with short var. length rests

Cl.

Hn.

B. D.

Pno.

Vln.

Vla.

Vc.

Db.

Electr

3

Repeat with short var. length rests

Fl. *ppp* Del - - - - - *p*

Cl. *ppp* Gran - - - - - *mf*

Hn. *p* Del - - - - - *f*
Rev - - - - -

B. D.

Pno.

Vln.

Vla.

Vc. *mp*
Gran

Db. *mf* Del - - - - - *mp* *f* Rev
Gran *mf* Gran

Electr

♩ = 92

x 4

4

2

Fl. *sempre mp delay*

Cl. *mf* *pp* *Rev* *FB*

Hn. *pp* *mp* *Gran* *FB*

B. D.

Pno.

Breath and trill on given pitch

mouthpiece backwards air sound

♩ = 92

Vln. *pizz.* *p* *mf* (very rapidly moving pan position)

Vla. *pizz.* *p* *mf* (very rapidly moving pan position)

Vc. *pizz.* *p* *mf* *f* *sempre mf delay* (very rapidly moving pan position)

Db. *pizz.* *p* *f* *sempre f delay* *poco a poco cresc... feedback to mf* (very rapidly moving pan position)

Electr.

♩ = 72

3

4

2

x 4

play microronal fingerings between g# and a.



FL. *pp* *mp* *p*
 air sound with flutter
 Rev FB
 sing pitches very close to actual pitch (for beating effect)

CL. *mp* *pp* *mf* *p*
 (tr)
 sing pitches very close to actual pitch (for beating effect)
 Rev FB

Hn. *f* *pp*

B. D.

Pno. *p*

Del - = = = Gran *f* *mp*

♩ = 72

Vln. Del - = = = - Del

Vla. arco *pp* *mf*
 bowing on or very close to the bridge make very airy sound with harmonics
 Del - = = = - Del
 FB

Vc. *mf* Del - = = = - Del
 FB

Db. *mf* Del - = = = - Del
 FB

Electr.

brusco "abrupt" (choose ad lib. pitches that cover the open claps for strongest sonority)

27

Fl.

Cl.

Hn.

B. D.

Pno.

Vla.

Electr

32

Fl.

Cl.

Hn.

B. D.

Pno.

Vln.

Electr

Rev FB

irregular rhythm

key slap

mouthpiece backwards

air sound

tap irregular rhythm with fingers on bass drum

f *p* *mp* *f* *Gran* *FB* *sempre f feedback*

mp *Del* *mf*

vertical tremolo with gradual succession: sul pont → normal → sul tasto
sul tasto → normal → sul pont

mf *Del* *FB*

grad. play more keyslap with sound

key and tongue slap

pp *p* *mp* *pp* *p* *mp* *mp* *Gran* *Rev* *mf*

f *FB* *mf* *f* *Del* *Gran* *FB* *mf*

pp *f* *arco* *pp* *f*

arco
Arco normale -
Blowing on or very close to the bridge
Make very airy sound with harmonics

3

irregular rhythm, molto airy (mye luft)

Fl. *pp*

Cl. *pp* irregular rhythm but try to follow the given one

B. D. *f* [FB] *sempre f feedback*

Pno. *f* [FB]

Vn. vertical tremulo with gradual succession: sul pont --> normal --> sul pont
sul tasto --> normal --> sul pont

Vc. *pp* Rev Del sul D sul G

Electr



4 21

breath and rests ad. libitum

Fl. *p*

Cl. *mp* breath and rests ad. libitum

Hn. mouthpiece backwards air sound *pp* Rev Gran *mp* [FB]

B. D.

Vc. arco *pp* Punta dell'arco - tip of bow
Bowling on or very close to the bridge
Make very airy sound with harmonics
Gran [FB] *mf*

Electr

44

Fl.

Cl.

Hn.

B. D.

Vla.

Vc.

Db.

Electr

Gran

f

p

FB

f

arco

pp

sul G

Punta dell'arco - tip of bow
Blowing on as very close to the bridge
Make very airy sound with harmonics

sul D

46

Fl.

Cl.

Hn.

B. D.

Pno.

Vla.

Vc.

Db.

Electr

3

4

22

Rev

Gran

mp

pp

mf

f

sempre f feedback

f

Del

sul A

How as close to the bridge as possible with finger in between.
Make as many overtones as possible

Finger position on the string above the bow.

vertical tremolo with gradual succession: sul point -> normal -> sul point -> sul into -> normal -> sul point -> sul point -> behind bridge

pp

Rev

Gran

pp

Gran

FB

51

Hn. *p* F1+ F2 slide out (irregular rhythm) *mp*

B. D. *f*

Vla. *f* FB

Db. vertical tremolo with gradual succession: sul pont. → normal → sul pont. → sul tasto → normal → sul pont. → behind bridge *f* *mf*

Del. *f* *mf* Gran

Electr.



3

4

53

Fl. *mp* *mf* Del. *mp* FB

Cl. *mp* Del. *mf* FB

B. D. *mp*

Pno. *mf* FB *mf*

Electr.

x 4 $\text{♩} = 92$

2

56 F1+F2 slide out (irregular rhythm)

Hn.

Rev Gran Del FB f Gran

B. D.

Pno.

$\text{♩} = 92$

pizz. (very rapidly moving pan position)

Vln.

pizz. (very rapidly moving pan position)

Vla.

pizz. poco a poco cresc... feedback

Vc.

pizz. sempre f feedback

Db.

pizz. sempre f feedback

Electr

60 wind to tone

Fl.

B. D.

Vln.

Vla.

Vc.

Db.

Electr

64 breath ad lib.

Fl.

Cl. wind to tone breath ad lib.

Hn. F1 slide out
p Del-
Rev *ff* *f* Gran

B. D.

Vln.

Vla. *f*

Vc. *f*

Db.

Electr.

f Del-
 FB

♩ = 72

x 4

4 24 2

68

Fl.

Cl.

Hn.

B. D.

Pno.

Vln.

Vla.

Vc.

Db.

Electr

f *Rev* *Gran*

pp *Rev* *Gran*

mp *f* *Del* *f* *Gran*

p *Del* *f* *Del*

pp *Gran* *ppp* *FB*

pp *Rev* *p*

Fl slide out irregular rhythm

arco flag. on IV
Bow below the strings.
Hair on the I and IV string all the time.
Diamond = Scordatura flag. arch

flag. on I

73

Fl.

B. D.

Pno.

Vln.

Vc.

Db.

Electr.

sul A

arco

Gran

flag. on IV

mp

f

Gran

Rev

Finger position on the string above the bow.

80

Fl.

B. D.

Vln.

Vla.

Vc.

Electr.

key slap with sound

mp

mf

ff

FB

Any type of Temple Bells for low, medium, high pitches (Tibetan bowls, Japanese Cup Bells etc.), placed Bass Drum (make a slight glissando with timpani pedal) Use appropriate mallet for best sounding solution.

p (adjust to overall volume)

f

arco

mf

Gran

arco

gliss.

pp

flag. on IV

arco

ppp

FB

pp

pp

f

Bow below the strings.
Hair on the I and IV strings all the time.
Diamond = Sounding flag, patch
gliss.

flag. on I

flag. on IV

87

Cl. *mp* windelapp *mf*

Hn. *mf* *Del* *Rev* *FB* *mf* *mf* *Del* *Rev* *FB* *mf* *mp* *Del* *Rev* *FB* *mf*

F1 slide out

mp *Rev* *FB* *mf* *sempre mf delay alla fine*

f *Rev* *FB* *mf* *sempre f feedback*

Pno. *mf* *Del* *Rev* *FB* *mf* *f* *mp* *Del* *Rev* *FB* *mf*

Vln. *gliss.* *gliss.* *gliss.* *Hit the fingerboard* *pizz.* **gradual succession: fingerboard → normal → behind the bridge* *f* *Rev* *pp* *tip of bow* *gliss.*

Vla. *gliss.*

Vc. *Gran* *flag, on IV*

Db. *pp* *Rev* *Gran* *FB*

Electr *pp* *Rev* *Gran* *FB*

90

Hn. *pp* *3*

Pno. *mp* *Rev* *f*

Vln. *gliss.* *Rev* *f* *move the bow vertical team. from the fingerboard to behind the bridge*

Vla. *pp* *gliss.*

Db. *pp* *flag, on I* *pp* *Del*

Electr *pp* *Del*

♩ = 92

4 26 2

93 Use various fingerings to play microtones between Bb and A and sing with glissando between 3rd to 6th below.

Fl. *p* gliss. *mf* [Del] [Gran] *sempr mf delay*
Cl. Use various fingerings to play microtones between G# and B and sing with glissando between 3rd and 6th below. *p* gliss. gliss. gliss. gliss. gliss. gliss. gliss. gliss. gliss. gliss. gliss. gliss. gliss. gliss. *mf* [FB] *sempr feedback*
Hn. *mf* *sempr feedback* mouthpiece backwards
Pno. *p*

♩ = 92

Vln. pizz. (very rapidly moving pan position) *p* *f* [Del] *sempr*
Vla. pizz. (very rapidly moving pan position) *p* *f* [Del] *sempr f delay*
Vc. pizz. (very rapidly moving pan position) *p* *f* [Del] *sempr f delay*
Db. pizz. (very rapidly moving pan position) *p* *f* [Del] *sempr f delay*
Electr. *poco a poco cresc... feedback to f*

♩ = 72

3

4

2

Fl. *gliss. gliss. gliss. gliss. gliss. gliss. gliss. gliss. gliss. gliss. gliss. gliss. gliss. gliss.*
p sempre cresc... granulation

Cl. *gliss. gliss. gliss. gliss. gliss. gliss. gliss. gliss. gliss. gliss. gliss. gliss. gliss. gliss.*
sempre poco a poco cresc... granulation

Hn. *f*
pp *mp* *mf*
 spitting tongue
 Rev

To bowed bowls
 Bowed bowls placed on a Timpani
f *FB* *sempre f feedback alla fine*

Pno. *mp* *f*
 Gran

♩ = 72

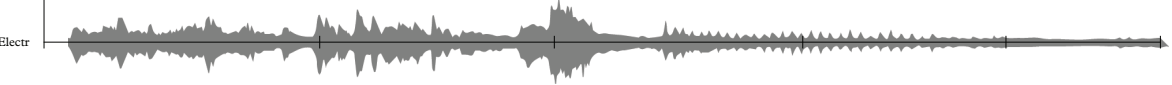
Vln. *f*

Vla. *f* Del FB arco

Vc. *f* Del FB arco sul A sul D

Db. *f* Del FB

Electr. *f* Del FB



102

Fl.

Cl.

Hn.

Vln.

Vla.

Vc.

Db.

Electr.

mp *FB* *f* *mf*

Play pitch with tremolo and sing approx. pitches (within major 2nd.)

pp *gliss* *p* *mf* *f* *mf* *mp* *mf*

Rev Del *f* *mf* *f* *mf* *mp* *mf*

Rev *Gran* *f* *mf* *mp* *mf*

sul D sul A *arco* *p* *FB* *poco* *gliss* *(as soft as possible)* *FB* *FB*

sul D sul G *Finger position on the string above the bow.* *Change from finger above the bow to the written double stop harmonics* *gliss* *(as soft as possible)*

p *Del* *Change from finger above the bow to the written double stop harmonics* *gliss* *(as soft as possible)*

Finger position on the string above the bow. *Change from finger above the bow to the written double stop harmonics* *gliss*

sul D sul A *arco* *Finger position on the string above the bow.* *Change from finger above the bow to the written double stop harmonics* *gliss*

p *Gran* *poco a poco cresc... granulation*

111

3 4 28

Cl. *gliss.* *gliss.* *gliss.* *gliss.* *gliss.* *gliss.* *gliss.* *gliss.* *gliss.* *gliss.* *gliss.* *gliss.* *gliss.* *gliss.* *gliss.*

Hn. *gliss.* *gliss.* *gliss.* *gliss.* *gliss.* *gliss.* *gliss.* *gliss.* *gliss.* *gliss.* *gliss.* *gliss.* *gliss.* *gliss.* *gliss.*

sempre mf feedback **f**

Pno. *p* *f* (FB)

Vln. *sempre cresc... feedback*

Vla. *Del* *Del* *mf* (FB)

Vc.

Db.

Electr

114

toneclapp and flutter. Quiet but forcefull. (breath where necessary)

Fl. *pp* (as soft as possible)

Del -----

f FB

mf *sempre cresc... delay*

Gran *sempre dim... granulation* *mf*

Cl. *gliss.* *gliss.* *gliss.* *gliss.* *gliss.* *gliss.* *gliss.* *gliss.*

Hn. Air sound with f valve out. play 1st and 0 valve ad libitum

P Rev *mf*

Pno. *mf*

FB -----

Vln.

Vla. -----

Vc.

Db.

Electr

116

Fl. *poco a poco cresc.*
f FB

Hn. **mp**
Gran

To Crotales

Pno. **p**

Del - - - - -
Rev - - - - -

Vln. (pizz. like) R.H./fingers slap on strings
pp
Del - - - - -

Vla. (pizz. like) R.H./fingers slap on strings
pp
Del - - - - -

Vc. (pizz. like) R.H./fingers slap on strings
pp
Del - - - - - **mf**

Db. **f** Gran

Electr

118

Fl. *mp* (as soft as possible in that register)

f *mp* *ff* Gran

Hn. *p* Rev

mp

Pno. *mf*

Vln. make short brakes (rests) ad libitum *pp* *sempre delay f al fine*

Vla. make short brakes (rests) ad libitum *f* *sempre f delay al fine*

Vc. make short brakes (rests) ad libitum *sempre mf delay*

Db. (pizz. like) R.H./fingers slap on strings make short brakes (rests) ad libitum

Electr

120

Hn. *mf* *p* *mp* *mf*

Pno. *Del* *Rev* *sempre mf delay* *sempre mf reverb*

Vln. *poco* *sempre*

Vla. *poco*

Vc. *poco*

Db. *Del* *FB* *sempre poco a poco cresc... delay al fine* *sempre poco a poco cresc... feedback al fine*

Electr

The score for rehearsal mark 120 consists of seven staves. The Horn staff (Hn.) begins with a melodic line starting at measure 120, marked *mf*, *p*, *mp*, and *mf*. The Piano staff (Pno.) features a complex texture with a dense pattern of notes and rests, accompanied by *Del* and *Rev* markings and the instruction *sempre mf delay* / *sempre mf reverb*. The Violin (Vln.), Viola (Vla.), and Violoncello (Vc.) staves enter with melodic lines marked *poco* and *sempre*. The Double Bass (Db.) staff has a melodic line with *Del* and *FB* markings, and instructions *sempre poco a poco cresc... delay al fine* and *sempre poco a poco cresc... feedback al fine*. An Electroacoustic (Electr) waveform is shown at the bottom of the page.

Crotales

124

Vib.

Pno.

Vln.

Vla.

Vc.

Db.

Electr

Del

Rev

f sempre *f* delay alla fine

FB ← *mf* sempre cresc... *fb*

128

Hn. *p* Rev *f*
f Gran

Crot. play with chopsticks or thin metal stick
pp FB *poco a poco cresc... feedback to mf*

Vln. *poco* *sempre* *f* *sempre f delay al fine cresc... feedback al fine*

Vla. *f* *sempre f delay al fine cresc... feedback al fine*

Vc. Tap with fingers on instrument body (brusco "abrupt" irregular rhythm var. length of rests between notes)
(ad lib. accent on few notes)
 Del FB *poco a poco cresc... delay from mf --> ff al fine*
poco a poco cresc... feedback from mf --> ff al fine

Db. Tap with fingers on instrument body (brusco "abrupt" irregular rhythm var. length of rests between notes)
(ad lib. accent on few notes)
 Del FB *sempre poco a poco cresc... delay al fine*
sempre poco a poco cresc... feedback al fine



(activate volume control and increase - decrease ad. libitum)

131

Fl.

Cl. wind tones

mp

Rev Gran

Crot.

Pno. *pp*

Gran. *mf*

FB

Vln. Tap with fingers on instrument body (brusco "abrupt" irregular rhythm var. length of rests between notes) (ad lib. accent on few notes)

Vla. Tap with fingers on instrument body (brusco "abrupt" irregular rhythm var. length of rests between notes) (ad lib. accent on few notes) *f*

Vc.

Db.

Electr.

133 wind pitch --> sound --> whistle tones sempre volume control al fine

Fl. *mp*

Cl.

Crot. *mf*

Pno. *pp*

mf FB *f* FB

Vln.

Vla. *sempre f delay alla fine poco a poco cresc... feedback*

Vc. *f*

Db.

Electr

135

Fl.

Cl.

Crot.

Pno.

Vln.

Vla.

Vc.

Db.

Electr.

pp

mf

Gran

FB

p

mf FB

pp

sempre dim... fb al fine

Del

FB

137

Fl. ^{no} play harmonies ad lib.

Cl. [⊕]

Hn. [⊗]
pp Rev
f Gran FB *f*

Crot. [⊗]
poco a poco cresc... feedback to f

Pno.

Gran FB *mf* Gran FB

Vln. [⊕]

Vla. [⊕]
f FB

Vc.

Db.

Electr

139

Fl.

Cl.

Crot.

Pno.

pp
Del
Rev

mf

f

Vln.

Vla.

Vc.

Db.

Electr

sempre poco a poco cresc... delay al fine
sempre poco a poco cresc... feedback al fine

sempre f delay alla fine

(sempre volume control ad. libitum)

143

Fl.

Cl.

Hn.

Crot.

Pno.

Vln.

Vla.

Vc.

Db.

Electr.

spitting toungue

mp

f

pp

f

mf

ff

Rev

Gran

FB

poco a poco cresc... feedback to ff

poco a poco cresc... feedback al fine (ff)

Del

FB

ff

145

Crot.

Pno.

Vln.

Vla.
f Del

Vc.

Electr

148

Fl.
mf Del

Crot.

Pno.
mp Del

Vln.

Vla.
f Del

Electr

(sempre volume control ad. libitum)

151

Fl. *ppp* *mf*

Crot. *ppp* *ff* *FB* *poco* *mf*

Pno. *ppp* *mf*

Electr. *Del* *mf* *Del*

154

Fl. *ppp* *mf* *poco*

Crot. *ppp* *mf* *sempre ff feedback alla fine*

Pno.


Electr. *f* *Del*


play harmonics ad lib.

158

Crot. *fade out...*

Electr.

activate volume control  (fade out volume of electronic)

deactivate volume control when electronics have faded out 

Press stop button when el. sound is faded out. **3** 27

