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Evolving the Drum-Kit

Frameworks and Methods for Diachronic Live Electronic
Performance Practice and Bespoke Instrument Design

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Declaration

I hereby declare that I am the sole author of this thesis. Wherever contributions of others are involved, every effort is made to indicate this clearly, with due reference to the literature and acknowledgement of collaborative research and discussions. None of the material has been previously submitted for a degree or other qualification.

Christos Georgios Michalakos
Edinburgh - 30 / 08 / 2013

Abstract

This thesis examines performance practice with the *Augmented Drum-Kit*, a personal evolution of the acoustic drum-kit with the use of digital technology. The practice is investigated from three perspectives: First, through possible spatial and contextual definitions of the instrument under development, taking into consideration the inherently open-ended nature of its building blocks: percussion and the computer. Second, by exploring the composer / performer / builder's practice paradigm in terms of musical and performative goals with such an emerging performance environment. Finally, as a diachronic practice between performer and all constituent technological parts of the composite instrument, towards the practice's ongoing development and evolution.

Using these discussions as starting points, this practice-led research proposes three intertwined novel frameworks for diachronic live electronic performance practice and bespoke instrument design.

Additionally, the developed instrument itself is detailed in the form of the devised design methods, schematics, diagrams and software, addressing questions such as intuitive control, gestural uniformity, consistent electro-acoustic vocabulary, distinct instrumental character, mobility, sound diffusion and transferability.

Finally, music portfolio consisting of five solo and group album recordings with the *Augmented Drum-Kit* is presented, while audiovisual examples from various scenarios and development stages are used to further illustrate the discussion.

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Introduction

> Percussion is not even an instrument. It is not a single instrument anyway. The percussion family consists of thousands of instruments coming from dozens of world cultures. And having a thousand instruments is very much like having no instrument at all. (Schick, 2006)

0.1 Motivation

In 2007, in an effort to expand my acoustic drum-kit's sonic palette, I began experimenting with commercially available electronic drum-kits. The experience, however, proved to be significantly disappointing. The musical outcome, as well as interaction with the electronic part of the instrument, not only did not help complement or expand the acoustic part, but felt entirely alien to the acoustic drum-kit's composite and hybrid character. The reasons behind this disconnection could be better understood by examining the acoustic drum-kit's nature. John Bowers describes performance environments for improvised performance as "assemblages of physical objects, microphones, computers and software" (Waters, 2011). One could argue that the commercial acoustic drum-kit today is one of the most popular examples of such an object assembly. As a unified instrument, the drum-kit acquired the form it has over a course of decades, incorporating hundreds of inventions and augmentations, responding to new musical needs. It is fairly obvious that the motivations behind its evolutionary course were always to make a single percussionist capable of controlling more sound sources simultaneously and more efficiently. This evolution was not only manifested through the quality of the specific sound sources (better drum skins and drum materials creating a larger dynamic range and longevity) but also by its standardisation as a performance environment, consisting of specific sound sources positioned in a specific formation. As an industrialised product, out of all possible percussion objects and relationship variations that could make up the drum-kit, only one is now being commercially sold, mostly pre-assembled and with only minor deviations.

Consequently, the design of digital electronic drum-kits has been largely informed by this specific acoustic formation. Except from the spatial configuration of the bass-drum, snare-drum, hi-hat, toms and cymbals, the electronic drum-kit's design reveals something perhaps more important about the acoustic drum-kit's perceived nature today: The electronic drum-kit pads

detect discrete hits performed on them and play back the respective assigned samples according to the hit intensities. However, this approach misses everything that is ambiguous between "hit" and "non-hit", as well as excitation means (such as wooden stick, hands or brush) and type of hit (staccato, scrape, etc), thus limiting significantly the electronic instrument's expressive possibilities. As an autodidact drummer and improviser, I have always been thinking of the instrument in terms of textural possibilities and interactions between those textures, rather than considering the standard version of the drum-kit as a fixed instrumental entity. As such, I was particularly nonplussed when I attempted to use the commercially available electronic versions of the instrument as these had very little performative similarity with the acoustic drum-kit as I knew it. At that point, it became obvious to me that I needed to reconsider not only what I wanted from the electronic augmentation of the drum-kit, but also reflect on the notion of the acoustic drum-kit as a performance environment in general. For that, I had to consciously redefine the boundaries of the instrument. Also, just as numerous inventors throughout the drum-kit's evolutionary course were practicing drummers who were finding solutions to their own musical problems[1], the democratisation of digital technology and resources today made it clear to me that the solution to my drum-kit's electronic enhancement problem should come from personal research and systematic consideration of all possibilities of what the electro-acoustic instrument can be. As I later became familiar with Chris Cutler's electrified drum-kit, I realised that my vision for my electronically augmented instrument was very close to his:

> Knowing what I missed with samples helped clarify what I wanted from electrification: an instrument that would respond to the minutia of performative variations, interact with itself and retain all the qualities of an acoustic instrument while extending itself completely into the electronic realm. An instrument in fact like an electric guitar, in which many of the techniques and attributes associated with the acoustic version are preserved but massively extended. (Cutler, 2005)

In order to achieve his goals, Cutler uses hardware effects and processing modules. In my case, the computing advancements of the last decade, as well as prototyping programming environments such as Max/MSP[2] becoming more widely used, imposed the use of the computer as the epicenter for the acoustic kit's electronic augmentation. This would allow me not only to program bespoke processing effects but, more importantly, it would enable me to develop a digital system that would not need constant parameter and mixing supervision of several hardware processing modules. Instead it would be managed both by appropriate mappings and machine listening techniques, using often the acoustic performance as a means of seamless control of the electronic sound. In some respect, I perceive this work as a personal evolutionary course of the drum-kit into the digital era, following its history of object assemblies, inventions and augmentations, while maintaining the design principles of the acoustic instrument's essence: being composite, hybrid and flexible.

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[1] Notably William F. Ludwig who developed the first bass-drum pedal in 1909
[2] http://cycling74.com/ (accessed June 2013)

0.2   Research Questions

From the point of view of electronically augmenting the drum-kit, this research attempted to address the following questions:

1. How can such an emerging hybrid instrument be controlled intuitively "as one would play a kazoo." (Bailey, 1993, 101)?

2. How can performative gestural uniformity be achieved with a hybrid instrument that consists of percussion (requiring larger gestures and a more physical performance) and the computer (inherently requiring microgestures for its control)?

3. What methods should be followed in order to create a consistent vocabulary between the two sound worlds?

4. How should the design of the hybrid instrument be approached so that it has a distinct character but is also true to the formless nature of its building blocks: percussion and the computer?

5. What tactics should be followed in order to be able to travel and perform extensively and in different contexts, just as with any traditional instrument?

6. How should electronic sound diffusion be implemented so that the electro-acoustic instrument (i.e. percussion and the computer) is perceived as one entity?

7. Can such a bespoke instrument be truly transferable? Should it be?

8. What exactly does my agency entail as a performer of such a personal means of music making?

0.3   Frameworks

Since any object can be used as percussion, the drum-kit is potentially one of the most fluid acoustic formations, maintaining at the same time a strong instrumental identity. The drummer knows how to extract sounds and excite objects, but is free to define his own performance environment. Similarly, the computer could be perceived as the equivalent of percussion in the digital realm. The laptop performer collects and uses synthesis techniques, live sound manipulation methods and repurposed sound transforming units. She then designs the interactions between herself, as a performer, and the devised instrument, just as the percussionist chooses how to position Tibetan bowls, scrap metal and brake drums around the drum seat. Consequently, the hybridization of these two conceptually identical potential instruments, gives great freedoms and design possibilities towards a highly personal instrument, keeping the most suitable elements from both worlds. Given the endless possibilities, it was

necessary to develop theoretical frameworks for personal instrumental design and shaping within my electro-instrumental practice, that would ensure a clear instrumental and performative identity. Choosing to embrace the fluidity and formlessness of the emerging *Augmented Drum-Kit* made the development of such frameworks not only desired, but vital. In the end, this approach allowed for the developed instrument to be perceived not as a static collection of specific objects and relationships, acoustic and electronic, but as a constant and consistent negotiation between myself as a performer and all the elements that comprise the instrument, guided by performative needs, context and environment, and afforded by the developed frameworks.

0.4 Output

The output of this practice-led research could be divided into three intertwined parts:

1. The three novel developed frameworks within which the *Augmented Drum-Kit* and my performance practice was defined and shaped:

   (a) Instrumental Spaces (as defined in *Chapter 1*)

   (b) Potential Musical Energy (as defined in *Chapter 2*)

   (c) Instrument Development Cycles (as defined in *Chapter 4*)

2. The developed instrument itself in the form of the submitted descriptions, design and mapping strategies, schematics and code.

3. Music portfolio in the form of five album recordings with the *Augmented Drum-Kit* (two of which are solo and three as part of group projects) as well as audiovisual material of performances with the instrument throughout its development.

0.5 Thesis Overview

- **Introduction** describes the motivations for this work, as well as some of the outcomes that it has produced.

- **Submitted Media** lists the musical works produced with the *Augmented Drum-Kit* in the form of five audio CDs and one DVD containing media and software. Additionally, a performance timeline is presented, situating in time all submitted or referenced works.

1. **Instrumental Spaces** describes the framework related to space and introduces the notions of *Ideal Performance Environment*, *Real Performance Environment*, *Transformation Space*, *Immediate Gestural Space* and *Extended Instrumental Space*.

2. **Potential Musical Energy** describes the framework related to my approach towards music making, defining it as musical energy "stored" between composer/performer/builder and the instrument under development. The factors comprising *Potential Musical Energy* are *Awareness*, *Agility* and *Vocabulary*. Also, the notion of the performer's *Telos* is introduced, being central towards defining one's own and instrumental and performative goals.

3. **Awareness** describes the first factor of *Potential Musical Energy*, as well as the mehods followed during the instrument's development in order to raise performative *Awareness*.

4. **Agility** describes the second factor of *Potential Musical Energy*. The methods followed towards shaping performative *Agility* comprise the third and final developed instrumental framework and are presented here, the *Instrument Development Cycles*. As it will be detailed, these are A) Interface Design Improvisation B) Aesthetic-Shaping Improvisation and C) Inter-Contextual Improvisation.

5. **Vocabulary** details the third factor of PME: the developed instrumental *Vocabulary*, illustrated by audio and video examples. Additionally, the rationale behind the use of its specific elements is discussed, as well the digital *Vocabulary*'s classification into three categories, 1) *Intertwined*, 2) *Peripheral* and 3) *Independent* in relation to the physical performance.

6. **Friction** describes the loss of *Potential Musical Energy* caused by unexpected factors manifested in real-life performance scenarios. Some of the employed problem solving techniques and adaptation methods are presented through practical examples and audiovisual material.

7. **Conclusion and Further Work** evaluates the frameworks developed as part of my performance practice, and discusses the methods with which the research questions were addressed. Finally, suggestions are given for further work and instrumental development.

Media

Music Portfolio

Figure 1: Submitted album recordings: (A) (B) (C) (D) (E)

A: Frrriction Solo Album 2011 (dur. 28min)

1. Frrriction I 04:32

2. Frrriction I Coda 00:42

3. Owtch-B 10:47

4. Frrriction II 03:47

5. Cosmonaut Down 04:53

6. Frrriction III 03:03

B: Signal Powder Group Album 2011 (dur. 35min)

1. Forêt Noire 06:07

2. Leave it Alone (Leave it Alone) 02:52

3. Signal Powder 05:25

4. Werewolf Whim Wham 03:42

5. Goofooyoo 06:24

6. Jein 04:33

7. Space Jockey 04:36

C: Node / Antinode Group Album 2012 (dur. 36min)

1. Antistrophe 07:06
2. Node 07:15
3. Derelict 06:58
4. Antinode 14:07

D: Socks and Ammo - NeVIS Live Group Album 2010-12 (dur. 40min)

1. SaA_v3 @ Lunchtime SARC 16:10
2. SaA_v2 @ SOUND Festival 09:08
3. SaA_v1 @ Sonorities Festival 15:41

E: Long Distance Solo Album 2012 (dur. 31min)

1. It's All Going Downhill 7:47
2. Long Distance I 5:00
3. Intermission 3:00
4. Boneless Iron 5:24
5. Long Distance II 9:14

Credits - The recordings feature the following performers:

(A) Christos Michalakos - Augmented Drum-Kit

(B) Christos Michalakos - Augmented Drum-Kit
Lauren Hayes - Piano, Celeste, Synthesizers, Computer
John Pope - Double Bass

(C) Christos Michalakos - Augmented Drum-Kit
Lauren Hayes - Synthesizers, Computer

(D) Christos Michalakos - Augmented Drum-Kit
Lauren Hayes - Piano, Computer

(E) Christos Michalakos - Augmented Drum-Kit

DVD Media File Listings

Audio Folder

- Bone.mp3
- Bevatron.mp3
- HKMR.mp3
- Hypogaeum.mp3

- Long.mp3
- Node1.mp3
- Node2.mp3
- Node3.mp3

Video Folder

- ICMC.mov Solo Performance - Excerpt
- NIME.mov Group Performance - Excerpt
- HAKEMIRA.mp4 Group Performance - Full
- LLEAPP10.mp4 Group Performance - Full
- BEAM.mp4 Festival Solo Performance - Excerpt
- MiRa.mp4 Group Performance - Excerpt
- ISEA.mov Group Performance - Excerpt
- POPP.mov Group Performance - Excerpt
- DM(T).mov Group Performance - Excerpt
- Bevatron.mov Solo Performance - Excerpt

Various Folder

- Cutler.mov
- Oxley.mp4
- Nowitz.mp4

Vocabulary Folder

- **Acoustic**

    - bowing.aif

    - flexstick.aif

    - scrape.aif

    - string.aif

- **Electronic**

    - _clean.aif
    - +++.aif
    - bit.aif
    - cat.aif
    - del.aif
    - env.aif
    - frz.aif
    - grab.aif
    - grn.aif
    - loo.aif
    - mach.aif
    - pad.aif
    - pzo.aif
    - rev.aif

    - scrb.aif
    - sun.aif
    - wsh.aif
    - xy.aif
    - fdb_bit.mov
    - fdb_tomview.mov
    - fdb.mov
    - frz.mov
    - grab.mov
    - loo_rev.mov
    - rev.mov
    - sun.mov
    - wsh.mov
    - xy.mov

NOTE: Accessing Media

Throughout the thesis, suggestions to access submitted media will be of two kinds:

1. **Parentheses** e.g. **"(/Media/Video/POPP.mov)"**. These intend to inform the reader that there is audiovisual material available relevant to the text, signifying the file path to its location.

2. **Square brackets** e.g. "[Please listen to **Album E: Long Distance** now]". These suggest more emphatically accessing a file, or listening to a submitted audio CD, signifying the file path or CD title.

Submitted Recordings and Performances Timeline
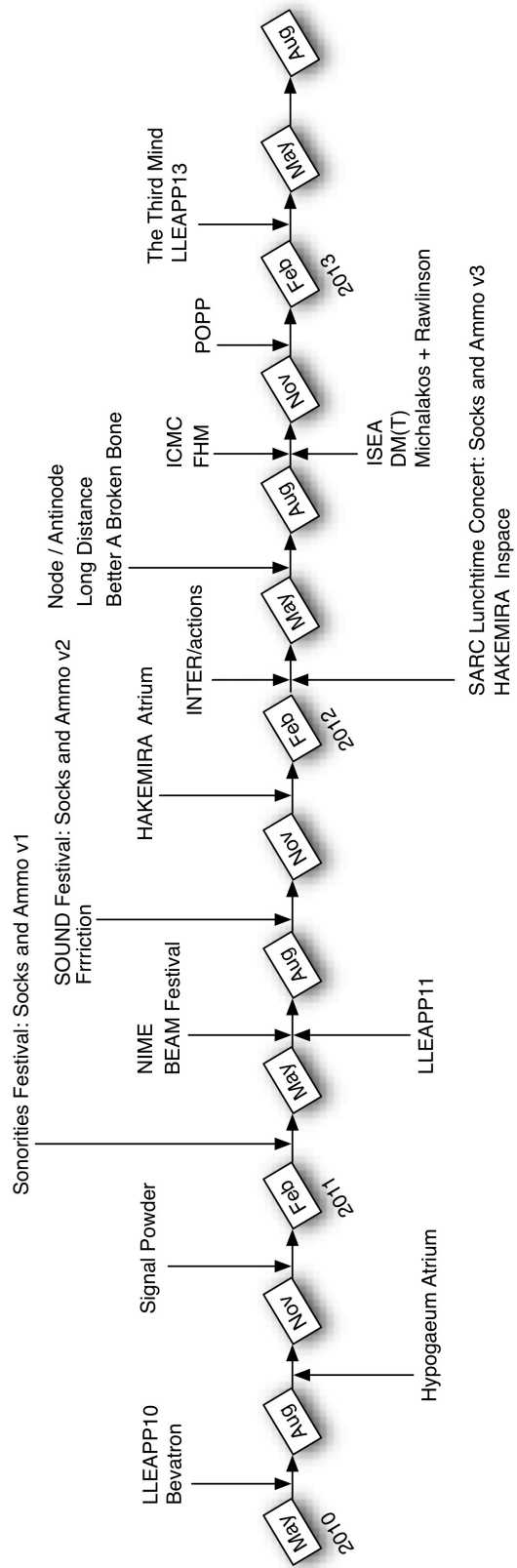
Figure 2: Timeline

Chapter 1

Instrumental Spaces

1.1 Introduction
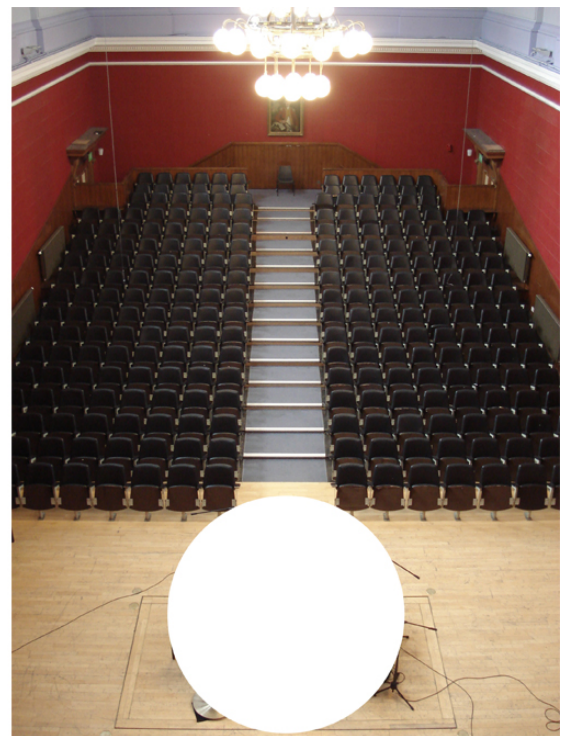
Figure 1.1: Immediate Gestural Space (left) - Extended Instrumental Space (right)

I will first examine the framework related to space that was developed as a result of my performance practice with the *Augmented Drum-Kit*, in order to explore the boundaries and outline the emerging instrument: Being a particularly fluid performance environment, any manifestaton of the ADK may depend on a combination of many factors, such as performance-specific musical goals, what one is able to transport to the venue, what the organiser is able to provide, possible influencing agents present, and sometimes interesting objects located in the perfor-

mance space found shortly before playing. To further illustrate the presented framework, I will compare examples of recent physical manifestations of the *Augmented Drum-Kit* in different performance scenarios, explaining the rationale behind the formational decisions. Finally, I will argue that in the field of new or augmented instrumental development, it is crucial to define such spatial frameworks within which these instruments are defined, shaped, fine-tuned, operate and evolve.

1.2   Spaces

Space is a particularly important factor in improvised performance. Spatial awareness not only relates to the concert hall or venue, part of the *Extended Instrumental Space* (EIS), but also to the performer's *Immediate Gestural Space* (IGS) which often defines her direct relationship with the instrument (Figure 1.1). In the case of a flute or a clarinet, the IGS is defined by the instrument's uniform body. For example, the fixed distance flute holes to be closed by the flautist, the piano keys to be pressed to produce the desired notes, and in some cases the inside of the piano to be struck by the pianist; in other words the innate set of properties of the objects, or invariants[1] (Gibson, 1977). In the case of table-top electronics, the IGS is defined by the spatial organisation of present objects and their relationships, which form a performance ecology[2] (Bowers, 2003).

I have conceived three central notions of space related to my own instrumental development and performance practice:
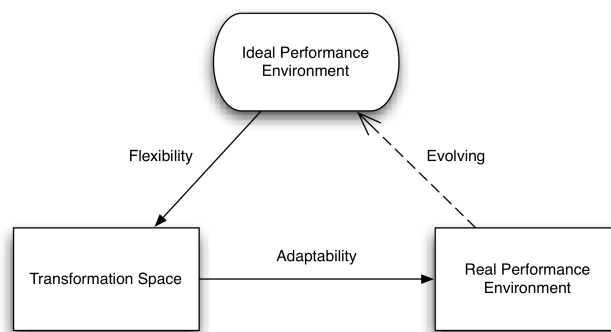
Figure 1.2: The Three Spaces

- Ideal Performance Environment (IPE)

  The conceptual *Ideal* space in which the instrument fulfils the performer's *Telos*[3]. Any physical manifestation of the *Augmented-Drum Kit* attempts to be as consistent with its

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[1](distinct from affordance in the Gibsonian sense, being always an emergent property of the interaction between an agent with a history in a particular environment)

[2]distinct from Waters' performance ecosystem (Waters, 2007)

[3]As defined in *Chapter 2: Potential Musical Energy*, briefly, the end term of a goal-directed process; the Aristotelian final cause.

current IPE as possible, in which the instrument would reach its theoretical full expressive and musical potential. This includes both the IGS and EIS. This conceptual space is constantly evolving, in parallel to the instrumental development.

- Transformation Space[4] (TS)

  The space within which the instrument is being developed, transformed, tested, fine-tuned, and assembled while planning *Real* performance scenarios. Through instrumental *Flexibility* and starting from its present conceptual IPE, the instrument is physically formed in the TS to fulfil *Real* performance scenarios. Richard Coyne describes:

  > Designers and makers of physical artifacts commonly associate workshops and studios with materials undergoing transformation: wood being cut, paint splashed about, casts molded, kilns fired up, glass blown, drum kits tested. (Coyne, 2010, 9)

- Real Performance Environment (RPE)

  The real world IGS and EIS within which the instrument materialises; the actual performance environment. This can comprise large reverberant concert halls, warehouses, jazz bars, broken cymbal stands, snare drums, bad monitoring and complaining neighbours—an intermingling of the technical, the conceptual and the social.

1.3   Ideal Performance Environment

Today there exist several definitions of what a musical instrument might be. Commonly, "an acoustical instrument that is a member of the classical orchestra"(Tanaka, 2009, 236); a violin, a cello, or a piano. What might not immediately spring to mind are the acoustic spaces within which these instruments operate and the social contexts they are part of. Franziska Schroeder and Pedro Rebelo write:

> Instruments are never stationary but are always given within a constantly changing, indeterminate background or horizon. Consequently, they are context dependent and, furthermore, the context itself is temporary and always subject to change (Schroeder & Rebelo, 2009)

When thinking of the electric guitar the answer can be even more complicated, since the instrument is not only the body of the electric guitar, but the body of the instrument when plugged into an amplifier and additional effects pedals[5]. Other similar inherent contexts could be, for example, a silent seated audience inside a concert hall in the case of a string quartet (within which a cello might operate), and a standing screaming audience in a rock venue in the case of a rock band (within which the electric guitar might operate). I believe that in the field of

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[4]This space will be further analyzed in *Chapter 6: Friction*

[5]As described by Fred Frith during his workshop at the Output Festival in 2007: http://www.youtube.com/watch?v=skd_70BINEQ (accessed June 2013)

NIMEs[6] it is important to define contextual considerations early in the development of the new instrument. For the classical pianist one could define as the *Ideal Performance Environment* the combination of their IGS (piano) and EIS (concert hall—in which a particular type of ritual is taking place (Small, 1998)). In the pianist's case, the *Real Performance Environment* might often converge to the IPE, since the history and development of the instrument has led to a plethora of high quality concert halls and pianos designed for these purposes. In this case, a set of practices and priorities has established itself and a network of supporting institutions and practices exist so as to present this particular IPE as a kind of pre-given ground, a form of common sense. Moreover, priorities about what constitutes a high-quality concert hall didn't arise as a result of purely objective criteria but emerged alongside and in interaction with the formation of the aesthetic priorities of the musical practices they were designed to enshrine (Thompson, 2004).

In the case of new instruments, clearly defined bespoke spaces do not exist. It is left to the instrument builders and performers to define their own *Ideal Performance Environments*, in combination with their musical decisions. I consider this matter of equal importance to any other instrumental design considerations, such as types of sensors, mappings or sound synthesis, which I see as inseparable from spatial attributes. "As the use of physical space becomes part of the design, the conceptual boundary between instrument and environment is rendered more ambiguous." (Green, 2011). A rock band's technical rider might include specific types of amplifiers and microphones, but aspects such as the fact that most group members will generally set up in parallel, having the drum-kit behind them while facing the audience are considered more or less given. Similar spatial preconceptions also exist for a string quartet. All these aspects have been shaped over years of performance within these contexts, and are present in the consciousness of people operating in and around these fields of music. Since in the field of NIMEs instrumental alterations can be disproportionately quick and impactful on the identity of instruments, similar notions and spaces have not yet had the time to develop around the instruments organically. This made it necessary for me as the composer/performer/builder of the *Augmented Drum-Kit* to actively seek my instrument's IPE, throughout the physical instrumental development, by performing extensively. For example, thinking about the audience, which I consider a part of the instrument's *Extended Instrumental Space*: What would be the *Ideal* scenario, in which the *Immediate Gestural Space* would be as impactful as possible? Having the audience surrounding it, having the instrument on a stage, having one-to-one performances? Can the audience talk during the performance, is the audience seated, can the audience see the instrument? Similarly, one could go on to consider every other aspect that contributes to the instrument's IPE. In the performance practice of 'live-coding', for example, ensembles often choose to project their laptop screens to the audience (including coding windows but also live text messaging between the members of the ensemble). It is not rare that these projections become the focal element of the concert. As such, they are arguably a part of the instrument, within the EIS (with the IGS being their computer keyboards and personal screens).

I perceive the *Ideal Performance Environment* of the *Augmented Drum-Kit* as an ever changing notion that evolves in parallel with the instrument. This means that while it can't be clearly

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defined (part of the instrument development methods[7] involves constant pursuit of its IPE), a specific aesthetic goal and style was always present for my instrumental practice, even if it was constantly refined. Drawing parallels with site-specific sound art, I see performances with the *Augmented Drum-Kit* as site-specific sound projects. The design of the instrument was informed by this perspective, thoroughly considering the relationships between performer and audience. As such, in a similar way that expressivity cannot be disconnected from the specific performers in instrumental design (different performers will always have distinct expressive relationships with the same physical instrument) the performance of an instrumental musical work and dissemination of a composition cannot be disconnected from the reality of specific human performers and a specific audience within a given space. Bob Ostertag writes: "I think most musicians working with electronics are probably not very satisfied with the state of electronic music today, and the crucial missing element is the body."(Ostertag, 2009, 103) I agree, and I continue that in many manifestations of computer music today, including NIME performances, the *Real Performance Environment* of a work's performance is often disregarded, or at least is not central in the creator's focus, which is perhaps more turned towards the conceptual or technical attributes of the work.

> One thing really surprised me participating in the NIME conference in NYC this summer, and that is the lack of really good musical applications of all the presented technology. I guess NIME is mainly about technology, but I was expecting more interesting performances during the organized concerts. There were some positive exceptions, but in general the music presented was mainly a demonstration of the technology.[8] (Heumen, 2007)

What Robert van Heumen describes corresponds to my frequent experience at technology centered festivals and conferences, perhaps due to the lack of such *Ideal Performance Environment* definitions, resulting in arbitrary *Real Performance Environments*. These notions are solidified through continuous performance practice, I contend. That is, through applied, transformative and reflective engagement with the instrument over time. Without this, instruments may stay in an embryonic state, which can lead to demonstration-like presentations, as observed by van Heumen. The notions of IPE and RPE as well as Transformation Space, were crucial throughout performance practice with the *Augmented Drum-Kit*, in order to be able to plan performance scenarios in terms of musical and human performative parameters where the technological aspects of the instrument would become transparent, leaving space to attributes such as struggle, tension and empathy to become the focus.

1.4 Immediate Gestural Space

As *Immediate Gestural Space*, I define the space within close proximity to the drum seat which I can exploit sonically throughout the performance. Denis Smalley calls such a space "a spatial zone within *reachable space*, the space being activated by the nature of causal gesture moving through that space in relation to the instrumental source" (Smalley, 2007). As seen in Figure 1.1,

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[7]As will be detailed in *Chapter 4: Agility*
[8]Quotation found in (Ferguson, 2010)
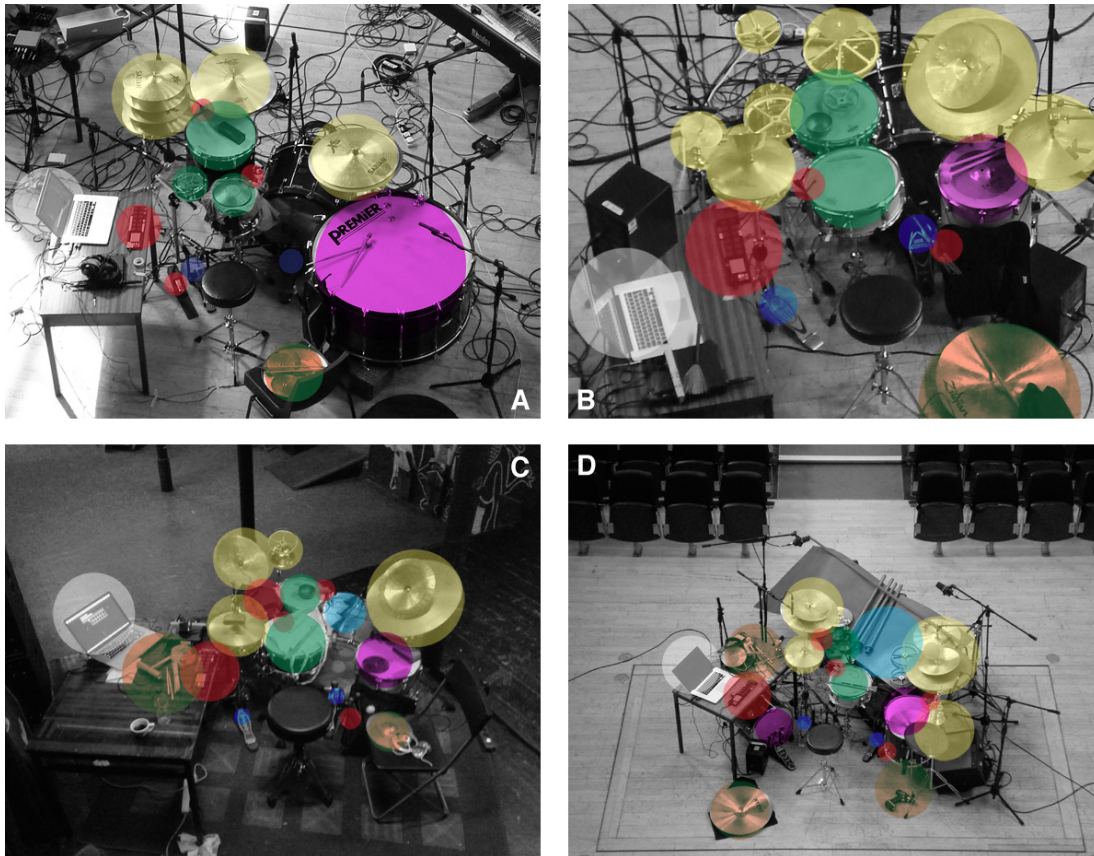
Figure 1.3: Real Immediate Gestural Spaces

I divide an instrument into its *Immediate Gestural Space* and *Extended Instrumental Space*. To illustrate the concept of IGS through my own performance environment, I present here (Figure 1.3), four instances of the instrument. This analysis attempts to provide an abstract representation of the material used in different situations and how each scenario shaped the formation of the instrument, both spatially and sonically. Between photos, all colours represent the same abstact sonic attributes, not necessarily specific drum parts, but general desired textural chracteristics that occupy the finite performance space around the drum seat.

A) Setup for *HAKEMIRA* group performance

B) Setup for *Better A Broken Bone* group performance

C) Setup for my ICMC[9] solo performance

D) Setup for *Long Distance* solo performance

The distinct IGS attributes I am spatially aware of during performances are:

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[9]International Computer Music Conference: http://www.computermusic.org/ (accessed March 2013)

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Green "Snare-ness" and/or surfaces for various smaller sonic objects

Yellow "Cymbal-ness" and longer decay sounds, pitched possibilities

Purple Feedback - sustained sound

Deep Blue Hi-Hat and bass drum pedals

Light Blue Different sound objects are placed here depending on the project

Red Interaction with the digital part of the instrument. MIDI controllers, triggers, pads, pedals

White Visual feedback from the digital part of the instrument

Bronze Sound objects or tools not presently used during the performance but ready to be employed. (e.g. woodblocks, bells or cymbals to replace currently mounted cymbals)

Despite their different aesthetic goals, my instrumental setups on all of these projects have common spatial relationships. The feedback tom / orchestral bass drum (Purple) was always on my right, "snare-ness" and surfaces of various smaller sonic objects was roughly in front of me with equal distance from my hands (Green), and the ride cymbal was right above the feedback tom with a second cymbal above it. Even though these formations could be expected—as they resemble a more or less traditional drum-kit setup—there are further reasons for their spatial distribution. Firstly, as will be seen in *Chapter 5: Vocabulary*, a central part of my vocabulary consists of preparing the snare drums with various small resonant objects and playing around and on them while using complementary DSP techniques, such as granular synthesis [Please listen to **(Album A: Frrriction - Track 1 - Frrriction I)** now]. I have found this spatial positioning to be the most suitable as I can quickly throw objects on the snare surfaces in front of me and incorporate new sonic elements instantly. Also, the ride cymbal is pierced with screws to achieve a prolonged decay time caused by the "sizzle". Since I mostly use the feedback tom[10] as a long decay or "drone-like" sound source, I use it in combination with the ride cymbal; I can hit with my hand the ride cymbal causing it to "sizzle" for a significant amount of time and then immediately press the tom's top skin with my palm to produce different overtones while the "sizzle" is still present. Their proximity makes it very easy to go back and forth, producing an alternating prolonged drone-based sonority. This, of course, is not usually present in a traditional drum-kit performance. In combination with a double bass bow, these two parts can be further unified by bowing firstly the ride cymbal, and then small cymbals pressed against the top of the feedback tom (B,C). In contrast to the objects placed on the snares, the objects placed on the feedback tom are usually placed not to be hit, but to be bowed, in order to achieve longer interactions with the feedback **(Album A: Frrriction - Track 3 - Owtch-B)**.

The rest of the cymbals (Yellow) and the space between the snares and ride cymbal (often the top of the kick drum (Light Blue)) are mostly decided upon according to the individual project's sonic requirements. For example, for the recording of *Long Distance*, I placed a metal sheet and

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[10]This will be explained further in *Chapter 5: Vocabulary*. Briefly, a speaker is placed under the floor tom producing feedback in combination with clip microphone placed above it resonating its membranes

metallic bars of various sizes found on site **(excerpt: /Media/Audio/Long.mp3)** as well as roto-tom bases (D). For the performance of *Frrriction* at ICMC 2012, I positioned three agogo bells. For *HAKEMIRA* (A) another ride cymbal and a "cymbal-tree" were used, since the goal was to produce more "open" and long decaying sounds, thus contributing to the more spacious nature of the music **(excerpt: /Media/Audio/HKMR.mp3)**. For the recording of the album *Better A Broken Bone*, instead of cymbals I decided to use numerous roto-tom bases and bells, since I was aiming to create pitched metallic sounds that would cut through the sound of a potentially dense free-jazz performance with electronics, a saxophonist and an electric guitarist **(excerpt: /Media/Audio/Bone.mp3)**.

1.4.1 Plasticity

Even though it always felt that I was performing on the same instrument throughout the different performances and projects (the full list of performances with the *Augmented Drum-Kit* can be found in Appendix G - Complete Performance History), this might not be obvious when considering variations in physical configuration. From the most minimal setup (e.g. snare drum and one clip microphone) to the most maximal (e.g. full drum-kit, cymbals, metals, clip microphones, triggers, objects), despite the differences, all *Augmented Drum-Kit* variations were perceived simply as different manifestations of the same instrument. It soon became clear that the defining factor is not the particular objects used (such as metal sheets, gongs or types of cymbals) but the spatial relationships between them and the way these are set up to interact with each-other, which is also true for the electronic part of the instrument. For example, just as the ride cymbal can be replaced by any cymbal or object providing "ride-ness" as long as it is positioned appropriately, the granular synthesis module could be replaced by any processing module responding similarly to the acoustic performance. What was constant throughout all performances was not as much specific textures produced by specific objects, but *how* I was able to reach them and *where* they were located, both in the physical and the digital realms. I realised that the supporting control system, the scaffolding behind the different timbres and the digital mappings, was more *definitive* than the sounds themselves. In this respect, I find the *Augmented Drum-Kit* closer to the digital sampler or the turntable, instead of other instruments that it would perhaps be more likely to be associated with, such as the piano or the saxophone. While a digital sampler performs specific sound manipulations on a loaded audio file, the particular sample being loaded into it does not define the instrument[11], in the same way that the particular cymbal mounted onto a stand does not define the *Augmented Drum-Kit*. Someone who regularly performs with the sampler might consider it to be the same instrument, affording the same gestures, despite different loaded material. Similarly,

> While the turntable itself is self contained, it is ultimately an open-ended system that depends on *content* played on it ... Finally, there is the question of *configuration*, as many turntablists perform with two or even three turntables connected by an audio DJ mixer. (Tanaka, 2009, 237)

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[11]The sampler makes it apparent how problematic the notion of instrument is; A sampler with nothing on it is a door-stop. A sampler with a particular sample, mapped in a particular way is a particular thing. Under the fingers of a particular player, it becomes a particular instrument.

I feel that, despite changes of sonic objects and other sound sources, the instrument remains the same when the most basic spatial relationships are maintained between my body and the drums, as well as between the digital system's constituent parts. Even when I am only using a snare drum with a clip microphone, as long as the drum seat height is correct and the drumhead suitable, as a performance system it can be considered as a subset of the full *Augmented Drum-Kit* and thus the same instrument. In other words, there might be a few minutes during a maximal *Augmented Drum-Kit* performance where I am focusing on the snare drum. During these periods I am still performing on the same composite instrument, but choose to not use the rest of the setup. I consider performing on a project requiring only a snare drum and electronics as exactly the same as performing on a project requiring the full instrument, but without having to bring the rest of the setup on the stage. With portability being a frequent issue, but also a matter that needed to be dealt with immediately at the very start of the practice in order to be able to perform extensively, the instrument needed to be primarily *flexible*.

Free jazz percussionist Paul Lytton, describes the immobility of part of his setup:

> One of the things I would have liked to brought over but I can't is my amplified section of stuff. Which is just impossible because it's too heavy to ship the stuff around. That's sort of a frame with bits of wire and what-have-you stretched across it and amplified using pick ups and what have you. And I can modify the sounds. You hear what a wire sounds like. Most of the time you wouldn't hear that sort of thing. There are all these small sounds made louder and they're quite interesting in a musical context.[12]

I definitely did not want to be in a position having to make such compromises. In order to make the ADK as portable as possible, I started approaching the instrument's *content* in more abstract ways, based around sonic attributes. For example, the long decay and clearly pitched sound of a singing bowl when hit; the particular object is not important, since any object able to produce a long decaying pitched sound can be suitable for this function. As long as there is one object like that in the setup, I am able to produce specific sonic transformations with my electronics. If not, it is not possible to reach that part of my *Vocabulary*. Similarly, a cloth wide enough to cover the snare drum, floor tom and small tom is, in some ways, more important than the quality of the drums themselves. The performance variations that become possible when this cloth is used (from fully to partly muffled, varying acoustically the "high cut-off frequency", decay and loudness of the drums) make it a permanent object in my traveling equipment, given priority other other equally weighted objects, such as a small cymbal, that would perhaps be considered a more obvious part of a drum-kit. Also, it is not as necessary to use hi-hat cymbals; on many occasions I have used small roto-tom bases (also known as spoxes, which produce a very distinct pitched metallic sound when hit) unpitched metals, or chinese cymbals. The definitive aspect of this part of the instrument is being able to press a pedal with my left foot and make two objects tighter or looser, so that I can exploit the variation in decay with the drumsticks, as well as produce a repeatable sound with every foot press. As such, very light small objects can be used for this function, depending on the project and travel restrictions. It was by investigating methodically what really makes the constituent objects of the instrument important to it, and by defining its *IPE* that such flexibility was possible to

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[12] `http://www.efi.group.shef.ac.uk/fulltext/ftlytton.html` (accessed June 2013)

achieve, despite the preconceived immobility of the drum-kit as an instrument.
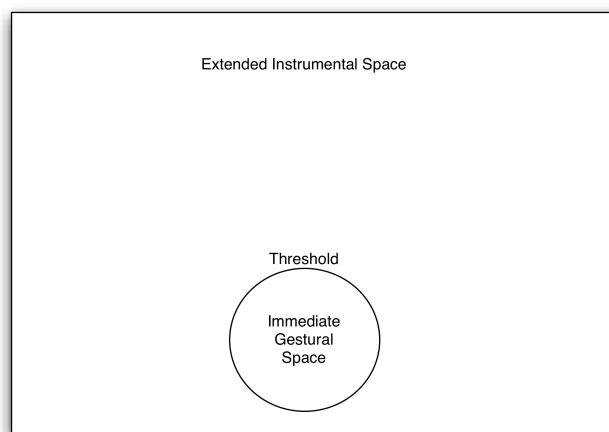
Figure 1.4: Threshold

1.5 Extended Instrumental Space

Every expressive sound manifestation within a space is connected with the space's acoustics, architecture, history and social context. A musical composition, with its inherent metaphors and constructed representations by a composer, can exist in more abstract representational systems such as notation, algorithms, recordings, or other form of documentation, according to the creator's goals. In my own compositional / performance practice most of the solo work is based around the concept of here and now, and the visceral, non-representational use of sound. In that sense, I consider my compositional work to be embedded within the instrument, while I see the different performances and recordings to be representations of the work adapted to specific spaces, media and scenarios, so that I can achieve the most effective version in each occasion. I consider the space which accommodates the *Immediate Gestural Space* of my instrument to be not only its physical extension, but an integral part of it. I define this part of the instrument as the *Extended Instrumental Space*. Here, I would also include in it the history and social context of the space I am performing in, since I believe that it has a significant effect on the performance, and thus the musical outcome. Coyne writes:

> Singers and instrumentalists adapt their style to the nature of the performance space, and composers take into account the characteristics of the space or medium in which their work will be performed. Music written for a cathedral will differ from that composed for a salon. Performers and composers tune their works to place. Resonance, the residue of sound decayed, muffled, and distorted, has been abstracted as a performance medium in its own right. (Coyne, 2010, 212)

In the case of the improvising musician in general, the division between IGS ends and the EIS is not always clearly defined, having a variable threshold (Figure 1.4). Improviser Han Bennink, for example, would sometimes get off the drum seat, continue drumming on the floor and end

up drumming on the walls of the concert hall[13]. Others might take an object from their drum-kit, such as a cowbell, and move around other instrumentalists, or members of the audience exploring the sonic space, as well as social interactions. For some pianists the threshold of their IGS ends after the piano keys and pedals, while for others it extends to the inside and outside of the piano, since for them the instrument affords extended sonic exploration. While all skilled improvisers are actively aware of the space that surrounds them, some have created projects exploring specific spaces. English saxophonist and improviser John Butcher along with Japanese sound artist Akio Suzuki went on a musical journey across Scotland and Orkney in 2006, playing concerts in a variety of resonant spaces. These spaces were chosen because of their distinct acoustic properties, and included a mausoleum, a wartime fuel storage tank and a cave—Each one saturated with its own history and acoustic character. "Doubtless, many of us have childhood memories of discovering a resonant space and of playing with its echoes, by making vocal noises of different volumes, pitches and durations, to discover their properties and possibilities." (Eyles, 2009). Butcher is arguably following the same approach in these unique spaces, perhaps treating them as what I am descibing in this text as the instrument's *Extended Instrumental Space*.
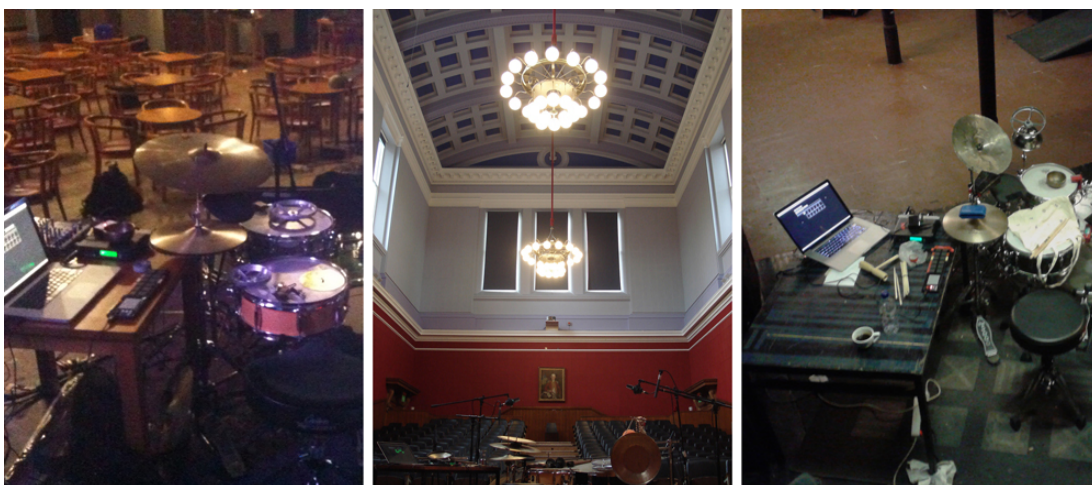
Figure 1.5: Extended Instrumental Spaces: Bar - Hall - Club.

Similarly, Norwegian guitarist Stian Westerhus has recorded an album[14] at the Emanuel Vigeland Mausoleum in Oslo, a tomb known for its natural reverb. Westerhus' *Immediate Gestural Space*—the electric guitar, amplifiers and various effects pedals, is now accommodated in a radically different *Extended Instrumental Space* than the concert venues he usually peforms in. This leads to a different musical aesthetic than his other studio works[15] clearly influenced by the space: "with the Vigeland mausoleum almost a musical partner, Westerhus can augment grander schemes with the nuanced results of slighter gestures." (Kelman, 2012). These two examples illustrate performers adapting their IGS into different EIS. For some other instruments, most notably pipe organs, the EIS is not only fixed in terms of a general type of performance space (concert halls, churches etc) but are indeed *built into* these buildings. Moreover, the coupling is so tight in the case of the pipe organ, that it is qualitatively difficult to separate IGS from EIS. Such types of instruments are acoustically coupled with their spaces: a pipe organ has al-

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[13]http://www.youtube.com/watch?v=G1T-Pxkp6SY (accessed June 2013)
[14]*The Matriarch And The Wrong Kind Of Flowers* (2012) - *Rune Grammofon*
[15]such as *Pitch Black Star Spangled* (2010) - *Rune Grammofon*

most nothing to it without spatial interactions (Blesser & Salter, 2006). As such, while John Butcher can take his saxophone (IGS) into different *Extended Instrumental Spaces*, the organist always performs on a fixed IGS into a particular EIS. In the organist's case, the *Real Performance Environment* converges to the *Ideal Performance Environment*.

In this respect the *Augmented Drum-Kit* is opposite to the pipe organ, as nothing is fixed: neither the IGS (consisted by the highly customisable computer and percussion) nor the EIS (ranging from a reverberant concert hall to an anechoic chamber or a cave) and this is why the notion of the instrument's *Ideal Performance Environment* needed to be conceived. Coyne describes a fish that "flicks against rocks and exploits the eddies in the water, some generated by its own movements, to swim faster than it could by brute strength."(Coyne, 2010, 14). This could be seen as the same practice as adapting my IGS in each given *Extended Instrumental Space*, thus taking advantage of complementary (or avoiding problematic) areas—spectral, aesthetic or otherwise—in each performance scenario.

1.6   Summary

Given the fluid nature and plasticity of the *Augmented Drum-Kit*, I introduced the notions of the instrument's *Ideal Performance Environment*, *Transformation Space*, *Real Performance Environment*, *Immediate Gestural Space* and *Extended Instrumental Space*. In combination, these developed concepts compose a instrument defining framework based on spatial and contextual attributes, which I outlined both theoretically and through practical examples. I expained that in the case of the *Augmented Drum-Kit* the perception of the instrument entails more general textural characteristics (such as "snare-ness" and "cymbal-ness"), the same applying to the digital part of the instrument (as will be seen in *Chapter 5: Vocabulary*). As such, the basis of the instrumental definition is dependent upon consistent spatial organisation of the assembled material, the specifics of which are interchangeable between instrumental manifestations. I argue that this fluidity, while maintaining instrumental consistency, is afforded by the developed framework, and specifically, the pursuit of the instrument's theoretical *Ideal Performance Environment*. This ensures the ability to adapt the instrument in each performance scenario, the main goal being the materialisation of the most suitable version of the instrument for each occasion, in an effort to maximise the stored *Potential Musical Energy* between performer and performance environment, as will be defined in the following chapter.

Chapter 2

Potential Musical Energy

2.1 Introduction

In *Chapter 1: Instrumental Spaces* I outlined the instrument based on spatial and contextual characteristics: from the *Ideal Performance Enviroment* (IPE) to its actual physical manifestations, the *Real Performance Environment* (RPE), and from the larger context within which the instrument materializes, the *Extended Instrumental Space* (EIS) to its *Immediate Gestural Space* (IGS). I see this framework as defining the instrument from the more general to the more specific, zooming-in until the instrument is clearly defined and stopping when any more zooming would make one lose perspective of a valid definition or make it inflexible. Such an excessive zooming-in, for example, would include the snare drum, specifically, as part of the instrument, instead of "snare-ness" the general texture which is what I am really looking after from this area within the *Augmented Drum-Kit*'s IGS. In the present chapter, I will examine performance practice with my instrument from another direction, introducing the framework of *Potential Musical Energy* (PME), which is my suggestion to perceiving music making with a new bespoke emerging instrument. As it will be explained, the notion of PME is complementary to the concept of the instrument's IPE. I see it as analogous to *potential* music stored within notation for fixed musical performance with traditional instruments. The difference is that here, *potential music* is stored between the performer and the instrument in the form of PME, to be released in the different performance scenarios through improvised performance. The bigger the convergence of the *Real Performance Environment* to the *Ideal Performance Environment* is in a performance scenario, the bigger the *Potential Musical Energy* is in this particular occasion, fulfiling the performer's *Telos*, as will be defined here.

2.2 Actualising

"Motion is 'the actualisation of that which is potentially, as such.' I.e. if there is something which is actually x and potentially y, motion is the making actual of its y-ness."(Ross, 1995, 84)
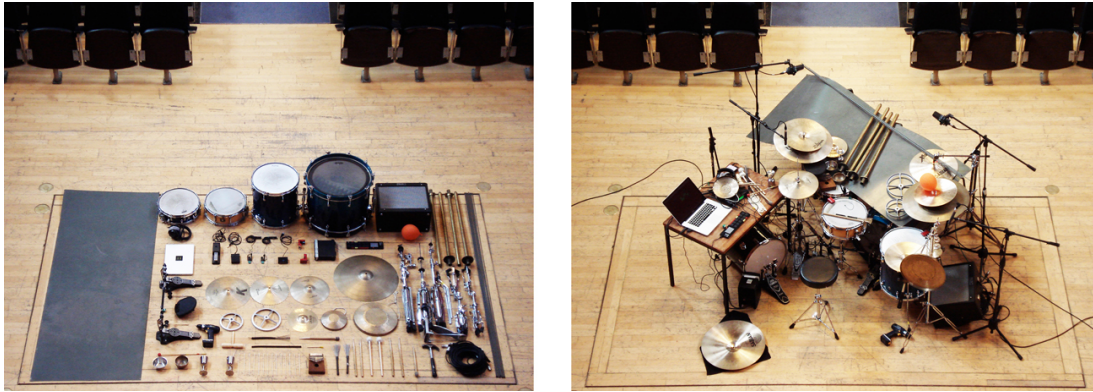
Figure 2.1: Motion: x to y

In (Figure 2.1) is pictured the *Augmented Drum-Kit* before and after its assembly for the recording of the solo work *Long Distance*, in the Reid Hall, Edinburgh, in July 2012.

[Please listen to **Album E: Long Distance** now]

On the left, one can identify loose patterns of spatial organisation of some of the instrument's components, grouped together in the three dimensional space. This organisation is based roughly on the type and function of the material. A few identifiable groups are the idiophones (cymbals), membranophones (drums), found objects (metal bars, baloon) excitation objects (drum-sticks, hammer), supportive (metallic stands), connecting (cables) and electronic (laptop, controllers, audio interface), among others. This organisational approach already makes a few assumptions, recognising past use and sonic potential of some of the objects, while taking into account their preconceived functions (for example, the fact that the drum-sticks are not used mainly for the sound they themselves produce, but as excitation devices of other objects, and are thus grouped separately from the handheld woodblock, which is built from similar material). While the potential for the particular IGS could have been actualised through infinite other configurations, the one I chose for the occasion of this recording appears on the image on the right (Figure 2.1). I believe that this was the most appropriate formation given the material choices of the image on the left (Figure 2.1) enabling me to achieve my desired musical goals given the space, context, aim and time in my instrumental development.

What perhaps is not obvious, is what happened between the two pictures. In other words, what caused the particular *movement* of the objects from the left to the right in Figure 2.1; how *x* became *y*.

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2.3 Materialising the Scenario

Before setting up the *Augmented Drum-Kit* for this recording, there were no compositional goals or musical structures in my mind. A significant number of the ideas that appear in the album emerged during the instrumental setup and were manifested during the recording, this being the case in most of my solo performances. The flexibility of the instrument around a stable framework, as well as previous experience of what can or can not work according to each space's particularities, leave a lot of creative space so that the process of setting up the instrument becomes almost as important creatively as developing and performing with it. For the case of *Long Distance* I can argue that *Friction*[1] converged to zero, as *Transformation Space* and *Real Performance Environment* overlapped. Having performed in the space numerous times, and being able to set up a day prior to the recording, therefore using the actual performance space also as a *Transformation Space*, minimized any losses coming from unexpected agents as in most other cases, when having to *adapt* the instrument's *Immediate Gestural Space* to the potential *Extended Instrumental Space*. In addition, there were no material restrictions (as can be seen in Figure 2.2) imposed by travel as the music department's Reid Hall is located approximately 200 meters away from my permanent *Transformation Space*.

Figure 2.2: Augmented Drum Kit - *Long Distance*

Some of the creative decisions taken during the setup that were afforded by the stability of the frameworks are, for example, the incorporation of the metal sheet, the different types of metallic bars, hammer and drill which were found on site, inside and outside the building. The fact that this sonic material was present and readily accessible made me reconsider any vague idea I had for the recording, and through *Flexibility* from the *Ideal Performance Environment* incorporate these newly found exciting sonorities into the *Augmented Drum-Kit*. The particular instrumental manifestation of the image in Figure 2.2 is shaped by the dynamic of the environment, the Reid Hall, Edinburgh, in July 2012, maximising the performative *Potential Musical*

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[1]as defined in section 2.5 and detailed in *Chapter 6: Friction*

Energy (see Section 2.5), and subsequently facilitate fulfil my *Telos* as a performer in this occasion.

2.4 The Performer's *Telos*

At the start of this research I considered myself to be an instrumental performer. What exactly does this entail however, and do all performers of musical instruments share the same ultimate *Telos*, in relation to their craft? Aristotle believes that the ultimate *Telos*, is that which constitutes the purpose *itself*, therefore is not the means for something else. There are however, smaller *Telē* which lead the the ultimate *Telos* (Aristotle, 1926). For example, someone plows to sow, then sows to mow, and then mows to eat, and so on. All these actions lead to the *Telos* of becoming a good farmer, something that then leads to living a better life. He claims that in order to understand what something *is* "it must be understood in terms of that end, which we can discover through careful study" (Clayton, 2005). As such, in order to understand what instrumental performance is for me, I considered it important to understand it in terms of its *Telos*. While I might share common smaller *Telē* with other percussionists, for example, save money to buy a snare drum, buy a snare drum to study rudiments, study rudiments to be able to roll, and so on, I could certainly claim that my own ultimate *Telos* is not to perform classical pieces of music, for instance.

Learning to play a musical instrument requires years of dedication in order to reach a desired level of skill, and after that point, constant practice is necessary to maintain a satisfactory level. Other than a few cases such as percussion or the computer, where the performer has significant control over the configuration of the instrument, the instrumentalist works solely towards developing the necessary motor skills and understanding the sonic properties and musical possibilities of a *spatially* fixed instrument. This fixation not only lies in the physical dimensions of the uniform instrument, such as the violin or piano, but also often in the type of music and performative context.

Early during their history, instruments had often a clearly functional role. Notably, trumpets and drums were used for signaling between hunters and for ceremonial or military purposes (Edward Tarr, 1988, 10). They were built and designed to serve specific functions within organised groups of people, and had to be efficient while carrying out these specific tasks. During a battle for example, the outcome and life of soldiers depended on efficient communication between units and the ability of the trumpets and drums to carry out the work they were designed for. This could be considered of the same importance as the efficiency of spears, axes, bows and other weapons. Atau Tanaka writes that "the term tool implies that an apparatus takes on a specific task, utilitarian in nature, carried out in an efficient manner" (Tanaka, 2009, 238). It is clear that at this point trumpets and drums, in such a context, fit this decription more than that of musical instruments, as we perceive them today. Obviously, the *Telos* of these performers would be the clear and efficient messaging of military units. When some of these devices started to be used not for purely functional purposes but as instruments for musical expression, their goal, in terms of carrying out specific tasks in an efficient manner was no

longer the focus. In this case the "efficient outcome" could not be defined as easily as being able to notify all units to attack.

With the rise of the orchestra, from an engineering perspective, the design goal for the instruments was to make their dynamic and tonal range wider, as well as estabilishing the distinct qualities that would allow for repeatable pieces of music. The *end* of the instruments in this case could then be defined as their ability to help performers repeatedly carry out the compositions as intended by the composers, as well as having a distinct timbral character. With repeatability of compositions becoming a central factor, performers began developing other skills to those of their predecessors, centered around this new political reality. While initially, music as a function would not be seen as separated into composition and performance, with the development of Western music, notation became stricter and stricter leaving less musical freedoms to performers (Cutler, 2003). What was previously conceived as one notion—music making—was now divided into two specialised processes and *ends*, composition and performance. Today, one of the defining factors of a succesful performer is having impecable sight-reading skills, and this is often a significant factor in determining a succesful career; this, however, is only one specific skill of the performer of a musical instument. As such, it is not rare for a highly skilled classically trained musician to have never performed without a score, or outside the classical musical environment. In that case, the *Telos* of the performer is being able to apply masterfully all acquired skills in a classical music performance scenario, interpreting the composer's vision and surviving as an orchestral musician up to the task.
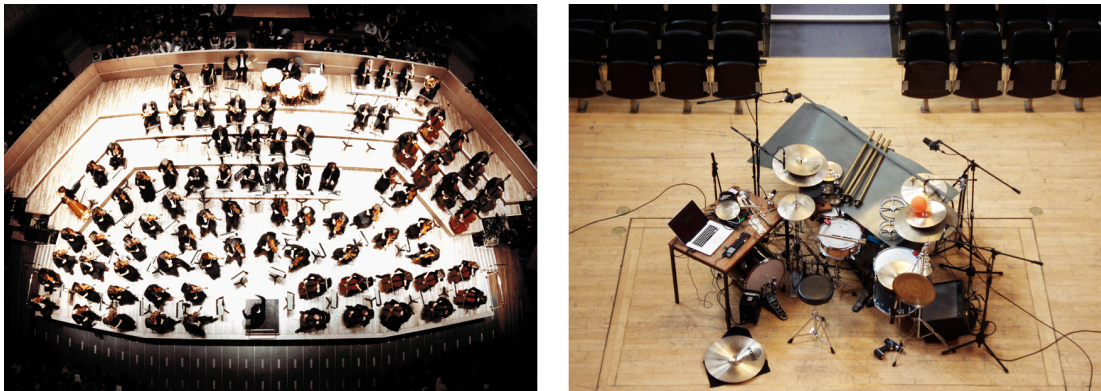
Figure 2.3: Controlling Sonic Material[2]

On the other hand, a violinist operating within the field of free improvisation needs significantly different skills and has different aims. Being constantly aware of the sonic environment, responding promptly, reacting to other performers' musical gestures and expressing musical intentions through the instrument by combining all skills acquired over the course of a career are some of them. In an ideal scenario during an improvisation, the performer is aware of all available environmental information at all moments: haptic feedback from the instrument; visual and aural cues from the other performers; overall sound; as well as other environmental information, for example the audience leaving the venue. All these parameters contribute towards the next musical/compositional decision. The more skilled an improviser is, the more seamless the integration and assesment of all these factors are as they result in the next musical gesture. Here, sight reading skills would be irrelevant, as they are not something the musi-

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[2]orchestra photo retrieved from `http://andrewhugill.com/manuals/seating.html` (accessed March 2013)

cal potential of the improviser depends upon. The *Telos* of the performer in this case could be defined as a masterful interpretation of all available environmental information shaping one's next musical decision. There is indeed a multitude of instrumental performative *Telē* following different paradigms. Sergi Jorda observes:

> Distinct virtuosity paradigms definitely coexist: whereas the classical virtuoso, with his infinite precision and love for details may appear closer to the goldsmith, the new digital instruments virtuoso, not unlike the jazz one, could be compared to the *torero* for his abilities to deal with the unexpected. (Jorda, 2005)

2.4.1   Paradigms

In order for my own performative *Telos* to become clearer, I first needed to reach a certain degree of expressive alignment with the instrument under development. As the composer / performer / builder of the *Augmented Drum-Kit*, I argue that improvisation is the most suitable vehicle of musical expression towards reaching this alignment. The notion of improvisation here is not used as "pre-composition". Bowers explains:

> For Schoenberg (1967), improvisation has a role in compositional work—but privately so, as the composer formulates, refines and works through "the musical idea", which will be ultimately realised by necessity as a notated work. This notion of improvisation or extemporisation as part of "pre-composition" is commonly heard. (Bowers, 2003)

In my case, it is rather used as "post-composition", reuniting the separated notions of the composer and performer through the development of a personalised performance environment embedding compositional decisions.

While a strict set of instructions to be carried out by trained technicians might be a valid practice for disciplines such as engineering or architecture (where efficiency and success can be measurable in terms of a product or building being constructed exactly as intended), this might not be the best paradigm for artistic efficiency. It is common today to consider a "good orchestral performance" as a faithful reproduction of the original composition, which is a similar criterion to that of building a motor engine according to the engineer's plans. Have in this case musical instruments been reduced to tools, "apparatuses taking on specific tasks, utilitarian in nature, carried out in an efficient manner"(Tanaka, 2009)? Is this problematic paradigm being followed by new instrument builders when they think of what a musical instrument is? The violin is indeed a potential instrument for musical expression but in the reality of the industrialisation of the orchestra it is being used very commonly as a tool for carrying out specific tasks through notated instructions by composers, following the architect's paradigm. Instrumental differentiation according to context, similar to instrumental function according to paradigm, as described here, has been pointed out by Théberge who thinks that the substantively different techniques of 'violin' and 'fiddle' are enough to render them distinct instruments (Théberge, 1997).

Instead of the architect's paradigm, which is widely followed today and affects the perception of what a musical instrument is, instrumental composers have perhaps more in common, with film producers. During the production of a film, several people are bringing their own expertise to the project, from the actors, to the sound designers, costume designers and make-up artists. The producer (or financially independent film director) has a specific idea of the film he wants to make, but generally there is more or less a two-way discussion with all these agents working towards the end goal, the film. The producer can be responsible for finding people that he thinks are capable of carrying out his vision based on their previous work. The instructions can be very clear, and scripted, but the exact same instructions can lead to very different results according to the people of choice.

In his 1962 film "Lolita", director Stanley Kubrick had a very specific idea of the movie he wanted to make. Having chosen Peter Sellers as an actor, however, he imagined aspects that Sellers would be able to bring into the project without specifically outlining them beforehand. To achieve that, he would let Sellers improvise in front of the camera, then discuss with him which elements he liked, continually *coaching* him until he could get the best out of the performer for his project. "Always open to exploring the options for playing a scene, Kubrick encouraged Peter Sellers to improvise in front of the camera for Lolita. Eventually, they built up the role of Quilty, adding the various disguises he uses to stalk Humbert and Lolita."(Miller, 2010) Kubrick is often characterised as a perfectionist; this, however, was not manifested by fixing *a priori* all his films' parameters and insisting on them regardless of the human agents or specifics of space and time but by being creatively flexible in order to optimize the potential of most parameters of the artistic project coming from different agents[3].

It is in Western concert music since the late 18th century that the notion of the divinely inspired creator/composer has been accentuated so much, for several reasons, with notable examples such as Beethoven saying "Do you think I worry about your lousy fiddle when the spirit moves me?" in response to a complaint to one of his violinists, Schuppanzigh (Blum, 1987). I find it problematic that performers of even traditional and established instruments are often being used interchangeably by composers, denoting a loss of performer and instrumental individuality, something that extends to the perception of their practice and *Telos*.

2.4.2 *Telos* and Potential

In the end, it is a responsibility of each performer to identify his or her practice and define one's own individual ultimate *Telos*. In relation to the separation of music making into discrete processes as established by the Western paradigm, Simon Waters writes:

> I see the separations and distinctions as essentially symptomatic of a very short
> period of musical history in a fairly localised geographical area, and I regard current

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[3]Of course, there are (and have been) film producers and directors that can be as fixed to their own ideas regardless of the pragmatic factors, as some composers; The producer/director's example is used here because it fundamentally involves numerous artisans negotiating on different levels simultaneously, and it is an inherently collaborative practice

developments (DJ culture, turntablism, downloading, sampling, real-time composition and improvisation, laptop performance etc). as part of a socially self-regulatory negative feedback process returning us to a 'joined-up' situation of music as practice. (Waters, 2007)

I see my own practice as part of the "return" to a joined-up situation of music as practice. Furthermore, I see my *Telos* as interlocked to my emerging *Augmented Drum-Kit*. I do not perceive my instrument simply as a mediator of musical expression, but as a storage unit of *Potential Musical Energy* as will be defined in the following section. Similarly to a score incorporating *potential* music, to be actualized during a performance according to the performers, physical instrumental qualities, space and so on, I see my instrument as incorporating *potential* music to be actualized according to each performance scenario. *Potential Musical Energy* stored and released through my instrument is my personal interpretation of music making towards my performative *Telos*.

2.5   Potential Musical Energy

"Potential energy is the energy stored in a body or in a system due to its position or due to its configuration ... Another way to think of potential energy is that it is stored energy or stored work."(McCall, 2010, 74)

In physics, gravitational potential energy is defined as the energy stored by an object as a result of its position; it equals the mass (of the body), multiplied by the gravitational acceleration, multiplied by the height (of the body from the surface of the earth)[4]. A ball, for example, will roll down a hill when given the slightest push because of the energy that is stored within it by being placed on top of the hill. Similarly, an arrow positioned in front of a drawn bow string, will convert its stored potential energy into kinetic energy on its way to a target. This energy depends on the bending of the bow and its construction quality; the decision of the string's release, type and the target lies with the archer who also provides the necessary *Agility* to perform an efficient release, minimizing possible energy losses (such as potential energy converted to friction and not kinetic energy). I attempt to align this idea with musical improvised performance, defining the musical energy stored between performer and instrument as *Potential Musical Energy* (PME). A strict definition would be impossible, and perhaps irrelevant—what kind of metric system would one use for PME? One could seek however a similar conceptual parallelism to the definition of physics in similar fuzzy terms as Jorda's definition of music instrument efficiency (Jorda, 2005). Since the mathematical definition of potential energy is "$Mass \times Gravity \times Height$", I suggest that *PME* can be perceived as a combination of the performer's "$Awareness \otimes Agility \otimes Vocabulary$" (AAV). This is not necessarily a multiplicative relationship, it could be additive, exponential, or something different altogether. For argument's sake I accept that PME is maximised when the individual factors are *optimized*, whatever this might entail for each of them. These all relate the performer to the notion of an instrument or other means of expression, and are all affected by *Friction* (see *Chapter 6: Friction*), which

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[4]For small heights compared to the radius of the planet

could be perceived, for now, as the loss involved when actualizing the performative musical potential.
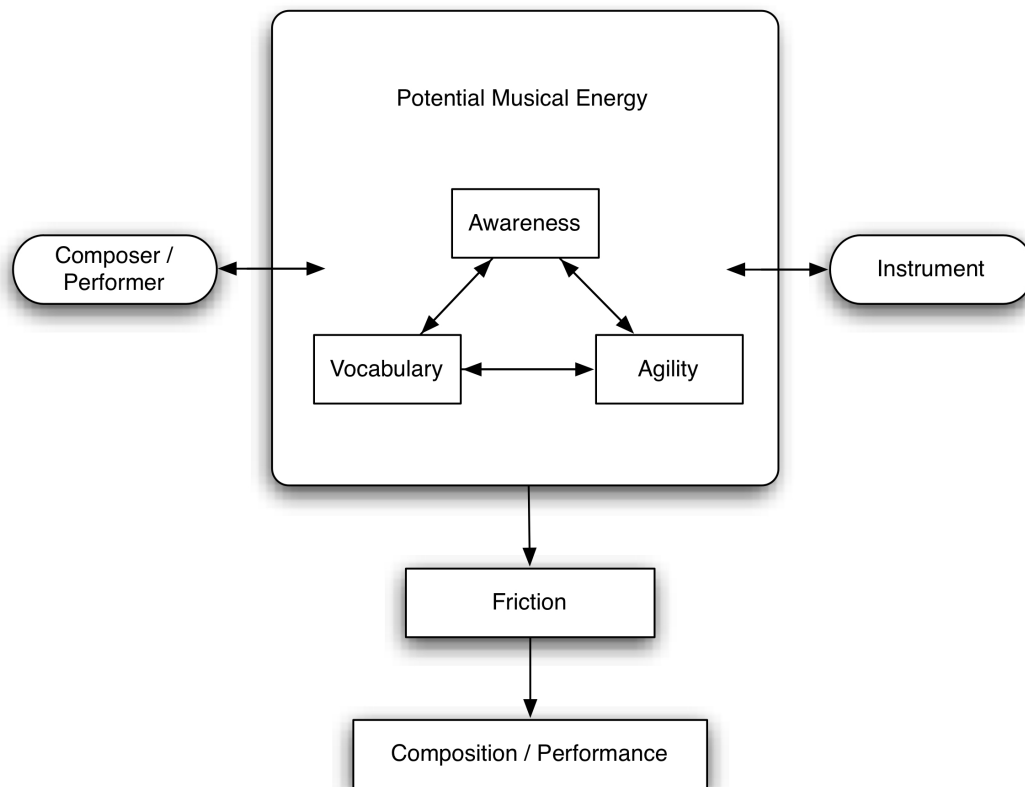
Figure 2.4: PME Framework

Practically speaking, an improviser who has been actively involved in the field for several years and has developed heightened perception of his musical surroundings (*Awareness*), who practices daily his instrumental technique (*Agility*) and actively seeks to expand his musical language with new possible sonic gestures and sonic material (*Vocabulary*), is arguably storing more PME than someone who lacks on any of those factors. Being involved in the field as a listener, for example, attending improvised concerts and listening to recordings might expand significantly *Awareness* of all present musical elements during an improvisation. However, lack of instrumental practice might cause one to not be able to contribute meaningfully or, at least, at will, despite knowing what one would like to contribute. On the next level, being unable to cope with unexpected factors and parameters introduced by *Friction* might render irrelevant all previously acquired skills. A performer with higher PME but bad *Friction* management might practically deliver a poorer result than someone with lower PME but excellent Friction management skills. A missing monitor speaker or a less than ideal stage might put the first off balance, while the second will find ways to adapt and deliver a subjectively satisfactory performance. I see an experienced improvising saxophonist holding her instrument onstage just before the concert starts, as PME about to be released. The time spent over the years to develop her AAV in combination with the instrument, place her in a position where with a "slight push" she can easily "roll down the hill", just like the ball, or with the release of the bow string, hit efficiently a desired musical target.

Let us consider the *Instrument* here as a fixed entity, for example, a violin. In order to maximize the PME one would have to optimize the individual factors as mentioned above, AAV, related to this strictly defined instrument. However, when the performer can also develop or alter the instrument to fit their physical particularities or aesthetics, it can help rise significantly the PME by making it possible for the performer to reach a more satisfactory AAV combination than he would be able to with an unaltered or generic instrument.

Axel Mulder writes:

> This approach [Allowing musical instruments to be adapted to the motor skills a performer already may have may prefer or may be limited to] to the relation between performer and instrument should lead to a greater freedom for the performer to choose and develop a personal gestural "vocabulary" and, if the performer can already express these gestures skillfully, a shorter time to musical performance proficiency. (Mulder, 2000)

By augmenting an existing instrument based on the proclivities of the instrumentalist (by designing an electronically augmented saxophone for example) or by creating an entirely new one designed specifically for the needs of the performer (such as "The Hands" by Michel Waisvisz[5]), the composer/performer (who now becomes an instrument builder) not only works to achieve better expressivity by developing her AAV but crucially adapts the instrument to herself, meeting her half-way through the effort towards a higher PME.

Similarly, while developing the *Augmented Drum-Kit*, I was able to not only work on my AAV attributes as a performer, but also shape the instrument according to my evolving needs. I see the process of instrument shaping as another means of magnifying these attributes, this time from the instrument's point of view. For example, practically speaking, when I intend to perform a drum roll, the *end* being this particular sonority, I will choose to do it on a predesigned instrumental "ground", where granular synthesis and delays will enhance this sonic aesthetic. In this way the aesthetic sonic *end* that would otherwise have to be reached through drum rolls performed physically, becomes easier to reach by digitally accenting it **(Album A: Frrriction - Track 1 - Frrriction I)**. This means that by using "lesser" *Agility* (performing less drum rolls with breaks or half the speed causes less muscle exhaustion and fatigue), I am able to reach the same (or even a higher) PME, because of the electronic augmentations. The "saved" physical energy can now be spent on different aspects of the performance.

The specific factors of my performative PME, *Awareness*, *Agility* and *Vocabulary*, will each be examined thoroughly in the next chapters, both through practical examples as well as by outlining the theoretical methods developed for their individual optimization. Here are, however, brief definitions of these terms, which could be used as a more general point of reference to what the terms entail:

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[5] http://www.crackle.org/TheHands.htm (accessed July 2013)

- Awareness

The performative spatial, sonic, haptic and visual awareness of all elements that can contribute towards the next musical decision within the *Real Performance Environment* (*Immediate Gestural* and *Extended Instrumental* Spaces), as well as the decision-making process itself based on the aesthetics and musical experience developed over years. It can be practised from classic improvisation exercises without an instrument (such as passing on hand-squeezing to the next person in a circle), to playing in a group where only two performers are allowed to produce sound at any time, encouraging awareness of everyone's actions at all times in order to execute the exercises correctly. The improviser develops the sense of being aware of the environment, and in a musical context, decides on the most suitable gesture to achieve his musical intentions. Experience can also bring out the choice to actively ignore some cues, such as closing the eyes and relying only on aural information for example, but being intuitively aware that this decision has been made until one chooses to resume visual cueing input by opening the eyes again. In short, *Awareness* can be seen as the perceptual ability and aesthetic identity of the performer that differentiates him from any other performer that would be in the same position within a group of improvisers. It is the combination of all processes that generates the next intended musical decision.

- Agility

Agility can be seen as the mechanism through which the musical gestures emerging by *Awareness* are physically performed on the instrument's *Immediate Gestural Space*. It is a physical quality, and can be developed regardless of musical context. Similar to a boxing athlete who needs to develop the speed, stamina and strength necessary to perform in a match, or the balance, concentration and micromovements an archer needs to develop in order to aim the arrow to the center of the target, the saxophonist needs to develop and master her lungs, breathing system and fingering technique, and the percussionist works on different muscle groups from smaller to bigger in order to get the best possible combination of speed, strength and stamina. This is not initially relevant to aesthetic choices or musical intentions, but it becomes important, first by allowing the instrumentalist to expand the *Vocabulary* (for example, circular breathing on the saxophone is a physical technique which requires *Agility*, the mastery of which expands the performer's *Vocabulary*) and, second, to perform as efficiently as possible the next musical gesture decided by *Awareness*, chosen from the presently established *Vocabulary*.

- Vocabulary

Vocabulary is the "repository" out of which all musical gestures and sonorities emerge. It is developed by exercising *Awareness* and by developing the instrument through the *Instrument Shaping Cycles* (*Chapter 4*). During improvisation, possible new gestures that are fulfiling one's musical goals eventualy make it into the performer's conscious *Vocabulary* and become candidates for use in a future performance. For example, pushing a drumstick slowly and horizontally on a cymbal will cause a pitched sonic result. This could be defined as a distinct part of one's gestural vocabulary, and after having appeared during a performance for the first time by accident, it may eventually re-appear in future improvisations, depending on one's *Awareness*. Work on *Agility* alone can provide new elements to the *Vocabulary* too, such as circular breathing, as described above. Additionally, *Vocabulary* includes the material itself, such as the drum-stick to be pushed and the cymbal. It resides in its entirety within the theoretical *Ideal Performance Environment* from which the *Real Performance Environment* and more specifically *Immediate Gestural Space* emerges, by choosing the appropriate sonic material for each occasion in the *Transformation Space*. The musical gestures themselves with which the chosen material is excited, are decided

during the actual performance through performative *Awareness* and materializes using the developed *Agility*.

I see optimizing *Awareness*, *Agility* and *Vocabulary* as distinct "smaller *Telē*" to be achieved. In combination, they lead to the ultimate performative *Telos* through the emerging instrument, maximising the PME in every performance scenario through instrumental *Flexibility*, afforded by the notions of the *Ideal* and *Real Performance Environments*, as described in *Chapter 1*.

2.6   A Personal and Constant Negotiation

Despite compositional choices, technical development, time and effort that led to the formation of the assembly on the right (Figure 2.1), as opposed to the assembly on the left which took about two minutes to organise, both could be expressionally equally indifferent to another performer (even a percussionist). While the instrument was physically assembled the day prior to the recording, the form and functionality of the setup on the right embodies intuitively numerous stages of design (*Chapter 4*), continuous practice, fine-tuning, sculpting, assessing and trying to expand the edges of the instrument. This process, which took more than five years, shaped not only the instrument but equally molded myself as its performer, similarly to the lake's body of water taking the shape of the the lake's bed. This reality makes me highly compatible to it, but being so specific, it is perhaps *in*compatible to other performers, or at least, depending on what affordances they might find with respect to their own musical histories and priorities, it will be used in different ways. My musical intentions evolved in parallel with the instrument, in a constant state of negotiation, on the one hand interpolating and on the other extrapolating possibilities, requiring sometimes more effort from myself as a performer and other times from the instrument through informed design. Since much of the knowledge of the *Augmented Drum-Kit*'s use remains embodied and tacit, I do not consider it an instrument to be widely used and adapted by other performers, as is often the case with NIMEs[6]. In fact, I see it as exactly the opposite, a highly personalised and space specific instrument which is not even fixed between different performance scenarios but requires my agency to define the *Real Performance Environment* that would maximise the PME in each occasion. All assembled objects, acoustic, electric and electronic, make sense and are aesthetically unified only by adding the final component to this picture: the composer/performer/builder. Playing the metaphorical role of electricity that unifies the separate components of a computer and gives force to its existence, the composer/performer/builder unifies the separate parts of the *Augmented Drum-Kit* and realises its potential. The goal of this research was not to create a static or fixed instrument to be used "as is" from this point onwards which could be transferable, but to achieve a developing but expressive alignment (or agreement) between the instrument and the performer. At this point it would be a matter of pushing oneself strategically and repeatedly out of comfort zones as a duality when needed, in order to keep evolving towards new envisaged directions. I perceive the *Augmented Drum-Kit* as an instrument, analogous to how Simon Emmerson describes fourteenth century Buddhist temples:

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[6]Such as the *Eigenharp* http://www.eigenlabs.com/, which is being marketed as "the most expressive electronic instrument ever made" (accessed July 2013)

A contrasting Japanese attitude towards history and tradition is best exemplified by the case of a national shrine —a fourteenth century Buddhist temple — which is completely rebuilt from new materials every two years, and in which the tradition is regarded as not residing in the object itself but in the continuing knowledge of appropriate materials and building techniques (Emmerson, 2000, 70)

2.7   Collective PME

For *Long Distance*, the recorded performance involved myself as a performer on a somewhat maximal version of the *Augmented Drum-Kit* (Figure 2.2). The notion of PME was clearly defined in this case, myself being the only agent contributing the factors that comprise the performative PME (driven by my *Awareness* over the instrument and performance scenario, choosing material from the assembled *Vocabulary* by employing the developed *Agility*). For the collaborative effort of the duo *Můstek* as portrayed in the album *Node / Antinode*, or any other improvisational performance involving multiple instrumentalists, this function becomes more compicated. Performer "A"'s *Awareness* now also involves performer "B"'s agency, including their own *Awareness*, *Agility* and *Vocabulary*. Performing with another instrumentalist essentially means two musical agents, each utilising their own AAV simultaneously. I see every improvisational collaboration as an opportunity for a collective PME. I claim, based on the model presented so far, that performing with another improviser can potentially result in a common collaboration-specific *Vocabulary*, with possible elements that do not exist in either of the contributing *Vocabularies*. When I am performing as a percussionist with a saxophonist, for example, we are both bringing our own individual *Vocabularies*. However, some additional elements might emerge that would not be present had we not improvised together. By combining textures and extended techniques, some elements can be common and present only during co-performance. The collective *Vocabulary* becomes *Vocabulary-A* (Performer A's *Vocabulary* parts used for the specific collaboration) + *Vocabulary-B* (Performer B's *Vocabulary* parts used for the specific collaboration) + *Vocabulary-Extra* (Additional elements which are present during co-performance), which is a different "quantity" than the sum of its parts. In my opinion, the more consistent the final PME becomes, because of a final consistent collective *Vocabulary*, the more "succesful" the collaboration is. This can present certain problems when the number of performers rises, since *Awareness*, which I see as the judging factor as to which elements to keep and which to discard from the personal *Vocabulary* during co-performance, can fall significantly. This will be explored further in Section 2.7.2: I believe that with more than two or three performers, the more musical agents present the harder it becomes to maintain a consistent collective PME, and thus the individual PMEs can be destructive to the overall result, similarly to forces cancelling each-other in physics.

2.7.1   Case Study: Můstek - Node / Antinode

I have been performing with Lauren Hayes, a postgraduate colleague at the University of Edinburgh, in different formations since 2007. She uses pianos, analogue synthesizers and con-

trollers, and has been developing her performance environment for a similar amount of time as I have the *Augmented Drum-Kit*. This project's main characteristic has always been one of an egalitarian musical relationship. Given the time spent performing together there are many different manifestations of our practice which helped reflect and evolve it and our instruments further. Equally, a sense of trust within a well-known environment to express one's honest opinions and ideas helped progress much faster the aims of the group. In contrast perhaps, larger improvisation based groups may have more formal relationships between members, sometimes making it harder to take creative initiatives with which some might disagree or silently accept, causing prolonged stale musical relationships.

The tactics that helped make *Node / Antinode*'s collective PME more consistent, were decided as a result of reflections based both on a previous album recording[7], as well as the fact that we had both reached a very similar aesthetic place. The driving principle behind *Mŭstek* was to create a very direct and shackled musical relationship between the two performers by reaching a consistent collective PME. This could act as a stable ground (or consistent *Vocabulary*) that would enable us to expand it further by inviting other performers who could push or challenge our aesthetic and musical instruments, thus acting as the odd factor in the fundamentally balanced, dual relationship.

Both myself and LH have performed and recorded on numerous occasions in the Reid Hall in Edinburgh, so we had a very clear idea of what the possibilities and restrictions of the space were. For this recording, since we were aiming at a more dense and non-natural reverberation sound, we decided to *adapt* our instruments in a manner perhaps more suitable for a black box[8] venue. As such, we decided to use only one acoustic instrument, the drum-kit, to avoid having to make mix compromises due to the collective reverberant *Extended Instrumental* space, while LH used only digital and analogue synths (both recorded "line-in", with us performers wearing monitoring headphones).

Figure 2.5: Node / Antinode Setup

I see collective *Awareness* in *Node / Antinode* as being facilitated by the clear musical goal and experience of each other's musical agency, the foundation of which was built over the course of five years of collaboration and previous work. Spatially, in order to force an even more unified

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[7]*Signal Powder* with LH and John Pope, Newcastle based double-bass player

[8]meaning non-natural reverberation, and a sense of "anyplace" which would been in agreement with our non-Reid Hall space specific intended recording

visual awareness, we decided to set up our *Immediate Gestural Spaces* as close as possible, facing each-other, allowing us to react quickly to visual as well as to aural cues. We wanted the combination of the *Augmented Drum-Kit*, synthesizers and controllers to feel like one instrument, as can be seen in Figure 2.5. Similarly, *Vocabulary*-wise, in *Node / Antinode* LH adopted at points a percussive style of playing **(excerpt: /Media/Audio/Node1.mp3)** while I extensively employed techniques such as *distortion*, *bitcrushing* and *waveshaping* of my acoustic sound, mimicking some of LH's *Vocabulary* elements **(excerpt: /Media/Audio/Node2.mp3)**. The goal was to homogenize the collective PME by finding a common ground for our individual *Vocabularies* that would then hopefully generate new combined *Vocabulary* elements, as it arguably happened. It needs to be noted that the opposite approach, contrasting each-other, was followed as well. In **(Album C: Node / Antinode - Track 2 - Node)** for example, LH is playing long and slowly variating pitches, while I am playing short and fast drum-bursts cutting through her sound. Both approaches, mimicking and contrasting each-other's *Vocabularies*, require a mutual recognition and understanding of each other's project-specific sound worlds, which is perhaps the first step towards the new collaboration-specific *Vocabulary* elements.

[Please listen to **Album C: Node / Antinode** now]

While the duo *Mŭstek* started as a more abstract experimentation of two practitioners using acoustic instruments and electronics, over time there arose a division between the synthesizer-based "tighter" and denser sound, and the piano based material, which is more spacious, dynamic and textural. For the piano-based material I tend to adopt a more unassuming role for my instrument, perhaps a free improvisation mentality where I explore a larger range of dynamics and textures. The piano-based formation usually benefits from larger concert halls with longer reverberation times, while acoustic sound reinforcement is not absolutely necessary, as our electronics speakers would often be placed behind our instruments as localised electronics in the space. On the other hand, for the synth-based formation of *Mŭstek* I would see myself more as a conventional drummer, flirting with improvised noise-rock, jazz, perhaps more in line with the approach of Norwegian bands such as *Supersilent*,[9] and *Puma*[10], having a "noisier" and sonically dense approach. When using synths, LH is able to match the dynamic range of the drum-kit (by not having to use microphones but only "line-in"s) so it is a freeer scenario, without the worry of the drums being overly loud. Such performances require close-miked drums, and all sound, both acoustic and electronic, is ideally projected from a P.A. system. This injects a sound engineer into the equation whose job is to make sure of the correct balance between acoustic and electronic sound. (See the various employed stage plans in Appendix E - Stage Plans) A synth-based performance excerpt can be seen in **(/Media/Video/POPP.mov)**.

The final factor of *Node / Antinode*'s collective PME is *Agility*. With both of us developing, fine-tuning and constantly expanding our instruments in the course of almost five years, I feel that all technology involved had indeed become seamless in this recording and was no longer the immediate focus. From *Signal Powder* (the previous and our first album) to *Node / Antinode* we have been constantly performing as a duo in contemporary music festivals and conferences

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[9]Albums: *1-3* (1998), *8* (2007), *11* (2010) - *Rune Grammofon*
[10]Album: *Discotheque Bitpunching* (2008) - *Bolage*

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(See Appendix A - Performance Timeline) around the UK and Europe, something that not only helped us get useful feedback on our practice, but also made us more *agile* performers on our instruments, by continuously rehearsing and being on stage in very different environments. In excerpt **(/Media/Audio/Node3.mp3)**, for example, I remember performing completely shackled with LH, without worrying if the electronic part of the instrument is behaving appropriately, if I can hear all of the modules, or thinking of buttons I needed to press in order to change the sonic direction; all elements flowed into each-other organically. As such, I consider it *agile* not because I am playing fast, but because I am playing fast and am still in complete control of my instrument's electronic output *intuitively*, leaving space to consider only the musical attributes of the performance.

While this might not be necessary for traditional instrumentalists, I claim that given the flux of our emerging instruments it was by consiously working on the notions of *Awareness*, *Agility* and *Vocabulary*, and thus the project's collective PME, that we were able to achieve a more concise and satisfying musical result in *Node / Antinode* than in *Signal Powder*. (The recording of the latter will be examined in *Chapter 5: Vocabulary*).

2.7.2 Case Study: HAKEMIRA

HAKEMIRA consists of myself playing the *Augmented Drum-Kit*, Jules Rawlinson playing the laptop and controllers, Paul Keene playing a Fender Rhodes keyboard and electronics, and Lauren Hayes playing analogue synthesizers and computer. We have known each other personally (and have been aware of each-other's individual practices) since 2007. In 2011 we decided to perform together, which resulted in a series of four concerts in Edinburgh. The performance presented here was part of Edinburgh's Dialogues Festival and took place at *Inspace*[11] on the 7th April 2012. (The full performance can be seen in **(/Media/Video/HAKEMIRA.mp4)**. Also, see Appendix D - Commentary)

Since we had collaborated with each other in the past and were relatively experienced in the field of improvised performance with live electronics, there were significant expectations from my side for the musical success of the project. However, this performance sheds light on why this project did not reach its full musical potential. While no rehearsals or other preparation for these concerts took place, there was an establised understanding that the music shouldn't necessarily be "non-idiomatic improvisation" (Bailey, 1993), but might take a more tonal or even tempo-based approach. In reality this rarely materialised during the concerts, where the collective feeling, at least as perceived from my perspective, was a crisis of musical identity because of a lack of awareness of each-other's agency and contribution to the whole.

This might be attributed to a few factors, the most important being, in my opinion, lack of co-performer effort/result awareness. While resembling a more traditional instrumental formation (which included a drum-kit, an analogue synthesizer and a Fender Rhodes), all of us were essentially performing with bespoke instruments. As such, the individual instrumental

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[11]http://www.mediascot.org/taxonomy/term/71 (accessed August 2013)

identities within the group never became entirely clear to each other. Having only a vague idea of each other's musical intentions, caused by the partial disconnection between perceived performative physical effort and sonic result (multiplied by four, given the number of performers), resulted in a strong sense of uncertainty. I recall experiencing a constant feeling of waiting for something to happen so that everyone could boldly join in. However, such moments occured rarely and lasted only briefly. All members of the group felt the same on reflections post-concert.

In addition to the lack of awareness of the individuals' musical roles in this project, I would add problematic monitoring: The ensemble required a dedicated sound engineer managing all instrumental levels, as well as monitoring for all performers. As a drummer, had I tried to play something louder, even if my co-performers joined in, with the monitoring we were using (which consisted of the P.A. and one speaker for me) the sound would be masked by the acoustic drum-kit and I would feel that I was overplaying even if I wasn't. This added to the misunderstanding of each others' intentions. Also, the fact that I was performing the only acoustic instrument in the group, set me apart from the uniformity of the other players' sound projection (they were all using the P.A. for their instruments while I also had a drum-kit, in a space not suitable for impulsive sound). In a solo performance I would attempt to exploit the particularities of the space by *adapting* the IGS to the EIS. In this performance however, being part of a group, I already felt distanced from the other three performers because of the nature of my instrument and, not wanting to set myself apart even more, I assumed a non-commital stance until something interesting would occur with which I could join in more actively.

In Subsection 2.7.1 I described how in *Můstek*, the individual performers' PMEs were complimentary and combined to generate a collective PME larger than its parts. Here, because the number of performers was larger and time of co-performance as a four-member group entity was close to zero, it was harder to develop collective instrumental awareness that would unify and lead to complimentary PMEs and a more consistent and bold musical outcome. I believe that in this case the individual PMEs, in a sense, cancelled each other and led to poorer musical results than any of the constituent parts (being the PMEs of the individual performers). While each of the performers had a high level of *Awareness* regarding their solo improvisatory practice and performer *Telos*, in this case it seemed that each person's diminished collective *Awareness* within the four-member group kept the music in an exploratory pre-commited state. The higher number of players, in addition to lack of rehearsal (which might not be as necessary in the case of more traditional instruments where instrumental effort/result awareness and gestural metaphors are more or less established between performers), was quite possibly what prevented a more consistent performance. As it will be seen in *Chapter 3*, in order to address this issue and be able to improvise in any group scenario without requiring extensive rehearsal in order to meet a basic level of collective PME, at least from my part, I had to make certain design choices so that my instrument's effort/result perceived awareness and musical intentions are as clear to my co-performers as if I was playing an entirely acoustic instrument.

Having performed with each member of *HAKEMIRA* as duos in similar circumstances (improvised and without rehearsals), I believe that the musical outcome in all cases was more "successful" than when all four played together (in any of our four *HAKEMIRA* performances). It

was, at least, much more consistent and focused. I sense that the relative ease I experienced in the duos, arises from the fact that (regardless of extra effort/result awareness considerations) it is much easier to interpolate between the two performers' aesthetics and musical identities and finding common *Vocabulary* ground. For example, being aware of JR's personal musical aesthetic and *Vocabulary* made it easy for me to firstly meet him half-way by adapting my performance to accommodate his style, as he also did for me. From there, we were able to extrapolate and explore new uncharted "extra" *Vocabulary* territory where we would not have gone into if it wasn't for our collaboration, therefore making it meaningful. In the following short excerpt it is clear that there is constant communication and re-negotiation of the common ground between the two performers. Towards the end we start exploring a tempo-based idea, which for me, is one of the collaboration-specific *Vocabulary* elements as it is not usually a part of my own solo instrumental *Vocabulary*: **(/Media/Video/MiRa.mp4)**.

Similarly, in this performance with Marco Donnarumma, as part of another project, I mostly use distortion and feedback in order to get closer to MD's sound world. Subsequently, an almost noise-rock aesthetic emerges, unique to this collaboration **(/Media/Video/DM(T).mov)**.

2.8   Summary

In this chapter I introduced the notion of *Potential Musical Energy*, an analytical framework complementary to the spatial framework presented in *Chapter 1*. Through this, the performer's *Telos* is achieved as defined by himself or herself in relation to the bespoke instrument. Some existing performance paradigms were explored in an effort to find possible common grounds with established tactics. I argued that the film producer/director's paradigm and the method of specific performer *coaching* might be more suitable to the traditional composer's goals, than an approach of interchangeable performers and instruments assuming the roles of technicians and tools, leading to loss of expressive individuality. In the case of the *Augmented Drum-Kit*, I explained that it is not an instrument developed to be interchangeable and used "as is", but a notion related to technology as a diachronic practice, intertwined with my own performative and compositional needs as a composer/performer. I proposed PME's factors *Awareness*, *Agility* and *Vocabulary* and illustrated how these might work both in solo and collaborative settings. Crucially, I have suggested that these parameters do not simply aggregate in collective circumstances but might rather exhibit constructive or destructive interference. Finally, I argued that in order maintain a consistent PME in larger groups of performers, methods for raising *Awareness* need to be devised. One such method could be pre-performance rehearsals in order to raise co-performer instrumental awareness. As it will be seen in *Chapter 3*, my approach towards addressing this problem was facilitating co-performer instrumental awareness not through rehearsals, but through appropriately designing my instrument's effort/result perceived awareness and by theatricality, following as a paradigm the perceived effort/result awareness of an acoustic instrument. In the following chapter I will examine this approach, as well as the first factor of PME, *Awareness* in general, and the methods I used to raise it.

Chapter 3

Awareness

3.1 Introduction

In the next three chapters I will present and analyze the methods developed in order to opti-
mize *Awareness*, *Agility* and *Vocabulary*, the factors of *Potential Musical Energy*. In *Chapter 2*, I
defined *Awareness* as "The performative spatial, sonic, haptic and visual awareness of all ele-
ments that contribute towards the next musical decision". In the present chapter I will focus
on some of these aspects from the perspective of the *Augmented Drum-Kit*, such as visual, sonic
and spatial awareness, and crucially, perceived effort/result awareness. Instead of beginning
from the ground-up optimizing factors and building instrumental relationships around them,
the first aspect under examination will be the one usually considered last, if at all: How effort
and result with the new instrument will be perceived as a whole by possible co-performers and
audience. When this goal is set, the necessary measures will be taken to achieve it through the
rest of the instrumental factors related to *Awareness*. This is not to say that other performative
attributes, such as expressivity, will be sacrificed in any way in the sake of the envisaged ef-
fort/result perceptive *Awareness*, I find this however to be one of the most problematic areas
in improvised performance with bespoke instruments, as it was examined in *Chapter 2* with
the example of *HAKEMIRA*. If a saxophonist within a group plays a loud solo for a long time,
her cheeks get red, sweat starts to appear and if she tries to establish visual contact with other
musicians, it can be quite clear that she is looking for someone to help her out of it since she
has reached her physical limits. The attentive audience sees this and empathizes with her. She
doesn't have a choice but to sweat and provide all these visual cues, as it takes unavoidable
physical effort to produce the sound—all this is entirely clear to her co-performers as well. With
new digital and (perhaps less so) with augmented instruments, these obvious co-performer
Awareness paradigms are not given—sound generation does not necessarily involve physical
effort. These relationships need to be methodically designed, and established in a short time
after the start of a performance to co-performers (facilitating them understand more effectively
gestural and performative intentions with the digital instrument), and audience (making the
performance more engaging for them as they perceive a convincing relationship between the

performer and the instrument.)

3.2 Effort / Result Awareness

[Please watch the video Roulette TV: Chris Cutler[1]]
(also included in /Media/Various/Cutler.mov)

This is a solo performance by Chris Cutler using his "electrified drum kit"'[2]. Cutler uses several contact microphones placed on objects on a table, as well as miniature microphones, feeding hardware processing units. The parameters of these are being controlled either by his hands or feet, using pedals. His performance is heavily electronics-oriented. In fact, if one were to listen only to the audio recording of this improvisation, there would only be a few sections hinting at an acoustic drum-kit's involvement (mostly cymbals). This can be attributed to the fact that with the use of the contact microphones the impacts are treated as triggers exposing mostly the sound of the processing units and not the actual acoustic sound. This is clearly audible in the heavy reverb and delays; it is clear that such hardware units were designed to compliment instruments with often continuous (or pitched) sounds such as the guitar or vocals. The fast decaying nature of percussion doesn't leave much of the properties of the acoustic instrument in the processed sound. In other words, had these contact microphones been placed on a wooden table, tapping on them with the one's fingers would cause similar sonic results.

Some of the parameters of these processes are adjusted or changed in the course of the performance. For this approximately twenty-minute long performance, Cutler intervenes approximately sixty times with his hands alone to change parameters or effects. By using hardware units (assuming one is not using MIDI control via a CV to MIDI conversion), there is no option but to physically intervene when something needs adjustment, and when an effect is enabled, it is constantly and statically applied to the acoustic sound source. A solution that he employs to partially solve this problem is to send different microphones to different processing units. In this way he chooses the effects he wants to use according to the part of the drum-kit he plays. Finally, there seem to be occasional volume imbalances between some of the effects. Some of them become louder in comparison while some sound distorted or cause unexpected feedback (for instance, at [03:56]). While this might be an aesthetic desicion, it could also be a result of the use of different independent processing units requiring constant supervision throughout the performance; perhaps not entirely possible when all four limbs of the drummer are busy performing. Nevertheless, Cutler is arguably in complete control of his instrument.

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[1]accessed August 2013
[2]http://www.ccutler.com/ccutler/electrifiedKit.shtml (accessed July 2013)

This is a video of vocalist Alex Nowitz performing with his instrument:

[Please watch the video Alex Nowitz - Performance No 1; Galerie Sperl in Potsdam[3]]
(also included in /Media/Various/Nowitz.mp4)

Nowitz writes:

> While many artists in recent years have created many great musical tools and interfaces, consideration of the importance of the visual component in the presentation of musical ideas is often neglected, ignored or even completely denied. I feel it is crucial to the presentation of live electronic music that the performer understand not only the theatrical implications of its presentation but also the consequences of their neglect, as experienced in so many live electronic music performances today. (Nowitz, 2008)

I first saw Nowitz performing at the NIME 2011 conference in Oslo, and later saw him perform again immediately after my own performance at the *BEAM Festival* 2011. Three attributes made his performances very inspiring for me. His virtuosity as a vocalist, his instrument's acoustic and electronic consistency—making it at points impossible to identify the source of the sound, whether vocal or electronic—and his theatricality. Nowitz undertook a residency at *STEIM*[4] in 2007, where he collaborated with the composer Daniel Schorno to develop a customised system for vocal performance.

The differences between the two examples highlight very clearly some important elements of my own practice that I have tried to continuously shape. On a performative level, Cutler and Nowitz share the fact that possible co-performers and audience would be aware that there is undeniable physical effort involved in order to produce the sonic result. In Nowitz's case, we are sure that he is in absolute control of his electronics, very likely accentuated by theatricality at certain points. However, it is still not entirely obvious what the relationship is at all times. In Cutler's case, the relationship is arguably less clear, leaving more space for interpretation between effort and result. While Nowitz "grabs", "holds" and "throws" sounds with his physical movements, Cutler's gestures could be perceived as impulses initiating electronic processes which then take a more independent course in the digital realm, away from the starting point of the initial impulse performed physically on the acoustic instrument. Finally, while in Cutler's case the "joints" between the assembled technologies are fairly visible, in Nowitz's case the whole is perceived as one uniform instrument. As far as perceived awareness is concerned, it was clear to me that three important goals needed to be achieved with my instrument:

1. Physical effort should always be clear during performances.

2. The *Grey Area* (GA) of interpretation between this perceived physical effort and sonic result (acoustic and electronic), should be manipulated consciously through theatricality, afforded by my developed instrumental *Agility* (Figure 3.1).

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[3]accessed August 2013
[4]http://steim.org/ (accessed July 2013)

3. The integration of all technological parts (acoustic, electronic, electric, hardware and software) that comprise the instrument in each performance should be seamless.
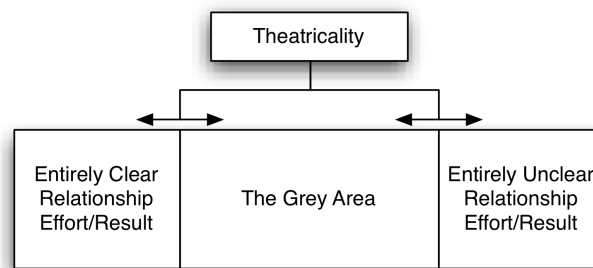
Figure 3.1: The Grey Area

As an audience member, co-performer and performer, I find the *Grey Area* to be the most exciting aspect in any new or augmented instrumental, or indeed traditional instrumental performance. Firstly, it gives the creative freedom to the observer to actively interpret the performer's gestures and thus making the performance more interesting. As a co-performer, I find effective *Grey Area* manipulation to be necessary since it helps raise a larger group's co-performer awareness significantly, by making clearer what the members' musical intentions are. As a performer, finally, I find GA manipulation through theatricality as perhaps the most powerful tool for guiding the audience's expectations, based on performer-instrument interaction ground already established during a performance. One extreme is an entirely clear relationship between effort and result (for example, triggering a sample when hitting a drum). The other extreme is electronic sound which cannot be coupled with any physical performance attributes whatsoever, leading to an entirely unclear relationship between effort and result (for example, a spectrally rich wall of sound combined with a static physical performance or a dynamically and spectrally irrelevant acoustic instrument such as a triangle). The first can lead to indifference and perhaps a demonstration-like performance, while the second one can lead to disbelief and possible loss of empathy towards the performer, the listener feeling cheated by the performative experience.

3.3 Augmented Drum-Kit: Raising Awareness

In this section I will focus on the aspects of the *Augmented Drum-Kit*'s *Immediate Gestural Space* related to performative awareness, as well as the methods followed to optimize them.

3.3.1 Visual Feedback

As it can be seen in Figure 3.2, the laptop screen which provides visual feedback from the digital part of the instrument, is positioned on my left, the same as in all photos included in Figure 1.3 of *Chapter 1: Instrumental Spaces*. While I cannot interact directly with it, I consider

Figure 3.2: Laptop Screen Position

the visual representation of the state of the electronics part of the *Immediate Gestural Space*. All mappings and controls (as will be discussed in *Chapter: 4 Agility*) were designed to prevent me from having to look at the laptop screen while performing. Theoretically, I should be able to close my eyes and reach the desired electronic textures with the same ease as hitting a cymbal, by intuitively remembering where it is located. Nevertheless, I decided to design a performance graphical user interface as a point of reference, which was sometimes required during performances. The main consideration was to be able to visually access all relevant information as quickly as possible. I see visual feedback for live performance as similar to road sign design: during the performance a quick glimpse should be enough to give all the necessary information needed instantly. Also, I only look at the computer screen occasionally and in a similar frequency as I might look at road signs or rear view mirror whilst driving. This led to the design of an interface that does not expose text based information of any kind on the performance screen, also contributing towards making the visual part of the digital realm of the instrument follow the acoustic paradigm: just as there is no text on a cymbal signifying that it is indeed the "Ride Cymbal", so that during a performance I know what to hit, my electronic performance screen should contain no explanatory text. After enough practice I was able to instantly interpret the visual representations of the electronics' state (Figure 3.3).

Each of the squares represents a DSP[5] module within the patch. This representation is based on the *Korg Nanopad2*[6], which I use to control the state (enabled/disabled) of the modules.

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[5]Digital Signal Processing
[6]http://www.korg.com/ (accessed June 2013)
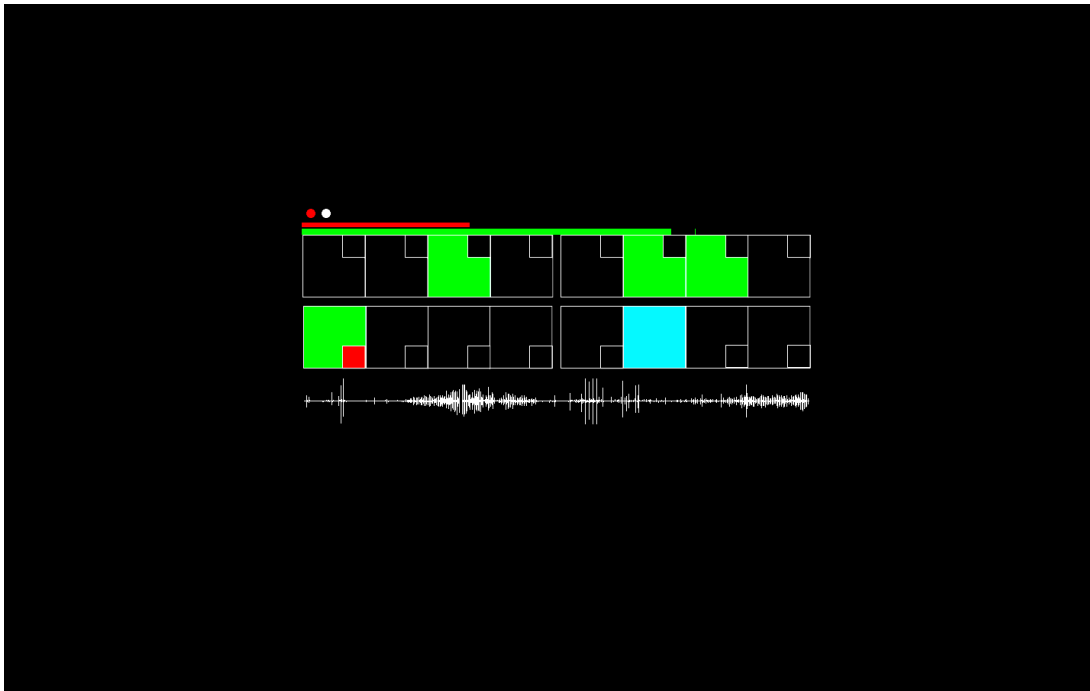
Figure 3.3: Augmented Drum-Kit Performance Screen

The green coloured ones that are enabled, function with live sound from the drum-kit. The blue one signifies that I can use my second *Korg NanoPad* to trigger segments of pre-recorded sounds by pressing the pads[7]. The smaller red squares within the larger green ones signify that all parameters of the respective module are presently "locked"[8] (also refer to Appendix F - Software Overview for a more detailed description of the performance screen). Through exhaustive practice and fine-tuning it was possible to achieve a mix of all electronic modules that was acceptable in any situation encountered thus far. With appropriate equalization the individual processes complement each other spectrally, without requiring mixing supervision during the performance (partially addressing the mixing imbalance[9] encountered in Cutler's performance in section 3.2, with the use of computer-based automated processes and digitally saved volume states). This allows for a clear and efficient visual representation of the digital world, which assures awareness of all vital information, in addition to the perceived aural cues through the instrument's electronic sound diffusion.

3.3.2 Sound Diffusion

After discussions with percussionist, composer and improviser Christophe Fellay[10] in March 2011, I decided to adopt a localized speaker approach for my solo performances, rather than send the sound to a stage-wide P.A. system or use any amplification for the acoustic kit. The idea is that the electronic sound is part of the instrument, and as such it should be situated in

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[7]A detailed description of all module functions will be presented in *Chapter 5: Vocabulary*

[8]A feature that will be explained further in *Chapter 3: Agility*

[9]in case the mixing imbalance was indeed unwanted and not an aesthetic choice

[10]http://www.christophefellay.com/EN/Welcome.html (accessed June 2013)

close proximity to the acoustic instrument in order to be perceived and felt as one consistent electro-acoustic performance environment. In some respect, I consider the *Augmented Drum-Kit* to be equivalent to the electric guitar in terms of how the amplified (or electronic) sound is related to the physical instrument. Of course, depending on the venue, the electronic and acoustic sound as a whole could be further reinforced by a pair of overhead microphones, but this should be something decided according to the needs of each performance. In addition, this approach assumes that the acoustic and electronic sounds are already balanced and so the overall sound is just reinforced for a larger venue, rather than having the separate sound sources mixed by an sound engineer. This enables me to be sonically aware of my instrument in the same manner that an acoustic instrumentalist is, and it also allows me to have a shared sonic experience with the audience (with minor deviations according to the venue). I find being able to perform comfortably "feeling inside" the unaltered and familiarly mixed electronic sound to be one of the most important factors towards personal instrumental awareness, when improvising with a bespoke electro-acoustic instrument.

Figure 3.4: Electronics speakers positioned behind the instrument - ICC 2012

When this sense is altered by a sound engineer (for example by boosting too much the low end of the frequency spectrum, or by using excessive compression—perhaps suitable for other types of music), there is no way I can react as a performer in order to correct it. On a psychological level, the localized electronics approach described here, reassures me that—since the speakers are connected directly to my soundcard—I have full responsibility and control of the sound. In case something goes wrong, I am the only person capable of correcting it, removing any second guessing and unnecessary communication with a F.O.H. engineer (e.g. pointing up or down to someone located on the other side of the concert hall, behind the audience, in order to turn up or down the volume of the monitors).

3.4   Case Study: The Third Mind - Awareness
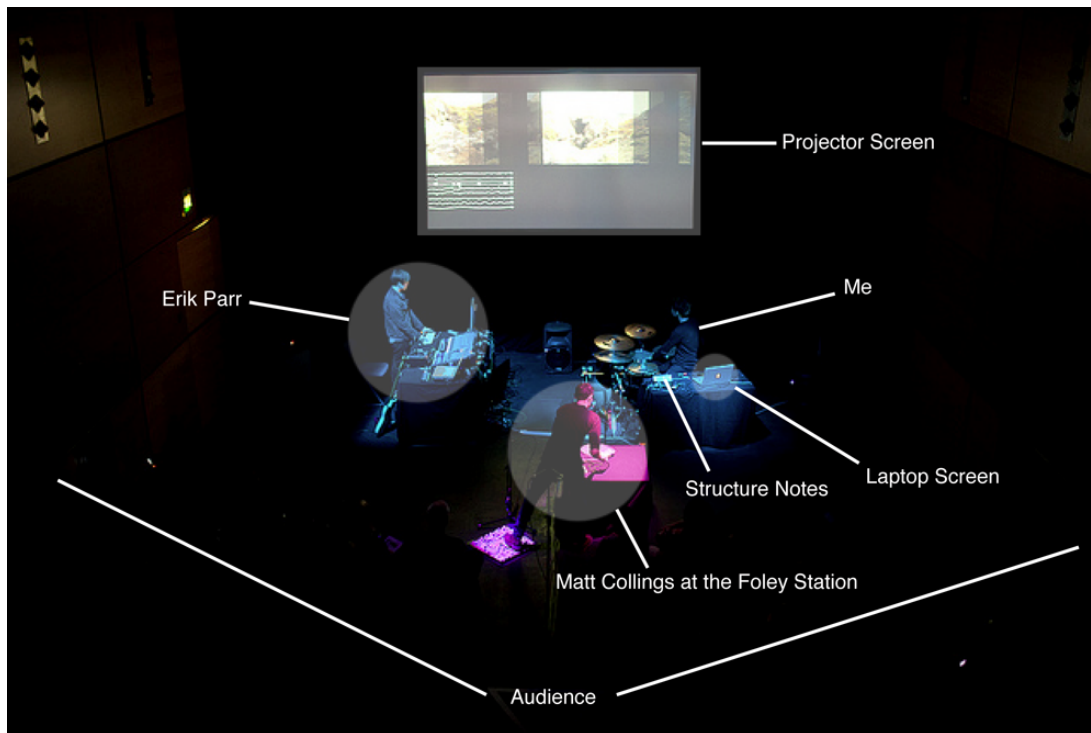
Figure 3.5: Points of Visual Significance - CCA Glasgow 2013

The Third Mind is an audiovisual installation and improvised performance created by composer Matt Collings and visual artist Erik Parr, supported by New Media Scotland and performed as part of Cryptic Nights in Glasgow in 2013. According to Matt Collings' proposal, one of the goals of the project was to create a work in which both sound and visual content were equally supportive of each other, a departure from traditional cinematic forms where sound and music act as support to the visual content, or vice versa in the typical music video structure, where visuals are subordinated to the musical content.

I was invited to perform with the *Augmented Drum-Kit* for the improvised performative part of the work. While the project itself involves musical aspects worth discussing, I will focus here on how visual awareness between performers, audience and projected computer graphics was achieved, being a central aspect of it. Participating in this project was an excellent test for my instrument, as up to that point I had never used it for works created by others, and involving having to react promptly to visual cues, or text-based instructions (the next similar performance setting was with performance artist Stelarc and mezzo-soprano singer Lore Lixenberg in 2011, without however having to follow visual instructions from the projectors (Figure 3.7)). As a performer of an augmented acoustic instrument, I had to be able to maintain visual contact with MC and EP, the projector screen, my laptop screen, the Foley station, which was set up both for audience participation and MC—and I should be able to react instantly with my instrument to audiovisual cues. This led to the setup that can be seen in Figure 3.5. I decided to set up the drum-kit sideways, so that I was facing MC and EP's mixer station in front of me, the projector screen on my right, the Foley station which MC is performing from in this photo, the audience behind him on my left, and my computer screen for possible needed visual feedback on my far

left.

While the need for aural and visual awareness is a central factor in improvised performances with acoustic instruments in general, this performance mandated, on the one hand, constant visual awareness of at least the projector's graphics (which reacted to some extent to the sound and signified the present performance section) and, on the other hand, of MC, with whom some pre-agreed musical gestures had to be performed based on body movements—such as MC's exaggerated guitar neck movements and percussive gestures from my part—so that Matt can synchronise his guitar phrasing. In Figure 3.6 one can see the notes I took during rehearsals and discussions with MC and EP. We decided on a loose structure for the performance, which was occasionally driven by musical gestures and at other times by the computer graphics' transitions. The performance was divided into eight sections, and while there were different approaches to how the performance was driven in each of them, I only wrote down the most crucial performance characteristics for my instrument that would help me remember what was discussed. Some of the comments (in English and Greek) read: Toms only - hands, Fragmented rhythms, Drum solo bursts, Hands - sparsely, FRZ (for spectral freezing), XY, GRAB, Loo (different electronic processes) and Reverb. Although these comments could be interpreted in numerous ways while still maintaining the vocabulary of textures they suggested, I had a very clear idea of what I should be doing in each section. The brevity only served as a safety net, in order to quickly get back on track in case there was uncertainty on any level. The density of all the described visual cues would not allow for an equally complex set of instructions, something that would also defeat the purpose of the project—being the progress of the work by mutual influence between audio and visuals.
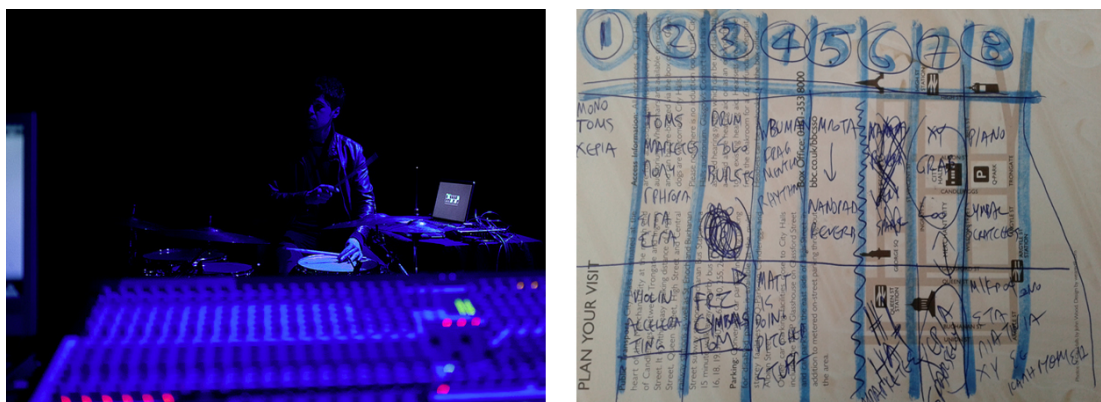
Figure 3.6: Laptop Screen - Instructions

In order for me to be aware of all discussed visual cues simultaneously and respond appropriately through the *Augmented Drum-Kit*, I had to be in a position to control the instrument with the same intuitiveness and ease as Matt interacted with the pebbles at the Foley station, or with his electric guitar. In such a performance, the instrumentalist's focus needs to be everywhere but the instrument, and every musical gesture with it should ideally be performed intuitively. Two factors helped achieve this: First, related to my instrument's *Immediate Gestural Space*, the design of my patch's screen visual feedback (Figure 3.3), which assured that all information required from the digital part of the instrument could be acquired visually instantly. Second, related to my instrument's *Extended Instrumental Space*, the stage setup secured clear visual communication between all agents (Figure 3.5). It should be noted that *The Third Mind*, as

conceived by MC and EP, did not necessarily involve new instruments. This meant that *The Augmented Drum-Kit* would have no excuses[11] and would be treated as any other traditional instrument in terms of prompt interaction between performers.

Figure 3.7: Stelarc - Prosthetic Head - Visual awareness not necessary

The audience ranged from people interested in media and the arts in general to simply curious passers-by, none of whom (or at least a very low percentage) would have an assumed knowledge in new digital instrument practice. While a real (or imagined) non-specialist audience is a very useful consideration for the instrument's development, I also see it as a good benchmark test: It is better for the audience to not like a work because of its artistic merits (while it is sensed that there is a real performance taking place) than (more commonly in new digital instrumental practice) to not know *what* to feel because of expressive, performative or dramatic uncertainty[12], often caused by confusion and an artistic goal falling between the cracks of all the technological elements employed. I consider the latter to be the ultimate failure in new digital or augmented instrumental performance, as this means that not only did technology not help make an artistic point clearer and brighter, but became an obstacle towards projecting the artistic message. In the case of *The Third Mind*, I believe that the development of my practice and instrument through the shaped *Agility* as will be seen in *Chapter 4* and the *Awareness* facilitating methods followed both in the IGS and the EIS, enabled me to achieve my performative goals, these being performing intuitively in any context with technology being a facilitator and not an obstacle.

3.5   Case Study: LLEAPP

LLEAPP (Laboratory of Laptop and Electronic Audio Performance Practice), is a yearly roving researcher-led workshop, founded at the University of Edinburgh in 2009 by members of

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[11]for possible performer-performer, performer-audience disconnection, perhaps present in more forgiving environments such as NIME or ICMC conferences, where often new instruments or works under development are being showcased.

[12]I am not refering here to conscious artistic ambiguity, which can be a quality sought after, but to unplanned ambiguity caused by misused technology

Sound Lab Edinburgh[13], with support from the Roberts' Fund for Student-Led Initiatives. It aims to highlight and address many of the issues related to the live performance of electronic music. I was a participant of the workshop with the *Augmented Drum-Kit* in Newcastle 2010, Norwich 2011, as well as Edinburgh 2013. The format of the workshop, until 2013, involved talks and group discussions, with a practical part involving collaboration between composers / performers / builders in smaller groups for two or three days, aiming to prepare a public final performance based on the concepts explored within the groups. Since it was perhaps felt that the formats of the workshops of 2010 and 2011 were not leading to very satisfying final performances (as well as wanting trying a different approach), there was a change of format in 2013 (as it will be further discussed in section 3.5.4). I attribute the problematic elements of past workshops to three basic factors, primarily related to *Awareness*:

- Co-Performer *Awareness*

- Spatial *Awareness*

- Instrumental *Awareness*

3.5.1   Co-Performer Awareness

With the use of a computer usually being a given (as implied by the "Laptop" in the title), perhaps the biggest issue from my perspective was performers staring extensively at their screen during rehearsals and performances, generally abandoning visual channels of communication. I often felt a sense of uncertainty as to whether or not a co-performer was performing or troubleshooting, especially when no other visual or audible cues were clearly perceivable. As such, for the most part co-performer effort/result awareness was very little. The logistics of the workshops also sometimes imposed less-than-ideal monitoring setups. Even when acoustic instruments were present, the electronic sound was either diffused by a stage-wide P.A. through a mixer, or localised speakers very close to each-other (Figure 3.8). This led to more uncertainty, since often during the performances—with everyone set up in parallel to each other and facing the audience—all information as to who is producing which sound was lost. As such, I often felt that the only way to contribute meaningfully would be to ignore the number of performers and their physical gestures, and to simply add to the overall soundscape, something that can lead to a radically different type of performance. This approach reminded me of playing within very large groups of improvisers, where one does not necessarily react by being aware of particular co-performers, but only of general aural cues. While this can be a valid performative stance, in this case the groups were not as big (usually around 4 people). In this case, I believe that this approach led to poorer musical results.

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[13]http://sites.ace.ed.ac.uk/sdresearch/ (accessed June 2013)

Figure 3.8: 2011 - LLEAPP (City Arts Centre, Norwich)

3.5.2 Spatial Awareness

The rehearsals of the individual groups typically took place in small studio rooms. Then all instruments and performance plans were taken on to the actual stage where the performances would occur. In my opinion, this challenged significantly (and in some cases even rendered irrelevant) all previous preparations. While a rock-band can rehearse in a studio room and then transfer the performance onto a stage, where both the spaces and the paradigm within which the band operates are clearly defined, with new digital instruments all of these aspects are in flux. As such, when the LLEAPP group prepares in a studio room, that space, with all performative dynamics developed between performers in it, *is* the *Real Performance Environment*, and in my opinion, the rehearsals prior to the final concerts in LLEAPP should be seen as the true performances. Then, by moving to the main stage, we were simply attempting to recreate the (preparational) performances of the smaller rooms. In the case that this approach needs to be followed (preparing material in one space and presenting it in another), we should perhaps treat the smaller preparation rooms as *Transformation Spaces*, where the final *Real Performance Environent* is envisaged without fixing specific musical elements that might only work in that room, but on performative attributes that are mode adaptable from the TS to the RPE (as it was perhaps done in some occasions). In this case, not only we did not know the exact positioning we would have in the main stage, but we also did not know where we would be able to hear ourselves and our co-performers from, as described in the previous subsection.

3.5.3 Instrumental Awareness

Every participant of LLEAPP arrives with some sort of *Potential Musical Energy* stored between themselves and their performance environment. Everyone has a personal *Awareness*, *Agility* and *Vocabulary* within their own developed practice. However, in order to be able to operate meaningfully within groups, people often tended to program more direct means of controlling their instrument, so that group instructions or decided strategies could be followed more easily. This led to, first, a significant amount of time spent on programming and not playing. Even if the programming was succesful for the group's goals, there would be no time left in the

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end to master the now new instruments created, resulting, again, in an uncertain performance. Second, I have the impression that the instruments were made simpler so that performers can respond faster, perhaps following the acoustic instrument paradigm. I see this approach as equivalent to taking a few strings out of a guitar because these notes are not used in a particular project. Although this plan makes the group's collective PME more consistent by making more consistent individual *Vocabularies* (the decisions regarding which "guitar strings to keep" were usually informed by discussions between rehearsals), it unfortunately does not work in the long-term, since the instruments now become too simple to be interesting or expressive for more sustained engagement. As such I don't see it as a pure solution to the general problem, but only as a method to secure the musical potential addressing only a specific performance problem (and I am referring here only to the rehearsing performances in the preparation rooms, not the final performance).

Rather than tackling these performative problems through fundamental changes to an instrument[14] one could instead proceed by adapting the existing instruments to the performance scenario, and then using all resources and time to find musical ways in which the individual performers' PMEs will be maximised in the RPE. Let us consider a group of an electronically augmented violin, an Apple iPhone with bespoke software and a laptop performer of ambient music. How would it be possible to design a consistent performance with these radically different individual instruments? The violin involves acoustic sound with a perhaps strong sense of localization on stage, so should the electronics be diffused in stereo through the same P.A. with the laptop performer? In a string quartet or a rock band, not only do the instruments complement each-other, but also suitable spaces have evolved for these particular genres of music: the concert hall and the rock venue or stadium. These spaces have been shaped by the music over the years and vice versa. On the other hand, new digital and personalised instruments not only do not have clearly defined equivalently individual expressive spaces (*Ideal Performance Environments* as described in *Chapter 1: Instrumental Spaces*) but combining instruments of such different approaches (to what performance entails for each of them), would require combining all the instruments' individual spaces in some way (unless they all already follow a paradigm where they can find a point of aesthetic reference, such as playing free-jazz with augmented drums, saxophone and piano). Instead of attempting to homogenize all these different instrumental paradigms (by, for example, placing them all together in the same stage and diffusing their sound through the same P.A.) I would suggest embracing their instrumental idiosyncrasies and use their differences as an advantage within the real performance scenario, something that was followed and led to an arguably more succesful final performance at LLEAPP 2013.

3.5.4   LLEAPP 2013

As mentioned, for LLEAPP 2013 at *Inspace*, Edinburgh, it was decided to adopt a different format. All performers would work in the same space throughout the three-day period and perform there. Also, there would be a central theme (drawing inspiration from Homer's Odyssey),

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[14]A detailed methodology of my own instrumental development and alterations procedure will be presented in *Chapter 4: Agility*

Figure 3.9: 2013 - LLEAPP (Inspace, Edinburgh) Day 1

and there would be a conductor and co-ordinator leading the workshop (Jan Hendrickse). In my opinion, most of the problems described above were solved, leaving greater space to creative and musical considerations:

A) Co-Performer *Awareness*

During the first day, JH suggested improvisational exercises without (and later with) instruments, heightening the sense of awareness between performers. The presence of JH as a mediator helped break some of the social barriers that were present in previous LLEAPP workshops, allowing for more bold interactions between players. As performers, we were all forced to become alert and conscious of co-performer communication, solving also to a big extent the problem of excessive laptop screen staring. While all of us have most likely performed previously in projects where we had to wave at co-performers and negotiate changes in music, performing within a group of people that have just met can often result in overly polite behaviour, which can make performative and musical interaction suffer. The exercises helped us get past this stage quickly.

B) Spatial *Awareness*

Preparing in the same space as the one in which we would perform, enabled us to experiment with different spatial formations. Initially we decided to perform onstage next to each other

(Figure 3.9), adopting a more traditional approach to group performance. However, it was decided towards the end of the second day that we should also attempt to spread within *Inspace*, and explore the idea of an audience walking around the space during the performance, making it an individual experience for each audience member according to their choices of listening position throughout the piece. With every performer now feeling free to position themselves within the space we were able as a group to make the most out of the space available for this performance scenario. Similarly to the performance and recording of my solo album *Long Distance*, here the *Transformation Space* and *Real Performance Environment* overlapped, leading to a performance with less *Friction* caused during the *Adaptation* process.

C) Instrumental *Awareness*

In contrast with previous LLEAPP workshops, for this one little to no programming took place. In combination with the approach of "making the most out what we have"—including space and individual PMEs—everyone was free to adapt their own practice into this performance scenario in a way that would be meaningful to them.

Personally, while during the first two days I was participating with the *Augmented Drum-Kit* by playing it as I always have, in order to adapt my instrument into this scenario I decided to completely change my approach to its excitation. Having performed previously at *Inspace* (for example, with *HAKEMIRA* as seen in *Chapter 2*), I was aware of its limitations regarding impulsive percussive sound. As such, I decided to step away from the instrument. I placed speakers around the drums and attempted to excite the instrument by resonating the membranes with my voice, feedback, and reverb from a distance (Figure 3.10). Being satisfied with the result, I decided to perform in this manner, resonating the *Augmented Drum-Kit* (and also exploring resonant frequencies of *Inspace*) through the microphone for the whole concert, apart from the very end where I returned on the drum seat and performed traditionally, for a brief time (perhaps inspired by the imagery of Odysseus returning home and reclaiming his kingdom).

Figure 3.10: 2013 - LLEAPP (Inspace, Edinburgh) Day 3

An important point made by JH during the debriefing session was that the success of the per-

formance could be attributed to approaching it as a context-specific problem: working with what we had by embracing its reality, both in terms of instruments and space. Finding pragmatic solutions to the performative problems while being flexible from an *Ideal* version of the instrument and adapting it to *Real* performance scenarios has been my method throughout my instrumental practice with the *Augmented Drum-Kit* (Figure 1.2). I consider this approach to be particularly relevant when multiple new digital instruments are used towards a common performance, with radically different *Ideal Performance Environments* as in the case of LLEAPP. As I argue in this thesis, this makes improvisation and a context-specific mentality the most effective method for bespoke instrumental performance practice.

3.6   NeVIS

Based on a more traditional performance paradigm, I decided with my postgraduate colleague, Lauren Hayes, to design and implement a system that would facilitate our performances with our augmented instruments, my *Augmented Drum-Kit* and LH's *Hybrid Piano* in any context. We called this the Networked Vibrotactile Communication System for Improvisational Suggestion (NeVIS).

3.6.1   Facilitating Co-Performer Awareness

The motivation for the development of the system was to create a framework that would firstly guarantee a certain level of co-performer awareness irrespective of performance scenario and, secondly, influence the musical outcome. As seen, performing extensively was one of the main methods for developing and shaping my instrument. While certain measures were always taken in order to assure a good level of co-performer awareness, performing with another augmented instrumentalist can always present difficulties. Given the reality of extensive performance involving a variety of concert halls, stages, festivals, number of other performances taking place on the same stage, and so on, we needed a system that would facilitate co-performer awareness in any situation. Aspects such obstruction of visual channels of communication, excessive focus on our own instruments (since we were both still at early stages of developing our emerging instrumental *Awareness* and *Agility*) and even poor monitoring of each other's electronic sound, could become significant enough to compromise our collective PME and performance:

> During performances, we found that we would often drift into a state of semi-isolation, focusing on, gauging and reacting to the specifics of the individual augmented instruments (something also commonly observed within the larger improvisation group, Edimpro). Thus it was often difficult to attract the attention of the other player for visual cues. In order to remedy this, a nudge function was built into the system, which served as a tool to enable visual communication. (Hayes & Michalakos, 2012)

In addition,

> After performing together for a significant amount of time, performers begin to predict or expect what their well-known partners might contribute in any given situation. On one hand, this is of course an advantage in long-term collaborations, as players become familiar with the sonic worlds of their peers; but, in some cases, it can also lead to a lack of spontaneity, or at least spark a desire for a freshness of sorts. In our case, introducing a third, unpredictable agent into the system was certainly something that was appealing, not only for the sake of newness, but moreover because we would be able to consider its role in the construction of the sound and musical form. (Hayes & Michalakos, 2012)

The system aimed to address these two issues. It was developed over a six-month period, and resulted in the work *Socks and Ammo*, which was performed in numerous occasions, including Sound Thought festival (Glasgow) 2011, Soundings Festival of Sonic Art (Edinburgh) 2011 and NIME (Oslo) 2011 (as well as the performances presented as part of **Album D: Socks and Ammo - NeVIS**). Not only was the system useful, but also its musical identity started affecting the outcome of the performances as we became used to it and familiarised ourselves with its functions.

Figure 3.11: Socks and Ammo - Setup for Track 3: SaA_v1

NeVIS is driven by a time-based cues framework. Before performances, we have to decide on the number of sections and their durations, comprising the duration of the whole performance. After the concert's start, each of us receives fading vibrations on our skins, a few miliseconds before each section change, enabling synchronised gestures that would not have been possible otherwise during an improvised performance. Also, the system provides the possibility to "nudge" the other person by sending short vibrations to the other performer via a button on our MIDI controllers in order to attract their attention (visual or otherwise). Finally, it sends pre-decided tempo suggestions in the form of short rhythmical pulses. Other information such as each other's electronics sound density and spectral centroid can also be sent over the network, affecting the other performer's electronic sound (Figure 3.13). This aims to further unify the two digital *Vocabularies* through filtering and equalization, among others. A detailed description of the system's underpinings and technical aspects can be found in our collaborative published article (Hayes & Michalakos, 2012).

[Please watch the video **(/Media/Video/NIME.mov)** now]
(observe the section change at [01:49])

[Please listen to **Album D: Socks and Ammo - NeVIS** now]

After the Sonorities performance in SARC's Sonic Lab **(Track 3: SaA_v1)** (Figure 3.11), it was noted from audience members that a very strong sense of integration and coherence between the performers was evident in the music. While this sense of connection may be attributed to our long perfomance history and development of unfacilitated co-performer awareness, when compared to performances that we have given without using NeVIS, I believe that this was indeed due to the implementation of the network. Later, the system was also used for some of our *Mŭstek* synth-based performances, such as **(/Media/Video/POPP.mov)**.
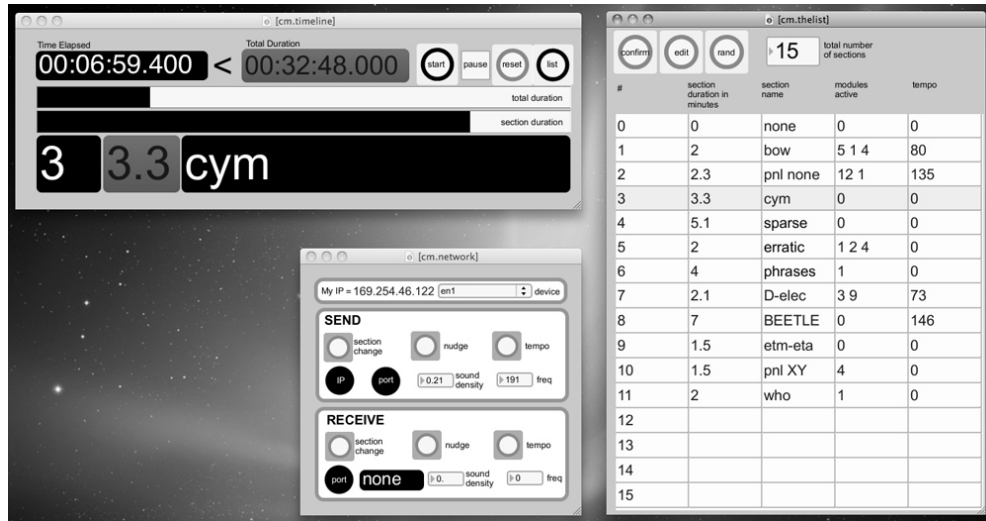
Figure 3.12: NeVIS GUI

NeVIS is essentially a combination of an early version of the *Augmented Drum-Kit*'s cueing system (Figure 3.12) expanded for local network and multiple performers, and LH's vibrotactile devices, which she had previously created and used for her solo piano and live electronics practice.

3.6.2 Evaluation

After performing with the system on a number occasions over an extended period of time, the anticipatory nature of our own responses receded. After this stage, NeVIS assumed the role of a helping tool for our improvisations, which was no longer the focus of the performance but rather acted as a safety net that could guarantee a sufficient level of co-performer awareness. It soon became an integral part of our collective performance environment and, after a certain degree of familiarity was achieved, the musical output became the main focus again. All perceived instructions and suggestions would be taken into consideration only if they served the already established performative dynamic and musical direction and, whilst they were often acknowledged, they were sometimes ignored too. Because of the autonomy of we performers within the developed framework, *all* vibrational information could potentially be ignored. However, this never happened in performances based around the work *Socks and Ammo* as we

aimed to understand how the character of the system might be manifested amidst our own playing.

> It was mentioned in the audience feedback at NIME that the system could clearly be perceived to be influencing the direction of musical progression in ways that would not otherwise have arisen naturally: this was illustrated mainly by the synchronised and often abrupt changes in direction. This feedback was encouraging, considering the context of this performance, as we were unaware to what extent an informed audience (here with explanatory programme notes) would be able to discern the effect of the system. (Hayes & Michalakos, 2012)

Similar comments were received after the Edinburgh performances as well, from audience members who were present during previous performances of ours, with and without NeVIS. When an element of unpredictability and surprise was introduced, the performances, conversely, appeared to take on a stronger sense of direction. Here is part of a review describing one of our performances with NeVIS:

> ...what was truly impressive in this performance was firstly the way in which every element of the performance whether acoustic or electronic was so completely integrated together to form a true unity of sound. Secondly, only from the programme did we realise that much of this music was improvised but like the best of jazz musicians who seem in a positively supernatural way to be able to read one another's minds, this duo thought and performed as one entity. (New Music Scotland, 2011)
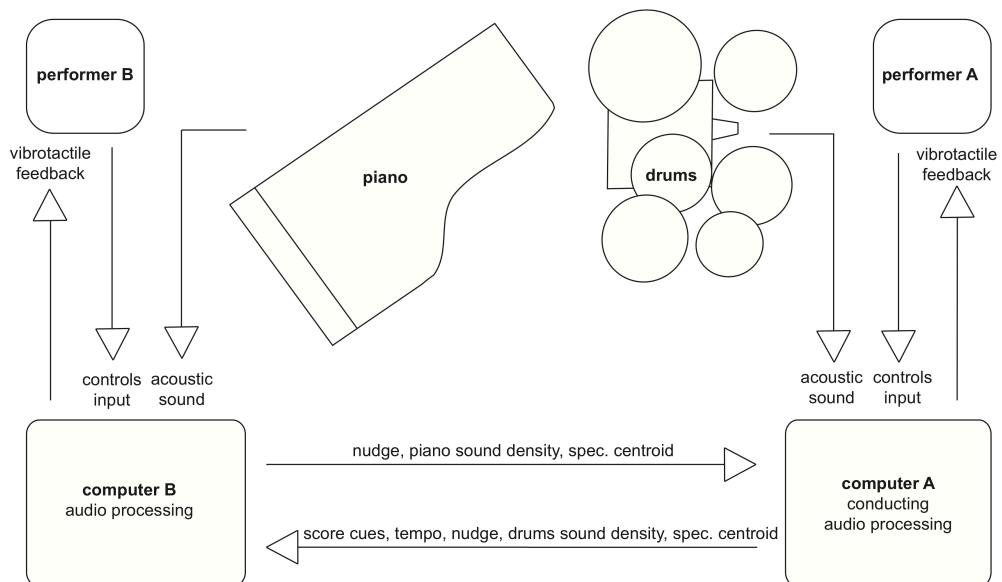
Figure 3.13: NeVIS logic

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3.7 Summary

In this chapter, *Awareness*, the first factor of *Potential Musical Energy* was detailed. Starting with two examples by Chris Cutler and Alex Nowitz, I first discussed my own goals for perceived performative awareness with the emerging instrument. I argued that manipulation of the perceived effort/result *Grey Area* is a powerful device towards facilitating co-performer awareness, and needs to be actively addressed during the development of a NIME. Subsequently, I described the methods that were followed in relation to *Awareness* in order to be able to manipulate it. Specifically, I designed the visual feedback from the digital part of the instrument to be as clear and efficient as possible, inspired by the road sign design paradigm, thus minimizing the time spent on screen gazing. Also, I decided to use a localized approach for the diffusion of the electronics, being in close proximity to the acoustic drum-kit, instead of using a stage-wide P.A. The whole electro-acoustic instument can then be further amplified as a whole through a pair of overheads, depending on the venue. This made the *Augmented Drum-Kit*'s instrumental identity clearer and more defined within groups of performers and hopefully to audiences. Additionally I presented case studies in which I was involved as a composer/performer with the *Augmented Drum-Kit*, focusing on different aspects of *Awareness*: visual, spatial, instrumental and co-performer. I have suggested how in performance with multiple bespoke instruments, the most efficient strategy would perhaps be embracing each instrument's identity instead of homogenizing their *Ideal Performance Environments* (by placing them on the same stage next to each other, for example), following the paradigm of LLEAPP 2013. Finally, the collaborative work NeVIS, a novel networked system for vibrotactile suggestion which facilitates co-performer awareness and musical direction in any scenario was presented and evaluated. In the next chapter I will focus on *Agility*, the second factor of PME.

Chapter 4

Agility

> I experienced a new kind of performance frustration - how could I control multiple performance parameters spontaneously during improvisation when my hands and feet were too busy to access other controls? (Oliveros, 2004)

4.1   Introduction

In this chapter I will present the third and final analytical framework of this thesis, which was central towards shaping instrumental *Agility*: *Instrument Development Cycles*. It includes three distinct stages of improvisatory practice: Interface Design Improvisation, Aesthetic-Shaping Improvisation and Inter-Contextual Improvisation. In combination with the spatial framework presented in *Chapter 1*, *Instrumental Spaces* and *Potential Musical Energy* presented in *Chapter 2*, I argue that the three interconnected frameworks consist a unified generalisable method for defining and shaping one's own bespoke instrument performance practice.

Additionally, I will examine the nature of the percussionist's and the laptop artist's practices being the building blocks of my own practice with the *Augmented Drum-Kit*. Finally, I will present the methods followed for the actual electronic augmentation of the drum-kit, enabling me to take advantage of the *Agility* developed over the years on the acoustic instrument.

4.2   Shaping Instrumental Agility Through Improvisation

In this section I will expand on the methodologies followed for the instrument's development in order to firstly shape it around my needs and then be able to become agile on it. Each *Stage* of instrumental development, even if not always entirely separated from each other, served as

a conceptual basis which was consciously followed in order to maintain an instrumental consistency. This enabled me to develop the necessary skills to move to the next level of design each time, instead of following a constant instrumental alteration approach, that could eventually lead to interaction design circles. Derek Bailey makes a few focal points regarding "the instrument" which I find useful to address in this section:

i) About learning to play an instrument John Stevens says: "Improvisation is the basis of learning to play a musical instrument. But what usually happens? You decide you want a certain instrument. You buy the instument and then think to yourself "I'll go and find a teacher, and who knows, in seven or eight years' time I might be able to play this thing" And in that way you miss a mass of important musical experience. Studying formally with a teacher might be the right way to achieve certain specific aims, but to do only that is a very distorted way of approaching a musical instrument. It has to be realised that a person's own investigation of an instrument—his exploration of it—is totally valid."

ii) There is no generalised technique for playing any musical instrument, However one learns to play an instrument it is always for a specific task. The Indian player, after succesful study with his master, is fitted to play Indian music. The flamenco [player] learns flamenco, the jazz [player] plays jazz, and so on. And in some respects the better he is at his chosen idiom the more specialised his abilities become.

iii) Technically, the instrument has to be defeated. The aim is to do on the instrument what you could do if you could play without an instrument. Ronnie Scott expressed this view when he said "I practise to become as close to the instrument, as familiar with it, as possible. The ideal thing would be to be able to play the instrument as one would play a kazoo."

(Bailey, 1993, 98, 99, 101)

From the moment of conception of a new instrument or instrumental augmentation, throughout its development with the use of technology, the goal is the expansion of the dynamic, sonic range and expressivity; according to my own definition, the maximization of the performer's *Potential Musical Energy*. In the field of augmented instruments, by exploiting skills already developed for the acoustic instrument, the composer/performer/builder attempts to expand on these skills, and with the use of technology to enhance the possibilities of the acoustic instrument. The question is, what kind of music does one have in mind when developing a new instrument? (Bailey's point ii). Are any existing established paradigms being followed (designing an augmented instrument to operate within noise-rock, for example) and if not, what are the factors that influence the direction in a process of constant decision making during the stages of design? In a state of flux, most of these instruments are constantly changing; composing a traditionally composed work for them can perhaps be fruitless. Without prior repertoire or recorded performances, it is hard to find good reasons for notating, and thus rending repeatable, a composition using such emerging instruments. Not only because the instrument might not exist in its present state for too long (making repeatability a non-issue), but also because, for most of such, their inventors are usually the only ones who are agile on them to some extent. Improvisation, on the other hand, can play a crucial role towards shaping the new instrument and simultaneously be a "totally valid" (Bailey's point i) means of expression, that embraces

the nature of these evolving instruments. In the case that the composer/improviser is also the builder, improvisation provides very direct and tacit feedback for needed improvements on the instrument.

I have divided the *Augmented Drum-Kit*'s *Agility* shaping framework into three *Stages* of improvisation, taking place from the instrument's conception until the final stages of its formation. This three-part *Instrument Development Cycle* then repeats indefinitely for further fine-tuning and evolution (Figure 4.1). In relation to the previous frameworks presented thus far, I suggest that *Stages A* and *B* take place in the instrument's *Transformation Space*, while *Stage C* takes place in various *Real Performance Environments*. Also, it is through repeated *Instrument Development Cycles* that the *Ideal Performance Environment* evolves.

These will be outlined in the following subsections:

- *Stage A*: Interface Design Improvisation

- *Stage B*: Aesthetic-Shaping Improvisation

- *Stage C*: Inter-Contextual Improvisation
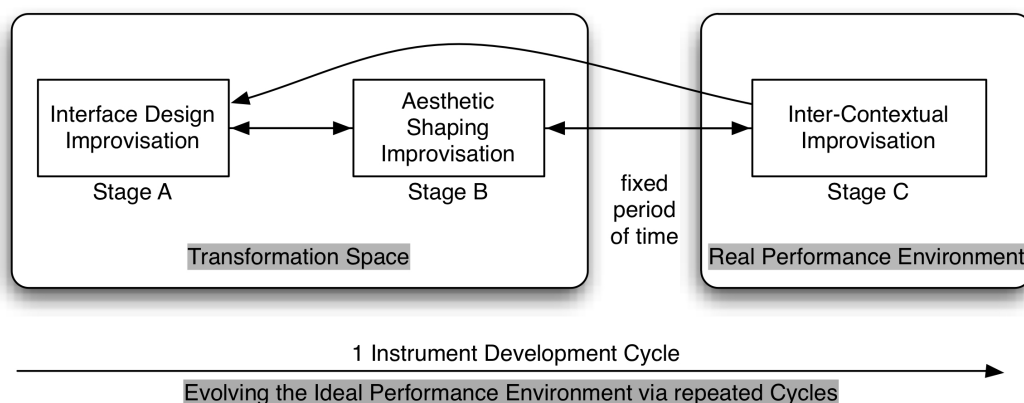
Figure 4.1: Instrument Shaping Stages

4.2.1 *Stage A*: Interface Design Improvisation

The first stage following the conception of the instrument could be denoted *Interface Design Improvisation*. The builder envisages an interaction between the control interface and the produced sound. In the case of an entirely new instrument, the idea is often based on some means of expressive solution or synthesis technique not available before; a single technological breakthrough or resource becoming available or affordable to the public (such as the *Nintendo Wii*

Remote[1] controller or *Microsoft Kinect*[2]). The challenge is thinking and designing the affordances of the new instrument on a blank canvas that will then have to make musical sense and be mastered by a performer. The same applies to acoustic instruments that are being electronically augmented or enhanced with the use of computers and sensors. Even though the goal is to take advantage of *Agility* already developed for the existing acoustic instrument, the relationships emerging from the new modes of interaction can sometimes be so distracting as to prevent the use of the acquired acoustic instrumental skills, not because of unfamiliarity with the newly designed interactions, but because of them not being gesturally balanced to the performer. *Interface Design Improvisation* is used towards realising how many parameters (and in which spatial configurations) one can be truly *agile* in, on a *physical level*, without necessarily addressing the aesthetic context of the instrument. It could be perceived as similar to designing a bow and arrow that can be used efficiently by someone according to his arm's length and strength, without necessarily worrying at this point what their purpose will be, hunting, sports, or some such.

Interface Design Improvisation lies between the conception of the new instrument and its relative fixation just before the instrument starts being shaped by musical intention and aesthetics. At this stage, the composer/performer/builder explores the relationships between actions and results in terms of ergonomics, physicality and gestural consistency. The musical result is not entirely relevant—even though ideas towards the aesthetic goals of the instrument are constantly being shaped in the mind of the builder, this is a period of testing the complexity of the design to meet one's initial physical idiocyncracies. The composer/improviser/builder also adopts the role of the designer. Through trial and error—much like in musical improvisation—as a designer, she is able to interpret the experience in a meaningful way, envisaging how these interactions will help formulate the final stage of the instrument. For example, one can use generic samples or white noise instead of more complex sound synthesis techniques while testing the possibilities of the *Nintendo Wii Remote* as a control interface. At this stage the focus is on possible mappings, gestural sizes and other control relationships.

I find the term improvisation more suitable here than "testing". During *Interface Design Improvisation*, the designer is not necessarily expecting a specific outcome of the controller. In this respect, the term improvisation is more fitting as it entails a sense of creative extrapolation of possibilities, not present in the term "testing". There are only a few predetermined parameters and constants, such as the use of a *Wii Remote* as a control interface for the new instrument in this example; it is, however, a matter of role-playing and imagination to match its affordances with possible musical scenarios not yet present, but emerging through this improvisatory design.

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[1] `http://en.wikipedia.org/wiki/Wii` (accessed June 2013)
[2] `http://en.wikipedia.org/wiki/Kinect` (accessed June 2013)

4.2.2 *Stage B*: Aesthetic-Shaping Improvisation

Once the interface design choices have been made, the next stage of crafting emerges. Again, it does not yet necessarily involve improvisation as high quality musical outcome, but pursuit of the instrument's identity through exploratory improvisation, with a focus on aesthetics and artistic direction. In *Stage A* the focus was to map the performer's intuitive gestures to the interface of choice, regardless of their musical impact. Here, the focus is on musical consequences. It involves a period of solo playing in the instrument's *Transformation Space*, where the composer/performer/builder decides—given the now fixed modes of interaction developed in *Stage A*—on the aesthetics of his instrument, matching his own goals and background, as well as intended metaphors.

Audience perception and theatricality are being considered, since it is here that it is decided how obvious to an observer the relationship between gesture and result will be (the possible range of the *Grey Area* as described in *Chapter 3: Awareness*). While in *Stage A* it was decided what would be the most suitable means to capture one's gesture based on the instrumental realities, it is now decided what the impact of this gesture will be on the sound, and subsequently, what an observer perceives as the relationship between effort and result.

Using the example of the guitar, it is here that it is decided whether the guitar—whose interaction with the performer and means to generate notes by plucking its strings was fixed in the first stage—will be an acoustic, electric, or MIDI guitar. While starting from the same action, plucking strings, these three instrumental types have a completely different sound world, aesthetics, social associations and presence. The act of improvisation in *Stage B* is not being performed on stage in front of an audience aiming for a high quality musical result, but has rather a private explorative character, leading towards the most suitable sound world fitting the performer's artistic vision. In a way, *Aesthetic-Shaping Improvisation* could be seen as the starting point of building the performer's *Vocabulary* through the emerging instrument.

In the development of the *Augmented Drum-Kit*, it was here that instead of using white noise and generic test sounds or processes, I started experimenting with other more musically meaningful textures and bespoke sound transformation processes. At this point, the instrument's character became clearer, interlocking my gestural interaction as decided on *Stage A* to the envisaged musical results at the beginning of the instrumental development.

(/Media/Audio/Bevatron.mp3) is the first solo performance with the *Augmented Drum-Kit*. It took place early during its development (see Appendix A - Performance Timeline). I would place it just after finishing *Aesthetic-Shaping Improvisation*, where instrumental affordances and aesthetic became relatively fixed for the first time, and at about the start of *Inter-Contextual Improvisation*, where I started performing with it more extensively both solo and in group configurations. Another recording excerpt from the same period is **(/Media/Audio/Hypogaeum.mp3**), which is a group improvisation with Lauren Hayes playing a piano frame.

4.2.3 *Stage C*: Inter-Contextual Improvisation

At this stage the instrument has a consistent form. The *Ideal Performance Environment* is defined for the first time, and the present and final part is aiming at a high quality musical output, fulfilling the instrumental performative vision within *Real Performance Environments*. From this point the instrument is being treated just as any other traditional instument that needs to be mastered. Performing extensively and in different contexts is perhaps the most crucial method in the whole process. In personal correspondence with composer David Bennett Thomas jazz pianist Dave Brubeck writes "I would add, seriously, that professional musicians are shaped by applications of their skills in every situation possible. That means seizing every opportunity to perform and participate in musical programs offered by your school and community." (David Brubeck, 1988) The same applies to NIMEs and any personalised instrument which needs to be mastered: immobility means, first, not developping sufficient *Agility* and, second, inability to shape both instrument and performance practice. Peter Brötzmann says: "...the younger people need more possibilities to play, because as I said before, you learn the stuff you learn on the road, being on the road, playing in clubs, playing concerts everywhere, wherever you can."[3]

Similarly, it is important to keep the instrument unchanged for fixed periods of time. During performances, one often notices choices that, in practice, turn out to be less effective than had been imagined during *Interface Design* and *Aesthetic-Shaping Improvisations*. An instinctive reaction to this is to correct them as soon as possible, perhaps in the next rehearsal or sometimes instantly, by intervening in the programming. The problem with this is that this phenomenon can become so frequent that in the end there is not enough time to develop a relationship with the instrument and reach the desired *Agility*. Something that might feel hard to accomplish during a performance and is immediately simplified with the use of programming or sensor placement might cause different problems such as diminished expressivity. One has to keep in mind here the traditional instrumental paradigm. A violin requires many years to master. One should be faithful to the work and design done so far and keep developing skills even when at first they feel counter-intuitive. If there is no progress towards solving or mastering a specific troublesome parameter and something is indeed in need of a change, then it should be altered during the next allotted period of time after each *cycle*, along with other troublesome aspects presented during the preceding performance period.

In the case of the *Augmented Drum-Kit*, this period was about four times a year, or every three months. Desired features and other problems which occured during performances were being noted and implemented during periods set aside for instrumental "research and development". As can be seen in Figure 4.1, once I was engaged in *Inter-Contextual Improvisation*, I needed to perform with it for three months[4] before I could go back to *Interface Design* and *Aesthetic-Shaping Improvisations* in order to alter problematic aspects. I call every transition from *Stage A* to *Stage C* an *Instrument Development Cycle* (Figure 4.1), after which one has the

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[3]Ljubljana jazz festival: Interview with Peter Brötzmann: http://www.youtube.com/watch?v=xtuxx403LJw&t=12m08s

[4]I've found that if a combination of new features could not be mastered and become embodied in approximately three months, then the design was not appropriate for my goals

opportunity to go back and forth to *Interface Design* and *Aesthetic-Shaping Improvisations*. The sequence described here presents the three clearly distinct *Stages* but, in practice, there is significant overlap. I have found that maintaining the discipline of keeping the instrument unchanged and intervening only during specific windows of time, was the most crucial aspect of the framework.

Inter-Contextual Improvisation also contributes towards the further development of one's instrumental skills and to ensuring that the new instrument can interact succesfully in any performance setting. This depends on the intentions of the design. I find it generally desirable to have constant control of at least the volume of the instrument's sound at any time (I am obviously refering to the digital part of the instrument here, as for the acoustic part it is a given). Improvisation can potentially require fast reactions, as well as mimicking and contrasting other performers of the group. Most acoustic instruments have this ability to some extent; it is very straight forward to just stop playing or play a loud sound on demand. I see Bailey's point iii (see Section 4.2), as relevant to *Inter-Contextual Improvisation*, as it is here, with the development of *Agility*, that the instrument becomes seamless, a natural extension of the performer's body, the focus being the musical output rather than instrumental design.

Improvisatory exercises as found in the book "From Sight to Sound" (Brockmann, 2009), instruction-based works by composers such as Christian Wolff[5] or John Zorn's Cobra (Zorn 1984) can all be relevant to and be performed by a group of experienced improvisers. The composer / performer / builder of the bespoke instrument should be able to perform within such a scenario, responding instantly and intuitively, while experiencing the new digital instrument just as an extension of the body: "as one would play a kazoo." (Bailey, 1993, 101).

The following is one of the first solo performances with the *Augmented Drum-Kit* after a few *Development Cycles* performed at BEAM Festival in London. In this, I recall having reached a satisfactory level of *Agility* with the emerging instrument:

[Please watch the video excerpt **(/Media/Video/BEAM.mp4)** now]

Eventually, all instrumental rough edges are smoothed. After a certain point, any new development involves mostly *Stage B: Aesthetic-Shaping Improvisation*, perhaps evolving the aesthetic intentions of the instrument or musical goals. While the *Ideal Performance Environment* is being constantly shaped in the mind of the composer / performer / builder after each performance or active engagement with the instrument, it is after each full *Instrumental Development Cycle* that it is practically consolidated. A detailed timeline with the submitted material and performances over the development cycles can be found in Appendix A - Performance Timeline

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[5]for example *Burdocks, 1970/71*

4.3   Unification of the Frameworks

Summarizing the relationships between the *Instrument Development Cycles* framework and *Instrumental Spaces* (*Chapter 1*), the following conceptual associations need to be clear at this point:

- *Stage A* and *Stage B* take place at the instrument's *Transformation Space*

- *Stage C* takes place within various *Real Performance Environments*

- Repeated *Instrument Shaping Cycles* evolve the instrument's *Ideal Performance Environment*

See also Figure 4.1

To unify all three frameworks, these stages primarily shape, and finally optimize performative *Agility* through appropriate instrument design, and over time raise instrumental *Awareness* while sculpting the *Vocabulary*. As such, *Potential Musical Energy* is maximized, helping achieve the performer's *Telos* as defined in *Chapter 2*.

4.4   Percussionist: Considerations

Any musician, classically trained or not, even during the early stages of interaction with her instrument, understands its possibilities and potential to an extent and is defined by it. A pianist's and a saxophonist's musical identities may be significantly informed by the conventional form of their instrumental means. These instruments have been developed and improved since their conception before reaching their current forms. The complex relationships between their acoustic properties, breathing, fingering techniques and muscle memory—all of which need to be acquired for mastery—are practised for many years by the performers, without having to deviate from the instrumental formation they started developing *Agility* with: the piano is still the piano. The percussionist, on the other hand—when not dealing with a uniform pitched instrument, such as the marimba—is primarily working towards mastering the relationship between his body and *any* sounding object. The complexity rises when one combines this skill on different sound sources, and one needs to learn how to make seamless transitions between different sound-producing units (rolling all over the kit and cymbals without interruptions between the different objects, for example). The difference with most other instruments is that the number of sound sources and relationships that can be developed between them is not finite, therefore the percussionist is constantly learning a new instrument. Arguably, the main characteristic of the percussionist's practice, as seen throughout this thesis, is formlessness—adapting all acquired skills to radically different circumstances. Improvising, as well as some composed works, might require building distinct *Vocabularies* by collecting

potentially interesting sound sources while designing effective performance environments in each occasion.

4.4.1 Bespoke vs. Commercially Available

Out of all possibilities, a few objects are being used repeatedly by composers, improvisers and percussionists. Cowbells, paintcans and brake drums for example, are used very commonly instead of entirely original objects (just as these were when first repurposed and used as percussion). This can be attributed to a couple of reasons: First, use by notable composers and other percussionists has made their sound iconic and recognisable and second, their industrialisation. The cowbell is now easily available from percussion stores, no longer repurposed, but constructed for percussionists to be sold anywhere in the world. While this might sound like a positive development, I find it symptomatic of the industrialisation of the orchestra, aiming for the repeatability of compositions or sounds, similarly to the standardization of the drum-kit. In search of new and original textures, someone could theoretically look in junk yards and antique stores to find something unique or fitting to their musical goals instead of an industrially manufactured cowbell. It seems, however, that a considerable number of composers and performers prefer to utilise such readily available and tried objects. This phenomenon highlights the influence of instrument marketisation on compositional decisions and aesthetics.

During a private conversation with the percussionist Roger Turner, I asked him about his metal rods that he often uses as drum-sticks. He replied that he bought quite a few years ago from an antique/scrap market, so that he had many of them in case he lost some. He has been using them ever since (and had not lost any at the time of the conversation). These rods contribute significantly to Turner's *Vocabulary*, as they produce a distinct light sound, often useful when improvising with instruments of smaller dynamic range, such as the violin or the flute. In addition, the light metallic material is much more effective for hitting small pitched bells and cymbals, as the sound produced is much more precise and focused. I also find it interesting that Turner, recognising the potential of these rods, decided to buy as many as he could that day, as it was not certain that he would be able to find any more of them in the future. I believe that this attitude towards highly personal and bespoke means of expression, in contrast to commercially available widely-used products (perhaps even more present in the world of computer music software), should be celebrated, moving away from the repeatability and transferability of instruments / compositions / resources.

While industrialisation serves the purpose of assuring a uniform working capacity of products (making replacement easy), my priorities for musical expression lie in the opposite direction. Whenever composers or percussionists choose to use unique customised objects, such as, for example, Tony Oxley's custom large cowbell, these often become the single most important and truly irreplacable items of their practice. Steven Schick writes

> The irony of contemporary percussion is that these unique bits of junk are the real instruments; they are specific and personal. The most recognizable icons of

percussion—the cymbals, bongos, bass drums, and triangles—are in fact just tools of the trade: generic, interchangeable, and nonspecific. (Schick, 2006)

[Please watch the video Tony Oxley: Taunton 1991[6]]
(also included in /Media/Various/Oxley.mp4)

In this video we see Tony Oxley improvising using his customised drum-kit. His setup allows for instrument-specific gestures such as the ones beginning [1:11] and [1.52]. An instrument that is as fluid such as the drum-kit can be adapted easily to the bodily needs and particularities of the performer. A piano player with small hand span, for example, has no choice but to cope with his physical "disadvantage" given the fact that the piano keys have a fixed distance. A percussionist with a small stature, however, can always place the cymbals lower, the snare drum higher, choose different types of drums and sticks, and so on. This can make the instrument the best possible for her personal needs, maximising the PME by maximizing the potential *Agility* that the instrument can afford. When an instrument can be personalised to such extent, just as Tony Oxley's drum-kit as seen on the video, it is irrelevant, as discussed in *Chapter 2*, for anyone else to become as agile on this particular instrumental manifestation, assembled by another performer. Even if someone tried intuitively to remember the locations of all the objects, acoustic interactions and produced sonorities, this instrumental configuration is not only the physical material that it consists of but it also embeds the builder / performer's embodied tendencies, aesthetics and muscle memory.

The critical difference between such a personalised instrument and anything commercially available, is that, for example, the typical classically trained pianist exists without her own instrument. Most concerts, even those that require significant preparations, can be performed on any high quality piano as long as the performer brings the unique preparations to be applied. In contrast, when Tony Oxley wants to use this instrument, it would take significant planning to be able to repeat a similar performance without this *exact* instrument, unless instrument defining and developing frameworks are in place, as presented in this thesis.

4.5   Percussion, Computer: Tabula Rasa

When the percussionist lifts his hand and strikes down on a snare drum with the drum-stick, the gesture is clear and the result entirely obvious. The physical nature of percussion and clear effort / result relationship make it one of the simplest and most revealing instruments regarding its sound producing mechanism. When the saxophonist plays, the audience can similarly perceive that the movements of fingers relate to different notes and can understand that there is a direct relationship between effort and result, however, it is not as obvious to the non-saxophonist which finger placement results in which note. This would place the saxophone in a *less clear* position than percussion on Figure 3.1. While, arguably, a performer can push the boundaries of the *Grey Area* through theatricality, instruments have an inherent character

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[6]accessed August 2013

of how clear their function is depending on their sound producing mechanism. Also, some instruments can have a more flexible *Grey Area* than others. For example:

- **Kazoo**

    1) Very clear inherent relationship between effort and result.

    2) Not very flexible *Grey Area*, because of the simple and uniform sound producing mechanism of the instrument.

- **Drum-Kit**

    1) Very clear inherent relationship between effort and result.

    2) Very flexible *Grey Area* afforded by the complexity of distinct objects consisting the instrument, as well as the relationships between them, making it possible to perform with an entirely clear relationship between effort and result (straight 4/4 rock beat) to an almost entirely unclear relationship (very fast and gesturally complex drum solo).

After the percussionist hits the crash cymbal once, the audience expects that every hit on the same cymbal will produce a similar outcome with variations, something that defines very clearly the performer, the instrument and their relationship. The cymbal has a single associated identity which can be extended with the use of techniques such as bowing, varying its sonority. The amount of variation, however, does not go so far as to result in a dissociation with the acoustic object, i.e. the cymbal will probably not sound like a jet engine and, even if it approximates that, it will always sound like a cymbal resonating according to the physical forces being applied to it before the audience's eyes. Tapping one's foot on the floor or knocking on a door (being daily activities for most audience members) result in a personal, embodied understanding of the relationship between the percussionist and percussion.

On the other hand, the microgestures typically involved in laptop-based performances, in combination with the common knowledge (and daily personal experience) that "the computer is a utilitarian child of science and commerce, a chameleon with no inherent property other than acting as an interface to desired functionality" (Paine, 2009, 216) can result in a very unrevealing and perhaps unrewarding experience for an audience. Artists today can use real-time digital signal processes and improvise intuitively, having potentially a level of control comparable to traditional instrumentalists. Depending on the intentions of the performer, software design, mappings, and *Agility* in the developed instrument, someone can be a part of a group of acoustic musicians, capable of calling and responding, immitating, contrasting, and generally being able to demonstrate musical behavior analogous to that of an acoustic instrument. However, contrasting percussion, if a laptop-based performance environment is not consciously designed to address these issues with the use of MIDI controllers and suitable mappings, it quite likely to result into performances with an entirely unclear relationship between effort and result, something not necessarily negative, but a fact.

Despite this physical disconnection, both computer and percussion share a very basic fundamental characteristic: They both are blank slates for instrumental design from the bottom up. Tanaka observes that "by itself, a computer is a tabula rasa, full of potential but without specific inherent orientation." (Tanaka, 2009, 239). I am arguing that the same principle is true for percussion. The percussionist and the laptop performer, both have an understanding of what the potential of their instrument is without however having an inherent orientation.

It is incumbent upon them to decide what types of building blocks and conceptual modules to use, which levels of physical control and instrumental resistance to balance, what level of complexity of performance and aesthetics to pursue. In this respect, when a percussionist chooses to use a Tibetan bowl, an American snare drum and an African djembe as part of her setup, it is similar to a laptop artist using FM synthesis, spectral gating and concatenative synthesis. Choosing resonant objects from different cultures and times is equivalent to employing sound synthesis and audio processing techniques taken from different audio programming concepts. Also, the same ideas of repurposing and customisation apply to both worlds. A custom-made cymbal is the equivalent of a custom-made audio module. A noise-gate used for its aesthetic audio qualities rather than its original purpose is comparable to using a brake drum as percussion, i.e. they are used for different purposes than the one they were designed for.

Also, just as the drum-kits of certain improvisers evolve organically over time alongside them, the performance environments of laptop performers evolve and adapt to their aesthetic goals. Percussionists and laptop artists start with the general skills required to excite objects and shape sound, and then continue by defining their own performance environments diachronically, by choosing from a universe of infinite possibilities, both of materials and possible relationships between them. While the two instruments could be perceived as being at the extremes in Figure 4.2, they are both equally flexible, providing great opportunities for unification:
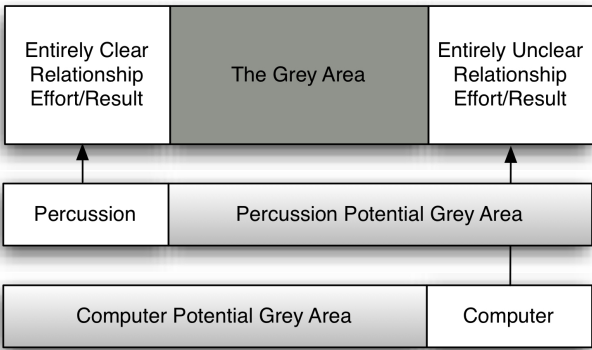
Figure 4.2: Percussion and Computer *Potential* Grey Areas

- **Drum-Kit**

    1) Very clear inherent relationship between effort and result.

    2) Very flexible *Grey Area* afforded by the complexity of distinct objects consisting the instrument, as well as the relationships between them, making it possible to perform

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from an entirely clear relationship between effort and result (straight 4/4 rock beat) to an almost entirely unclear relationship (very fast and gesturally complex drum solo).

- **Computer**

  1) Very unclear relationship between effort and result (unless otherwise designed with the use of MIDI controllers and suitable mappings).

  2) Very flexible *Grey Area*, since a computer-based performance environment can be designed to have from an entirely clear relationship between effort and result (tapping on a pad-type MIDI controller which triggers single samples with every physical gesture without looking at the screen) to an entirely unclear relationship (static physical performance with a dense sonic result, combined with extensive screen staring).

4.6 Augmented Drum-Kit: Shaping Agility

In the following sections I will describe the design principles behind the electronic part of the instrument, in order to shape the ADK's *Agility*. The general design goal was to control as intuitively and seamlessly as possible the electronics without sacrificing the embodied relationship with the acoustic instrument and *Agility* developed over almost fifteen years of instrumental practice.
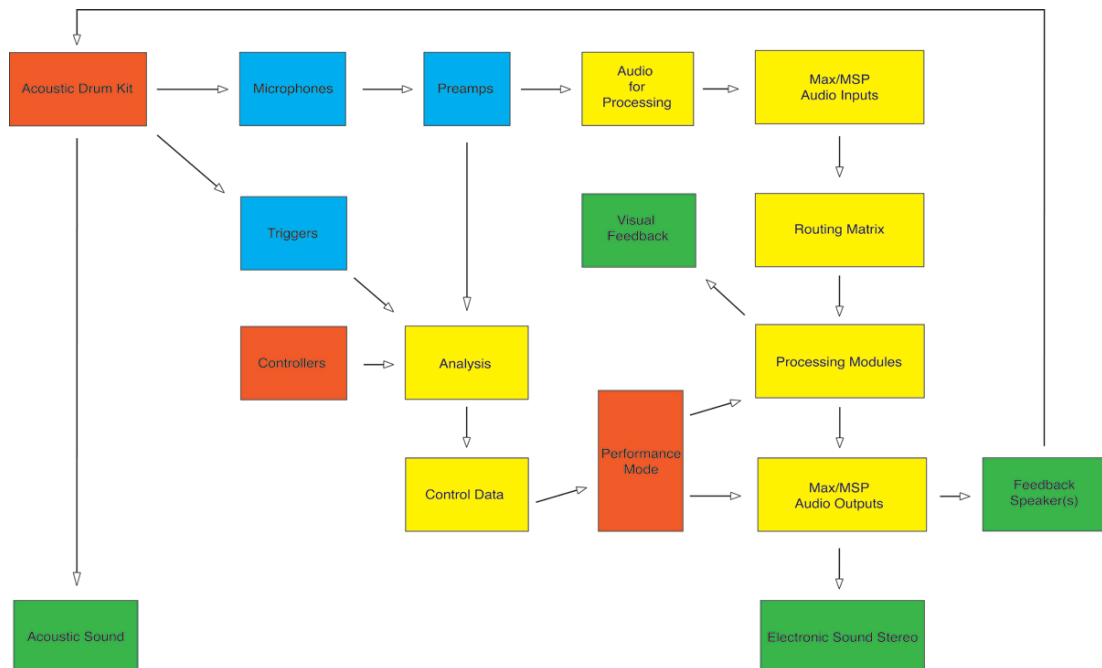
Figure 4.3: Instrument Logic

The orange colored boxes in Figure 4.3 signify physical means of control and interaction with the system: The *Acoustic Drum-Kit*, *Controllers*, and *Performance Mode* set at the beginning of the performance. Blue boxes signify independent hardware data capturing and conversion media that do not require supervision during the performance: *Microphones*, *Preamps* and *Triggers*.

Yellow boxes signify sections of the digital part of the instrument: converted *Audio for Processing*, *Analysis*, *Control Data*, *Max/MSP Signal Inputs*, *Routing Matrix*, *Processing Modules* and *Max/MSP*[7] *Audio Outputs*. Finally, Green boxes signify audible or visible results of the electroacoustic instrument: direct *Acoustic Sound* of the drum kit, *Electronic Sound Stereo*, *Feedback Speaker(s)* and *Visual Feedback*

4.6.1 Control Data Methods

When I started using live electronics alongside my percussion setup, the drum-kit's sound transformations were controlled by the use of MIDI controllers placed on a table next to the hi-hat. The main disadvantage of this approach was that the acoustic performance had to be interrupted to some extent in order to alter some of the the electronics parameters. This could be described as performing the electronics and percussion as two separate instruments simultaneously rather than one electroacoustic instrument. Many digital parameters were "exposed" for manipulation, which led to a significant amount of control. The gestural discontinuity, however, between the percussive gestures and the finer micromovements needed for controlling knob and fader-based MIDI controllers resulted in fragmented performances, focusing either on percussion or the electronics but not their integration. This was not necessarily unsuccesful; however, I was not satisfied by this level of interaction or perceived non-unification of the two parts consisting the instrument.

This setup can be seen in video **(/Media/Video/LLEAPP10.mp4)**, one of the very first public group performances with the *Augmented Drum-Kit* (Refer to the Performance Timeline in Appendix A). At this stage the instrument was between *Stage A* and *Stage B* during the very first *Instrument Cycle* of its development. The performance took place during *LLEAPP2010* in Newcastle, with Mariam Rezaei on turntables and computer, and Sean Williams on analogue synthesizers.
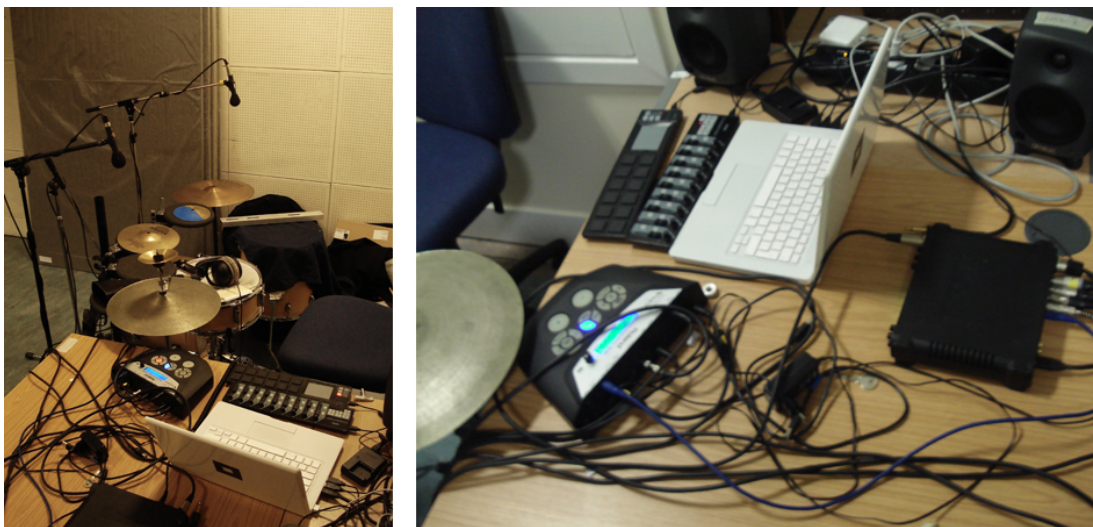
Figure 4.4: 2009 - Transformation Space G07 - First Setup

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[7]http://cycling74.com/ (accessed July 2013)

The next step was to include the electronic transformation controls as part of the percussive gestures. Using *Roland PD-8 Pads*[8] among my acoustic drum kit's setup (alongside the MIDI controllers seen in Figure 4.4) was the first important step towards augmenting the drum-kit. I was able to map multiple controls to these pads instead of the knobs and faders, something that led to more fluent performances because of gestural consistency of controls between the two worlds. At that time, I realised that if I wanted to create an electronic world extending percussion but staying true to it, the means of controlling it should have the same character as the acoustic instrument (gesture sizes, amount of effort, etc). Turning a knob continuously as part of a performance (that controls a cut-off frequency for example) means continuous control of a parameter, which is not characteristic of percussion performance. While a violinist or clarinetist has continuous control over the notes performed, the percussionist has no further control once the drum head is hit (unless one is using rolls; this is however playing multiple notes fast rather than controlling a single one for an extended time, or unless other extended techniques are being used, as will be seen in *Chapter 5: Vocabulary*). This is why I decided that the digital part of the instrument should be designed to respond to my physical gestures by discrete hits, similar to percussion (either on the *Korg NanoPad* or *Roland PD-8 Pads*).

These developments formed the first version of the insturment, after the first *Instrument Development Cycle* and led to the very first solo concert with the *Augmented Drum-Kit*, an excerpt of which can be seen in **(/Media/Video/Bevatron.mov)**.

4.6.2   Triggers

Even though now gesturally coherent, the hits on the pads would produce a characteristic acoustic sound (the impulse of the plastic material) which was aesthetically disruptive in live performance when compared to the acoustic kit sound, which was much more variable and dynamic. Obviously, the hits on the pads are not meant to be audible by conventional electronic drum-kit standards, merely being means to control the sound producing unit. Since they were now used to control electonic processes and not triggering samples with fast attacks that would mask the hits, their plastic sound was more exposed. I would either have to completely embrace the nature of this material, perhaps following a strategy similar to Martin Parker's *Beginner Drummer*[9] (Parker 2008) amplifying the material itself, or trying to supress the sound of the pads. I did the latter by placing various acoustic objects such as cymbals and bells on top of them (Figure 4.4). In this way, hitting the acoustic object on the pad would both produce an acoustic sound consistent with the acoustic drum-kit, and also trigger the MIDI value from the pad according to the hit's intensity.

One of the advantages of the drum-kit as a composite instrument is that with the use of contact microphones and triggers on different parts of it, one can easily extract discrete information. This, for example, would not be as easily possible with a more unified instrument such as the cello. By simply attaching a trigger on each drum, one can know exactly when each drum is

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[8]http://www.roland.co.uk/products/productdetails.aspx?p=617&c=98(accessed June 2013)
[9]http://www.tinpark.com/2008/07/beginner-drummer/ (accessed June 2013)

being hit and how loudly, similarly, the cymbals can be isolated with contact microphones. As such, it was decided to discard the pads and use triggers on all drums, towards a further gestural unification of the acoustic sound generation and electronic data input. This became a very robust and reliable system from performance to performance, as well as easy to set-up (Figure 4.5), which has been used ever since. The triggers, and by extension the drums, would now not only act as substitutes for knobs and faders but as constantly listening inputs that would provide information to the computer on the acoustic performance as a whole, shaping the electronics accordingly. The possibility of detecting each drum separately created the opportunity of mapping different functions according to the drum they were attached to.

Figure 4.5: DDrum Triggers

4.6.3   Processing Input Microphone Strategies

Regarding the live audio processing itself, three distinct strategies were devised. These will be analyzed in this section, categorised into the three time periods they were used.

1) *Studio Fixed - Jan 2010 / Feb 2011*. The digitally generated sound of the instrument consists both of sound synthesis and live sound transformation techniques, as will be seen in *Chapter 5: Vocabulary*. For the latter, different strategies have been considered throughout the development of the software towards capturing the acoustic sound. Initially, I attempted to capture the full drum-kit's sound using several microphones and a mixer feeding the mixed stereo output into the sound card. The microphones consisted of two cardioid overheads and three clip microphones, one for each drum and one for the kick drum. Even though this setup was satisfactory, it was not practical in terms of mobility. Having already to carry a hard case of various cymbals and other objects, as well a backpack full of electronics, triggers, pedals and more objects, adding another case with a mixer and very expensive microphones would make traveling close to impossible.

2) *Focused - Feb 2011 / May 2012*. The next setup would be used for the greater part of the research as it proved to be both portable and effective. Two clip microphones were used, one attached (mostly) on the snare drum and the second one on the floor tom. In the previous implementation I noticed that most of my performance was centered around the snare drum area ("Green" areas as described in the *Chapter 1: Instrumental Spaces*) and the various objects

placed on it. Even though the whole drum kit was miked and ready to be processed, most of the microphones were not used nearly as much as that on the snare drum. By deciding to use one clip microphone for the main processing I was solving the transportation problem, as no mixer and multiple microphones would be now required. If I wanted to process a specific acoustic sound such as a gong, I would simply place the object within the "Green" area in order for it to be picked-up by the clip microphone, something that I was already doing anyway. If I wanted to capture and process any of the kick drum or cymbal sounds—fixed objects far from the "Green" area—I could take the clip microphone off and place it close to these, most commonly pushing it against them with one hand and playing with the other, something that was quickly adopted into my performative gestures.

3) *Dynamically Changing - May 2012 / Aug 2013*. The third and most recent approach, involves miniature omni-directional DPA microphones[10] attached to my wrists and arms, coming out of the bottom of my shirt and into the sound card (Figure 4.6). The idea that an object produces sound only when either of my hands is close to it in order to excite it, solved the problem of placing static microphones around the drum kit. With only two miniature microphones constantly changing position and capturing only what is being hit, scraped, or scratched at any given moment, it became the most portable and efficient microphone strategy. This method created a few monitoring feedback problems, which were managed with more careful speaker positioning and input level management.

(See detailed the diagrams in Appendix B - Input Strategies)

Figure 4.6: DPA Miniature microphone attached on left arm

4.7   Software

(Also refer to Appendix F - Software Overview)

The *Max/MSP* patch[11] comprises eighteen discrete sound processing modules. These will be

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[10]http://www.dpamicrophones.com/en/products.aspx?c=Item&category=128&item=24035 (accessed June 2013)

[11]main patch located in **(/Software/_cm.main.maxpat)** of the Software DVD

examined in greater detail in *Chapter 5: Vocabulary*. Continuing my focus on *Agility*, I will describe the means by which I can manage these modules, either directly or indirectly, through mapping, audio analysis and timed based events, in order to seamlessly influence the electronic sound through the acoustic performance.

4.7.1   Performance Mode

The software can operate in two modes: 1) *Free* (default mode) 2) *Time-Driven Cues*. These modes signify the way in which the sound processing modules are *initiated*, and how their parameters are influenced:

1) *Free*: This is the software's default mode. The modules are enabled or disabled via a *Korg NanoPAD2* MIDI controller, with each pad representing one processing module. It is mostly used for entirely improvised performances and allows me to initiate or supress the desired electronic *vocabularies* directly at any given time. For consistency, I decided that for each of the eighteen modules (*Chapter 5: Vocabulary*), only three parameters would be "exposed" as musically expressive parameters. For example, on the reverberation module (REV), I am only able to access the *size*, *decay time* and *high frequency cutoff value*. This means of enabling or disabling parts of the digital *Vocabulary* of the instrument at will could be parallelised to switching between cymbals, preparations or type of drum sticks during a performance. It can be done seamlessly as long as the performer is familiar with the switching gestures required, and has incorporated them into his performative gestures.
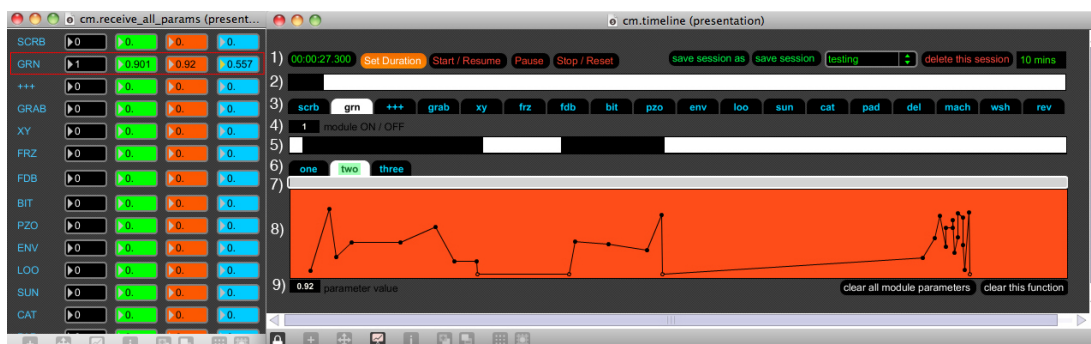
Figure 4.7: Timeline

2) *Time-Driven Cues*: Here one needs to load a predetermined performance session, which includes cue time durations which enable or disable modules accordingly and, functions sending values to the modules' parameters. The function-editing, cue-editing and timeline *Max/MSP* window can be seen in Figure 4.7. At the start of the performance, pressing the laptop's spacebar sets off a clock which will control the modules' state according to the predetermined performance session, while the three exposed parameters will get the predecided values. In the *Max/MSP* window (Figure 4.7) we can see:

1. We are currently about 27 seconds into the performance of the performance session called

"test", which lasts in total 10 minutes.

2. The performance's progress bar.

3. The eighteen processing modules. We have chosen to edit/inspect the contents of "grn", the granular synthesis module.

4. "1" signifies that "grn" module is currently ON.

5. This bar enables us to edit the ON/OFF state of the selected module; black signifies ON (as confirmed by the number box on 4)).

6. Here we have chosen to edit/inspect the second out of the three exposed parameters of "grn".

7. One can zoom into the function for more detailed value management through the bar here.

8. Parameter functions are edited here, always between 0 and 1 for all parameters.

9. The second of the three controllable parameters of "grn" is presently 0.92.

On the left side we can see a collective monitoring window of all the parameters of all the modules. Highlighted is the (GRN) module, which as we have just seen is enabled (signified by the "1"), its first value is 0.901, its second value is 0.92 (as seen in the editing function), and its third value 0.557. (Please note that (1)-(9) numbers in Figure 4.7 are added on the screenshot for the purposes of explanation)

The *Time-Driven Cues* mode should be regarded only as having a supporting role to the performance. This means that at any point I can override values and performance state by enabling or disabling modules, intervening to the predecided parameter timeline via the *NanoPAD2*. By using the foot pedal, I can still control module values. The predetermined sessions have the role of a safety-net, rather than forcing a fixed performance. Such a predetermined session can be as specific or general as required, by fixing less or more electronic module parameters, according to the musical intentions.

4.7.2 Foot Controls

Coming back to the concept of maintaining the inherent performance attributes of a drummer, I decided to use two foot controllers alongside the drum-kit's hi-hat and kick-drum pedals. Since I usually use my hands much more often than my feet on the acoustic drum-kit, I concluded that it would be more practical to incorporate some parameter control as part of the feet performance, the foot control pedals also matching the foot performance gestures needed for the kick drum and hi hat pedals.

The idea was to use complex mappings from the two controllers (Figure 4.8) to all eighteen modules' parameters—"one-to-many" mapping according to Hunt and Wanderley (Hunt & Wanderley, 2002). Since the pair of controllers would affect the three exposed parameters of each module in different ways, I found that controlling three or more modules simultaneously made it almost impossible to be consciously aware of how each module is being affected. This is why I see the interface development and design-oriented *Stages A* and *B* being distinct to the performance-oriented *Stage C* (see Section 4.2.1).

Starting from the fact that I would be using two foot controllers, I applied mappings that made musical sense to each module individually. I then improvised with different mappings for each module and parameter set, according to what I considered expressive in each occasion. When all of the mappings were fixed (after *Stage A* and *Stage B* - Section 4.2.1) my memory of their function would no longer be relevant, and might I say, even distracting. In order for me to be able to perform intuitively, I had to re-learn the mappings with my body in a musical sense, trying to forget all the design choices and goals I had in mind when I was designing them. If I had done the designing succesfully, these goals should be achieved without me being aware of the technical means, but only of intuitively navigating the different possible *Vocabularies* of the instrument.
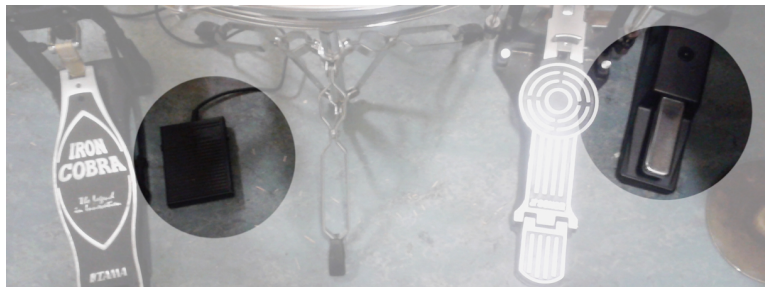
Figure 4.8: Foot Controls

This could be thought of as similar to building a motorcycle and then driving it. When breaking or steering, one does not have in mind how these functions work mechanically or what exactly happens internally within the machinery of the motorcycle. Rather, one acts intuitively, based on previous experience and present conditions. In fact, thinking consciously about changing gears, flashing and so on can lead to an accident. I insist on the importance of fixed periods of time set aside for learning and becoming expressive with the instrument. Practically, while I did design the mappings according to imagined scenarios, I would never be able to imagine what will happen, for example, if I switched five of the modules ON and used the foot controllers in a particular manner. If I was satisfied and able to approximately repeat this result, I would consider it succesful and would try to become *Agile* in the gestures required to achieve this. Another point here is that while some parts of the *Vocabulary* required effort in terms of physical intensity and stamina while others required effort in terms of subtlety and precision. All these varied expressive characteristics led to extensive improvised performance with the instrument as a whole, in different scenarios, which proved to be an efficient means of shaping these mappings while becoming intuitively *Agile* in the instrument.

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4.7.3 Extracted Information

A more detailed description of the the six streams of information extracted from the two foot controllers (and how these affect the processing modules) can be found in Appendix C - Data Control Tables). Here I list them briefly :

1-4) From the *Expression Pedal*:

Primary Control : Pedal MIDI Value: 0-127

Event 1 : MIDI Value = 0: True

Event 2 : MIDI Value = 127: True

Additional : MIDI Value Change Rate (speed of pedal movement; value is unimportant): 0(no pedal movement)-1(fastest movement possible)

5-6) From the *Switch Pedal*:

Event 3 : Toggle = ON: True

Event 4 : Toggle = OFF: True

Reflecting on these choices based on the framework described in Section 4.2 for developing the instrument while shaping *Agility*, I would place the choice of two foot controllers and the six decided streams of data as part of *Stage A*: Interface Design Improvisation. Then deciding how these streams of data will affect the sound and sculpting the instrument's *Vocabulary*, fall under *Stage B*: Aesthetic-Shaping Improvisation, as will be seen in *Chapter 5: Vocabulary*.

4.7.4 Locking

Let us assume that I am currently performing having enabled six modules simultaneously, and that I would like to explore this sonority a bit further by playing independently with the acoustic instrument, without necessarily having to keep performing the same physical gestures on the foot controllers in order to maintain the present parameter state. By simply hitting on the pad highlighted in Figure 4.9, all exposed parameters of these six modules "lock", and stop responding to the foot controllers. In this way, the digital system's synthesis and audio transformations maintain the same character, transforming all incoming audio in the same manner. For example, this would mean for the granular synthesis module that the *grain size*, *pitch* and *grain density* are *not* affected by the controllers anymore, but are transforming the sound with
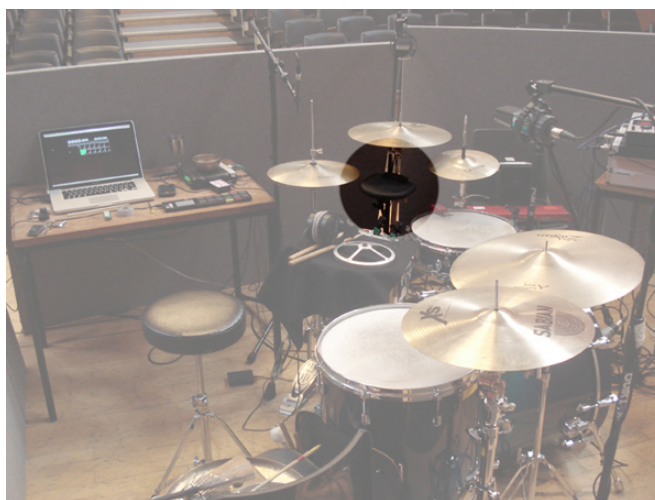
Figure 4.9: Lock Pad

fixed parameter values[12]. While in this state, hitting the small tom loudly (above a certain threshold) will cause all modules to "unlock", resuming parameter control from the pedals. I chose the small tom for this function instead of hitting the pad again, because this allows resuming performance seamlessly on the acoustic instrument, while making the parameters active again—this "disguises" in some respect the transition. Choosing to hit the pad for the "unlocking" would make the function very obvious to a third party, and possibly disruptive; by hitting the pad, the electronic sound would change drastically and then I would continue on the drum-kit, which would appear as a very unnatural and imposed sonic transition.

4.8   Summary

In this chapter, the third and final developed framework was presented, describing the *Instrument Development Cycles*. In addition, it was detailed how it is associated with the previously presented frameworks, *Instrumental Spaces* and *Potential Musical Energy*. As part of this, three distinct stages of personal instrumental development were suggested, each focusing on specific aspects of the emerging instrument. Crucially, fixed periods of time are set within each *Instrument Development Cycle*, to ensure that the performer has enough time to develop the desired *Agility* over the new version of the instrument, preventing impulsive design decisions, a common phenomenon caused by the immediacy of the digital medium. The contrasting physical performative natures of percussion and the computer were also discussed, while it was argued that because of their shared formless essence, the combination of the two instruments provides great opportunities towards a highly personalised instrument. I believe that this unification of drums and live electronics might not have happened as much as with other electronically augmented instruments in the past, because of their inherent gestural incompatibility. However, this can be addressed today with the use of the computer and appropriate mappings. The methods followed towards this unification and development of *Agility* were then presented, ranging from control data input methods, to audio input strategies. Finally, the instrument's

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[12]these being the last dynamically changing ones at the moment of the "lock"

software was outlined and the basic principles behind its functions were explained. In *Chapter 5*, methods towards the final factor of PME, *Vocabulary*, will be presented and illustrated through audiovisual examples.

Chapter 5

Vocabulary

5.1 Introduction

Figure 5.1: Vocabulary

Vocabulary is the final factor of *Potential Musical Energy*. While it involves techniques of exciting sonic textures, it involves to a large extent the materials used themselves. In the case of the *Augmented Drum-Kit*, the matter becomes relatively more complicated than it would have been in the case of more fixed instruments. As it has been shown, specific definitions of what these instruments can include do not exist, the limit being the finite space available around the drum seat in the case of percussion, and the computer's finite processing power. While in the case of augmenting a cello one would not have many arranging choices in the acoustic realm, the instrument's IGS being clearly defined, in the case of percussion the textural combinations and arrangement possibilities are endless. For the *Augmented Drum-Kit*, the method followed was to initially include as much material as possible from both worlds, and in the process to

sculpt the sonic world of the instrument into a unified consistent electro-instrumental performance environment. As it was illustrated in *Chapter 1: Instrumental Spaces*, the formlessness of these instruments was embraced instead of working against their nature, by not thinking of the instrument in terms of specific objects and DSP processes but in terms of desired sonorities and attributes present within the *Immediate Gestural Space* in each scenario.

Initially, I will explain this process through examples, then present methods of unification between the two sound worlds, and outline the extended acoustic techiques employed. Finally, the distinct modules of the *Augmented Drum-Kit*'s digital *Vocabulary* will be listed, illustrated with the use of audiovisual material, and categorised according to their relationship to the physical performance's gestures.

5.2   Sculpting / Restricting

I find Martin Heidegger's phrase "Every man is born as many men and dies as a single one" particularly compelling whilst creating a bespoke performance environment. The work of shaping a personal expressive voice through the *Augmented Drum-Kit* required first and foremost the acceptance that it is a process of loss and restriction. Compared to all possible scenarios, objects, relationships, one is forced to constantly reject or choose between options, make compositional decisions, cross aesthetic points of no return and render the instrument more and more specific with every step. It starts as many possible instruments but ends up as one, albeit a much more efficient one. In terms of *Vocabulary* I think that this motion from a more generic to more concise aesthetic is clear between the two albums, *Signal Powder* and *Frrriction*
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[Please listen to **Album A: Frrriction** now]

Frrriction is the first solo album recorded with the *Augmented Drum-Kit*. As one can see from the performance timeline (Appendix A - Performance Timeline), it was recorded after a few *Development Cycles*, solo and group performances, almost a year after the group recording *Signal Powder*. At the time I started feeling quite satisfied with the instrument's level of potential expressivity and consistent *Vocabulary*, so I wanted to capture its state with this recording. Each improvisation in the album focuses on specific parts of the instrumental *Vocabulary* at the time. While in *Frrriction* each piece revolves around a specific acoustic and/or electronic area of the instrument, *Signal Powder*, on the other hand, followed a much wider and exploratory approach. The recording of SP took place during one of the first *Development Cycles* (Appendix A - Performance Timeline), and more specifically during *Stage C* of the third *Cycle*. Being relatively early during the whole instrumental development, its aesthetic inconsistency is apparent between the pieces. This is clear not only from the physical material acquired that could potentially be used as percussion (Figure 5.2, but also from the electronic part (note also that LH uses a piano, a celeste and an analogue synthesizer in this album).

[Please listen to **Album B: Signal Powder** now]

Associating these two albums with the discussed notions of AAV[1], in retrospect, for *Signal Powder* I attempted to employ a much wider *Vocabulary* (many different drums, cymbals, a glockenspiel, as well as multiple electronic processes within *Ableton Live*[2] and *Max-for-Live*[3] which were gathered and put together in an exploratory and playful manner, being the case for the electronic processes in the very first cycles).

Figure 5.2: Signal Powder: Surrounded by drums

As a result, the instrumental and aesthetic *Awareness* was much lower—resulting in a more inconcise aesthetic direction as can be heard from piece to piece—similarly, instrumental *Agility* suffered. *Frrriction*, on the other hand, was recorded three *Cycles* after that, and in comparison the *Vocabulary* was much more consistent, having been fine-tuned and shaped through numerous performances and rehearsals in the period in-between. This process of restricting and sculpting could be perhaps seen as similar to subtractive synthesis, where one subtracts elements from a rich spectrum, in order to achieve a desired sonority. The now tighter and more concise *Vocabulary* of *Frrriction* resulted in a much higher level of instrumental and aesthetic *Awareness*, and through the extensive performances I acquired a much higher performative *Agility* on the instrument, which resulted, in my opinion, into a higher PME than the collective PME of *Signal Powder*, and thus a more "succesful" musical outcome.

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[1] *Awareness, Agility, Vocabulary*
[2] https://www.ableton.com/ (accessed June 2013)
[3] https://www.ableton.com/en/live/max-for-live/ (accessed June 2013)

5.3   Unification from the digital side

At the forefront of the instrumental development was the idea to create a consistent electroacoustic sound-world. Not only should the sound properties of both acoustic and digital worlds be complimentary, but the properties of the digital gestures should be similar in terms of density, dynamic range and character. To achieve this, a series of digital signal processing techniques were employed to emulate percussion performance elements, as well as considerations introducing more general drum-kit concepts present during a performance. These are:

- Electronics Effort / Result Perception

  All electronic processes were conceptually divided to three groups: *Intertwined*, *Peripheral* and *Independent*. The point of that being the conscious distinction between modules that are entirely tied to the physical performance, following the drum-kit's sound decay durations (Intertwined); modules that have a clear starting point from the drum-kit but then become ambiguously connected to the physical effort leaving space for theatricality to highlight or supress this connection (Peripheral); and finally modules that have a clear starting point from the drum-kit but are then clearly independent from the performance. In each case strategies have been devised that assure the perception of the whole as one unified instrument.

- Unique Events

  In improvised percussion performance there are numerous occasions when some sounds or textures cannot be used anymore. Scratching a balloon until it pops, dropping chopsticks over the drums until they're all scattered on the floor around the instrument, or hitting a cymbal hard enough to make it fly off and land on the ground, are all such events. The digital world on the other hand is theoretically always unchanged, eerly consistent, and when something goes wrong (such as a software crash) it usually affects the whole computer, and it is not expected by the performer (the equivalent of that in the acoustic world would be for the stage to collapse). Within the digital part of my instrument I have explored the notion of such unique events, bringing the digital part closer to the spontaneous nature of improvised percussion and also helping to avoid certain distinct sounds becoming clichés with their repeated use. One such example is reverb with large decay values, which when used during a performance, after the module turns off once it cannot be re-used unless the patch is restarted. As this effect is quite obvious and memorable, this restrictive decision of using it only once, for a short period of time during a performance, forces me to be absolutely certain when I decide to use it.

- Digital Snares

  A very characteristic element of the drum-kit sound is the wide effect of the snare drum's snares on the whole sound of the kit. When the snares are on, even when the small tom,

kick drum or floor tom are played, every hit reacts with the snares of the snare drum creating an overall buzzing sound. The effect is such that in music festivals with different performers sharing the stage, one needs to rememeber to turn the snares off as even other instruments can make them resonate, potentially ruining other performances. In order to re-create this interaction between the different processing modules of the digital instrument with such a unifying element, I decided to use *waveshaping*. Just before the final output within *Max/MSP*, I have placed a waveshaper which when On is applied to all processing modules which are set up in parallel, slightly distorting all digital elements, resembling the all-pervading buzzing of the snares.

All of these efforts towards unification are coming from the digital world. However, just as crucial was the development of extended techniques in the acoustic realm, often inspired by, or emulating DSP techniques.

5.4   Unification from the acoustic side

Extended techniques are generally defined as techniques for sound generation that use the instrument in an unorthodox way, or in a way not intended by the inventor. Pioneered by notable improvisers and percussionists such as Eddie Prevost, Andrew Cyrille, Han Bennink, Roger Turner, Sunny Murray, John Stevens, Rashdi Ali and Steve Noble, and then reproduced, reinvented and adapted by many others, these techniques extend the instrument to theoretically uncharted territory. This is not intended to be an exhaustive list of extended techniques but simply a list describing the ones I have incorporated into my gestural *Vocabulary* in an attempt to bring the acoustic sound closer to present electronic textures. Please note that all following media examples are located in the **(/Media/Vocabulary/Acoustic)** folder.

- **Stick Choice**

  It is common for most drummer impovisers to use a wide range of drum-sticks. From wooden sticks to soft malets and brushes, most types of commercially available sticks have been used in my performances. A distinction that should be made here is between the normal firm commercial wooden sticks and customised very thin, long and flexible sticks made out of reed, or piano wire. Such sticks are being used notably by Steve Noble and Roger Turner. I find their use very advantageous especially when improvising with instruments of a much smaller dynamic range such as a violin. In contrast to the firm, thicker commercial sticks—where when hitting a snare drum or cymbal most of the energy is absorbed by the resonant body producing a louder sound—with flexible thin sticks a significant part of the energy is distributed onto the sticks themselves because of their flexibility. Being less firm makes rolling or playing faster more difficult, as the bounce that would be expected from a firm stick is diminished as well; Given enough practice however, one can become familiar with this and work around it.

- **Bowing** - (**bowing.mp3**)

  This technique requires a string instrument's bow, such as a double bass, and a cymbal or other resonant object to be bowed, such as a piece of metal or singing bowl. Percussion is conventionally designed to be hit, producing sounds with fast attacks and relatively fast decays. With this technique I achieve two goals. Firstly I am able to generate continuous sound by bowing constantly on a resonant object (otherwise impossible for the drum kit unless rolling, or circularly scraping a brush stick on the snare), and secondly to produce pitched sounds. Every resonant object and especially cymbals can easily produce distinct frequencies by exploiting overtone variations in the otherwise relatively unpitched nature of the drum kit. This technique can be also combined in the electronic realm with spectral freezing, looping and pitch transposition, and therefore provide the base for many DSP techniques without alienating too much the electronic sound because the initial pitch comes from the acoustic world. Bowing is used also extensively in combination with the feedback floor tom, as will be described.

- **Scraping** - (**scrape.mp3**)

  This technique is performed with a normal drum stick and a cymbal or other metallic object. Instead of hitting a cymbal, it is performed by moving the stick while placed perpendicular to the cymbal surface producing overtones. This technique is also used for producing pitched material although the result is usually less constant than bowing as it is sometimes hard to reproduce exact overtones—it aims to extract a specific type of sound from the cymbal, but it hard to know what the exact tonal result will be until one performs it.

- **String** - (**string.mp3**)

  An acoustic guitar string is fixed on one of the snare drum's tuning screws, while on the other side, it is attached to a customised permanently attached drum tuning key. This gives the possibility to create varying pitches, by tightening or loosing of the string while playing on it. The string can be both hit or bowed, providing yet another source of pitched material.

- **Flexible Stick Pressing** - (**flexstick.mp3**)

  This technique involves pressing a flexible stick such as a timpani mallet or customized piano wire made friction mallet[4] against the drum heads. The bottom of the stick is fixed by the wrist anywhere from the center to the edge of the drum while the rest of the palm controls the bouncing of the stick caused by the weight of the tip (usually round and much heavier than the flexible stick). When the pressing is performed abruptly and with enough force, it is possible to achieve a very mechanical sound close to a delay effect with very small delay times. When used in combination with actual DSP delay effects, it

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[4] `http://www.gongtopia.com/sound-chamber/friction-mallets.html` (accessed June 2013)

is sometimes hard to distinguish which sound is electronic and which is acoustic.

- **Amplified Prepared Kalimba**

Even though this technique involves amplification, I classify it as an acoustic extended technique since amplification is used only to highlight the subtle details of the sound otherwise impossible to hear. A contact microphone is fitted on the wooden resonant body of a kalimba while springs are placed between the metallic bars. By displacing the springs rhythmically, the mechanical sound of the springs returning to their original position is captured and amplified. In addition, placing the whole kalimba on top of the snare drum and pressing on it, creates a whole body of resonance which is being picked too by the contact microphone, thus providing further opportunities for enhanced subtle sounds.

- **Prepared Drums**

Figure 5.3: Spring prepared snare

This approach involves placing various objects on top of the drums (such as the amplified kalimba) to provide enhanced or restricted sound possibilities, depending upon the type of preparations. A woodblock, for example, would diminish the decay of the snare sound while making it higher in pitch due to its weight on the snare skin. A 6-inch cymbal on the other hand is light enough to not change the pitch of the drum, but when pressed against the drum head and hit, it resonates the whole snare body, creating a mixed pitched snare sound. More extreme preparations involve fixing springs within the drum heads, or use a cloth over all or part of the drums; this drastically diminishes their decay and amplitude, and attenuates some of their higher frequencies.

5.5 Tony Oxley - Vocabulary

Tony Oxley is among the first improvising percussionists to incorporate electronics into their performance environment, and I consider his practice to be a significant influence in the design of my own instrumental *Vocabulary*. In this section I will attempt to portray some of his basic ideas that have propagated into my own practice, making the transition from his analogue based electronics to my digital, computer-based approach. Derek Bailey describes Oxley's setup:

> Quite differently, Tony Oxley's percussion equipment, although including many acoustic items, leans more to electronic extension. The acoustic part is: drums—eight, various sizes and textures; cymbals—fourteen, various sizes, thicknesses, weights, sounds, cowbells—five, from 6 inches to 16 inches; wood surfaces—five, wood blocks and oriental skulls; saucepans—two. The amplified section of the kit is: amplified frame containing cymbals, wires, various kitchen equipment, motor generators, springs, used with 3 contact mikes (home-made), 2 volume pedals, 1 octave splitter, 1 compressor, 1 ring modulator and oscillator, 1 amplifier and 2 speakers. (Bailey, 1993, 101)

Figure 5.4: Tony Oxley at the Barbican 2006[5]

Oxley's setup is not only unique as a collection of objects, but all the items offer something individual to the combined sonority of the kit. In a BBC interview Oxley describes:

> ...some of the cymbals are quite large. But one of the things with drummers

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[5]photo by Andy Newcombe

that perhaps takes a while for them to get to the point is that, when you have even in the jazz kit, ride cymbals, crash cymbals and a hi-hat, if those sounds that they produce are mainly in the middle of the spectrum they're not going to mean much because they're all more or less on the same vibratory level. So of course, with a hi-hat like that [SOUND], no matter what I actually play on the rest of the kit that will penetrate ... I don't see the point of carrying around six cymbals if they all sound the same."[6]

Oxley describes consciously designing and thinking about the overall sound of the acoustic setup. By meticulously choosing all particular elements of the drum kit, he works towards making the most out of all individual items by thinking in terms of spectrum, spectral masking and texture. This process could be compared to studio equalisation, where the producer tries to make all the elements of a recording as distinct and audible as possible by bringing out certain frequencies, cutting others that might be present and thus masking other instruments and eliminating unwanted resonances. He also discusses travelling, removing the performance setup from a comfortable environment and making compositional and aesthetic decisions based on this reality. The finite amount of percussion one can carry on a tour is similar to the finite amount of processing afforded by the computer, and thus, using Oxley's exact words, there would be "no point" designing "six" CPU intensive processes "if they all sound the same", in the case of my *Augmented Drum-Kit*'s digital vocabulary.

He then continues:

> Next one (cymbal) is [SOUNDS]. Now you can hear underneath it a very low texture [SOUNDS]. That's not coming from the cymbal, that's coming from this drum [SOUNDS]: the cymbal is placed exactly to stimulate, to 10 per cent, the drum. [SOUNDS]. Can you hear that? Of course, you need ears for this! But that is the drum it's stimulating ... And of course, typical of my kit, many things are overlapping so if I hit one thing it will stimulate some things around it or even actually catch like this [SOUNDS]. I don't have to; it depends how you use it. And our wonderful Swiss, small, recognisable, standard, genuine cowbell [SOUNDS]. Actually came off a cow."[7]

In this section he goes further, describing the spatial relationships of his sonic objects. These are not only positioned so that he is able to access them efficiently during the performance, but they are strategically placed to interact sonically with each other. He even gives a perceived percentage ("10 per cent") of this "stimulation" of the drum by the cymbal. Oxley's performance environment consists of unique objects from various cultures and times such as a Swiss cowbell, a Byzantine bell and oriental skulls, that not only provide spectrally distinct sounds to his drum-kit, but their positioning and relationships with each other allow for multipurposed percussive gestures, something that Oxley seems to be fully aware of and has consciously designed. This mentality and modus operandi were adopted for the design of the acoustic as well as the digital part of the *Vocabulary* of my instrument as will be outlined in the following section of this chapter.

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[6] The full transcript as well as audio files can be accessed at: `http://www.efi.group.shef.ac.uk/moxkit.html` (accessed June 2013)

[7] see previous footnote

5.6   Augmented Drum-Kit: Sculpting Vocabulary

During the development the digital part of the *Vocabulary*, I used various real and non-real time processing methods. It is not in the scope of this section to document all of them in scientific detail, as such documentation exists elsewhere, for example (Zölzer, 2011). I see the use of these processes as comparable to the use of acoustic sonic objects which serve particular purposes within the sound palette. As such, just as I am not documenting in detail how a Tibetan bowl is manufactured, but instead why and how it served a purpose in my setup, I will discuss how my processing modules are used and what is the aesthetic rationale behind their creation and incorporation. In addition, I see each processing module as interchangeable as any cymbal or drum of my setup. What is important to the instrument is the framework, interface, control methods and mappings used combined with these modules, in accordance with to their sonic role. As such, any module can be replaced with a new one, as long as its controls can be managed in a meaningful way by the existing control data methods and as long as it makes musical sense.

As mentioned in Section 5.3 of the present chapter, all processing modules are rougly divided into three categories: *Intertwined*, *Peripheral* and *Independent*, according to their relationship to the physical performance, not necessarily because of how they theoretically work, but mainly because of how they are being used by myself and perhaps perceived by co-performers and audience. This relates to a big extent to physical effort/result perceptive relationship, as discussed in *Chapter 3*. For more details on how each module parameters are controlled please refer to Appendix C - Data Control Tables.

5.6.1   Intertwined

The following modules work in direct gestural connection with the acoustic performance. They can be seen as direct extensions or enhancements of my physical gestures. They are also designed to be perceived by the audience as directly connected and immediately influenced by the performance on the acoustic drums, and are thus characterised by similarly "percussive" fast attacks and decays. It *is* possible to extend these sounds for longer periods of time; however, in order to achieve this, one needs to keep performing on the acoustic instrument or use one of the controllers. In either case, one must provide physical effort in order to sustain the sound, just as in the case of the acoustic instrument.

Please note that all following media examples are located in the (**Media/Vocabulary/Electronic**) folder, and that the same "clean" acoustic sample (**_clean.aif**) was used as the input to each module for demonstration purposes. Also, in some cases, video examples (located within the same folder) are presented additionally, taken from real performance scenarios.

- **GRN** - (**grn.aif**)

  This module is based on live audio granular synthesis and more specifically the *Max/MSP* external object mdeGranular[8]. Granular synthesis here is used with a very small density and relatively large grains, not resulting in a uniformed pitched "sound cloud", but in discrete granulated pitch shifted segments of the live incoming audio. This makes it very useful for percussive interplay, something that often leads to me immitating the processing effect on the drums.

- **XY** - (**xy.aif** - **xy.mov**)

  A combination of two effects: Firstly two modulated comb filters and secondly signal delay used with small vaying values. The second is triggered with loud snare drum hits by applying short random (within a confined length in miliseconds) amplitude envelopes every time a hit above a certain threshold is detected. It works very well in combination with the "flexible stick pressing" acoustic technique.

- **CAT** - (**cat.aif**)

  Based on *concatenative synthesis* and more specifically *CataRT*[9]. CataRT reproduces grains from a corpus of segmented audio files according to the proximity to a target position in the descriptor space (Schwarz, D., Beller, G., Verbrugghe, B. & Britton, S., 2006). I use the real-time audio from the acoustic drum-kit in order to trigger the segments from the descriptor-analysed corpus, which includes a multitude of sound textures and samples, from acoustic drum-kit to analogue synthesizers and prepared piano.

- **PAD** - (**pad.aif**)

  While not a processing module itself, when switched ON, the *NanoPad* MIDI controller pads can be used to trigger fragments of the afforementioned (CAT) corpus directly. I tend to use this when I want to use solely electronic sound. In this case, the fragments are effectively acting as the incoming source of processing for all electronic modules. As such, all processes that were previously applied to live incoming audio, are now applied to the *NanoPad*-triggered percussive sample grains.

- **BIT** - (**bit.aif** - **fdb_bit.aif**)

  Applies *bitcrushing* to all incoming sound. It distorts the sound by reducing the resolution or bandwidth of the incoming signal.

- **WSH** - (**wsh.aif** - **wsh.mov**)

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[8] http://people.ace.ed.ac.uk/staff/medward2/software/mdegranular/ (accessed June 2013)
[9] http://imtr.ircam.fr/imtr/CataRT (accessed May 2013)

Applies *waveshaping* to all outgoing sound, digital and acoustic, just before the final digital to audio converter output.

- **PZO** - (**pzo.aif**)

  A roving contact microphone applied to various objects according to each occasion, amplifying and *low-pass* or *high-pass filtering* them.

5.6.2 Peripheral

According to the performance requirements, The following modules can be employed in various roles, from seemingly very shackled connections to physical gestures, and on to looser relationships.

- **SCRB** - (**scrb.aif**)

  Each time the module is initiated, all incoming audio for the next five seconds is recorded. Then, I can "scrub" through the buffer using my pedal (this could be perceived as scrubbing a vinyl record, with the difference that when the playhead is not moving, the present spectra of the sound create a constant static drone.) allowing me to produce sounds ranging from fast erratic buffer position changes, to static drones when, for example, one "locks" (as explained in *Chapter 4: Agility*) the buffer position. I usually tend to record something pitched or distinct, usually a single hit, which I can then play around in, by acoustically performing the same hit repeatedly, while moving the scrubbing playhead position of the same pre-recorded sound with the pedal, creating an interesting interplay between the actual hits and the electronic slowed down, sped up, or erratic versions of the same sound.

- **+++** - (**+++.aif**)

  This module uses delay with varying pitch and feedback values. It could be described aesthetically as a dirty and "noisy" module (potentially the "noisiest" of all) and is shaped by the incoming sound, while at times, when the feedback is set to maximum, it can lead to a wall of sound. The effect is also being sent to CNMAT[10]'s swapping delay object for further textural variation.

- **GRAB** - (**grab.aif** - **grab.mov**)

  Inspired by Martin Parker's work *Grab*[11], this module consists of two constantly looping very short buffers, initially empty. When a hit exceeds a certain volume threshold, the

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[10] http://cnmat.berkeley.edu/ (accessed July 2013)
[11] http://www.tinpark.com/2008/05/grab/ (accessed June 2013)

first buffer records all incoming audio shortly after the "'loud" hit. The pedal controls the buffer's playback length, which can result into different perceived "tempos", since the perceived speed is connected wth the playback length. With the next "loud" hit, the next buffer records the "loud" sound in an identical manner, and now the previous buffer keeps playing back at a steady tempo (the last one at the moment of the new "loud" hit) while the pedal now controls the second buffer's playback speed. I find this way of creating a perceived "tempo" through playback a good and more organic alternative to a traditional sequencer, which I did not want to include in my modules. While I wanted my patch to have the option to have a steady pulse-based capability, after experimentation I decided that a traditional sequencer sounded too clinical and imposed, while in (GRAB) the "grabbed" looping buffers are captured segments performed and repeated in real time, which if I did not intervene would keep repeating just like two single-sample sequencers.

- **DEL** - (**del.aif**)

This module delays the incoming sound and applies *ring modulation* to it. In all modules, delay is used for a different purpose, and almost never with a steady delay time. Here delay was used to highlight the *ring modulation*, which was initially applied on the incoming sound without any delay. The result of this, however, was too static and mostly masked by the acoustic sound hits. With the delay, the percussive patterns that have just been performed on the acoustic instrument are still present, however appear with delay which makes them now audible, almost "between" the acoustic hits, and also varying by controlling dynamically the delay with the expression pedal. This gives me the freedom to choose how much deviation from the perceived "real-time" application of the effect to apply.
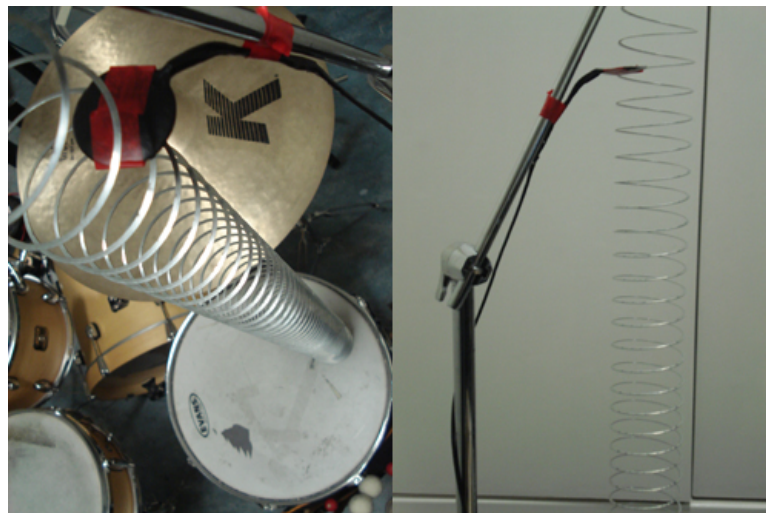
- **ENV** - (**env.aif**)

Figure 5.5: Piezo attached on a metallic slinky

When this module is enabled, the incoming audio's amplitude determines the amplitude

of long looping samples (being about 12 minutes each), a technique known as amplitude envelope. For example, if I play the cymbal from a very low to a very high amplitude, the looping sample's volume (which would be audible from the monitors) will have the equivalent volume motion from low to high. This technique is very effective and computationally tight, connecting very efficiently the acoustic and electronic gestures. I tend to use two loops here, one controlled by the incoming signal from the kick drum, and one from the small tom. Additionally, the roving piezo microphone can be used to control the envelopes, attached on various objects.

- **REV** - (**rev.aif** - **rev.mov**)

  A reverb module is applied to all effects. The interesting part here is that its decay time is set using the NanoPad's XY's *X* coordinate, (See Appendix B for detailed controls of all modules) but in order to mute it I need to press the pedal down (pedal value = 127), keeping also in mind that other modules might be affected by this pedal. In this way I can perform for some time on the drum kit with reverb ON and then I simply have to press the pedal in order to disable it, without this necessarily being perceived by the audience. I usually combine this with the start of a new section or idea, so it can have a more dramatic effect. As described earlier, I also have the option to make this change only usable once during the performance, as part of the "unique events" approach.

- **FRZ** - (**frz.aif** - **frz.mov**)

  This module is based on Michael Norris' "Spectral Freezer" VST, and spectrally "freezes" the live incoming audio. Instead of "freezing" one instance, this module's function is that new elements are constantly added to the sonority according to the pedal's value. When the pedal value is 0, the incoming audio is unaffected. The more the value rises, the more time it takes for currently "frozen" elements to fade-out. When the pedal value is 127 all incoming sound "freezes" indefinitely, which can result into a dense wall of sound.

5.6.3 Independent / Exit Strategies

The following modules could be considered as having a background role in relationship to the more "real-time" performative elements. Even though they are all produced from the acoustic percussion signal, their amplitude envelopes and diminished response to the acoustic sound give a sense of dissociation with the current sonic events in the acoustic performance. These were designed to be not too complex sonically as to cause a complete dissociation with the performance, thus ensuring that it is obvious that they emerged from it. In other words, the audience should feel that they have nothing to do with what the performer does presently, but it should be obvious that they were created in front of their eyes (and ears), and thus they too are consistent with the instrument. Additionally, since in this case these modules have a more independent behaviour, strategies needed to be developed in each occasion for when it is decided that they should stop, so that their disruption does not feel imposed and unorganic

(such as, for example, pressing a pad on the *NanoPad2* that would instantly mute a very dense wall of sound)

- **LOO** - (**loo.aif** - **loo_rev.aif**)

  (LOO) is a simple one layer looper, used in combination with a spectra-multiplying external *Max/MSP* object. In a thought process similar to that in (GRAB), where I did not want an obvious sequencer, here I didn't want to include an obvious looper. This is why I included the spectra multiplication object, multiplying the live-recorded loop's spectra with the same 12-minute looping samples spectra as described in (ENV). The pedal controls the amount of mix between the clean and the spectrally multiplied looping sonorities. This creates the possibility for very interesting dynamic variations between the two, retaining the sense of a looper, but not quite as static.

  As with all the modules included in this category, one has to deal with the problem of how to get out of an electronically "dense" background sound once into it. If I simply chose to mute it it by pressing a button on the *NanoPad2*, I believe that the audience might feel in some ways "cheated"; for each significant sonic change I wanted to include some equally dramatic physical gesture so that the audience perceives visceraly that every big change requires an equivalent amount of effort on the instrument, *or*, as decided in this case, to make it seamless. This is why I chose to mute it by using a ten-second fade out sequence, initiated by the Switch pedal. In this way the transition becomes very seamless; I initiate the fade out while taking the performance into a new direction, which takes over, so that when the loop is finally inaudible it is not too clear what happened to it.

- **SUN** - (**sun.aif** - **sun.mov**)

  SUN samples all incoming audio and plays it back at different speeds. One can get out of this sonority by simply by performing less densely on the acoustic instrument; this results in the module's sound to become less dense over-time, and eventually stop, until it gets "fed" again by incoming audio.

- **MACH** - (**mach.aif**)

  MACH is used to produce clearly pitched material. This module re-synthesizes the incoming audio with the use of spectral analysis and re-synthesis. When the pedal value is 127, the module freezes at its current synthesis state, with constant amplitude and frequency values. It is very useful for providing a distinct tonal element within the otherwise largely unpitched percussion performance. It works very well with cymbal bowing and scraping. When the pedal value becomes 0 then the present synthesis instance is the last one, until it fades out completely.

5.7 Feedback Tom

(**fdb.mov** - **fdb_tomview.mov**)

Figure 5.6: Feedback

The feedback floor tom was first devised and used during the *LLEAPP* workshop of 2011. It was conceived as a solution to the aforementioned problems of spatial and instrumental awareness[12] in a group of performers coming from different backgrounds and practices, and using a very wide range of instruments. Instead of using a shared P.A., a mixer and monitors for everyone, it was decided that in this case it would be preferable to use localised speakers, each being responsible for their own sound levels while making sure that they can hear everyone else. Since I was also using an acoustic instrument, I decided to take this localised approach (which I was already using for the drum-kit with a stereo pair of speakers behind me) even further, and use only the floor tom with a speaker underneath it to produce feedback, dismissing the rest of the instrument, both acoustic and electronic. Given the time restrictions (two days of preparation for a concert) this was a seemingly simple idea that would allow me to effectively improvise and interact with the rest of the performers. The speaker resonates the whole floor tom and the top of the skin, making it possible to place objects such as small rocks, rice, twigs and chopsticks that bounce, producing textural continuous sounds. Also, pressing the skin with different amounts of force and on different positions produces different overtones, timbres and amplitudes. When combined with the rest of the drum-kit, more drums can resonate, most notably the snare drums, so this gives an extra layer of sound possibilities —I can turn the snares on or off for more variations of resonance. Apart from the range of sounds produced, one of the most important features was the physical control of the electronic sound. Placing too many objects or damping the top skin of the tom with the open palm would stop the resonance and thus the feedback, providing a direct way to mute the sound if desired without the use of a MIDI controller. Making more electronic processes dependent on the feedback would provide a means for physical control of them as well. For example when the feedback module is used, there is an option to "bitcrush" the sound, sending it to the left and right monitors, thus unifying further the acoustic feedback texture and the digital bitcrushed version which follows my performance on the floor tom. Further research showed that this idea has been thoroughly explored by "The Feed-Drum"[13] produced by Istituto Gramma in collaboration with CRM -

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[12]as described in *Chapter 3: Awareness*
[13]http://www.youtube.com/watch?v=chhxK_RhZIk (accessed July 2013)

Centro Ricerche Musicali and Art Mama Factory. Also, improviser Sean Baxter[14] has also used a floor tom and feedback. Two more speakers can be optionally used, usually placed under the snare drum and in front of the bass-drum, for more possible feedback-based resonances (as was used during LLEAPP 2013 and described in *Chapter 3*.

5.8   Summary

In this chapter, the individual elements of my performance environment's *Vocabulary* were detailed and illustrated with the use of audio examples and video segments of their use in real performance scenarios. Being the final factor, alongside *Awareness* and *Agility* which were expanded in the previous chapters, *Vocabulary* concludes the framework of *Potential Musical Energy* stored between performer and instrument. As seen, the strategy followed in this case was to start from the incorporation of multiple parts and objects and sculpt over time a compact and concise *Vocabulary*. Tony Oxley's *Vocabulary* was discussed based on his own descriptions of the textural capabilities of his setup, and the ways in which his ideas propagated into my own performance practice. Namely, creating co-influencing sonic relationships between the parts of the *Augmented Drum-Kit*'s *Vocabulary*, and using elements that are offering distinct elements into the overall *Vocabulary*, just as Oxley uses cymbals whose function and sonority is unique within his setup. Also, the individual electronic modules comprising the digital vocabulary, were categorised depending on the relationship they have with the physical performance, into 1) Intertwined, 2) Peripheral and 3) Independent. Finally, a significant part of the overall *Vocabulary* of the *Augmented Drum-Kit*, the feedback floor-tom, was presented, which provides another means of gesturally unifying the electronic and acoustic sound worlds through physical pressure on the floor tom top skin.

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[14] http://www.youtube.com/watch?v=1xnHt6JM7kM)) (accessed July 2013)

Chapter 6

Friction

"Do not repeat the tactics which have gained you one victory, but let your methods be regulated by the infinite variety of circumstances" - Sun Tzu c. 551-496 BC

6.1 Introduction

Until this point in the thesis I have outlined the development of the *Augmented Drum-Kit* through the notion of *Potential Musical Energy* and its factors, *Awareness*, *Agility* and *Vocabulary*. Coming back to the conceptual map that was presented in the *Chapter 2: Potential Musical Energy* and included also here (Figure 6.1), one can see that the theoretical quantity of PME related to the performer and the instrument is subject to *Friction* which manifests itself when these theoretical quantities materialize into real-life performance scenarios. The importance of extensive performance as a method, specifically the repeated *Inter-Contextual Improvisation* as a means to evolve the instrument's *Ideal Performance Environment* has also been detailed. The materialization of *Real Performance Environments* needs to be distinct and situation-specific, since different circumstances demand different actions in order to maximise the occasional PME by minimizing losses caused by *Friction*. In this chapter I will examine travel and performance with my instrument, and will analyse the idea of *Friction* that is generated betweent constituent parts of the instrument during the process of materializing *Real Performance Environments*.

6.2 From the *Ideal* to the *Real*

For the *Augmented Drum-Kit*, where many individual parts—literal and metaphorical—comprise the composite instrumental system, each of them can be a source of potential liability, as well as each connection between them (similarly, literal and metaphorical). Subsequently, one needs
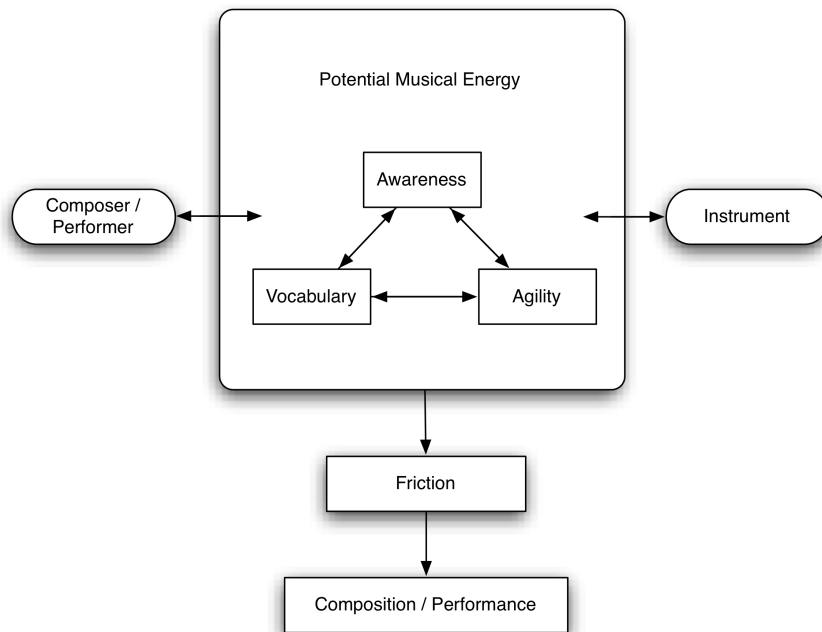
Figure 6.1: Conceptual Map

to devise strategies in order to be able to ensure a certain level of PME. Ancient Chinese military general, strategist and tactician Sun Tzu's notions of victory and defeat might not belong literally in the field of improvised performance, however, notions such as satisfaction, failure, success, disappointment, fulfilment and embarrassment, can often express the feelings of an improviser after a concert[1] While the Sun Tzu quotation in the header of the present chapter refers to tactics in warfare, I believe that it is also applicable to improvised based performances, where one needs to keep changing improvisational tactics and instrumental shape throughout different spaces, contexts, and musical objectives. Just as any goal can be divided into a set of particular smaller goals or steps in order to be achieved, improvising successfully with a new instrument in various scenarios can also be seen as an endeavour with specific parameters and variables. While musical success cannot be guaranteed, it being a matter dependent on varying human parameters, part of my performance methods involves maximising each performance's PME.

Being guided by the emerging *Ideal Performance Environment* (*Chapter 1: Instrumental Spaces*) within which the new instrument reaches a maximum PME, a few discrete stages were shaped, through which the *Real Performance Environment* materializes in all scenarios. Perceiving each performance as a different problem to be solved, the general methodology applied can be seen in Figure 6.2. For example, let us examine the hypothetical scenario that I am invited to perform within a group of performers as part of a festival in another city. Starting from the *Ideal Performance Environment*, and assuming that my instrument is *Flexible* enough to accommodate the needs of this particular concert, I will plan a performance environment that takes into account means of travel, performance space, co-improvisers and their instruments, and will sculpt the particular version of the instrument needed for this occasion in the instrument's

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[1]"with music, and that's the risk, the much bigger risk, you have to do it, otherwise you feel bad and you feel ashamed"- Peter Brötzmann, *Soldier Of The Road*: `https://vimeo.com/28409850` (accessed July 2013)

Ideal Performer State

Ideal Performance Environment

Flexibility

Transformation Space

Adaptability

Real Performance Environment

Real Performer State

Entropy
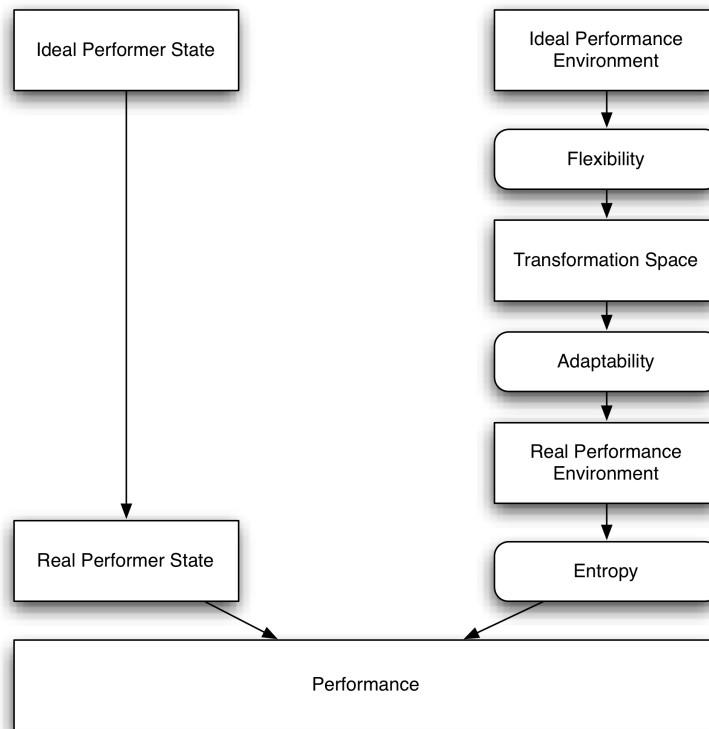
Performance

Figure 6.2: From the Ideal to the Real

Transformation Space. Then, once all material has moved to the performance space, through car, train or airplane, I will attempt *Adapting* the envisaged version of the instrument to the *Real* and final version of the instrument, a combination of the *Real Immediate Gestural* and *Extended Instrumental* performance spaces. Once the system is set up and ready for performance, I will have to make sure that it will stay on a fully functioning level until the actual performance, managing *Entropy*, which might cause one or some of its parts to fail before the start of the concert. Finally I must perform, having managed to set myself in a *Performer State* as close to *Ideal* as possible. These stages will be explained in detail in the following sections.

6.3 Friction

I define *Friction* as the loss of *Potential Musical Energy* manifested during the *Adaptation* process, because of the infinite variety of circumstances affecting the transition from the *Ideal Performance Environment* to the *Real Performance Environment*.

Prussian general and military theorist Carl von Clausewitz writes about *Friction* in war:

> If one has never personally experienced war, one cannot understand in what the difficulties constantly mentioned really consist, nor why a commander should need any brilliance and exceptional ability. Everything looks simple; the knowledge required does not look remarkable, the strategic options are so obvious that

by comparison the simplest problem of higher mathematics has an impressive scientific dignity. Once war has actually been seen the difficulties become clear; but it is still extremely hard to describe the unseen, all-pervading element that brings about this change of perspective. Everything in war is very simple, but the simplest thing is difficult. The difficulties accumulate and end by producing a kind of friction that is inconceivable unless one has experienced war. (Clausewitz, 1832/1997, 65)

This accumulation of challenges and *Friction* was the most defining and constantly present factor in my own performance practice and travels. It was often unexpected, and significant enough to wear out and occasionally render irrelevant prior plans, technical or musical. Similar to what von Clausewitz describes, it seems theoretically simple to develop a personal instrument and perform regularly in different fields of music and venues. It is however only obvious to the continuous practitioner how significant and numerous the subtle difficulties are, most often requiring considerable adaptation and problem solving skills. Clausewitz continues:

> Imagine a traveller who late in the day decides to cover two more stages before nightfall. Only four or five hours more, on a paved highway with relays of horses: it should be an easy trip. But at the next station he finds no fresh horses, or only poor ones; the country grows hilly, the road bad, night falls, and finally after many difficulties he is only too glad to reach a resting place with any kind of primitive accommodation. It is much the same in war. Countless minor incidents—the kind you can never really foresee—combine to lower the general level of performance, so that one always falls far short of the intended goal.

Clausewitz describes "performance" in military terms, but the idea is equivalent to musical performance. A missing drum rag; a loose cymbal stand; a crashed DSP module; a missed bus forcing one to carry a 20 kg cymbal case for 3 kilometres and thus causing physical exhaustion; a MIDI controller knob suddenly not responding, and any other arbitrary cause of difficulty and frustration, are all such factors that by themselves would not necessarily lead a performance to failure, but in combination can compromise the instrumental assemblage and performer state. All unforeseen results of *Friction*, can end up being as defining to the actual performance as the design choices for the instrument itself.

6.4   Heaven and Earth

Sun Tzu writes in (Tzu, 2005):

> There are Five Fundamentals
> For this deliberation,
> For the making of comparisons
> And the assessing of conditions:
> The Way,
> Heaven
> Earth,

Command,
Discipline.

He explains:

Heaven is
Ying and Yang
Cold and hot,
The cycle of seasons

Earth is
Height and depth,
Distance and proximity,
Ease and danger,
Open and confined ground,
Life and death

I interpret this duality of Sun Tzu's Heaven and Earth as the duality between variable natural phenomena in time and space which one has no control over but can partly observe them, protect oneself from, or take advantage of (Heaven), and the more palpable fixed space and object parameters which one has a more direct relationship with (Earth). Most of the factors consisting the *Real Performance Environment* could be categorised into either of those. Choosing where and how to perform, under which circumstances, but also being prepared to embrace the unexpected change and adapt, can be the deciding factors for a performance's outcome, even before the actual performance takes place. The assessment of each performance's "Heaven and Earth" is what mandates how to shape the envisaged performance environment in the *Transformation Space* before the performance, through *Flexibility* from the *Ideal*.

Sun Tzu writes:

So it is said;
Know the enemy,
Know yourself,
And victory is never in doubt,
Not in a hundred battles.

Know Heaven,
Know Earth,
And your victory
is complete.

The qualities that lie within the performer, as well as the qualities that lie within the instrument as a result of its methodical development, *Awareness*, *Agility* and *Vocabulary*, all influence the performance's *Potential Musical Energy*. I could parallelize the first of Sun Tzu's verses "So it is said ... hundred battles" with having achieved a good level of PME, which assures the potential for many good performances. However, in order to guarantee a good performance

always (or at least the potential for one), one needs to be aware of *Heaven* and *Earth* as argued in the second verse. These could be seen as the factors of the real life performance scenario within which this theoretical quantity of *PME* is being manifested. By taking advantage of *Heaven* and *Earth* in each particular scenario and by "knowing yourself" through the AAV development as discussed in all previous chapters, "victory is complete".

6.5 Flexibility

Early during the development of the instrument it was decided that improvisation should be its main method towards creating the bespoke performance environment (*Chapter 4*). This decision was not only taken as a result of personal aesthetics and my own intended performer *Telos*, but was also based on the objective fact that as a new evolving instrument, its physical space could not be strictly fixed and defined, and therefore compositions with fixed musical parameters might be negatively restricting some of the possibilities presented by different *Extended Instrumental Spaces*. This is why a more open-ended explorative approach to performance was taken by always adapting to different scenarios.

In composed music which involves acoustic instruments and electronics or electroacoustic pieces, setting up for a concert most likely involves fine-tuning the sound of the performance or fixed media to the space. This might require equalisation or other signal processing techniques. This approach assumes a performance of fixed musical gestures, being either automated within the performance software or performed on the physical interface or acoustic instrument as the piece requires and as guided by notation. The strictures of the score and its predetermined sound world is what requires all these pre-concert fine-tuning processes.

I see my performance practice as working from another direction towards addressing this problem. Instead of fine-tuning an unavoidably fixed performance's *sound* to the space, I am constantly fine-tuning the *performance* itself to the space instead, in real time, making sure that the space will be complementary to the musical gestures throughout it. Essentially, this means that, for example, I will not usually use very dense electronics or drumming in a large reverberant space. Similarly, I will interact with possible resonant frequencies that some spaces might have. Given that a performance might occur in anything from a very expensive and acoustically treated concert hall to an a warehouse or a garage, it was more important for me to become flexible by making my instrument adaptable to any situation, rather than create a number of fixed or traditionally composed works, which would be performed only once or twice and would only work in a particular space. Planning a solo performance in this sense in my own practice room does not entail learning a specific sequence of events to be repeated during the performance, but by having an impression of what the *Real* space and context is going to be, deciding on the physical sonic materials that will work best in that specific scenario to describe my musical ideas. Then, assemble these materials, and perform in the *Transformation Space* with the chosen *Vocabulary* while becoming comfortable with the specific formation. Such materials might include different types of cymbals, metals, wooden and plastic resonant objects, pitched and non-pitched sounds, different drum-sticks and so on. Planning entails envisaging the *Real*

Performance Environment to the best of my knowledge at the time, and sculpting a version of my instrument in the *Transformation Space*, which will then have to *adapt* into the *Real* space. A very successful planning, for example, would match the RPE, minimizing *Adaptation* requirements at the actual space of the performance and thus also minimizing *Friction*.

6.5.1 Transformation Space
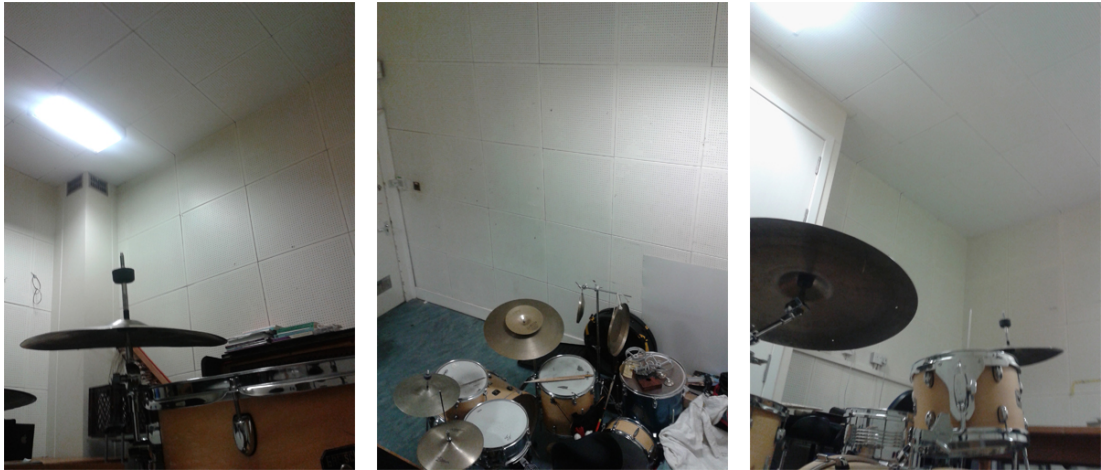
Figure 6.3: Room G07 - Transformation Space

All research, planning and *Stages A* and *B* improvisations as part of the *Instrument Development Cycles* with the *Augmented Drum-Kit* took place in room G07 in Alison House, at the Music Department of the University of Edinburgh. Having a permanent TS was crucial towards shaping the instrument. On one hand, the room was soundproofed, with close to no physical reverberation, thus allowing fast percussive acoustic and electronic gestures. Before G07 I was assigned another room, smaller and not acoustically treated, making it next to impossible to produce the sound I was envisaging, or any dense loud sound in general, acoustic or electronic; the room would become "boomy" very easily. One could claim that I could *Adapt* the instrument, as described, to that "boomy" room, however, this is not this space's purpose, being the instrument's *Transformation Space* which *needs* to have certain neutral sonic attributes. Had I continued developing my instrument in that working space, it would have taken a very different aesthetic direction than the one it has today. Also, I was able to leave the *Augmented Drum-Kit* set-up in G07 permanently, making it easy to practice, have a break, and then return the next day to continue practicing, just as a pianist would be able to without having to spend a significant amount of time each day setting up his instrument, before each rehearsal. Any real progress in the development of the *Augmented Drum-Kit* started at the moment I was able to use an adequate *Transformation Space*. I cannot stress enough here the importance of having such personal and permanent spaces in new digital instrument design and performance practice in general, something which is, sadly, not often pragmatically possible in academic departments. While architects and designers can work on their individual projects within the same spaces, or in close proximity, sound artists and musicians cannot.

Practicing in such a relatively dead space did not mean that this would be the *Ideal Performance*

Environment of the instrument; it was however desirable for this space to facilitate a neutral representation of the instrument and expose its sonic core (an extreme version of that might perhaps be practicing in an anechoic chamber), rather than practicing in a reverberant space that might have had peculiarities that would prevent me from having a more objective sound perspective. Then, by *adapting* the instrument to a concert space for a performance, some of the instrumental characteristics would become magnified while others would be supressed, according to the occasion and as described above. Objectively, the conditions of the *Transformation Space* are never similar to the ones of the *Real Performance Environment*. I approached this consideration by working on more general musical parameters such as the composition of the sonic material, density, dynamics, pitch content, and so on, and then *adapted* these attributes according to the space of the performance. This could realistically assure the potential for successful performance.

6.6   Traveling / Migrating

The form of the *Augmented Drum-Kit* was often shaped by restrictions imposed by travelling (as seen in *Chapter 1: Instrumental Spaces*). The computer, whose open ended nature was discussed in *Chapter 4: Agility*, imposes restrictions on the software based on its finite memory and processing power. In the virtual space of the software where everything appears possible, there is a CPU and memory "ceiling" which forces the programmer/performer to include only those elements that both work together aesthetically, and do not reach this ceiling, or compromise the environment's stability. Furthermore, for my instrument, the *Max/MSP* patch has been developed and used only on my own computer[2]. Any CPU percentage within which the environment is tested to be stable and effective, is true *only* for this particular machine. Any migration of the software to another machine would potentially require fine-tuning, perhaps other required software updates, and even elimination of some elements of the patch that would cause an older machine with an inferior processor to cause instabilities or other unexpected problems. Similarly, in the acoustic realm, during the planning stage in the *Transformation Space*, the specific traveling conditions play an important role towards the decisions of materials. This is not only an aesthetic choice as described earlier based on the context and space of the performance, but also forced by number of other practical restrictions. For example, travelling by car, train, or airplane presents different sets of restrictions regarding the size and weight of equipment. When traveling with an airplane for example the maximum baggage allowance is often 20 kilograms. This parameter is also combined with the type of festival and event, and whether or not the travel is funded. If it is not, then a solution must be found without having to book extra baggage, but deciding which are the few most important aspects of the setup that would still make the performance work. Practising and traveling is essentially assessing the expected performance scenario and solving the problem of presenting something that is not a compromise, but a version of the instrument that is true to the *Ideal Performance Environment* given all restrictions. As such, I see physically traveling or moving the instrument's acoustic components from one space to another as installing my performance software on a different computer. Some spaces can afford some of its components, while some others all of

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[2]Macbook Pro 2009: OS X, Version 10.6.8 - Processor: 2.4 GHz Intel Core i5 - Memory 4GB 1067 MHz DDR3

them and it is up to the planning of each performance to assess which of the components can work and how travel will restrict them.

6.7   Adapting to the Real Performance Environment

This stage takes place upon the arrival to the space for sound checking, until waiting for the performance to start. It involves matching the envisaged to the *Real* scenario, and assessing whether or not *Adapting* is possible. As I defined my instrument in two parts in *Chapter 1: Instrumental Spaces* the *Immediate Gestural Space* and the *Extended Instrumental Space*, I will discuss these factors separately.

6.7.1   Immediate Gestural Space: Friction

The *Immediate Gestural Space* assessment starts from the type of acoustic drum-kit provided by the organiser. Two common mistakes can be the size of the bass-drum and a bad quality drum seat. My performance rider specifies a small kick-drum of 18″ and a drum seat that can be raised, but these details are often disregarded. Instead I am often provided with a standard 20″ or, a 22″ bass-drum. This not only has consequences on the sound produced by this particular drum, but also on the placement of the drums around it, as its width makes the height of the tom mounted on it to rise significantly. This causes setting up the rest of the drums in different angles and heights in order to adjust the gestures. For solving this problem I place the tom on a second snare drum, and tune the kick drum to a higher pitch.

A bad drum seat leads to less than ideal positioning and posture and thus a less effective performance. Perceiving the instrument as the "performer's cockpit", the seat should position the performer in the most efficient posture possible, similar to a racing car or motorcycle seat. A very low drum seat can make it impossible for me to perform as intended. Another problem is not providing a drum rug, which causes the kick drum and hi-hat to move forward throughout the performance. Providing a lesser number or non-boom type cymbal stands, too high or too low tables to fit the electronic controllers, audio interface and computer, are all *Friction* factors contributing towards diminishing PME (Figure 6.1).

Adapting to each occasion is essentially damage-controlling and troubleshooting, and indeed there might be situations where the *adaptation* is not possible without compromising the instrument and subsequently the performance. The variations between the deviations from what was asked to the promoter and was was actually provided from the performance are endless. These are however mostly expected since, as discussed, the drum-kit consists of many different objects and parts, but it is established in the common perception of people as one unified instrument. Instead of treating the rider as a list of discrete objects to be acquired, the instrument is often treated similarly to a "high quality piano" or "high quality harp" a uniform instrument which will be acceptable regardless of the specified details.

6.7.2   Case Study: ICMC - Extended Instrumental Space

Similar troubleshooting and assessment takes place for the *Extended Instrumental Space*, and sometimes *adaptation* is impossible, or too risky: I was accepted to perform at ICMC 2012 held in Ljubljana, Slovenia. The conference ran from Sunday 9th September to Saturday the 14th. My performance was planned for Monday the 10th at Kino Šiška, one of the largest venues in Ljubljana[3]. As such, most of the pieces using acoustic instruments had to be reinforced with microphones, through a P.A. system that was also used for the electronics. In an ideal scenario for solo performance, I want the drums to be purely acoustic, without using microphone reinforcement, and have the speakers behind me facing the audience. In this case however, given the size of the venue, I was considering using microphones for the drums, and sending the electronics to the F.O.H. This would most definitely affect the character of the performance as the experience of the space would be radically different. I would go as far to say that an amplified drum-kit is a different instrument (similarly to the distinction between the 'fiddle' and the 'violin' (Théberge, 1997)). The preference for no acoustic reinforcement was of course included in the performance rider, but as is often the case in large conferences, the seemingly secondary rider details were disregarded (perhaps because of high amount of participants whose needs need to be accomodated with restricted resources). While I enjoy performing with an amplified drum-kit in projects such as synth-based *Můstek* or *DMT*, in this situation the subtlety and organic nature of the acoustic sound was amongst the intended goals for the performance. *Adapting* would not be impossible; I would, however, have to change significantly my intended performance's aesthetic.

Figure 6.4: Menza Pri Koritu Setup

On the day of the performance, I arrived around 5pm at Kino Šiška, on the assigned time for my soundcheck. When I walked in the hall, I was informed that there was no drum-kit due to an organisational miscommunication. Having been in the venue the previous day for the opening night's concerts, I was aware of the challenge I was about to face, and the time it would require trying to adapt my planned acoustic approach for the bigger venue of Kino Šiška. The

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[3]"Kino Šiška ranks among largest and technically most advanced venues of its kind in Europe. The large Katedrala hall with its 743 m2 can hold 800 visitors standing or 450 seating in various configurations" http://www.kinosiska.si/en/about/vision-and-mission/ (accessed June 2013)

organisers, being helpful and trying to find a solution quickly, attempted to locate a drum-kit which would have to be brought to the performance space. However, since the time of my soundcheck had already passed, I would definitely have to do it hastily some time between the end of all soundchecks and the start of the performances. In addition, as described, the present venue would require more time to adapt to because of its size. As such, I decided to ask them to pull out of the day's performance line-up and find another date, preferably in a different smaller venue. I am certain that had I decided to proceed and perform on that day after the described circumstances, there would be a significant probability that the performance would have failed, for at least three reasons: First, the adaptation of my envisaged performance environment to the *Real* performance environment would be challenging even if I had enough time to sound-check and prepare in comfort. Second, the fact that I would have to squeeze-in my soundcheck somewhere between other sound-checks or after their end, would cause me to be in a much less-than-ideal *Performer State*, caused by the stress of the situation. Lastly, the fact that there were quite a few other performances taking place on the same stage, which required moving equipment and connecting cables and audio interfaces before each performance, would lead to an increased risk of *Entropy* based failure, a concept that will be defined in Section 6.8 of the present chapter.

In the end, my performance was re-scheduled for Friday, the 13th of September in *Menza Pri Koritu*, an autonomous social centre in the centre of Ljubljana, Slovenia, located on the site of former military barracks, a much more suitable place for my performance. Firstly, the venue was considerably smaller and thus I would be able to proceed with my initial planned acoustic version of my performance with localised speakers for the electronics. Secondly I had more than two hours at my disposal to fully set up and adapt my performance environment, and lastly I would be the only performer onstage, with the rest of the performances being either video based art or installations located in other parts of the space. This secured the stability of the instrument from sound-check to performance. Also, I really enjoyed the social context of the space, in general, which was far from the formal environment of Kino Šiška. People were standing up instead of sitting in chairs in silence, a bar was alongside the audience, meaning that people would feel free to move around to order drinks throughout the performance without feeling forced to stay still and quiet if they didn't want to, or even keep talking to each-other if the performance was not interesting enough. Performing there made me realise that this space was very close to my *Ideal Performance Environment*, which, again, was evolving constantly by improvising extensively while arriving at such conclusions practically.

[Please watch the video excerpt **(/Media/Video/ICMC.mov)** now]

In this close to *Ideal* scenario a few things standed out for my performance practice:

1. I didn't introduce in any sense my instrument. While technology and the use of a computer is the central aspect in such conferences, I find it that the performance itself should expain everything needed explanation in regards to what the instrument is and how it relates to the performer. If not, it would be a matter of redesigning parts of the instrumental interaction during the next *Development Cycle*, rather than (perhaps "apologetically") explain what I am trying to achieve with technology through an introduction or program

notes.

2. I particularly enjoyed being aware of an "alive" audience. Based on the previous description of the space, I was aware that the attendees had a freedom of movement within the space and were able to talk with each-other, or leave during performances. Contrasting a perhaps artificial deafening silence and politeness towards the performer in more formal settings, I felt liberated by the fact that I was not expected to follow formal guidelines mandated by an equally formal environment. As such, I purposefully started my performance while the audience was still "loud" and talking to each-other, and saw it as a challenge to draw their attention without introducing the performance, something that would make them quieten. The two-way interaction continued throughout the performance; I can claim that it was one of the most enjoyable performances in an academic context, precicely because of this freedom and awareness of a reacting audience that talks to each-other when is bored, stays silent when interested in what they see/hear, yell to the performer, and can even take breaks for smoking cigarettes.

This is, in my opinion, when the technology employed becomes transparent, and the focus comes back to the human performative element, which is why the digital augmentation of the drum-kit was attempted in the first place: a better performance. If technology was indeed the focus of a performance, I would consider it an obstruction rather than a launchpad (as discussed in *Chapter 3* for *The Third Mind*) and a definite step backwards from the acoustic version of the instrument—no-one is interested in the violin during a great solo violin performance. All these realisations rarely come to mind in the *Transformation Space* where a new instrument is being developed. It was by extensive performance, and practical instances like this that my instrumental *Ideal Performance Environment* started moving away from the largely followed (even in the NIME milieu) classical music "silent and seated" audience paradigm and move more towards free-jazz and noise music contexts which fed directly into *Vocabulary* and *Agility* design choices, applied in each subsequent *Development Cycle*.

6.8 Entropy

I define this stage as the time between the end of the sound-check and the start of the performance. Arguably, it is the most disregarded stage by performers, and possibly the source of most problems that can arise with newly assembled technology. The issue is that very slight intervening factors in the setup can have major unwanted consequences and even lead a performance to failure. One of the definitions of the term entropy is "a process of degradation or running down or a trend to disorder" (Merriam-Webster Dictionary, 2013), and this is exactly what takes place between the system being "sound-checked" and set up in its ideal condition and the time to actually perform.

6.8.1 Internal System Entropy

The time between sound-checking and performance can vary greatly. Software that has been thoroughly tested and performed with, which might have not failed in the past, could fail when the first knob turns and a MIDI stream of numbers is detected at the start of the performance. This can happen, for instance, if the system needs to stay ON for a considerably longer time than ever tested for before. An operating time of constant five-hour use or idleness, for example, followed by a sudden change (in this case the start of the performance) might have not been tested even once. Every time the patch changes through the addition of a new processing module or modification of an existing one, the whole system becomes compromised to unexpected problems, and needs to be tested again, either by simulating repeatedly long pauses followed by activity, or long continuous activity. This practice also helps build the trust of the performer to the instrument. For a saxophonist, for example, who is used picking up the saxophone, placing its holder around their neck, positioning or adjusting the reed, might also feel natural having to also initiate the patch, adjusting volume pedals and making sure that all inputs are working as intended onstage before the performance begins. The immediate and more direct sound producing nature of the drum-kit on the other hand, would perhaps require an equivalent response from the computer system in order for it to be perceived as one instrument by myself, co-performers and an audience. Since all that is required for percussion is to simply hit a drum with my hands and start the performance the moment I sit on the drum seat, the computer should not require any more preparation than that, and there should not be any doubts in the mind of performer that the system will work as intended. This is why at the end of each *Development Cycle*, the system is stress-tested for significant hours at a time, to ensure that I will be able to leave it ON after the sound-check and once the performance starts the system will be in full working condition.

6.8.2 External Entropy

This part refers to any external intervening factors that can affect the system's functionality. A simple power cut of a few seconds caused by an engineer or other performers replacing a power adaptor powering one of the MIDI controllers of the system, will cause it to stop being "recognised" by *Max/MSP*, even if is turned ON again when the power returns. This will cause an unpleasant surprise when the performance starts. The controller will be seemingly ON but the control changes will not be affecting the software anymore. At this point, unless the performer decides to stop the performance and restart the whole system, the imagined performance will take a very different course depending on the controller affected.

Another similar example would be intervening with monitors. From the simple case of someone tripping on a cable unpowering a monitor, or moving monitors between acts and performers, there are cases where the monitors do not function as intended or simply haven't been switched back on. When the performance starts, the lack of, or erroneous monitoring sound will cause stopping and restarting the performance when the problem is fixed, something that in the case of an improvised performance will have a significant impact on the performer's

psychology.

While stress-testing the system after each *Development Cycle* minimizes possible *Internal Entropy*, in the case of *External Entropy* it is not as easy to find a robust solution. Unless one waits in the same space for the whole time between rehearsal and performance, most cases will require trust that nothing has been affected by other rehearsals / performances and simple testing before the actual start will be sufficient. The best approach to this reality would be the choice of an appropriate performance scenario, a safe enough "Heaven and Earth" (see Section 6.4) that would assure minimum *Entropy* (for example, no other performers onstage, trusted sound engineers and so on). A few quick system-checking actions, that I've always found helpful to do are:

- Tapping onto the snare microphone to see if there is incoming audio to the patch

- Slightly touching all the controllers to see the visual cues on the computer screen ensuring that they are still operating

- Making sure that both monitors are still ON (via a light indication or similar)

If something in the software does not work, I simply restart the patch, something that at this point can't be avoided. Without affecting my aesthetic preference of starting the performance immediately without any troubleshooting and adjusting time on stage, all these actions occur in less than five seconds. I personally find it distasteful spending more than one minute in front of a silent audience, staring at my screen while reloading the patch, initiating presets and adjusting dials. This is why I prefer taking the risk of *External Entropy*, rather than load the patch before each performance. In fact, I see preparing the computer onstage as distancing myself from the audience. The more time I spend setting things up while looking at the screen in front of the audience before the concert starts, the more "things I know that they don't" about the performance about to start and thus the greater the barrier is to communication between myself and the audience. This might evoke unsympathetic or alienating feelings. On the other hand, sitting on the drum-kit and making electronic and acoustic sound instantly without interacting with the computer at all, perhaps helps bring the audience closer to it (or at least make them sympathetic towards it), by making the digital technology transparent, and relying instead on well-known and sympathetically "understood" technology i.e. the drum-kit.

6.8.3   Case Study: INTER/actions

I was invited to perform at the INTER/actions Festival in Bangor, Wales on April the 12th 2012. In the same performance session were Andreas Weixler and Se-Lien Chuang's *Enhanced Phenotype* for 9 performers, Pierre Alexandre Tremblay's *La rupture inéluctable*, Martin Parker's *GruntCount*, Konstantinos Vasilakos' *B[ye]Grain*, and Eric Maestri's *Ritratto Vivente*. My performance would be the last one of the evening.

A problem became aparent when I was informed of the line-up. The number of performers, technology involved, change-overs and stage space made impossible for my instrument (which takes up a considerable amount of space and time to set-up) to remain at the same place without any movements between rehearsal and performance. Having to set-up again just after some-one else's performance would make sound-checking in the first place irrelevant. A solution would be performing first in the evening and dismantling everything for the next performers. However, the setup for the piece *Enhanced Phenotype* was even more complicated involving nine performers using networked computers and cross live processing. The fact that the setup can't move from sound check to performance was included in the rider.

As a solution, I decided to set-up below the stage and slightly to the right (Figure 6.5). I also decided not to use any sound reinforcement as I was now closer to the audience. Also, in-stead of sending my electronics' stereo pair to the F.O.H. that would then send the electronic sound to a P.A. that was now dispositioned in relation to my acoustic kit, I used two speakers on the left and right of the drum-kit that were connected directly to my audio interface. This made things simpler as it eliminated a few possible sources of failure, such as something get-ting disconnected or misplaced during the change-overs. Apart from the technical side of it, I find the aesthetic factor equally important, if not more. Moving parts of a drum-kit, tables, electronic hardware and so on in front of the audience and then engaging with the computer screen, restarting patches, testing microphones (as discussed in the previous Section 6.8.2) and when everything works finally start performing, could be frustrating. It can also remove any impact, edge, boldness and perceived performative intuition from the performance, since the whole process becomes demystified.

Figure 6.5: INTER/actions - Off the stage

On the 7th of April 2013, I attended a Peter Brötzmann and Paal Nilssen-Love concert in Glas-gow. Apart from appreciating the musical quality of their improvisation, I related to a very specific aspect of their performance which was the essence of my own instrumental develop-ment, and was also the main reason why I chose to set up off the stage in Bangor. In the review of their performance in "Herald Scotland" the reviewer writes: "Counterflows closed with a storm of ferocious physicality from German saxophonist Peter Brötzmann, 72, who with a curt "yeah"? to Norwegian drummer Paal Nilssen-Love (The Thing, Atomic) launched into iconic

sonic overdrive from the get-go."[4] Being able to start promptly and reach the sonic extremes of the instrument (amplitude, intensity, or otherwise) shortly after being onstage, was one of the instrument's design axioms and primary goals. This of course did not not mean that I would *always* do that, I did not want, however, to be restricted by the digital part of the instrument in case I wanted to do so. Any meticulous preparations and adjustments (necessary primarily because of the digital part of the instrument), need to happen in the *Transformation Space* and sound-check, hidden from the audience, as the spontaneous and improvised nature of such a performance can get compromised by the sense of immense amounts of work required to make it possible. The meticulousness should be sensed and felt by the audience, but on a visceral or subconscious level, and not by witnessing in real-time how much effort it takes to set-up for the performance. In order for my performance to reach its maximum aesthetic effective-ness, the audience should even feel that there is an air of carelessness, playfulness, or even irresponsibility, which are all afforded by the robustness of the instrument.

Jorda argues:

> When we find a performer who does not care about the monitor; when we see someone on stage capable of lovely caressing and of violently striking the instru-ment without fear, chances are we are facing a memorable performance. (Jorda, 2005)

As some of these performative attributes might not go hand in hand with other necessary tech-nical notions related to the instrument, such as coding and troubleshooting, it is preferable for the audience to not experience the "work" behind the "fun". By choosing to have the perfor-mance below the stage in Bangor I was trying not only to *adapt* my envisaged performance scenario to something technically possible, but also to something aesthetically consistent with the desired performative attributes.

6.9   Performer State

Performing requires not only reaching a particular frame of the mind but also a physical state of the body. Furthermore, improvised performance requires a creative and alert mental state, which quite possibly nevertheless differs from performer to performer. The reality of ensuring that every aspect of the instrument will work as intended from the sound-check to the perfor-mance, is certainly a matter that unless dealt with via tactics developed as described above, will affect to a big extend the performer(/composer/builder)'s state. Also, when technology is involved, the performer's state might be disrupted because of the need for troubleshooting or adjustments. In the case, for example, that I walk onstage to perform and find that there is a problem with the patch, I have to abandon my performer's state of mind (which doesn't necessarily include remembering cerebrally what the programming behind the software is), become a programmer or hardware technician, and then, when the problem is resolved, be-

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[4] http://www.heraldscotland.com/arts-ents/music/day-three-glad-cafesouthside-studios-glasgow.20738874 (accessed July 2013)

come a performer again. I could define the *Ideal Performer State* as the state in which the performer is as prepared as possible, mentally and physically to engage in musical activity, and *Real Performer State* as the state which was possible to achieve within a given *Real Performance Environment*.

6.10   Case Study: ISEA[5] - Friction

With enough rehearsal and preparation, a certain degree of assurance that the system will work as intended can be achieved. Different types of malfunction can be dealt with different types of troubleshooting skills developed by the performer from past experiences. For example, losing the grip of a drum-stick can be intuitively solved by grabbing another one, which is placed in close reach particularly for this eventuality. Software malfunction might require a more complex cerebral process. In this case, questions such as "Do I stop the performance until the problem is solved and start again?" or "Do I keep improvising on the acoustic instrument while trying to re-launch the software?" might arise and be answered through other complex thoughts such as "I've already played for fifteen minutes so I might as well play for the next five minutes acoustically" or "If people see the screen of the computer restarting they'll know the software failed, which might be embarassing, but perhaps it is also interesting to see me struggling to fix it while performing—another layer of troubleshooting performance in parallel to the musical performance". While as discussed, one can take measures towards such *Friction* management, performance failure can be introduced through many different routes, often unimaginable.

I participated in 2012's ISEA held in Albuquerque, New Mexico. I travelled there to perform a solo improvised set, and a trio performance with Marco Donnarumma playing his *Xth Sense*[6] and Adam Parkinson playing an iPhone using customised audio processing software. Signs of what was to take place appeared early in the planning process when we were informed that there was no "rehearsal and sound-check time assigned" and that "we should find another space to rehearse and sound-check", as we were expected to simply show up before the performance and start playing. Upon further discussions, and after we realised that the particular organisers had no prior experience of organising such types of concerts (being mostly practitioners of other fields which are part of ISEA, such as digital design and electronic arts), we convinced them that rehearsal in situ was absolutely necessary and managed to secure a couple of hours of setting up and sound-checking between the three of us. When we arrived at the performance space we realised that most of the material we required and which was on our performance riders was not present, including a good quality P.A. system (Their initial suggestion was to use two wall-mounted speakers of a very bad quality). This problem was solved in the process by convincing them again to rent an acceptable P.A. system and drums from a music related hardware renting company in Albuquerque, which usually organises rock and country music concerts, and whose three sound engineers were present to help set-up and be responsible of the F.O.H.

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[5]International Symposium on Electronic Art
[6]http://marcodonnarumma.com/works/xth-sense/ (accessed July 2013)

Once the sound-check began, the first thing that was dismissed from the *Augmented Drum-Kit* was my feedback floor tom, as the engineers wouldn't allow me to use their equipment for this purpose since "it could have harmed it". It proved futile to explain that I have had performed with the same setup in various conferences and festivals and never had any problems, as my patch controls the feedback digitally and never exceeds a certain level. I decided to take the localised electronic sound approach without acoustic reinforcement, using two speakers connected directly to my audio interface, so that I have complete control of my electronics. I did this because I concluded that the sound engineers' ignorance was dangerous to the performance. Throughout the rehearsals, they made more than a few sarcastic remarks, such as "that noise you're making is really nice!" among others, so I was trying to avoid giving them any intervening agency on my sound in any way. Still, localised speakers did not stop one of them coming repeatedly on stage during my performance, turning the speaker volumes down and eventually turning off completely Marco Donnarumma's volume during our trio performance:

[Please watch example **/Media/Video/ISEA.mov** now]

While this behaviour from organisers or local sound engineers might not be entirely surprising to a gigging musician, this example is mentioned since these performances were part of ISEA, perhaps the leading symposium on electronic arts. What I am really illustrating is how a performance can fail in the field of new instrumental practice when everything was planned in theory by the composer/performer/builder. Using Sun Tzu's terminology again, while as performers and practitioners "we knew ourselves" and had won "battles" in the past, in this case we did not know "Heaven and Earth" (or at least we thought we knew, given the high profile of the conference), so "victory was incomplete".

The fact that we were performing in such a prestigious setting (Laurie Anderson was performing as part of ISEA too, later that day), did not prevent some of the aspects within the *Real Performance Environment* from introducing *Friction* that in this case compromised the *Potential Musical Energy*. The instrument does not end where its physical dimensions end, but again, where the *Extended Instrumental Space* ends in its entirety, including social context and other agents e.g. F.O.H. engineers. When the laptop artist sends a stereo audio signal to a mixer controlled by an engineer, the engineer's agency becomes part of the instrument. In the example described above, while deciding to eliminate this risk by using localised speakers after picking up on comments during the sound-check, it was not enough to prevent the engineer's agency on the instrument. This particular EIS included three audio engineers willing to go on the stage in the middle of the performance and, in their eyes, protect their property, while in my eyes alter my *Immediate Gestural Space*. The question becomes, would the best option for my performance in that scenario be to perform a very quiet and spacious improvisation that wouldn't cause them to come onstage? Should I refuse to perform in the first place under these circumstances? Should I do what I wanted regardless of these factors? Given the fact that I had travelled to the United States just for these performances, and was in a much less-than-*Ideal Performer State* because of having to fight for everything, from rehearsal time to an appropriate drum-kit and an acceptable P.A. system, I consciously went with the third option. This resulted in a musically and aesthetically failed but otherwise very fun performance, albeit

for wrong reasons.

Within my software, I use an analysis module which, among others, detects the present amplitude of the performance. Sometimes I play consciously not to exceed a specific amplitude as it will trigger certain events. During the performance in Albuquerque I felt the exact same interaction with the F.O.H. engineers: Every time I exceeded a certain level or did something sonically "provocative" (after a while it became quite obvious which gestures they considered to be loud or provocative), an engineer would come onstage to turn the volume down, something which happened 8 times in total. In this case the engineers became an integral part of the instrument (perhaps not operating as a simple mathematical function like my amplitude analyzer), incorporating complex socio-political dynamics as to what is loud to them (even though the concert was not particularly loud), offensive or provocative, and cause a result on my electronic sound. What's more, I really had no way of reacting to their reaction, other than perhaps getting up of my instrument, turning the volume back up and keep on playing.

6.11   Conclusion

In this chapter, I defined and examined *Friction*, an all-pervading notion manifested during the materialization of the *Real Performance Environment*. For this, the concepts of *Transformation Space*, *Flexibility*, *Adaptability* and *Entropy* were detailed, which all relate to *Friction*, in different ways. Also, practical examples were presented in order to further illustrate these ideas, as well as tactics towards *Friction* control. While such methods might be secondary in the field of NIMEs in general, depending on particular instrumental definitions, in the case of the composite and fluid *Augmented Drum-Kit* their considereation was crucial: The more the constituent parts, technological or conceptual, composing the instrument, the more the potential *Friction*. Since my basic method for developing and shaping the emerging instrument was by performing extensively in different scenarios and musical contexts, *Friction* was expected, and might I say, welcome during the early stages in order to highlight the instrument's problematic areas and address them.

Chapter 7

Conclusion and Further Work

7.1   Conclusion

This dissertation has proposed a unified three-part framework for personal ongoing instrumental design and development, including: *Instrumental Spaces*, *Potential Musical Energy* and *Instrument Development Cycles*. In parallel, the progression of the *Augmented Drum-Kit* as an instrument, as well as the methods and design strategies based on the frameworks were documented and further illustrated by the produced musical outcome in the form of music portfolio and audiovisual material.

In *Chapter 1* I have described the first proposed framework related to *Instrumental Spaces*. This was developed in order to address the research question set at the beginning of this research: "How should the design of the augmented instrument be approached so that it has a distinct character but is also true to the formless nature of its building blocks: percussion and the computer?" I claimed that by using this framework, it is possible to define the instrument without necessarily fixing it in terms of specific physical objects, but through the physical spatial notions of *Immediate Gestural* and *Extended Instrumental Spaces*, by thinking of the instrument in more generalised sonic attributes, such as "snare-ness" and adapting them for each performance scenario. Also, the notions *Ideal Perfomance Environment*, *Transformation Space* and *Real Performance Environment* were introduced. I argued that envisaging the IPE (theoretical because of the instrument's constant evolution), which is a combination of the *Immediate Gestural Space* and *Extended Instrumental Space*, is crucial in the field of digital new instrumental development in order to maintain aesthetic consistency. Finally, the importance of a permanent *Transformation Space* in which the instrument materialises from the *Ideal Performance Environment* was stressed, in order to then adapt to each performance scenario's *Real Performance Environment*.

In *Chapter 2* I described the second proposed framework, *Potential Musical Energy*. Here, it was suggested that potential music "stored" between the performer/composer/builder and the

emerging instrument and, released during improvised performances, can be perceived as PME. This was inspired by the notion of Potential Energy in physics which suggests the energy stored in a body because of its position, or its configuration. PME consists of *Awareness*, *Agility* and *Vocabulary*, and is related to the notion of the performer's *Telos* defining the *end* of one's practice. For example, an orchestral percussionist and a improvising percussionist do not share the same performer *Telos*. This chapter addressed the research question of "What exactly does my agency entail as a performer of such a personal means of music making?" and also, partly, the question "Can such a bespoke instrument be truly transferable? Should it be?". It was concluded that, in the case of the *Augmented Drum-Kit*, the instrument is not a fixed entity, but a notion related to technology as a diachronic practice, intertwined with my own performative and compositional needs as a composer/performer. As such, it would not be sensible to consider the instrument neither as interchangeable nor transferable. Finally it was proposed, through examples, that PME can have both contructive or destructive qualities in group projects, with the individual performer PMEs acting similarly to complementary or cancelling forces in physics.

In *Chapter 3* I presented and defined *Awareness*, the first notion of *Potential Musical Energy*. Here, the initial research question " How should electronic sound diffusion be implemented so that the electro-acoustic instrument (ie percussion and the computer) is perceived as one entity?" was addressed, with the use of localised speakers close to the drum-kit, perhaps being to the instrument what the amplifier is to the electric guitar. This opposed the tendency of many NIMEs to use a wide stage PA leading to sound dislocation from the performer. Also, 1 to 3 speakers are used in close proximity to the drum membranes generating feedback with the microphones placed above them. This provides not only another means of sound unification but also a physical means of controlling the electronic sound by pushing the membranes or placing objects on top of the drums. The importance of fast visual access to parameter control was discussed, and how the textless symbol-based visual feedback of the *Augmented Drum-Kit*'s software influenced by road-sign design, required the similar speed and information efficiency in a performance scenario. Finally, NeVIS, a collaboratial tool for improvisational suggestion was presented and evaluated, which was designed to facilitate co-performer and co-instrumental awareness in any performance scenario.

In *Chapter 4* I described the third and final proposed framework, *Instrument Development Cycles*, each *cycle* consisting of A) Interface Design Improvisation B) Aesthetic-Shaping Improvisation and C) Inter-Contextual Improvisation. This framework was created in order to firstly facilitate the development the second factor of *Potential Musical Energy*, *Agility*, and eventually raise *Awareness* and sculpt the instrument's *Vocabulary*. It can also seen as a suggested solution to two of the initial research questions: "How can such an emerging hybrid instrument be controlled intuitively "as one would play a kazoo." (Bailey, 1993, 101)?" and "How can gestural uniformity be achieved with a hybrid instrument that consists of percussion (requiring larger gestures and a more physical performance) and the computer (inherently requiring microgestures for its control)?" Consistency in physical gestures is ensured during *Stage A: Interface Design Improvisation*, a period dedicated *solely* in investigating the necessary technology and suitable spatial configuration of the interface, without necessarily addressing the instrument's sonic or musical aesthetics. Intuitive control of the instrument is developed through the fixed periods of time dedicated to inter-contextual performance in *Stage C: Inter-Contextual Improvisation*. I

have argued that through repeated development cycles, as presented in this framework and illustrated by my own performance timeline and musical portfolio, that the instrument is not only shaped consistently around the performer/composer/builder's needs but also intuitive instrumental control is eventually achieved.

In *Chapter 5*, I demonstrated how I was possible to achieve a "consistent vocabulary between the two sound worlds" by sculpting it from a maximal explorative *Vocabulary* (as presented in **Album B: Signal Powder**) to a more consistent and concise *Vocabulary* (as presented in **Album A: Frrriction**). Also, I have described the methods followed towards unifying the two sound worlds, firstly by simulating acoustic attributes of the drum-kit into the digital realm, such as "snare buzz" and "unique performance events" and by also similating electronically produced textures with the use of extended techniques on the acoustic part of the instrument. Finally, it was detailed how all processing units are categorised according to their relationship to the physical performance into 1) Intertwined, 2) Peripheral and 3) Independent. In the third case it was also discussed how "exit strategies" needed to be devised when it was decided to disable these modules. Their independent nature (being perceptively disconnected from the physical performance, as opposed to the first category, which is entirely intertwined to the physical and thus stopping to perform physically results into immediate stop of the electronics) required extra considerations to not make their stop be perceived as too imposed or unnatural.

In *Chapter 6*, *Friction*, one of the most crucial factors of this performance practice, was defined as the loss of *Potential Musical Energy* manifested during the *Adaptation* process because of all unpredictable elements during the transition from the *Ideal Performance Environment* to the *Real Performance Environment*. It was argued that this ever present notion should be actively addressed by composer/performers, while necessary preventive measures should be taken against it as it can compromise any methodically envisaged *Real Performance Scenario*. This chapter attempted to address to the question "What tactics should be followed in order to be able to travel and perform extensively and in different contexts, just as with any traditional instrument?", by presenting various practical examples with the *Augmented Drum-Kit*, where extra measures were necessary to prevent performance compromise. For example, choosing a different more suitable *Extended Instrumental Space* at ICMC and deciding to setup and perform off-stage at INTER/actions.

7.2   Method

The method followed for the development of both the frameworks and the musical output was heavily performance-oriented. Performance here was not only used for the creation of new artistic work, but also served as a driving function or a clocking device, as all frameworks required extensive performance as the 'fuel' powering the practice's progression. Specifically, for *Instrumental Spaces* in *Chapter 1*, the *Ideal Performance Environment* is evolving from feedback from each performance's materialised *Real Performance Environment*. For *Potential Musical Energy* in *Chapter 2*, performance contributes towards the practice's progression on multiple levels: Firstly, extensive performance helps raise instrumental *Awareness* (and co-performer

Awareness in the case of group performance). Secondly, instrumental *Agility* can be developed only through performing repeatedly and engaging, physically, with the emerging instrument. Finally, the instrument's *Vocabulary* only became concise and consistent through repeated performance practice. As such, in order to progress any of its factors, and subsequenctly *Potential Musical Energy*, performance as a method was necessary. The third framework, *Instrument Development Stages* described in *Chapter 4* utilises performance, possibly in the most direct manner: A fixed period of time (*Stage C: Inter-Contextual Improvisation*) is assigned specifically for performance, during which, all technical instrumental development is halted. This aims for the performer to embody the new design choices made in *Stage A: Interface Design Improvisation* and *Stage B: Aesthetic-Shaping Improvisation* in different performance scenarios, aiming in parallel to produce musical outcome while evolving further the instrument's *Ideal Performance Environment*.

7.3   Constant Feedback

Not only was it important to perform regularly in order to progress the development of the instrument, but often performances as part of major academic conferences and festivals around the themes of computer and contemporary music or new instruments, such as ICMC, NIME, Sonorities, SOUND, BEAM, and so on (the full list of performances with the *Augmented Drum-Kit* can be found in Appendix G - Complete Performance History) was vital. While the developed frameworks ensure a valid personal instrumental development in any case without necessarily requiring third person feedback, in my case, performing in such festivals ensured the academic validity of the project. The peer-reviewed work submission and acceptance guidelines, as well as, perhaps more importantly, presenting the instrument repeatedly to a wide range of established practitioners and being to some extent part of this community and social milieu, acted as another instrumental fine-tuning mechanism alongside the three frameworks, which accelerated instrumental progress significantly, and is hopefully obvious between all submitted media. These practical and social aspects of the work informed this dissertation to a great extent and its theoretical tangents, which in turn, informed the practice again. I find that such events are particularly necessary, especially during the very first instrument development *cycles*, while I consider constant peer feedback invaluable. Continuous negotiation between composer/performer/builder and technology within a dynamic social context is the pinnacle of this practice.

7.4   Further Work

Possible further work on this project could be divided in two areas, firstly the technological and secondly the aesthetic direction. A interesting development for the instrument would be the further customisation of the electronic sound projection. While certain steps towards non-stereo sound diffusion were taken with the use of 1-3 speakers used to resonate the drum skins

(more commonly the floor tom skin), it would be interesting to explore diffusion possibilities in a way resembling more to the composite nature of the acoustic instrument. For example, instead of having two monitor speakers behind the drum-kit, 5-6 smaller speakers of different frequency responses could be spread around the drum-kit or positioned inside some of the drums, each having a different function or sonic role. These would be directly connected to the audio interface, just as the localised speaker approach described in *Chapter 3* and then a pair of overheads could be used to further reinforce the electro-acoustic sound if necessary in larger venues. While this might make travelling more demanding, as an amplifier and the speakers would have to be brought by myself (today all standard monitors are being provided by the organisers, which was important for the present stereo-based choice), I find that both the stereo diffusion of a vast majority of new instruments, and the use of the full frequency range in most cases, might be conceptually problematic. I believe that with the *Augmented Drum-Kit* I have suggested working more towards this direction, expanding on the true nature of the acoustic instruments in the case of augmented instruments, and finding more bespoke means of sound projection according to the emerging instrument's *Ideal Performance Environment* in the case of entirely new ones.

On another level, I also aim to further develop the Networked Vibrotactile Communication System for Improvisational Suggestion (NeVIS), as presented in *Chapter 3*, as I believe that there still is a lot of musical potential. Today, NeVIS works with pre-decided cues and time durations and it has mostly been used for two performers. Ideally the system would be scalable to multipe performers, and suggesting musical directions based on more abstact (than strictly time-based) pre-decided compositional choices, also taking into account musical material already detected during a performance, in real-time. This would of course require a greater level of technical sophistication, it would however help facilitate significantly performative awareness within groups, especially in the field of NIMEs, where as it was argued it can be more challenging to achieve. Such a system would also be in line with the framework of *Potential Musical Energy*, as these suggestions would be interpretable not in the form of strict notation but perhaps as more universal sonic attributes which each performer can interpret according to their own performance environment and musical aesthetics, such as density, pulse, and so on.

Finally, I will keep attempting to actively participate in and organise workshops and events that bring together composer/performer/builders, addressing the issues described in this thesis, such as LLEAPP and Inventor Composer Coaction (ICC)[1] (Which I co-organised in 2012 with Tom Mudd[2] and Lauren Hayes[3]). I believe that one of the most crucial elements on an aesthetic level is exposure to as diverse musical scenarios as possible, not necessarily within the academic environment. I plan to continue, as I have up to this point, collaborating and performing with the instrument as regularly as possible, finding common ground with other practitioners in order to further evolve my performance practice. The latest projects I am involved with using the *Augmented Drum-Kit*, all exploring and expanding different aspects of the instrument include: *FHM* with John Ferguson[4] playing a laptop-processed electric guitar

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[1] http://www.inventorcomposer.net/ (accessed August 2013)
[2] http://www.tommudd.co.uk/ (accessed August 2013)
[3] http://www.laurensarahhayes.com/ (accessed August 2013)
[4] http://www.johnrobertferguson.com/ (accessed August 2013)

with external controllers and Lauren Hayes playing drum machines, analogue synthesizers and laptop, *DMT* with Marco Donnarumma[5] playing the *Xth Sense* a biophysical musical instrument producing sound with the sound of the muscle tissue, and Atau Tanaka[6] playing the Apple iPhone, as an expressive, gestural musical instrument, and finally, a duo with Michael Edwards[7] playing saxophones and computer.

In the end, I do not make any distinctions between all the technological elements consisting my instrument. Electronic, acoustic, analogue and digital, they all serve very specific purposes within the setup and I did collect and assemble them in particular formations in order to facilitate reaching my musical *Telos*. Digital technology here is only completing parts of the picture that were missing from the acoustic version of my practice, or expanding it, while any further new technological additions will be simply solving the same problems in better or more efficient ways. I am very sceptical towards technological fetishism, often present in the community of digitally-based sound performance practice and music technology. Technical breakthroughs such as innovative game controllers, motion capture tools and new audio programming solutions can indeed present new unforeseen and exciting possibilities. However, I find their often hasty incorporation and use to be distracting. The frameworks and methods developed in this thesis are addressing live electronic performance practice and instrument design as a *diachronic* practice, advocating selective and precise use of technology. While it was stated numerous times that the essence of this instrument is its formlessness, this does not mean thoughtless and arbitrary use of available technological material in general, but flexibility *within* the presented instrument-defining and shaping frameworks. An organism evolves only *when* and *if* it is necesary. In the future, any enduring instrumental progress will come as a result of change in the environmental factors surrounding the instrument and myself as a performer, over time, just as a biological entity. Any imposed changes implemented fast and in isolation, with the arbitrary incorporation of new technological elements, drastic interaction design changes, or conceptualized in the form of academic articles and actualized without being informed by practice, will be most likely rejected by the reality of the performance environment—just like a body transplant is rejected by its receiver. In the constant pursuit of my musical *Telos*, whenever there is a desire to pursue a new aesthetic direction, all I need to do is expose the instrument and myself within the appropriate environment, if it exists, and through the proposed frameworks ensure consistent instrumental development, or decide the *Augmented Drum-Kit*'s complete reinvention.

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[5] http://marcodonnarumma.com/ (accessed August 2013)
[6] http://www.ataut.net/site/ (accessed August 2013
[7] http://www.michael-edwards.org/ (accessed August 2013)
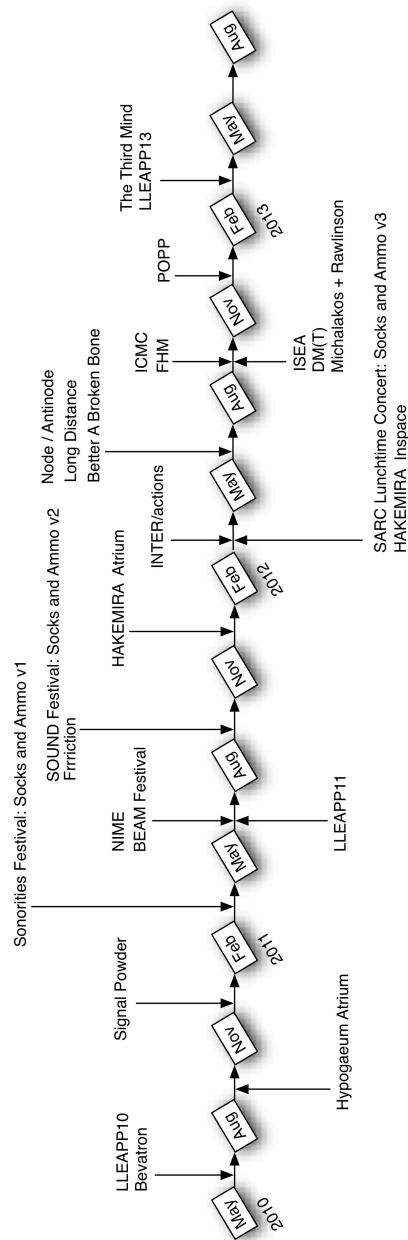
Appendix A: Timeline

Figure 7.1: Cycles / Performances: Each month arrow represents one cycle

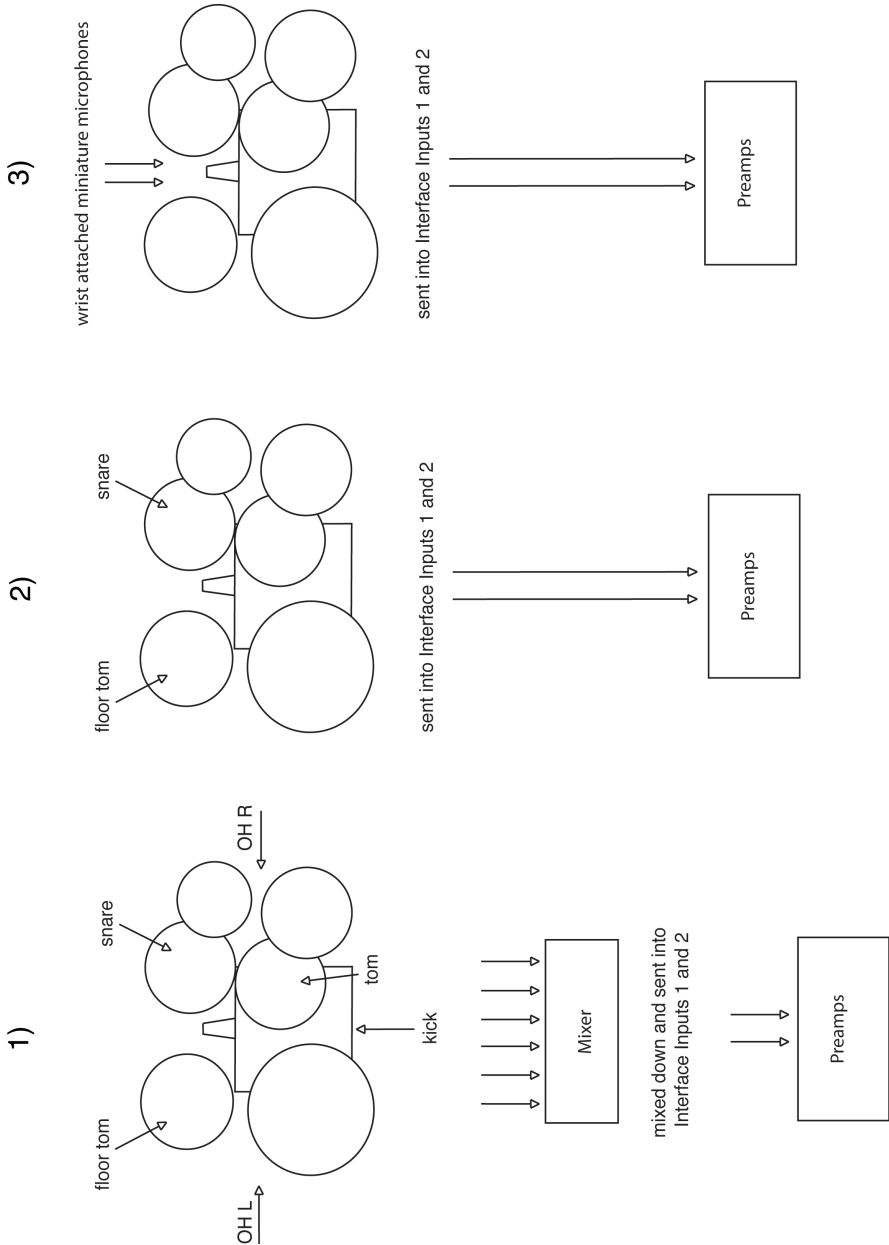# Appendix B: Input Strategies

Figure 7.2: 1) Studio Fixed 2) Focused 3) Dynamically Changing

Appendix C: Tables

Inputs	1	2	3	4	5	6	7
Use	Processing Audio 1	Processing Audio 2	Floor Tom Trigger (Feedback)	Kick Trigger	Tom Trigger	Pad Lock	Piezo

Table 7.1: Audio Interface Inputs List

Outputs	1	2	3	4	5
Use	Stereo Left	Stereo Right	Floor Tom Feedback Speaker	+ Feedback Speaker (Optional)	+ Feedback Speaker (Optional)

Table 7.2: Audio Interface Outputs List

Expression Pedal	Primary Control	Event 1	Event 2	Additional
Info / Condition	MIDI Value	Value = 0	Value = 127	Change Rate
Output	0-127	TRUE	TRUE	0(min)-1(max)
Switch Pedal	**Event 3**	**Event 4**	-	-
Info / Condition	Switch Toggle ON	Switch Toggle OFF	-	-
Output	TRUE	TRUE	-	-

Table 7.3: Expression and Switch Pedals: Information Extracted

	1	2	3	4	5	6
GRN	Density	Length	Pitch	Amplitude	Mute	-
ctrl	Pedal Value	Function 1	Function 2	Function 3	Pedal=0	-
WSH	Wet Signal	Wet Signal	Mute	-	-	-
ctrl	NanoPad2 Y	Function 1	Pedal=127	-	-	-
CAT	Length	Transposition Variation	Reverse Probability	Crossfade Time	Gain Variation	Input Volume
ctrl	Pedal Value	Pedal Value	Function 1	Function 2	Pedal Rate / Function 3	Pedal=0
PAD	Grain Trigger	Length	Pitch	-	-	-
ctrl	NanoPad Pads	NanoPad X	NanoPad Y	-	-	-
XY	Delay Time	Switch	Feedback	Ramp Time	Mute	-
ctrl	Pedal Value	Pedal=127	Function 1	Function 2	Pedal=0	-
PZO	Low Pass Freq	High Pass Freq	Switch	-	-	-
ctrl	Pedal Value	Pedal Value	Pedal=127	-	-	-
BIT	Resolution	Sample Rate	Degrade	Mute	-	-
ctrl	Pedal Value	Function 1	Function 2	Pedal=0	-	-
+++	Sweep Feedback	+Pitch Factor	+Feedback	+Loop Depth	Mute	-
ctrl	Pedal Value	Function 1	Function 2	Function 3	Pedal=0	-
DEL	Delay Time	RingMod Freq	Switch	Mute	-	-
ctrl	Pedal Value	Pedal Value	Pedal=127	Pedal=0	-	-

Table 7.4: Module Parameter Controls A

ENV	Amplitude Envelope 1	Amplitude Envelope 2	Mute	-	-	-
ctrl	Signal Input 4	Signal Input 5	Pedal=0	-	-	-
FRZ	Freeze Factor	Hi Bin Cutoff	Randomize Phases	Mute	-	-
ctrl	Pedal Value	Function 1	Pedal Rate / Function 2	Pedal=0	-	-
SCRB	Sample Position	Record	Mute	-	-	-
ctrl	Pedal Value	Switch	Pedal=0	-	-	-
GRAB	Playback Length	Switch	Clear Buffers	-	-	-
ctrl	Pedal Value	GrabBonk	Switch	-	-	-
REV	Wet Signal	Decay Time	Size	High Freq Damp	Diffusion	Mute
ctrl	NanoPad2 X	Pedal Value	Function 1	Function 2	Pedal Rate / Function 3	Pedal=127
LOO	Taint Mix Wet	Playback Rate	Switch Rate	Fade Out	-	-
ctrl	Pedal Value	Function 1	Pedal=127	Switch	-	-
MACH	Ramp Times	Freeze	Mute	-	-	-
ctrl	Pedal Value	Pedal=127	Pedal=0	-	-	-
SUN	Output Volume	Mute	-	-	-	-
ctrl	Pedal Value	Pedal=0	-	-	-	-
FDB	Output Volume	-	-	-	-	-
ctrl	Pedal Value	-	-	-	-	-

Table 7.5: Module Parameter Controls B

Appendix D: HAKEMIRA commentary

```
[00:00] - [03:40] exploration - sparse gestures - non-commital
[03:24] Lauren introduces a musical phrase on the synths holding everything together
[03:24] - [05:50] everyone tries to join in
[05:50] climax of this idea
[06:35] Christos introduces a rhythmical phrase to extend the section
[07:04]-[07:13] confusion
[07:13] idea dies
[07:24] back to square one
[07:24]-[08:30] noodling
[08:40] fragmented rhythms which Paul supports and everyone eventually joins in
[10:10] idea dies
[10:10] - [10:20] Paul insists
[10:30] - [11:18] possible rebirth of previous section
[11:18] idea dies again
[11:29] square one again
[11:29] - [11:55] noodling
[11:55] Christos makes bold gestures
[11:55] - [14:00] everyone tries to join in
[13:30] Lauren introduces long pitches
[14:00] Jules introduces percussive rhythm
[14:30] Hope for a consistent section but rhythm stops at [14:40] so it starts
feeling dead again
[15:20] Lauren still tries to hold onto what she does
[16:00] Christos gives the final blow to the section sensing that it's about to die
[16:16] new idea with Lauren's bass synth and everyone joins
[17:50]-[18:52] climax of the idea
[18:52] idea dies
[19:00] new idea
[19:00] - [24:10] each member is very aware of their role in this section, there is
good listening and consistency - perhaps the most coherent part of the while concert!
[24:10] - [26:06] waiting
[26:06] Christos plays
[26:10] Lauren joins
[26:16] Paul joins
[26:27] Jules plays more sounds
[26:40] still thinking that this is going nowhere, Christos decides to play something
loud
[27:30] nothing seems to be happening, everyone waiting
[28:00] idea dies
[28:00] Lauren plays pitched phrase hoping to hold it all together
```

[28:00] it doesn't succeed

- end of first part -

[29:30] Christos plays semi-rhythmically
[30:15] everyone joins in coherently
[31:12] for some reason Christos stops (!)
[31:17] everyone unsure where to go from here, Christos tries to make up for it
[32:16] Lauren plays bass synth with good potential for the group's unity
[32:47] Christos tries to support Lauren rhythmically and Paul joins in but the bass stops, which eventually makes everyone stop. Jules makes more sounds
[33:40] Christos decides to play on the snare and hi-hat boldly since the performance is about to end and wants to at least finish confidently
[34:50] - [35:33] a coherent ending with the help of Paul's chords and Lauren's bass which however sounds a bit expected
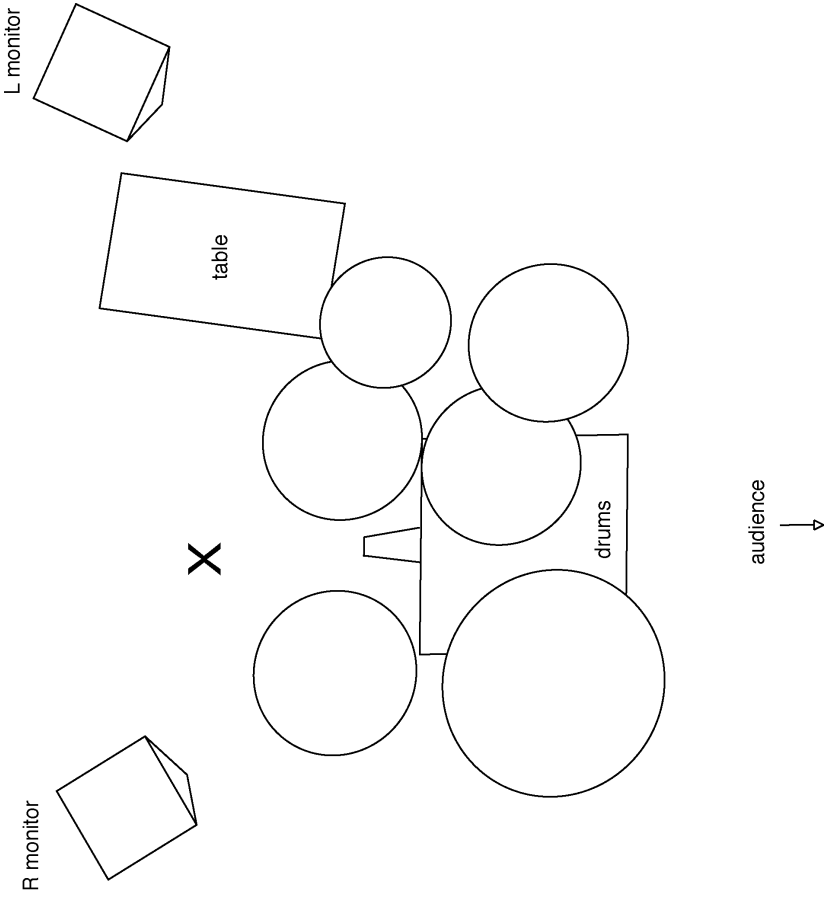
Appendix E: Stage Plans
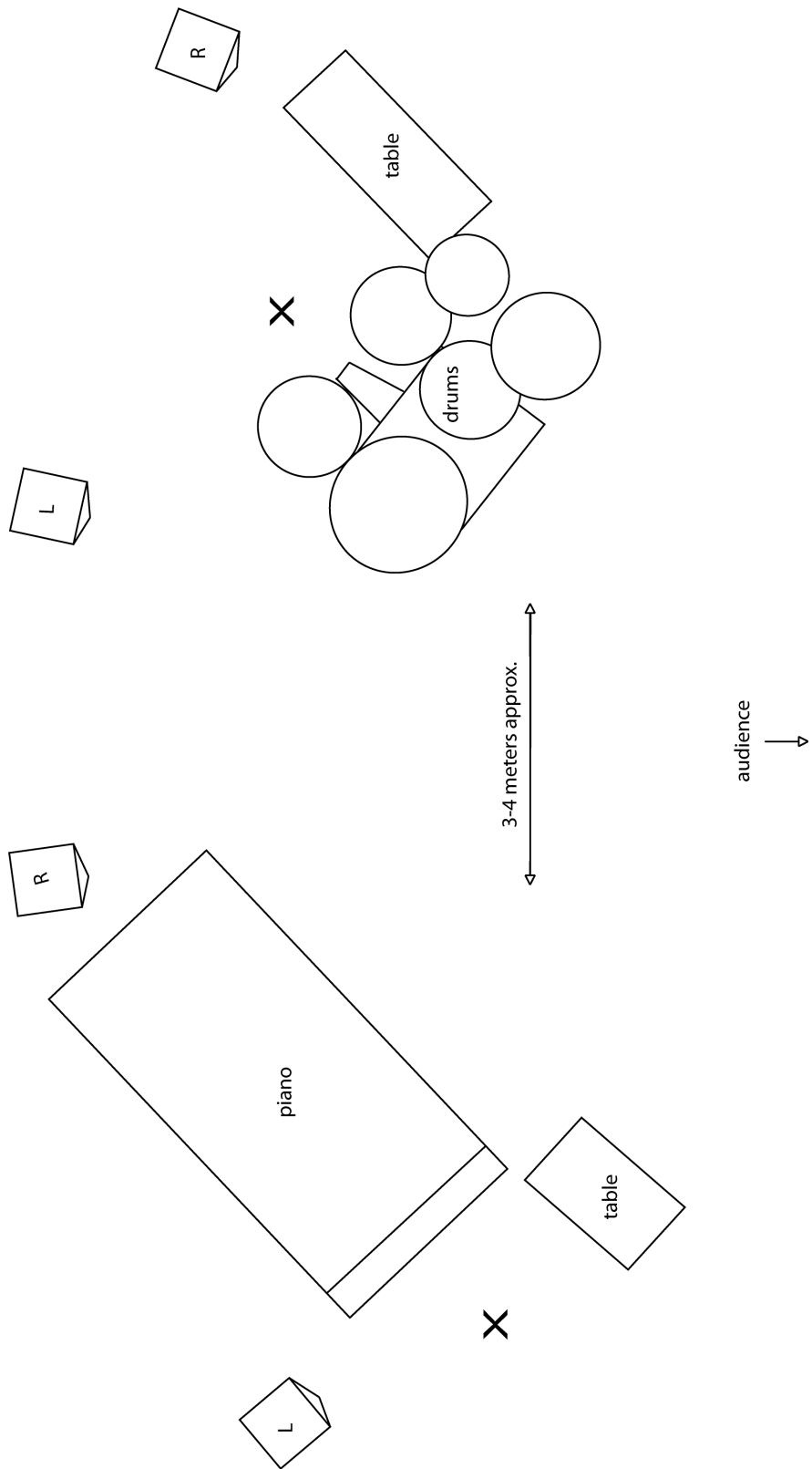

Figure 7.3: Solo Performance Stage Plan

Figure 7.4: Můstek Piano / No Amplification / Localised Electronics Stage Plan
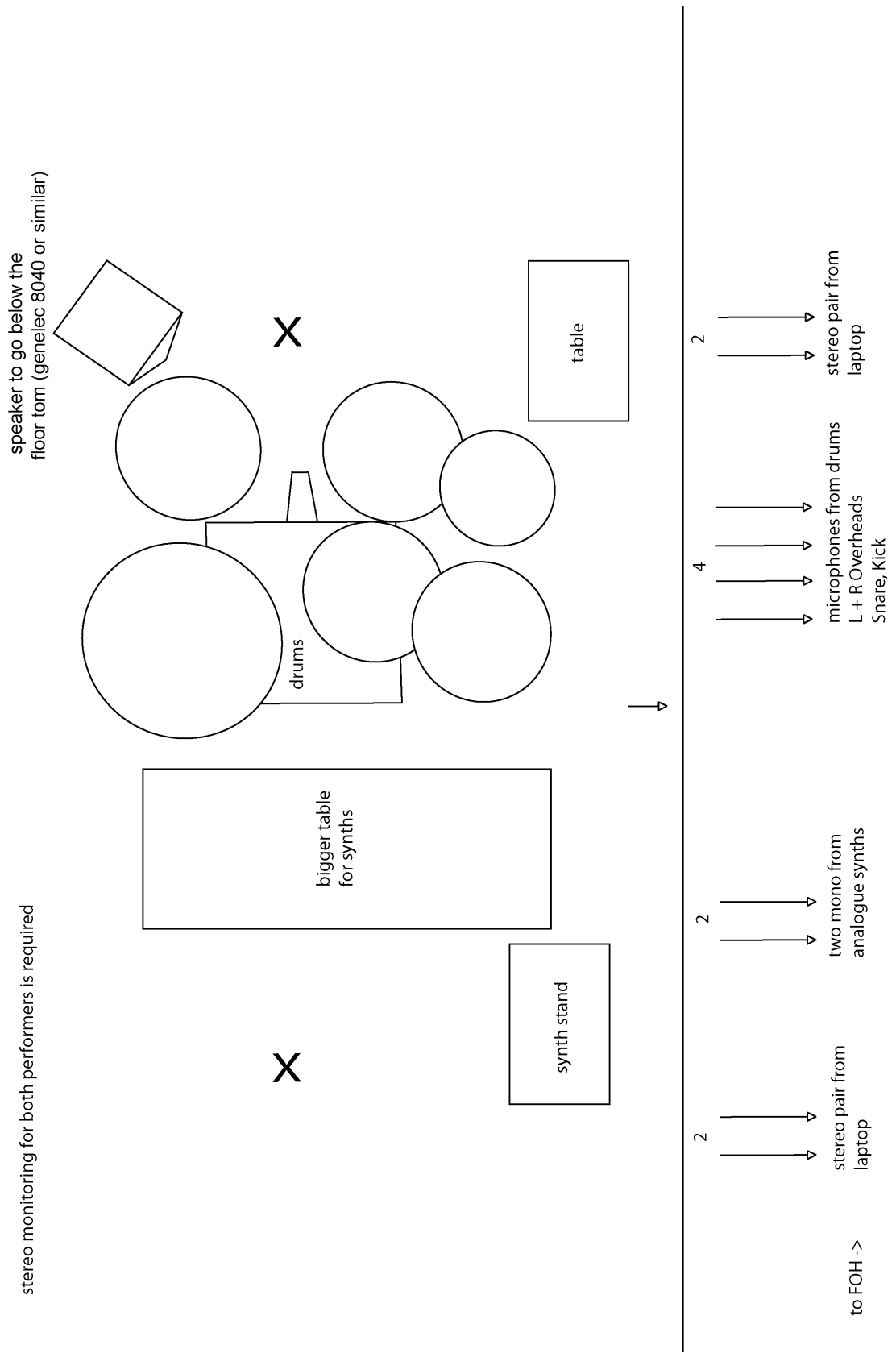
Figure 7.5: Mŭstek Synths / Instrument Amplification / FOH Electronics Stage Plan

Appendix F: Software Overview

The instrument's software was developed for and used with
Max/MSP Jitter - Version 5.1.6 on Mac OS X 10.6.8

FTM&Co: http://ftm.ircam.fr/index.php/Download
CataRT: http://imtr.ircam.fr/imtr/CataRT
noise-gate~ / **sweeping_delay~**: http://cnmat.berkeley.edu/downloads
au~: http://www.michaelnorris.info/software/au.html
taint~: http://www.sarc.qub.ac.uk/~elyon/LyonSoftware/MaxMSP/FFTease
bonk~ / **fiddle~** :http://crca.ucsd.edu/~tapel/software.html
mdeGranular~: http://people.ace.ed.ac.uk/staff/medward2/software/mdegranular/
RTC-lib: http://www.essl.at/works/rtc.html

Soundhack: **+Pitchdelay**: http://www.soundhack.com/freeware/
Smart Electronix: **mdaDubDelay** / **mdaRingMod**: http://mda.smartelectronix.com/
Michael Norris: **Spectral Freezing**: http://www.michaelnorris.info/software/soundmagic-spectral.html

All required Max/MSP packages, externals, VSTs & AU are included in the *Software* folder.

Please follow the installation instructions for the specific packages including them in the

Max 5/*Cycling '74* folder. Also, please copy the provided VSTs and AU into their respective folders within *Library/Audio/Plug-Ins.*

-

For more details regarding exact audio interface input / output use and module parameter assignments please refer to the thesis' *Appendix C: Tables*

Here is an overview of the electronic setup. It is important that all hardware connections are set up before the initialisation of the Max/MSP patch:
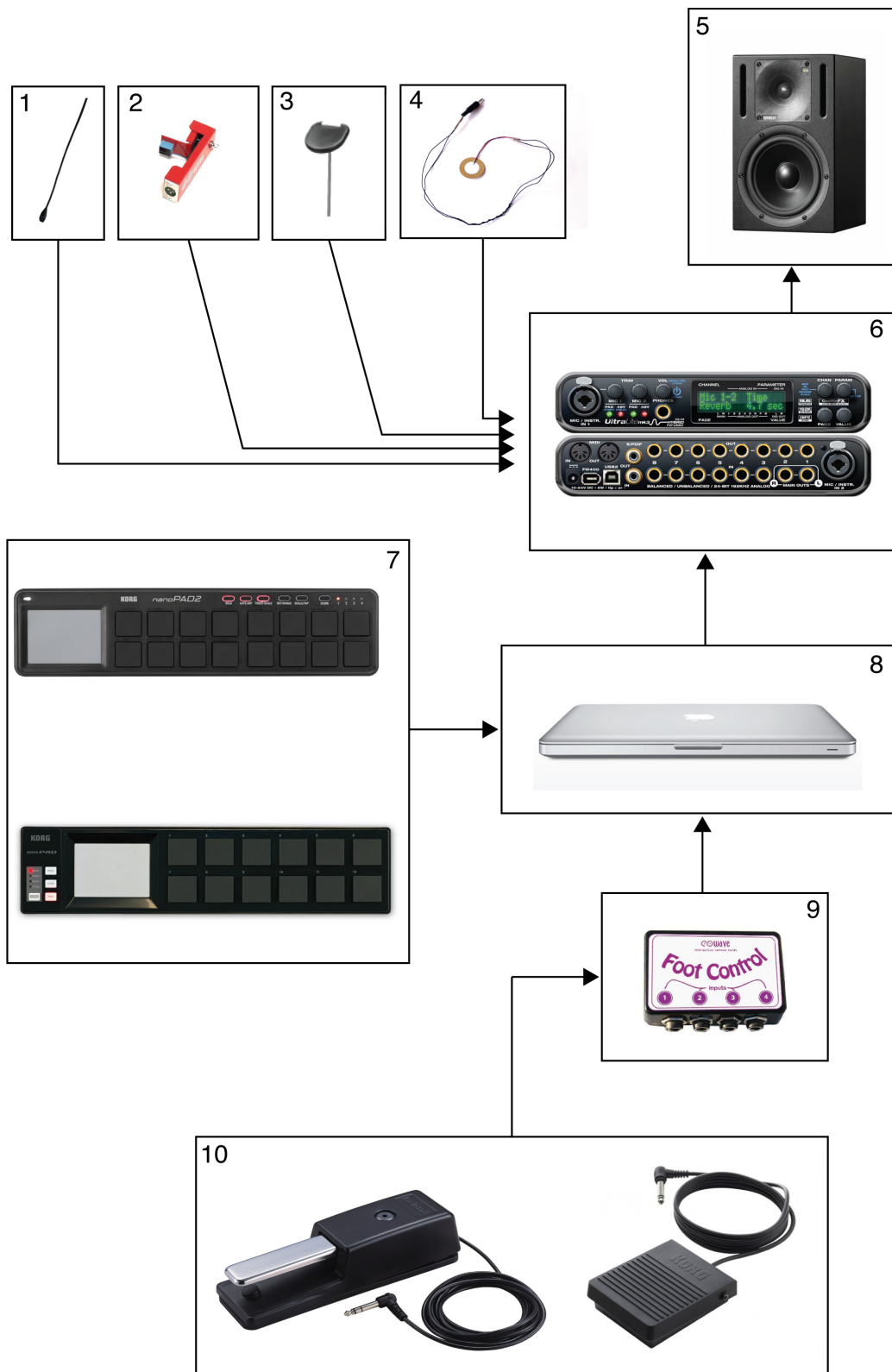
The hardware used, as seen above, is:

1) 2 x DPA 4060 Miniature Omnidirectional Microphones
2) 2 x Ddrum Triggers attached on the Kick Drum, Small Tom and Floor Tom
3) 1 x DrumXtreme DX-MIDI-Pro Pad used as the "Lock Pad"
4) Custom made contact microphone
5) 3 x Genelec HT208 (2 Stereo Audio Interface Outputs + 1 Floor Tom Feedback)
6) Firewire MOTU Ultralite mk3
7) USB Korg NanoPad + Korg NanoPad2
8) Apple Macbook Pro: Mac OS X 10.6.8 (Processor 2.4GHz i5, Memory 4GB DDR3)
9) USB Eowave Footcontrol
10) Roland DP-10 Damper Pedal and Korg PS3 Switch Pedal.

==LOADING THE SOFTWARE==

==1) Load the file _cm.main.maxpat located in the Software folder==

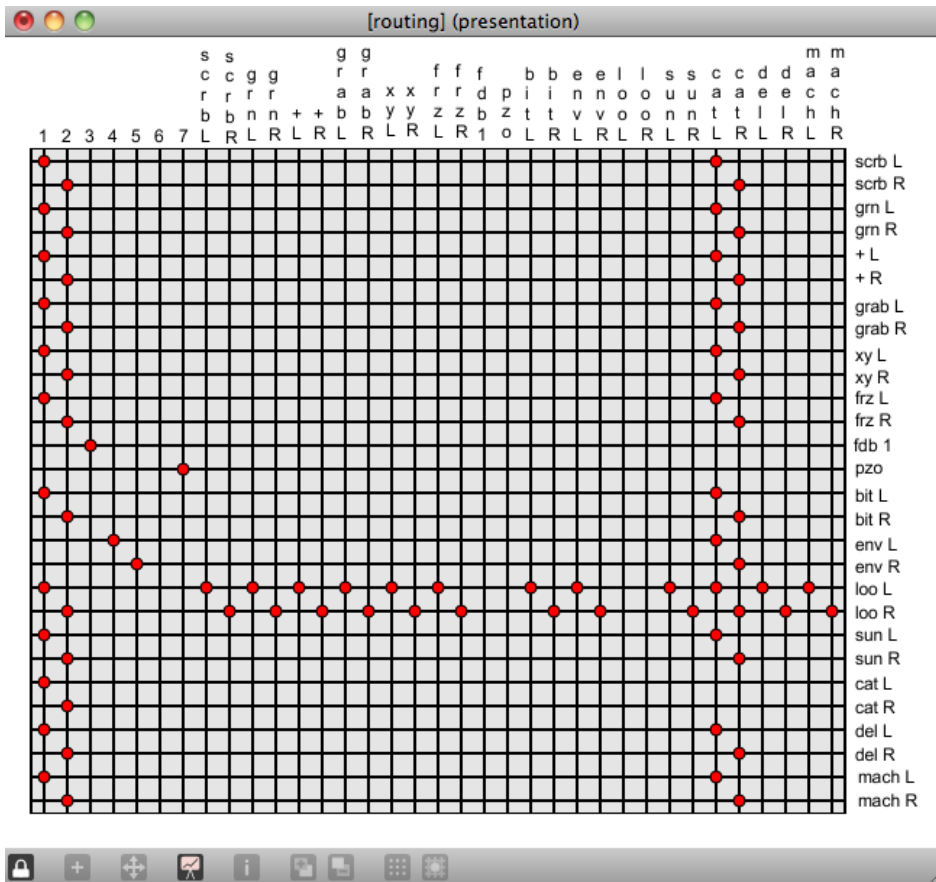(Please note that the loading time can vary according to each machine's specifications. A slight delay is to be expected, nevertheless.)

The main window of the patch will load as can be seen here:
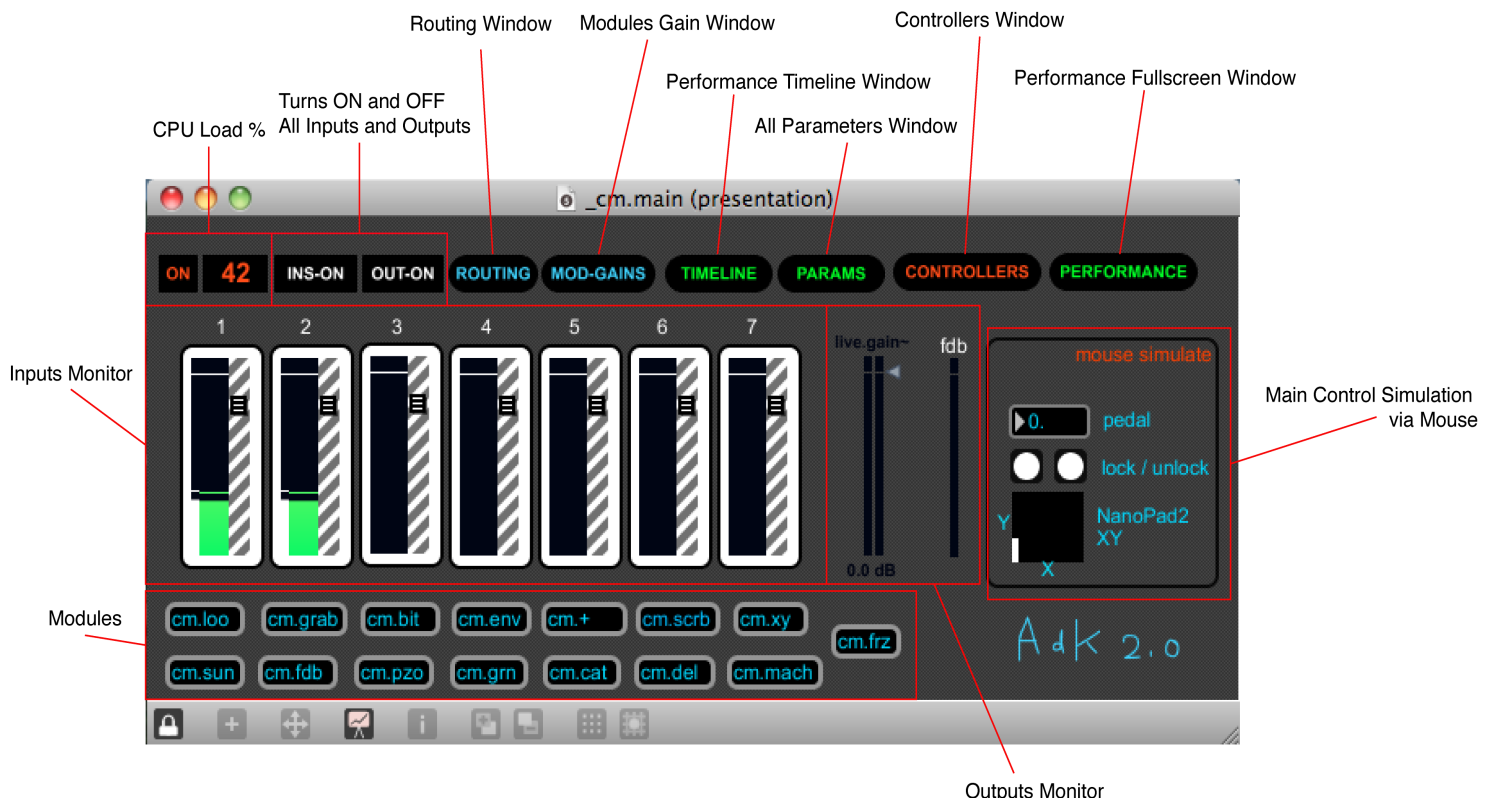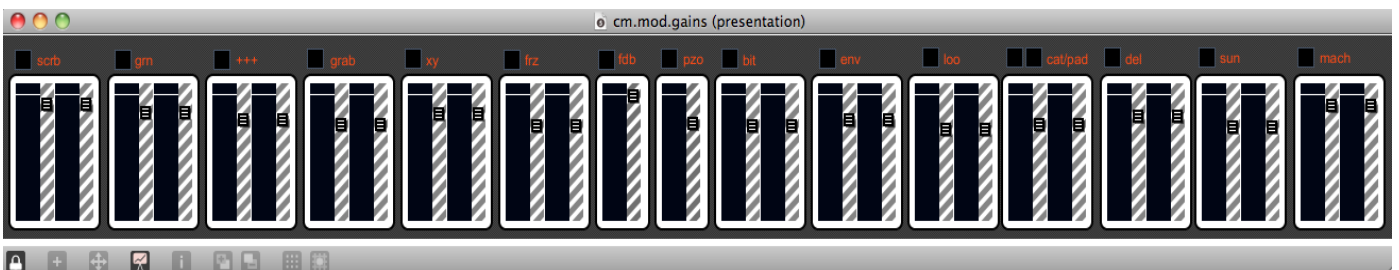
From here, the following windows can be accessed through their respective buttons:

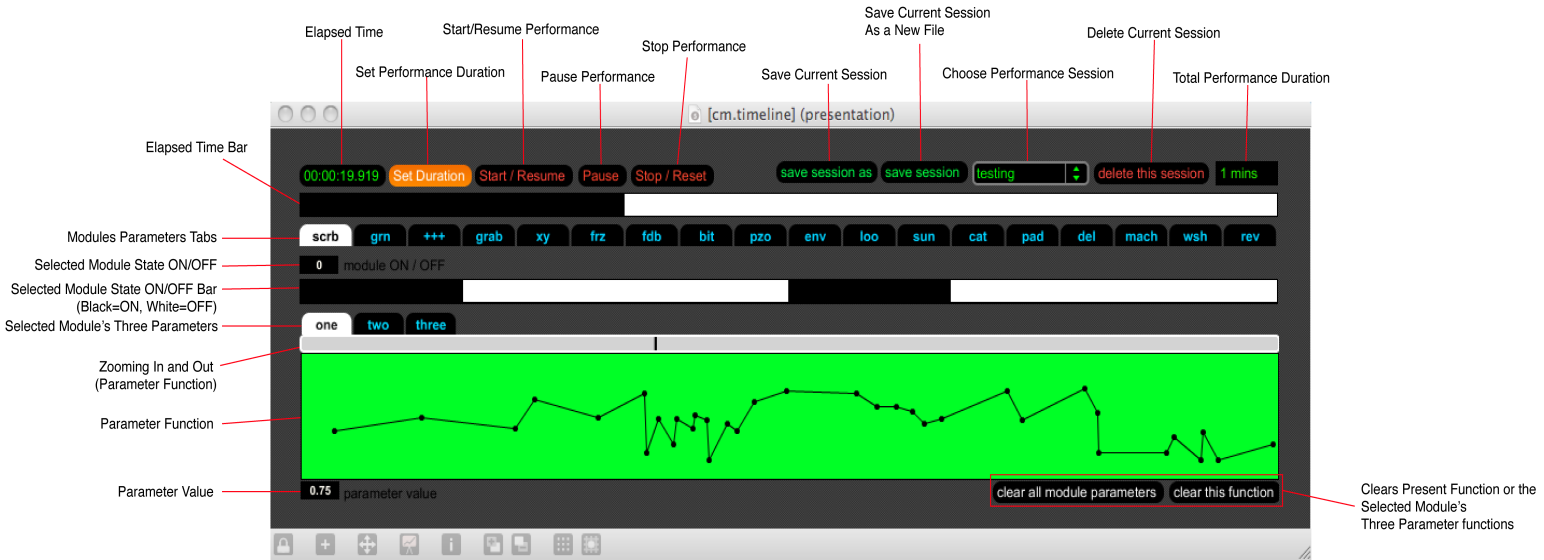**a) Routing Window** (audio routing between the various modules)**:**

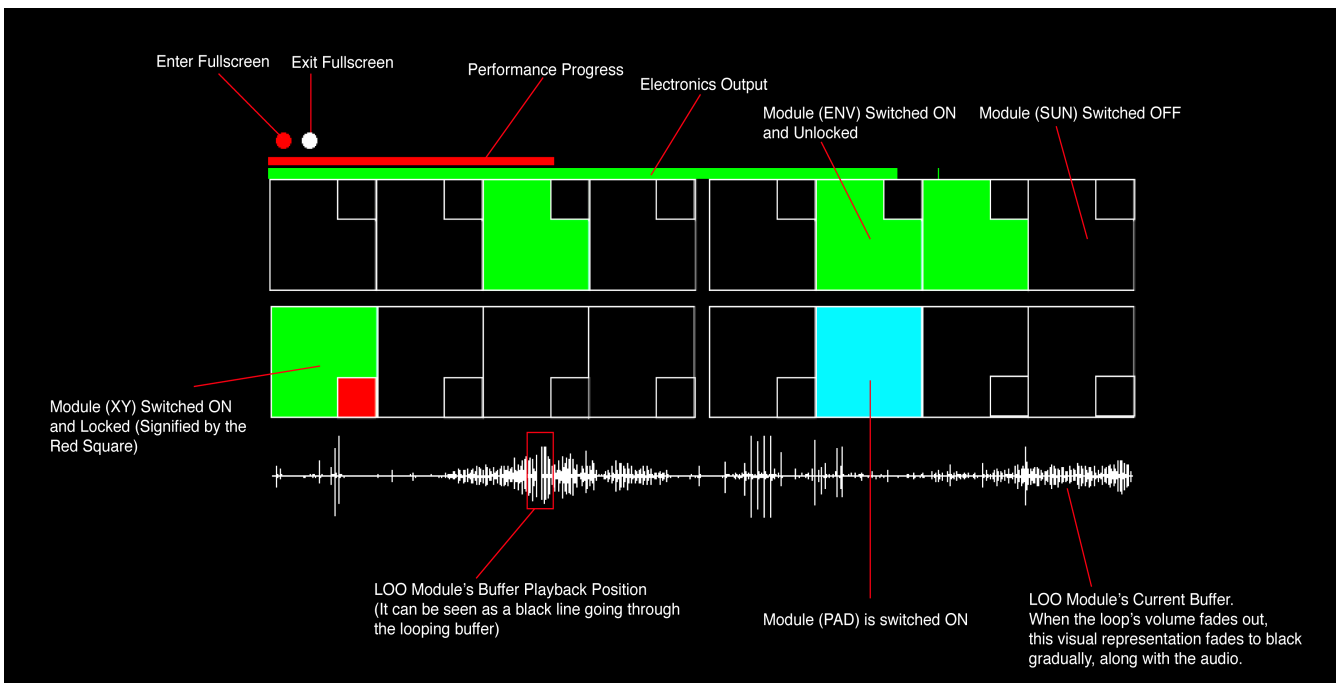**b) Modules Gain Window** (collective module gain control)**:**

c) Performance Timeline Window:

This window is relevant only when it is desired to perform based on a pre-decided structure. This involved modules being switched ON and OFF at certain points, while three of the modules' parameters are pre-decided and stored via functions.

Elapsed Time
Set Performance Duration
Start/Resume Performance
Pause Performance
Stop Performance
Save Current Session
Save Current Session As a New File
Choose Performance Session
Delete Current Session
Total Performance Duration
Elapsed Time Bar
Modules Parameters Tabs
Selected Module State ON/OFF
Selected Module State ON/OFF Bar (Black=ON, White=OFF)
Selected Module's Three Parameters
Zooming In and Out (Parameter Function)
Parameter Function
Parameter Value
Clears Present Function or the Selected Module's Three Parameter functions

d) Performance Fullscreen Window:

Enter Fullscreen
Exit Fullscreen
Performance Progress
Electronics Output
Module (ENV) Switched ON and Unlocked
Module (SUN) Switched OFF
Module (XY) Switched ON and Locked (Signified by the Red Square)
LOO Module's Buffer Playback Position (It can be seen as a black line going through the looping buffer)
Module (PAD) is switched ON
LOO Module's Current Buffer. When the loop's volume fades out, this visual representation fades to black gradually, along with the audio.

Both during a Free (default) or a Timeline based performance, the controllers operate in the same manner. The Korg NanoPad2 having 16 pads is used to switch ON and OFF the modules, while the Korg NanoPad is used to trigger corpus grains directly within the module **PAD** (Blue Colour) (as opposed to **CAT,** which triggers segments from the same corpus as "close" as possible to the live incoming sound from the drum-kit according to the assigned descriptors)

Here, it can be seen in more detail where each module is assigned, which is also consistent with the visual representation on the Performance Fullscreen Window:

PAD - Manual Corpus Grains Triggering
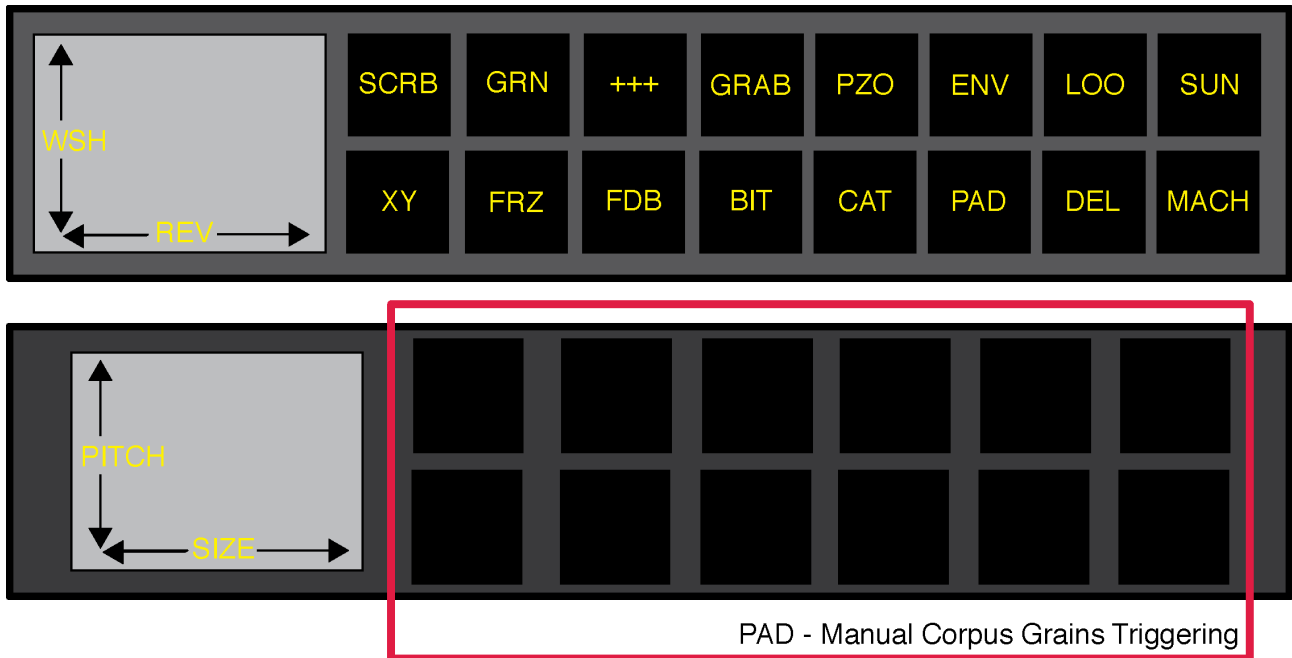
Additionally, some of the audio interface's effects are applied before the final output on the electronic sound. These are: equalisation, compression and reverb.
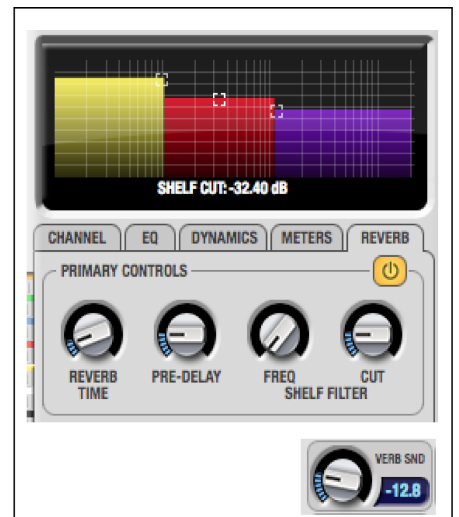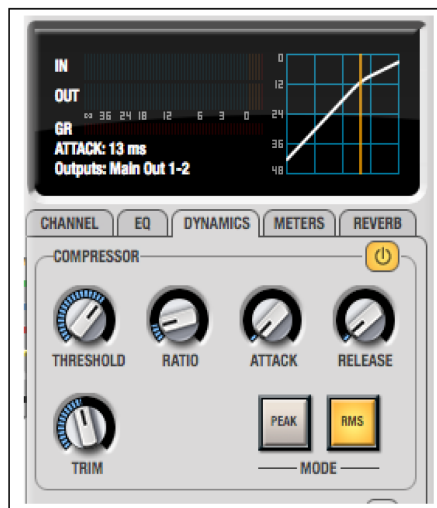
Appendix G: Complete Performance History

18.04.13 LLEAPP Concert 2, Inspace, Edinburgh

16.04.13 LLEAPP Concert 1, Inspace, Edinburgh

12.04.13 solo @ Goldsmiths University, London

30.03.13 with Edimpro and Supersonic @ Reid Hall, Edinburgh

06-07.03.13 Third Mind performance @ Cryptic Nights, CCA, Glasgow

27.02.13 with Edimpro and Sabine Vogel @ LRA, Edinburgh

23.02.13 with the Concordia Laptop Orchestra @ Network Music Festival, telematic concert

12-13.02.13 Practical Workshop and Concert with Centrifuge @ Inspace, Edinburgh

25-27.01.13 Inspace Residency with Matt Collings @ Inspace, Edinburgh

19.01.13 with Black Isle Corpus @ PRAXIS, Atrium, Edinburgh

-

08.12.12 wih Edimpro and Notes Inégales @ Inspace, Edinburgh

21.11.12 with Mǔstek @ POPP, Centre for Contemporary Arts (CCA), Glasgow

14.10.12 with Black Isle Corpus @ Banshee Labyrinth, Edinburgh

04.10.12 with Marco Donnarumma @ Data is Beautiful, Budapest

26.09.12 with Jules Rawlinson @ The Atrium, Edinburgh

23.09.12 solo @ ISEA 2012, Albuquerque

23.09.12 with Marco Donnarumma and Adam Parkinson @ ISEA 2012, Albuquerque

09.09.12 solo @ ICMC2012, Ljubljana

05.06.12 with Lauren Hayes and John Pope @ Reid Hall, Edinburgh

10.05.12 with Svoboda, Edwards, Parker and Hayes @ Reid Hall, Edinburgh

09.05.12 Death Ground premiere for Noisy Nights @ Jam House, Edinburgh

12.04.12 solo @ INTER/actions, Bangor

07.04.12 with HAKEMIRA @ Inspace, Edinburgh

30.03.12 with HAKEMIRA @ The Bone House, Edinburgh

23.03.12 solo @ Sonorities Festival, Belfast

18.03.12 with Edimpro and Raymond MacDonald @ Reid Hall, Edinburgh

23.02.12 with Můstek @ SARC Sonic Lab, Belfast

28.01.12 with Můstek @ Network Music Festival, Birmingham

-

05.12.11 with HAKEMIRA @ The Atrium, Edinburgh

23.10.11 with Můstek @ sound2011, New Music Scotland, Aberdeen

11.08.11 with Můstek @ Whitespace, Edinburgh

10.08.11 with Můstek @ Whitespace, Edinburgh

24.06.11 with Stelarc and Lore Lixenberg @ BEAM Festival, London

24.06.11 solo @ BEAM Festival, Brunel University, London

18.06.11 with HAKEMIRA @ Reid Concert Hall, Edinburgh

15.06-17.06.11 Reid studio, album recording session with Matt Collings

14.06.11 with Edimpro and Anne La Berge @ LRA, Edinburgh

31.06.11 with Můstek @ NIME 2011, Oslo

16.05.11 with Hayes and friends @ Forest Cafe, Edinburgh

13.05.11 performing Jules Rawlinson's PUTTP @ Soundings Festival, Edinburgh

13.05.11 with Pope and Hayes @ Soundings Festival, Edinburgh

03.05.11 LLEAPP 2011 conference and performance, University of EA, Norwich

25.04.11 with Edimpro and Diemo Schwarz @ LRA, Edinburgh

09.04.11 with Můstek @ Sonorities Festival of Contemporary Music, SARC, Belfast

04.02.11 with Můstek @ Sound Thought Festival, The Arches, Glasgow

-

19.11.10 with Edimpro, Mick Beck and Phillip Marks @ LRA, Edinburgh

06.10.10 with Můstek @ The Atrium, Edinburgh University

28.09.10 with John Pope and Lauren Hayes @ Voodoo Rooms, Edinburgh

02.09.10 with John Pope's Sigil quartet @ Newcastle University

15.07.10 solo @ Reid Concert Hall, Edinburgh

22.05.10 LLEAPP 2010 conference and performance, Newcastle University

18.04.10 with Dave-Murray Rust @ Unique Beats, Edinburgh

12.01.10 with Můstek @ Stills Gallery, Edinburgh

Imposing a Networked Vibrotactile Communication System for Improvisational Suggestion

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This paper describes the implementation of *NeVIS*, a local network system that establishes communication between individual performers, as well as between laptop and performers. Specifically, this is achieved by making use of vibrotactile feedback as a signalling tool within an improvisational setting. A discussion of the current developments regarding the use of networks within improvisation is presented, followed by an outline of the benefits of utilising the haptic feedback channel as a further sensory information pathway when performing digital music. We describe a case study of the system within the context of our computer-mediated improvisational duo Můstek, involving piano, percussion and live electronics. Here, a cueing system or framework is imposed over the improvisation and is transmitted directly to the skin of the performers via tiny vibrations. Additionally, performers may make use of simple vibrotactile signals to enhance traditional visual cues that are often employed within performance. A new work, *Socks and Ammo*, was created using NeVIS, and was presented at various international conferences and festivals. We also tested the system itself within a group of postgraduate researchers and composers. Qualitative evaluation of the musical outcomes as experienced both by the performers and by the listeners at these events is offered, as well as implications about the nature of collaborative music-making.

1. INTRODUCTION

The motivation behind much of the current laptop-centred networked performance seems to be the construction of enhanced musical relationships within a system comprising performers and instruments. Often, due to the logistics of performing with laptops, where information is displayed on a sizable screen, and the laptop is usually placed on a table along with peripherals, such as soundcards and controllers, the scope to facilitate gestural anticipation, recognisable visual cues, or meaningful physical movements is much more reduced than with performances using traditional instruments. As Seddon observes, 'when jazz musicians play together they have at their disposal verbal communication, non-verbal communication (e.g. eye contact, aural cues and body language) and musical communication' (Seddon 2005: 47). When a percussionist hits a drum, the other performers and the audience have a clear idea of the causal agency between the action and the resultant sound. However, in the field of electronic music, and moreover laptop performance, it becomes more difficult to rely on physical gesture to convey, for example, the onset of one's sound to an audience, or to communicate with other performers. This may be due either to the nature of the interface being used – in the case of mice, keyboards or other devices involving micro-movements of the hand – or to the complexity of the sonic outcome, where it may be unclear how a sound has been produced, or indeed who has made it.

1.1. Networked music performance

Along with recent technological possibilities, these issues of performance and communication have driven musicians and sound artists increasingly to explore various types of networked music performance (NMP). A large portion of this research deals with high-quality uncompressed audio streaming. For example, the *SoundWIRE* project, at CCRMA, Stanford, examines methods of creating networks over the Internet as a means of extending the realm of computer music performance. In fact, one particular concert spanned a geographical distance of over 6,000 miles (Cáceres, Hamilton, Iyer, Chafe and Wang 2008). Such NMPs were emulated in the *Apart Project*, undertaken at the Sonic Arts Research Centre, Belfast, in order to 'better understand conditions for performance that are created, facilitated and suggested by geographically displaced network performance environments' (Schroeder, Renaud, Rebelo and Gualdas 2007). Various scenarios were constructed in which performers in dislocated situations received audio and video feeds of each other, both with and without latency, so as to help better understand the complex effects of musical cues. Whilst thoroughly technically descriptive, this project clearly alludes to the power of networks in relation to social concepts, such as community. Moreover, it concludes that rather than trying to recreate that which occurs on the stage, one should 'rather take advantage of the

network itself as a medium for performance' (Schroeder et al. 2007: 139).

This idea of using the network as an agent for performance has been realised with the emergence of numerous laptop orchestras, such as *PLOrk*, based at Princeton University. Using local wireless networks and focusing on data transmission of parameter and timing control, rather than audio-streaming (although not precluding wired audio networks), this group has developed strategies for performing with laptops and localised speakers by applying techniques for real-time synchronisation, cueing, scheduling and non-bodily visual communication (Trueman, Cook, Smallwood and Wang 2006). Here, the notion of connectivity within the digital realm is furthered by the introduction of a 'conductor machine'. This can guide the piece by, for example, sending simple text instructions to the performers, or by directly affecting specific parameters such as tempo (Trueman et al. 2006).

Two further projects that draw on this idea of a virtual conductor, but remain within the realm of improvisation, should be mentioned. Anne La Berge and Robert van Heumen's duo *Shackle* consists of a local network between two laptops, over which a series of cueing commands are sent (La Berge and van Heumen 2006). These directions include 'aspects of restriction, either in sound material, timing, dynamics or other musical parameters' (La Berge and van Heumen 2006), and are presented in a somewhat abstracted form to the audience on a projection screen. Additionally, the players may skip past a particular state, if so desired. The ensuing performance presents the two musicians indeed *shackled*, but clearly toying with and struggling against the imposed restrictions. Similarly, external direction is given to a group of four performers in Eric Lyon's *Selected Noise Quartets*, where instructions are generated in real time and sent to each performer via a laptop screen (Lyon 2011). Here, it is noise itself that guides and creates the structures behind the improvisations; the performers must be able to react quickly to the often highly unpredictable changes. Again, a struggle may arise as the instructions are frequently unfamiliar, and may in fact be technically impossible to carry out. Yet, through all the exertion 'the voice of each musician is heard; and behind it, the voice of noise' (Lyon 2011:98).

1.2. The reintroduction of haptic sensation

The *Selected Noise Quartets*, which are performed on acoustic instruments and electric guitar, demand a great deal of dexterity from the players. However, it is arguable that, compared to what can be achieved with conventional instruments, the level of physical sensitivity and control required for such deftness is absent in *digital* musical instruments (DMIs). Most traditional instruments are constructed to be played with the mouth or hands, where the largest number of sensory receptors in the body can be found (Rovan and Hayward 2000). Performing with these instruments provides the player with a wide range of physical forces and vibrations, which create an embodied knowledge about the nature of the sound being produced. Vibrations felt through a percussionist's hands from the mallets and through the legs from the bass drum pedal, as well as the *bounce* that the taut drumskin offers, all inform the performer about, for example, the dynamic, timbre or shape of the sound that is being produced. Hence what is heard through the ears is supported by this physical feedback mechanism, which creates a closed loop of ongoing listening and sensing, playing and readjusting. This all occurs before, and whilst, making each subsequent sound. Thus, by introducing artificial vibrotactile feedback to DMIs, some attempt may be made to restore this vital sensory information.

Generally, interfaces for digital musical offer minimal haptic feedback. They rarely reveal to the performer any tangible information in themselves about the qualities of the sound being made. Working with specially designed haptic interfaces, such as Claude Cadoz's *Modular Feedback Keyboard* (Cadoz, Lisowski and Florens 1990), physical forces, including resistance and pressure, can be carefully introduced to enhance our interactions within the digital realm. Furthermore, as the sensing nerves on our skin are capable of detecting extremely complex patterns of data (Gunther and O'Modhrain 2003), additional *vibrotactile* feedback can be added to DMIs by way of actuators, such as motors. Marshall and Wanderley, at CIRMMT, McGill University, measured the effects of embedding vibrotactile stimuli in DMIs, with varied results (Marshall and Wanderley 2011). They noted that while adding vibrotactile feedback may improve the *feel* of the instrument, the extra sensory load caused some participants to feel less in control of their playing. However, this may in fact be beneficial in terms of creating a *challenging* instrument that could be mastered *over time*. Indeed, it is generally accepted that haptic feedback can assist learning processes (Davidson 1976), and, as discussed above, it is undoubtedly significant in the role of building a performer's perception of sound. Moreover, this experience is uniquely private to the performer, forming an intimate relationship between musician and instrument.

2. BACKGROUND

This section gives a brief contextual summary of the musical activity surrounding this project. The Networked Vibrotactile Improvisation System (NeVIS) arose out of a two-year-long collaboration between the authors, both composer/performers, combining

piano and live electronics (Hayes) with percussion and live electronics (Michalakos). Both being practitioners of digital augmentation and hybridisation of our chosen acoustic instruments, we inevitably began to develop strategies that attempted to tackle some of the issues related to performing with augmented acoustic instruments in a collaborative environment. We also both engage in a variety of extended techniques. To give some information about the systems being used: typically, the acoustic percussion or piano sound is amplified, and is also converted to a digital signal for further processing. Analysis of the incoming sound occurs continuously, in real time, and the various parameters derived, including pitch information, density and dynamics, are used to drive assorted processes within Max/MSP[1] and Max for Live.[2] Additional controllers such as foot pedals, sensors and MIDI interfaces are often also employed; these provide hierarchical control over various parameters within the software. While our individual approaches have both favoured hybridisation that makes use of machine listening techniques, we have found ways to integrate these additional devices without losing any sense of flow or agility. In fact, being able to dynamically control the level of one's digital sound is something that we have both found to be a necessary feat.

The creation of the NeVIS project emerged both from ideas developed throughout our experience as the improvising duo Můstek (Figure 1), as well as through individual research exploring on the use of vibrotactile feedback as a performance tool (Hayes 2011). Involvement with large-scale ensembles, such as Edimpro (see Edimpro 2009), a free improvisation group consisting largely, but not exclusively, of students and staff from the University of Edinburgh Music Department, also raised questions about communication strategies within group improvisation. Further influence came from participation in workshops dedicated to the performance of electronic music and improvisation, hosted by, notably, Fred Frith and Christophe Fellay, and the *Converging Objects* workshop by Anne La Berge and Robert van Heumen (2010). Lastly, both authors partake in the yearly roving-researcher-led *Laboratory for Laptop and Electronic-Audio Performance Practice* (LLEAPP), founded at the University of Edinburgh in 2009 by members of Sound Lab Edinburgh (2007), with support from the Roberts' Fund for Researcher-Led Initiative; this workshop aims to highlight and tackle many of the issues related to the live performance of electronic music (see LLEAPP 2009). Now in its third year, LLEAPP provides a framework for collaboration and discussion among postgraduate researchers and music-makers from around the UK.

[1] http://cycling74.com.
[2] http://www.ableton.com/maxforlive.

Figure 1. Můstek performing *Socks and Ammo* at Sonorities Festival, SARC, Belfast, 2011.

3. MOTIVATIONS

The main threads that emerged from the various aforementioned scenarios and improvisations revolved around:

- strategies for structuring improvisations
- strategies for communication between performers
- novel interaction between performers.

One of the most exciting yet possibly troublesome aspects of group improvisation is that, rather than a single-person-led evolvement, ideas may be put forward by any agent present (Edwards 2010). Moreover, new material may be emergent, appearing only as a result of everything that has previously been put forward by the present assemblage. We began to consider new methods that might challenge these characteristics of improvisation, which appeared to be ubiquitous. Furthermore, after performing together for a significant amount of time, performers begin to predict or expect what their well-known partners might contribute in any given situation. On one hand, this is of course an advantage in long-term collaborations, as players become familiar with the sonic worlds of their peers; but, in some cases, it can also lead to a lack of spontaneity, or at least spark a desire for a freshness of sorts. In our case, introducing a third, unpredictable agent into the system was certainly something that was appealing, not only for the sake of newness, but moreover because we would be able to consider its role in the construction of the sound and musical form.

A further motivation for imposing this system was noted during the post-concert discussion of the LLEAPP workshop of 2010 at Newcastle University's Culture Lab. The improvisations of electronic music presented on that occasion generally seemed to settle on an average of fifteen minutes' duration: as participants, it appeared that we were neither daring by performing extremely short works, nor confident in demanding more time, where needed. It was felt that different

approaches to structure, in terms of duration, would have helped significantly in nearly all of the pieces presented.

Naturally, the role of structure within improvisation is a complex issue. Analogies have been drawn between improvisation and vocalising, either as monologue, emulating the flowing nature of singing (Sudnow 1978), or as conversational dialogue (Healey, Leach and Bryan-Kinns 2005). The latter types of comparisons suggest that a certain pattern of interaction occurs within group free improvisation, whereby one person provides a new idea and the others listen and respond to it, just as may happen with a new choice of topic in conversation. Analysis of group improvisational sessions seems to confirm this (Healey et al. 2005). However, this phenomenon suggests a certain structure and development to the music: it does not readily facilitate synchronisation points or cues between players. Just as would not typically happen in conversation, a group of performers would not usually move synchronously to a set of new ideas, unless a clear cueing command was given. This was one of the main motivations for creating the imposed framework: these cue points would be suggestions to simultaneously move to new material, without implying a fully pre-composed piece. Just as Bavelas and Chovil give extensive evidence that certain 'nonverbal acts are an intrinsic part of language use in face-to-face dialogue' (Bavelas and Chovil 2006: 110), we claim that within musical improvisation, too, nonverbal communication is fundamental, and worth exploiting beyond merely the gestural domain.

While traditional visual cues continue to exist between performers using electronics, there is increasingly a need to find other solutions to some of the problems that arise when working with new technologies. Dislocation of the sound source and the loudspeakers means that stage layouts become complex and often confused, another point raised, and clearly evident, with regard to some of the performances at LLEAPP 2010, and subsequently at LLEAPP 2011, at the University of East Anglia, Norwich. Naturally, the origins of the acoustic sounds of augmented instruments are situated within the body of the instrument. Ideally, any approach to positioning loudspeakers should involve a conscious effort to integrate the electronic audio. However, due to the nature of a particular space or the availability of equipment, often loudspeakers are *not* placed proximally to the acoustic component of the hybrid system, and so discerning what each player is actually doing can become a difficult task. Similarly, it can be difficult to always situate instrument stations so as to maintain an adequate line of sight between performers. As well as engaging with the acoustic instrument, performers will often be manipulating other devices, such as foot pedals or MIDI controllers; this may expend the amount of time available to watch out for cues from the other players.

The individual systems that we used for this project were designed to enable as much freedom from the constraints of looking at laptop screens or focusing on interfaces other than the original acoustic instruments, which were employed both as sound sources *and* as controllers. Nevertheless, especially in the early stages, we often felt consumed by the operation of our hybrid instruments.

4. METHODOLOGY

The NeVIS framework was developed in response to the aforementioned issues.

4.1. Vibrotactile device

At the core of the system is a novel device that transmits haptic feedback in the form of vibrations onto the skin of the performers. First used as a solo performance tool for piano and live electronics, and designed to signal sections within a score and rhythmic information, the system's development is fully documented by Hayes (2011). The device was built from an Arduino[3] microcontroller and three small Samsung disk coin-type pager motors (each 1.5 V, 70 mA and measuring less than 1 cm in diameter). These were connected directly across the Arduino's ground and pulse-width modulation/digital pins. The motors were fixed to a glove made of a thin elasticised material, which the performer wore on her left hand. Two of the motors were positioned on either side of the back of the hand, and the third was positioned directly underneath, on the wrist. In this way, the performer, even whilst playing the piano, could accurately perceive three discreet channels of information. The extremely small and light nature of the vibration motors meant that the performance would not be impeded in any way by the device, as no extra noticeable weight would be added to instrumentalist's hands.

Long-length wires were run from the motors to the Arduino, which was connected to a laptop using a standard USB cable (Figure 2). Information was sent to the three motors via the Arduino using Max/MSP, the same software environment that was being used for the digital signal processing (DSP). This allowed the system to be easily integrated with the pre-existing performance patches. By simply toggling between on and off states, vibrotactile pulses were created; but, by additionally using the pulse-width modulation feature, a clearly noticeable increase in intensity of vibration could be experienced. In duplicating the device for duo performance, we found that using a glove was not suitable for the percussionist: when
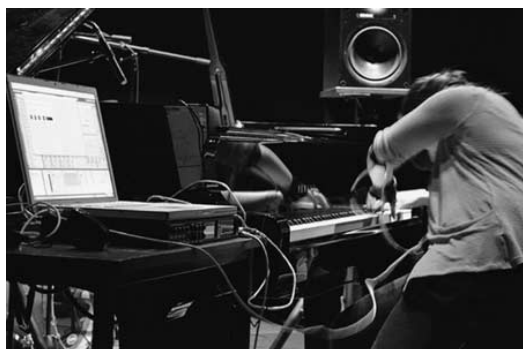
[3]http://www.arduino.cc.

Figure 2. Lauren Hayes wearing the vibrotactile feedback device.

positioning the motors on the hand, perceivable changes in vibration were ambiguous due to the natural feedback felt from hitting the drums. To rectify this, a further device was created, which was worn on the upper left arm of the percussionist. Here, the motors were positioned around an elasticised armband. Again, we experimented with the positioning of the motors, and concluded that placing them equidistant around the circumference of the arm gave the most discreet and discernable results.

4.2. Structure by suggested cues

A cue-based framework, the core of which is timed event-points, drives the system. That is to say, before a performance, the participants must decide on the number of sections that the piece will consist of, and the duration of each section. This information must be entered within the Max/MSP patch; alternatively, there is an option to allocate an arbitrary number of sections, or to have these sections assigned random durations of a minimum of thirty seconds. Enforcing a minimum section length was an aesthetic choice, used to allow for a moderate amount of time for propagation of musical ideas. The total duration of the piece is also displayed within the graphical user interface, mainly as a guide for concert situations where a predetermined piece length is required. The performers may allocate names to each state, although, as discussed later, this is merely ancillary and optional. The section changes are simply predetermined cues, but the performers do have the option to pause the timeline, by pressing a button on a MIDI controller, and to remain for longer within a certain section if desired.

One of two laptops acts as a conductor, sending the timing cues and other information, which will be outlined below, as OSC[4] messages over a local network

connection to the second laptop. The sections and their corresponding durations are shown on the laptop screens (Figure 3). More important, however, is that this cue list should be perceived cutaneously, through the surface of the skin of the performers. Just as how, within a notated or graphic score, different symbols or instructions signal particular musical events, so too is it the *interpretation* of the different vibrational sensations felt by the performers that is crucial here.

As mentioned above, the first layer of the system consists of the section cues; these being points in time during which major musical cuts may occur throughout the improvisation. These changes can be textural or rhythmical, and either in the acoustic or electronic sound worlds. Although the specific moment when these events occur within time-line is predetermined by the cue list (unless, of course, one of the performers freezes the state of play), it is left up to the players to decide whether to acknowledge and respond to these suggested prompts. For this reason, the different sections are also annotated with generic names, which may suggest a musical description understood by both performers (such as *sparse*), but are vague enough to apply to various situations. For example, who should play sparse? Is it rhythmically sparse, or a sparing use of pitches? It should be noted that looking at the screen for such information is optional, and is something that we constantly try to move away from, or completely avoid. Hence, to recapitulate: *how* changes are made and *what* is changed in the musical progression is entirely up to the performers. They will merely receive a signal telling them *to* change, along with a textual suggestion, should they decide to look at the laptop screen.

The only other quasi-predetermined parameter is tempo. This is sent in the form of a pulse, and is included not so as to enforce strict time-keeping, but rather to serve as a foundation around which possible interlocking between parts can be created. Of course, this can occur naturally within playing, but again this is an additional suggestion to be integrated, or not, as desired by the individuals present. The performers must predetermine the tempos of each section within the patch (zero, if undefined), but they do have the option to stop receiving the pulse if it becomes either too distracting, or unfitting to the current state of play. We both use the small and discreet Korg *NanoKontrol* [5] MIDI controller as part of our extended instruments, and so, by simply pressing a button on the interface, we can turn off the tempo vibrations. This was easy to add to the pre-existing systems, and seemed the most logical way to control this parameter: since we were already adept at using these
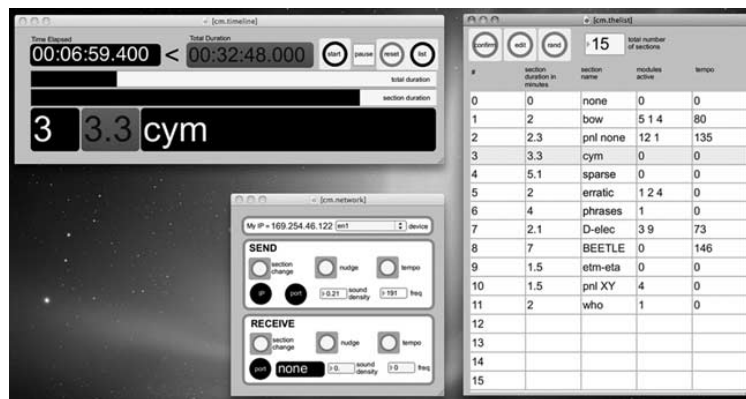
Figure 3. Graphical user interface of the NeVIS interface and cueing system.

controllers it was simply a case of repeating an action that was already learned. An alternative would have been to attach a further button or sensor to the wearable part of the device, but this could have potentially interrupted play. Of course, the situation may transpire where one performer is playing along with the pulse, and the other may have turned it off; this is just one scenario where the *voice* of the system itself may become noticeable. Another advantage of the suggested pulse is that we often slipped into a few standard tempi during previous improvisations, and so the conducting provided a gentle prod towards fresh ideas. Moreover, transitioning synchronously to a new tempo is virtually impossible without some form of direction. This would have to come either from one of the players, or, as in this case, from the cueing system.

4.3. Communication between performers

During performances, we found that we would often drift into a state of semi-isolation, focusing on, gauging and reacting to the specifics of the individual augmented instruments (something also commonly observed within the larger improvisation group, Edimpro). Thus it was often difficult to attract the attention of the other player for visual cues. In order to remedy this, a *nudge* function was built into the system, which served as a tool to enable visual communication. This is initiated by pressing a button on one of the MIDI controllers, sending a burst of three short pulses to the arm of the other musician, over a duration of 1,800 milliseconds. This would simply alert us to make eye contact: the meaning or intent of the actual visual cue given after contact was made would depend, of course, on the ensuing gestures, glances or signals. However, this nudge function certainly helped to *enable* these exchanges.

As an artistic choice, we have always performed in close proximity to each other. However, this system could certainly be used across greater distances and locations providing that a low-latency network could be established. Parker describes a networked performance across three different cities where not only audio, but also control data was exchanged, with a latency low enough to enable real-time performance (Parker 2006). This is an example of what Gil Weinberg terms as 'the Bridge approach' (Weinberg 2005), whereby performers in distant locations attempt to play as if they were spatially together. Certainly NeVIS could be tested in more extreme situations, but our aims were to investigate the effects of the system on the structural outcome of the music, and to enhance our already established communication practices.

4.4. Musical parameters

Although, as stated, the role of the network was limited to signalling and other simple forms of communication, an additional element was added to allow for the exchange of parametric data. The densities of the individual acoustic instrumental sounds, already being calculated in both our patches for internal processing, were sent over the network and mapped to various modules (in the other performer's patch), thus influencing the overall musical texture. Similarly, the spectral centroid of each performer's final output, after all DSP, was also swapped and used in a similar manner. The aim was to explore how parameters less easily perceived than, for example, pitch or amplitude might be useful for affecting the electronic processing. Additionally, each cue point can be assigned up to eight numbers, which will enable or disable sound processing modules within Max/MSP as the piece progresses, creating a more fluid, less disjointed performance during the improvisation. Selections that are displeasing to the performers can easily be overridden using the MIDI controllers. Due to differences in the hybrid instruments, only one of the performers chose to utilise this feature, as it was more conducive to their particular approach.
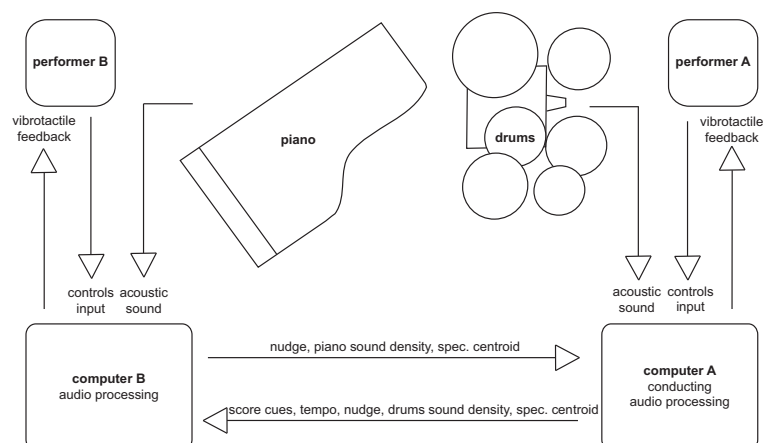
Figure 4. Signal flow of the NeVIS system.

4.5. Choice of modalities

As mentioned earlier, issues of privacy, feedback and creating intimacy with the instrument are just some of the benefits of working with the haptic sensory channels. Furthermore, when working with laptops, using haptics may help to free performers from the constraints of looking at the monitor for visual feedback (Hayes 2011). With this in mind, we decided to use vibrotactile feedback as the method for communicating the signals and cues discussed so far. Within electroacoustic music, in the absence of a conductor, the use of click-tracks for performers is often deployed, whereby a metronome pulse is heard through headphones. Stockhausen's *Helikopter-Streichquartett* (1995) is an extreme, although perhaps apt, example of this phenomenon: four performers play from inside four helicopters, spatially distanced from each other, and directed only through click-tracks on headphones. It was felt, however, that the use of headphones reduces the ability to listen clearly to the overall sonic results: indeed, simply discerning distinct electronic parts in a group setting can be difficult enough. Furthermore, the tempi to be transmitted across the network were only suggestions, which could be easily disabled, and so a constant audible sound would be too distracting. Thus, short continuous pulses (lasting 75 milliseconds) were transmitted to the hands and arms of the performers, allowing the tempo of each section to be adequately perceived.

Similarly, having a visual nudge or alert represented on the laptop screens would not suffice, as we tend not to fixate on the monitor while performing; a signal of three short bursts of vibration was transmitted instead. For the same reason, the section cues were indicated by a vibrotactile sensation that was short enough to trigger an impulsive reaction from performers, but that would also give just enough time to prepare any electronic changes that might be necessary. A ten-second approach signal was used, which increased in intensity over the duration. This length was chosen as it gave adequate time for any musical changes to be made, yet preserved enough of the spontaneity that we wished to arise from the appearance of the synchronisation points.

5. RESULTS

The system (Figure 4) was developed over a six-month period, and the resulting work, *Socks and Ammo* (sound example 1), was performed at various festivals and conferences, which included Sound Thought (Glasgow), Sonorities Festival of Contemporary Music (Belfast), Soundings Festival of Sonic Art (Edinburgh) and NIME[6] (Oslo). With the exception of Soundings, where a guest double-bass player participated in the improvisation without using NeVIS, the system was used in the same format. Not only its usefulness, but also the musical character of the project became apparent the more that it was adopted in performances. The nudge function was immediately utilised as a simple communication tool, and helped to improve our general communication on stage. Moreover, as this is a private method of interaction, it arguably helped to give the audience the illusion of a more integrated and polished performance. We certainly found that it helped to quickly rouse us from the states of absorbed isolation that sometimes occurred, and re-establish any required visual contact. Indeed, at the Sonorities concert in SARC's Sonic Lab, it was noted from audience feedback that a very strong sense of integration and coherence between the performers was evident in the music. Of course, this sense of connectedness may be attributed to our collaborative history, but in comparison

to performances that we have given without using NeVIS, we believe that this is indeed due to the implementation of the network.

The section changes raised several points worthy of discussion. The knowledge that there was an imminent change very often resulted in a state of self-awareness and anticipation, rather than an engaged performance or progression with musical ideas. This was particularly noted when testing the system with other performers at LLEAPP 2011. Here, participants initially found the system restrictive and counter-intuitive to their former improvisation practice, but after some time they began to comment on the potential usefulness of it. Indeed, after performing with the system many times over a period of several weeks, the anticipatory nature of our own responses receded. At this point, NeVIS became more clearly useful as a tool to shape the improvisations. This can be attributed to the fact that, when we had performed extensively with the vibrotactile feedback, it became an integral part of the performance; and after a certain degree of familiarity was achieved the musical output became the main focus once again. The perceived instructions and suggestions would be taken into account *only* if they served the already established musical material and direction, and, whilst they were very often acknowledged, they could be and *were* ignored too.

Of course, due to the autonomy of the performers within the framework, all cues could potentially be ignored and therefore be rendered meaningless. However, this never happened in performances as we wished to understand how the voice of the system might be heard amidst our own playing. Certainly, it was mentioned in the audience feedback at NIME that the system could clearly be perceived to be influencing the direction of musical progression in ways that would not otherwise have arisen naturally: this was illustrated mainly by the synchronised and often abrupt changes in direction. This feedback was encouraging, considering the context of this performance, as we were unaware to what extent an informed audience (here with explanatory programme notes) would be able to discern the effect of the system. Similar comments were received at Edinburgh performances, from audience members who had heard us perform in both scenarios, with and without NeVIS. When an element of unpredictability and surprise was introduced, the performances, conversely, appeared to take on a stronger sense of direction.

6. FUTURE DIRECTIONS

To date, the NeVIS project has been used with a relatively static predetermined cueing structure. Further developments will focus on creating a real-time non-randomised suggestion system based on machine listening techniques. This will be realised by creating a database of pre-recorded musical gestures, whereby the system will become more familiar with the individual performers the more gestures that it learns. IRCAM's *Gesture Follower*[7] and Fiebrink, Trueman and Cook's *Wekinator*[8] are possibilities that we have started to explore for this purpose. It is hoped that, with the implementation of these systems, the selection of processing modules within each section may become more meaningful. Rather than being selected at random by the system, or pre-determined by the users, the instrument will respond to what is being played. We hope to explore how the emergence of the cues over time might function in a similar manner.

Further exploration into the vibrotactile representation of audio will be undertaken by examining more complex models of analysis of the resultant sonic output. We will investigate which types information can be successfully and usefully integrated into the vibrotactile network. Schroeder et al. created visual avatars from analysis of the incoming signals; the data was recreated as an abstract image from an amalgam of distinct parameters, and was used to assist the improvisations (Schroeder et al. 2007). We will attempt to establish whether similar information can be represented in the form of haptic feedback, and if this enhanced perception of the sound will in any way aid the improviser. Finally, the system will be expanded to multiple wearable devices and be made wireless. It will then be tested with a larger group of performers.

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