My Physical Approach to *Musique Concrète* Composition

Portfolio of Studio Works

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Copyright Statement

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Abstract

My recent practice-based research explores the creative potential of physical manipulation of sound in the composition of sound-based electronic music. Focusing on the poietic aspect of my music making, this commentary discusses the composition process of three musical works: *Comme si la foudre pouvait durer*, *Igaluk - To Scare the Moon with its own Shadow* and *désert*. It also examines the development of a software instrument, *fXfD*, along with its resulting musical production. Finally, it discusses the recent musical production of an improvisation duet in which I take part, Tout Croche.

In the creative process of this portfolio, the appreciation for sound is the catalyst of the musical decisions. In other words, the term "musique concrète" applies to my practice, as sound is the central concern that triggers the composition act. In addition to anecdotal, typo-morphological and functional concerns, the presence of a "trace of physicality" in a sound is, more than ever, what convinces me of its musical potential. In order to compose such sounds, a back-and-forth process between theoretical knowledge and sound manipulations will be defined and developed under the concept of "sonic empiricism."

In a desire to break with the cumbersome nature of studio-based composition work, approaches to sound-based electronic music playing were researched. Through the different musical projects, various digital instruments were conceived. In a case study, the text reviews them through their sound generation, gestural control and mapping components. I will also state personal preferences in the ways sound manipulations are performed. In the light of the observations made, the studio emerges as the central instrument upon which my research focuses. The variety of resources it provides for the production and control of sound confers the status of polymorphic instrument on the studio.

The text concludes by reflecting on the possibilities of improvisation and performance that the studio offers when it is considered as an embodied polymorphic instrument. A concluding statement on the specific ear training needed for such a studio practice bridges the concepts of sound selection and digital instruments herein exposed.

Keywords: composition, musique concrète, digital instrument, studio performance, improvisation

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Introduction

Context

My affection for the production of albums in popular music culture has had a huge impact on my musical decisions. Their rich approach is at the origin of my interest in music. I could not imagine myself composing electronic music if I had not come across influential albums such as *The Shape of Punk to Come* by Refused or *Geogaddi* by Boards of Canada. It always seemed to me that the production of an album was a task very similar to what we try to do in electroacoustic[1] research.

My practice is in line with the French tradition of *musique concrète*. The writings of Schaeffer, Chion and Bayle have greatly influenced my musical creation. Moreover, the inspiring music of Bernard Parmegiani, Pierre Henry and Luc Ferrari have convinced me of the power and beauty of fixed-media music[2]. Also, my training is the one embedded within the aesthetic of the Montreal school of acousmatic music (Dhomont, 1996). My practice has integrated the aesthetic and gestures specific to this school by giving me the opportunity to rub shoulders with its main protagonists: Robert Normandeau, Gilles Gobeil, Martin Bédard, Georges Forget. Hence the frequent use of terms such as "cinema for the ears," "typo-morphology of sounds," "electroacoustic writing techniques," etc. in my writings (Thibault, 2011).

The continuation of my research in Huddersfield allowed me to diversify my practice significantly. The work environment offered in Huddersfield has opened my mind to divergent practices of musical exploration and experimentation. Huddersfield is the place where I chose to take an interest in improvisation, noise, minimalism, analogue synthesis and performance. Huddersfield is the place where I assumed the plurality of being a digital musician: "A digital musician is typically an amalgamation of performer, composer, engineer and informed listener, all to a certain extent." (Hugill, 2012, p. 241)

[1] The usage in this text of the term "electroacoustic" refers to the definition given by Emmerson and Smalley (2001) in The New Grove Dictionary of Music and Musicians: "Music in which electronic technology, now primarily computer-based, is used to access, generate, explore and configure sound materials, and in which loudspeakers are the prime medium of transmission."

[2] The term "fixed-media music" refers to a music that is composed in studio and that has a finished reality on any kind of support. It has come to replace the notion of "tape music" with the technological evolution of the medium.

Portfolio Content

The present document comments on the musical production undertaken in the context of the doctoral period. It will focus specifically on 1) the composition of three musical works, 2) the development of a digital instrument, and 3) the musical explorations of my duet, Tout Croche. *Comme si la foudre pouvait durer* is a post-acousmatic[3] piece that allowed me to reconnect with the immediacy of playing in the studio. With *Igaluk - To Scare the Moon with its own Shadow*, I wanted to develop a live electroacoustic music which took advantage of its performer's virtuosity. *désert* is a fixed-media work that takes full advantage of the studio as an instrument. *fXfD* is a digital instrument used for composition, improvisation and performance that has enabled a varied musical production.

The second part of the body of work is based around *fXfD*, a digital instrument used for composition, improvisation and performance. It has enabled me to produce varied music. The instrument has gradually developed from rudimentary Max patches to a extensive Ableton Live session through testing and validation in the live context. In its current state, *fXfD* relies on in-software digital feedback to generate sound. Its development and practice will be commented upon in Section 3.3.

The third and last part of my doctoral research deserves to be mentioned in this document: the duet Tout Croche. Tout Croche is the meeting point of two musicians, myself and Stephen Harvey. We originally wanted to make music outside of the academic box. We ended up realizing that the academic box is bigger than we expected as I find myself discussing our production as part of my research. Within the scope of this thesis, Tout Croche's full-length album titled *Super Silent* and a cassette titled *zero dBFS* will be considered. This project merits some attention in order to understand how improvisation and performance has gained importance in my compositional approach. Please note, in the context of a collaborative project such as Tout Croche, attribution of ideas can be problematic or blury. At all time when Tout Croche's production is discussed, it will be attempted to make this attribution of ideas as clear as possible. The intention here is not to present Tout Croche's music as solely my own but, instead, to show how influential it has been on my solo production.

The portfolio submitted is a diverse corpus of electroacoustic pieces that consists of acousmatic music as well as electronica music, which borrows from the aesthetics of metal music and takes advantage of free improvisation. Yet, there is a strong cohesion between the pieces. All of them are composed with sound as a central concern; they are, in effect, *musique concrète*. The reasoning underlying the selection of such sounds is therefore important to reach an understanding of my creative process. A sound is selected firstly for its morphological attributes and, simultaneously, for

[3] "Hence cross-arts work is ideally 'post-acousmatic' in the sense of 'taking account of and moving beyond' and not necessarily (as is sometimes supposed) 'anti-'." from (Emmerson, 1998) who himself cites Simon Waters' *Electroacoustic Music: Composition Beyond the Acousmatic* (1996).

the function it plays in a given music. The referential and anecdotal aspects of a sound also play a role in this choice. Yet, the presence of a "trace of physicality" in a sound, in reference to Smalley's gestural surrogacy and embodiement theories, is more than ever what convinces me of its musical potential.

The back-and-forth between theoretical knowledge, sonic manipulations and composition will be defined and developped under the concept of "sonic empiricism." However, this trial-and-error process has so far been very arduous in my practice. The result is a generational observation that work in a home studio is too often solitary, slow and rigid.

In order to revitalize my practice and find those "traces of physicality" within the sound, I have explored various ways to integrate the digital instrument in my practice. I herein undertake a case study of the various solutions explored as part of my musical production. The text reviews them through their sound generation, gestural control and mapping components. *Igaluk* enabled the design of a "composed instrument", specific to the performance of the musical piece. *fXfD* is an instrument designed for electroacoustic improvisation. In light of my production, it seems clear that the studio is the instrument central to my research. It is the range of means the studio offers to control sound that converts it into a polymorphic instrument. The potentiometer, the sound capture, my modular synthesizer named *LucyL* and the routing will be the central components of this analysis. A sound-based composer must know how to interpret such a polymorphic instrument in order to develop a practice where physicality has its place.

Of course, this discussion on the instrument also refers to the subjects of performance and improvisation. Comments on performance will be included in the observations made on the instruments. Improvisation has taken on a very special role since I became interested in the instrument. It has now become an integral part of my musical practice. In fact, its impact on my musical production will be discussed as a conclusion to Chapter 1 (see Section 1.4) and will be identified in the Conclusion as a key element of my future research.

I would like to draw attention to the fact that the perspective offered in this document is essentially poietic[4]. An aesthesic[5] description of my work is out of the question, as I am convinced that my perception of my own work is deeply flawed. Instead I will focus on describing the poietic process of my creation in order to identify habits, techniques, sonorities but also mannerisms and clichés that characterize my work as composer. Such awareness of the creative process will enrich the musical discourse and allow me to develop as a composer.

[4]Nattiez (1990, p. 92) definition of poietic: "By 'poietic' I understand describing the *link* among the composer's intentions, his creative procedures, his mental schemas, and the *result* of this collection of strategies; that is, the components that go into the work's material embodiement."

[5]Nattiez (1990, p. 92) definition of aesthesic: "By 'aesthesic' I understand not merely the artificially attentive hearing of a musicologist, but the description of perceptive behaviors within a given population of listeners; that is, how this or that aspect of sonorous reality is captured by their perceptive strategies."

Chapter 1

The Home-Studio Generation: Observations on my Practice

I would like to start by establishing some observations made through my practice. In the context of this document, these remarks are important because they have justified several decisions in the creation of attached works. Needless to say, I am a Digital Native[6]. Born in 1984, I always had access to a computer at home. Even if they worked with $5^1/_4''$ floppy disks, the fact remains that computers have always been part of my daily life: "[...] immersion in a digital environment tends to be the most important variable in predicting if someone is a digital native in the way they interact with the technology." Helsper & Eynon (2009) In the context of my musical production, I will argue that I am a "digital native composer." As a musician, I made the choice to use the computer rather than the guitar as a means of musical expression. No matter how much effort I would put in my guitar practice, it seemed then that the computer provided a means of expression more suited to my life experiences. Subsequently my training was mainly organized around the teaching of techniques performed on a computer. In addition to learning numerous software applications, I chose to develop my programming skills in order to have control over the music making process. Over the years, I have developed a working method that used the computer almost exclusively as its creation tool. For example, the composition of my piece *L'instant en vain* (2009) required a considerable amount of sound manipulation on the computer since sound capturing was minimal. It was my belief then that the majority of sounds could be crafted by some computer manipulation. My participation in the revamp of Cecilia[7], a front-end interface for Csound, was another example of this assumption that computers were omnipotent. The essence of my practice resided in the interaction with this little box full of buttons, the computer. I have long thought that I could use solely the computer in order to produce all aspects of my music. I believe this is symptomatic of my education as a first generation "digital native composer". This thesis is, in a sense, a statement of the failure of this

[6] "[Digital natives are] 'native speakers' of the digital language of computers, video games and the Internet." Prensky (2001)

[7] `http://code.google.com/p/cecilia4/`

computer-only practice, a statement of the shift from the computer as a unique interface to a more diverse musical practice. Yet, it does not deny the influence that this tool has had on my musical creation.

My development as a "digital native composer" has happened in parallel to the advent of the home studio. Suddenly, it was possible to make music with minimal equipment (a computer, a sound card and a pair of monitors, even headphones) for a fraction of the cost of studio-grade equipment[8]. This democratization of tools has led to the obsolescence of a wide range of studio equipment. For instance, I never had to learn sound design on magnetic tape. The operation of an analogue console is understood to me in great part because the interface of a DAW[9] borrows heavily from this paradigm.

With the home studio, my work now focused exclusively on a single object, the computer: "[...] the emergence of the personal computer disrupts the cultural and social landscape. The big change here is the appearance of an "all-in-one" tool. The computer is the Swiss Army knife of electroacoustic music."[10] (Normandeau, 2004) The possibilities offered by the computer indeed suggested the existence of an all-in-one solution. It could record, edit, process, compose, mix and diffuse our sounds. However, I will argue that the computer as a unique musical interface in fact had an impact that exceeds its technological features. The computer has influenced my approach to electroacoustic composition. Perhaps, the "digital immigrants,"[11] professors, in their boundless enthusiasm for home studio technology, have underestimated the extensive change that the computer has imposed on electroacoustic practices. Without intending to be reactionary, I will assess my practice and identify aspects of my compositional work that are imposed by the computer. Thus I will determine that my practice is marked by a blatant lack of spontaneity; the art I've made so far is slow, rigid and lonesome. This information will prove useful in understanding the choices made for the continuation of my research.

1.1 A Solitary Art

The social impact of the computer on music production is considerable. Undoubtedly, my electroacoustic music production takes on an individual nature because of the context of creation in the home studio. This is understandable since the computer, this all-in-one tool around which the home

[8] Operating costs of a home studio are paltry given the easy access to pirated software on the Internet.

[9] Digital Audio Workstation

[10] Original quotation in French: "[...] l'apparition de l'ordinateur personnel bouleverse le paysage culturel et social. Le grand changement ici, c'est l'apparition de l'outil 'tout-dans-un'. C'est le couteau suisse de la musique électroacoustique." (Normandeau, 2004)

[11] Prensky (2001) states that "[t]hose who were not born into the digital world but have, at some later point in [their] lives, become fascinated by and adopted many or most aspects of the new technology are [...] *Digital Immigrants*" . He adds that "as Digital Immigrants learn [...] to adapt to their environment, they always retain, to some degree, their 'accent,' that is, their foot in the past."

studio revolves, was conceived and designed as an individualistic interface (Hamman, 2002). For example, it is hard to imagine multiple users simultaneously controlling a mouse or a keyboard to edit and process sounds. The solo use of the home studio is also determined by the positioning of the commonly used near-field monitors in home systems. The ideal listening position (sweet-spot) is often so limited that it can hardly be shared (Fazenda & Davies, 2001). And the situation is even worse with headphone listening, which imposes total isolation from the environment. Yet, this solitary practice comes in opposition to the culture of studio collaboration in popular music (Moorefield, 2005). Somehow, the advent of the computer has invalidated the means that made studio performance a social process.

The possibilities of home musical production mean that the studio has lost its status as a gathering place:

> [The composer] can 'write' any time he chooses, he can work out the details to perfection. He can leave his work on stand-by, no one will change the settings of his equipment [...] And this freedom promotes the appearance of a much more personal music, closer to the personality of its author.[12] (Normandeau, 2004)

Unfortunately, I have found that the glorification of personal aesthetics is often achieved through self-imposed isolation. This is especially true now that Internet offers a dehumanized music distribution. The presentation of one's music, which was once an opportunity to meet with the community, has now become, with online distribution, a message in a bottle sent into a digital ocean. All of these factors suggest that my music is a lonely computer art, at times disconnected from the humanity of exchanges between musicians. In his text *The Digital Musician*, Hugill (2012, p. 243) summarizes that state of lonesomeness I am trying to describe here:

> There has been one very significant consequence for music-making from these changes to the workplace. The typical computer workstation is designed for the single user, often further isolated under a pair of headphones. The act of making becomes an act of production, with perhaps a CD or DVD, film or website as the outcome. This object may be passed on, once again, with only minimal social contact. If the musician in question does not engage in live performance, then he or she becomes an almost completely isolated figure. It should be stated and restated that music is a social activity. Isolation can be musically unhealthy, and a pervasive culture of individualism has a downside.

However, this tendency to individualism is being overturned by a new generation of musicians, which I find inspiring. More than ever, digital musicians are taking action in order to meet and play together. Perhaps the democratization of electroacoustic music is actually happening as I write these lines. Perhaps more time was needed for the electroacoustic music composer to understand the creative potential of the computer. I have many examples of students in the Computer Composition

[12] Original quotation in French: "[Le compositeur] peut 'écrire' à l'heure qui lui plaît, il peut peaufiner les détails jusqu'à la perfection. Il peut laisser son travail en suspens, personne ne viendra modifier les réglages de ses appareils... Et cette liberté favorise l'apparition de musiques beaucoup plus personnelles, beaucoup plus proches de la personnalité de leur auteur." (Normandeau, 2004)

class who have regrouped to make music collectively[13]. This solitude of the home studio has been addressed in several of my musical projects. The inviting of guest musicians into the studio was a first solution in order to humanize the sound sources in my compositions. Although this solution allowed me to create pieces such as *De velours et d'acier* and *Reckless Brown Dream*, solitude was still a major factor in the pursuit of my research. What became apparent is that the guest musician has not made a commitment to actually participate in the creation of a piece. Therefore, the composer is left alone to work on sound recordings , although they at least have the contribution of a musician embedded in them.

Over the doctoral period, collaborations with composer friends have become a priority. The respect I have for these collaborators gave me the confidence to share the tasks of creation. Tout Croche, introduced earlier, is one example where we create improvised noise music. The project has been highly influential in the renewal of my creative process and has inspired multiple subsequent collaborations. Electroacoustic improvisation is also central to the project with Sylvain Pohu, Gros Castor. My collaboration with Ryoko Akama is rooted in a common passion for the EMS Synthi VCS3 synthesizer. The music produced in this context has a minimalist aesthetic. In such collaborations, each plays a role according to his/her abilities. Through playing together, they ultimately expanded my knowledge as a musician. Collaborations have been important in the context of this Ph.D. because they have stimulated a practical research in my solo practice. Works created collaboratively will be included as part of the appendices and will be referred to to explain the unfolding of certain essential ideas of my approach.

1.2 A Slow Art

The nature of the interaction with the computer also makes my music a slow art. In the first place, repeated listening, which is characteristic of the electroacoustic medium (see Chapter 2), has always promoted an offline type of editing that focuses on details:

> [The composer is] in a position of being able to listen again and again to a performance, to become familiar with details [he] most certainly had missed the first time through, and to become very fond of details that weren't intended by the composer or the musicians. The effect of this on the composer is that he can think in terms of supplying material that would actually be too subtle for a first listening. (Eno, 2008)

I have found that, with the proposed interface of the computer (mouse, keyboard and monitor), the embedding of details in the work has reached unprecedented levels, and this observation seems to be shared by many: "While [graphical editing] enables greater experimentation, it also heightens tendencies for the artist to become obsessive about their work as the majority of audio tools can isolate and zoom in on minute details in a composition." (Homer, 2009, p. 91) The edition of audio

[13] Among others, Birkhouse Recordings (`www.birkhouse.info`) comes to mind, who not only releases music but also organizes events.

samples and the control with automation curves offers such precision that the composer finds it difficult to put into perspective the microscopic editions in the macroscopic structure of his work. That phenomenon is amplified by the infinite number of tries (without consequence) allowed by the "undo" function. This feature complicates my composition decisions, as I continually face a multitude of possibilities. Vande Gorne (2008) has reported in a private interview that composition decisions were much more definitive back when magnetic tape was in use. The snip of the blade and the mixing on tape required a complete acceptance of each decision, the analogue technology made it difficult to revert to an older state. In short, the number of microscopic choices the contemporary electroacoustic composer must make can transform his job into a slow process focused on detail.

Alongside the arrival of home studio technologies, a significant transfer of knowledge was taking place between a generation of "digital immigrant" composers and I, a "digital native." The generation of composers who taught me had first learned to work the studio using analogue technologies: magnetic tape, mixing console, synthesizers, etc. The sound manipulations were physical and required tape handling on the reel-to-reel recorder, mixing at the console and *séquences-jeu* recordings. For that generation, the development of digital technologies came as a blessing to alleviate their strenuous, imprecise and restrictive work with tape. The computer provided unexpected control, accuracy and simplicity to those who had had to synchronize multiple machines, file pieces of magnetic tape and tune drifting synthesizers. Music made by "digital immigrants" was reactionary to the difficulties they had encountered in the analogue studio. As a proof of that statement, the musical production of a generation of Montreal composers is based on precision and control (Dhomont, 1996). This generation formed in analogue studios now taught composition almost exclusively on computer. I argue that part of their knowledge has not been transmitted to the "digital natives". The physicality of the studio work, which was intuitive to my teachers, was not an obvious concept in the context of my work on the computer. The physicality of studio practice was lost to the benefit of precision offered by the tools.

Strangely, the precision offered by computer tools is first and foremost visual. The edition of sound is accomplished on the computer screen using a graphical representation of the sound phenomena. There is a disconnection between the aural perception of a sound phenomenon and the visual manipulations that the tools permit. Are we guided by our ears when we edit a sound with our eyes? The illogic of this paradigm did not stop me from spending a considerable number of hours on the edition of sounds to include in my musical pieces. I now question this slow and tedious work that seems to have lost its musical significance[14]. My intention is not to criticize the editing possibilities the computer offers (I still use them abundantly) but the works that focus almost

[14]The accuracy of the process is such that one wonders if this precise editing of sounds can actually be heard or if it is only imagined by the composer.

exclusively on microscopic sound edition to create music. I have no interest in such music anymore since it contains a sensibility only accessible to the creator who has heard his work repeatedly. Instead, I am searching for a music that creates connections between the creator and the listener by including a certain humanity, a trace of physicality, to his music.

At first glance, *désert* may seem contradictory to this argument. The structure of its movements and the articulation of the materials suggest that the piece is one of those precision music pieces. It is not. My intention (and the realisation of piece) was to regain the power and energy that acousmatic expression offers without falling into a tedious work of edition. The majority of the articulations and gestures contained in the piece were performed on the synthesizer following a constructivist approach[15] and, therefore, required minimal editing. Therefore, *désert* is by far the most reactionary piece of my portfolio as regards this concern of slowness. This reactionary tendency to slowness has emerged within the context of Tout Croche. Most musical pieces by Tout Croche were composed from the editing of preceding improvisations, which borrowed from the aforesaid constructivist approach. In summary, performance in studio now occupies a significant place in the revitalization of my musical practice. Assuming my role as a musician in the studio limits the offline manipulations that slow down the creative flow. Section 3.4 demonstrates that the studio is the instrument that allows me this direct expression in electroacoustic music.

1.3 A Rigid Art

I perceive an inherent rigidity in my early production of electroacoustic music with computer. This rigidity is not due to the fixity of the electroacoustic medium. A music is considered fixed onto a media if it sounds identical[16] every time it is played back. The rigidity discussed here corresponds to an artificial, inflexible character that a certain electroacoustic music takes on because of its creation on the computer. It is the result of musical parameters being controlled by perfectly reproducible computer processes that offer little or no subtlety. For example, this phenomenon of rigidity occurs when MIDI notes are perfectly aligned to the time grid of the sequencer. When automation curves are performed systematically (using straight lines for instance), sound parameters evolve in a mechanical way which is perceivable to the trained ear. Repeated use of a sound in a composition can also have this effect. What follows is a computed, artificial evolution of sounds that I describe as rigid.

Now, this feature of computer music production appears to be a manufacturing defect, a lack of subtlety and blatant control. Indeed, the tool, in its most standard use, easily generates these rigid

[15]The constructivist approach of composition is discussed by Tremblay (2012b, p. 4): ≪ [...] composers tend to talk about composing in the studio as a two-part process: generating a pool of material, and then composing with it. We could define this approach as constructivist, as they use the studio itself as an instrument to experiment with their source material, before deciding what to use from this experience to compose the piece. ≫

[16]If one does not take into account the wear of the media and the acoustic space which can both change.(Bates, 2004)

sounds. So when they are heard, one actually detects a lack of rigour and control by the creator[17]. Not extensively documented in the literature (Ostertag (2002) discusses it), rigidity is a factor that may explain the apathy experienced by a certain audience in response to electroacoustic music. It may also explain why physicality and embodiment have become predominant topics of contemporary musical research. As an early attempt to tackle this problem in my doctoral period, a place was made for performance in the studio with *Comme si la foudre pouvait durer* and the live electronics field was explored with *Igaluk*.

My music has suffered from this rigidity. Listening to the piece *De velours et d'acier* reveals a form of rhythmic rigidity imposed by the sequencer's tempo grid: "These perfectly aligned cuts can reveal the underlying writing technique and impoverish the musical discourse."[18] (Thibault, 2011, p. 35) The phenomenon is discernable in various ways in my body of work and in the fixed-media music repertoire. The doctoral period has enabled an emancipation from this rigid use of the technology. Most of all, my research integrated the practice of electroacoustic improvisation and comprovisation (Dudas, 2010) to overcome the technological rigidity:

> Using the studio as a composition tool is powerful and contemporary, and allows the listener's judgement to be at the forefront. Brainstorming is kept as a fluid process, without the hindrance of a long production process, and this swiftness is a key element to keep the music alive, with a sense of performance to it. Critical improvisational practice allows that immediacy of judgement over different versions, yet with enough instrumental control to give the ability to reproduce and improve gestures. (Tremblay, 2012b, p. 13)

This methodology has become an integral part of my practice. Performance and improvisation come in response to the rigidity imposed by automatic computer processes.

1.4 A Few Words on Improvisation

> " There are those for whom [free improvisation] is an activity requiring no instrumental skill, no musical ability and no musical knowledge or experience of any kind, and others who believe it can be reached by employing a highly sophisticated, personal technique of virtuosic dimensions. Some are attracted to it by its possibilities for musical togetherness others by its possibilities for individual expression." (**?**)[p.85]bailey92

As Bailey expresses, opinions on free improvisation differ widely. In this brief section, I will try to elaborate a personal opinion on improvisation based on my playing experiences.

In my Master's thesis (Thibault, 2011), a brief section explained the importance of improvisation in the revitalization of my composition practice. It mainly focused on improvisation as a technique for generating lively source materials. In relation to the corpus discussed here, this usage of improvisation has remained highly pertinent. Free improvisation in the studio has been abundantly

[17] I do not doubt that some knowledgeable composers are conducting informed research on artificial sonorities obtained with the computer

[18] Original quotation in French: "[C]e découpage trop parfait permet de déceler la technique d'écriture sous-jacente et appauvrit le discours musical." (Thibault, 2011, p. 35)

practiced in order to discover, explore and exploit the musicality of a sonorous process to its full potential. In this procedure, the studio acts as a witness and captures the ephemeral moments of creativity that I have encountered. *Séquence-jeu* is the term most commonly used by the electroacoustic community (Reibel, Dhomont, Vande Gorne, Normandeau, Tremblay, etc.) to describe the process of recording an improvisation made with a sounding body in order to produce sound materials for subsequent composition. This method of improvisating in the studio clearly has affinities with the concept of comprovisation discussed by Dudas (2010, p. 30):

> "[I]mprovisation [...] is this kind of musical play and experimentation with technology that has accompanied us from the studio into the home studio of today's electronic musicians, and this relationship of improvisation as a material-generator for composition is still an important aspect of much electronic and computer music today."

It also resembles the creative process often found in the pop culture and described by Eno (2008) and Moorefield (2005). A good example of this sound generation process imparted to improvisation can be found in the piece *Comme si la foudre pouvait durer*, which involves a series of improvisations edited down to a fixed composition.

As I consider myself a composer before an improvisor, it has been easy in the past to reduce the impact of improvisation to the subordinate function of a writing technique for my compositional process. But during this doctoral period, a thorough practice of improvisation within the live context was initiated. This has considerably modified my perception and appreciation of improvisation. I now see improvisation as a powerful companion to composition, not its subordinate :

> "Written compositions are fired off into the future; even if never performed, the writing remains as a point of reference. Improvisation is in the present, its effect may live on in the souls of the participants, both active and passive (ie audience), but in its concrete form it is gone forever from the moment that it occurs, nor did it have any previous existence before the moment that it occurred, so neither is there any historical reference available. " (Cardew, 1971)

Cardew offers a eurological perspective to free improvisation (Lewis, 1996) but it certainly is the one that resembles most my practice of improvisation. I strongly believe in the potential of improvisation in order to create new and authentic music that fully takes advantage of the improviser's musical knowledge and personality. The purity and beauty found in those unpolished, highly irregular musical moments are valued. It is by improvising that I realised the beauty and difficulty, the control and prediction, the vocabulary and expertise, the intellectual and sensory acuity that the practice required; one must compose in realtime and, simultaneously, perform a music with conviction.

There seems to be a tendency in literature about improvisation to compare its practice with composition. As Bowers (2002) explains, improvisation has been often regarded as a lower, less complete form of music creation than composition. Yet it seems to me that improvisation and composition are two complementary disciplines which are important to the development of musicians who are close to both their musical sensibility and knowledge:

> "I do think that composition and improvisation are different aspects of the same process. [...] I think the process of creating just about anything involves combinations of rational thought, intuitive choice, ingrained memory, and desire. I could apply all of those words to both composition and improvisation. The process is different, and occupies different time frames, but other aspects are essentially similar." (Fehrenbach, 2002, interview with Fred Frith)

In my practice, improvisation and composition are reconciled instead of being opposed. Each project takes advantage of a variable amount of both. Improvisation offers a lively and human feel to the music, whilst composition offers precision and perfectibility. For instance, improvisation plays a predominant role in the production of Tout Croche. I first encountered free improvisation in the context of the duet. Now, music produced by Tout Croche presents itself as both improvised music performances in concert and studio albums based on improvisations. In this particular context, virtuosity resides in the listening and synergy between the two performers in order to form and explore musical worlds. *désert* appears as a project that takes advantage of both the creative potential of improvisation and the organisational potential of the studio. Improvisation at the modular synthesizer allowed the development of sonic materials and primitive musical forms. The subsequent reorganisation of these improvisations has generated a series of *musique concrète* pieces that retain a sense of liveliness and physicality. Finally, *fXfD* is essentially a musical instrument for the practice of electroacoustic improvisation in concert. With this instrument, electroacoustic improvisation is revealed as a negotiation of the various characteristics of the sounds (anecdote, sound attributes, musical function and the trace of physicality) by "sonic empiricism".

During the doctoral period, improvisation has gained an important place in my creative process. This assimilation of improvisation now allows me to develop projects that integrate both my preoccupations for organisation and precision as well as my interest for alive and physical music. In the next Chapter, my creative process will be analysed in relation to the selection of sounds in my music.

Chapter 2

A Music Based on Sound: Reviving *Musique Concrète*

> *[...] le son concret est une réalité sensible, stable et qui présente à la perception une inépuisable richesse d'aspects, tout comme une photographie ou une sculpture.*
>
> Michel Chion

Recording has been a powerful tool for the democratization of music. The proof is that music is now everywhere in our daily life: from background radio to phones ringtones and the concert of cars rolling to techno beats. Over the twentieth century, however, the impact of recording has also been felt in the way music is made. The recording of sonic events has given us access, through repeated listening, to a wealth of information that was previously imperceptible in live music. Sound is somehow zoomed in on by the aural magnifier that is recording:

> The effect of recording is that it takes music out of the time dimension and puts it in the space dimension. As soon as you do that, you're in a position of being able to listen again and again to a performance, to become familiar with details you most certainly had missed the first time through, and to become very fond of details that weren't intended by the composer or the musicians. (Eno, 2008, p. 127)

I strongly agree with Chion (2009), who said that music has undergone a schism from the moment it became recorded. Live music and recorded music do share a common vocabulary but they serve different purposes. An analogy can be drawn to theatre and cinema which are two related yet different art forms. Live music aims to share a communal experience between performers and audience in a specific place (Cardew, 1971) as recorded music is interested in the perfectibility of the resulting sound offered to the listener (Eno, 2008). Since its inception, *musique concrète* has sought to exploit the particularities of recorded music to develop a new art form:

> [...] when I proposed the term "musique concrète", I intended [...] to point out an opposition with the way musical work usually goes. Instead of notating musical ideas on paper with the symbols of solfege and entrusting their realization to well-known instruments, the question was to collect concrete sounds, wherever they came from, and to abstract the musical values they were potentially containing.[19] (Schaeffer, 1977, p. 23)

[19] Original quotation in French, translated into English by de Reydellet (1996, p. 10)

Thus *musique concrète* has triggered a research that still continues today on the creative possibilities of recorded music.

Since its conceptualization by Schaeffer, the concept of *musique concrète* has evolved considerably. It has changed in conjunction with technological developments, from the locked groove of a vinyl record to the magnetic tape to the computer (Chion, 2009). It has also transformed and multiplied to keep pace with aesthetic and formal discoveries, engendering, for example, acousmatic, electronica, sound art and industrial music (Landy, 2007; Adkins, 2007). Despite these technological and stylistic changes, the premise of *musique concrète* has always remained. Sound bears a musical potential that the creator recognizes, sublimates and organizes into a work: "In the case of *musique concrète*, we produce sounds [...] as fragments of speech whose position in the puzzle that is our piece then determine."[20] (Chion, 2009, p. 36) In this light, my musical production can be considered as *musique concrète* because my creative process first focuses on the collection, the fabrication and the manipulation of sonic materials, which afterwards inspire me to produce a more elaborate construction, a music. Sound itself triggers the composition act. As I am particularly attached to the concept of sound as a music generator, it is undoubtedly the term "musique concrète"[21] that best summarizes my practice – even if Chion's definition refers only to the art of fixed sounds. I will argue that the term "musique concrète" refers first and foremost to a state of mind, a disposition for sound in the composition process of a work.

From early on in my composition practice, the concept of a sound-based music has been inspiring. It seemed very natural to craft "beautiful" sounds that would end up making music when properly organised altogether[22]. I invested time and energy in order to learn techniques to collect sounds, to manipulate them and to perfect them. Sound capturing became an integral part of my practice. I perfected my programming skills in order to develop my own tools, the development of Cecilia being an example of this. New software applications have always seemed like exciting opportunities to craft sounds differently. Ultimately, selection of these sounds has always been done in an intuitive way.

Sound Example 2.1 (Sound selected intuitively)**.** *The sound of this bowed metallic string could be described as beautiful. Its grain, its gesture and its tension are attributes that seemed important in its selection. It was included intuitively in the pre-doctoral piece* Un pied dans ma poubelle *(2010).*

Yet, that moment of awareness when the musical potential is heard within a sound constitutes the heart of my *musique concrète* creative process. This process of negotiation between the material

[20] Original quotation in French: "Dans le cas de la musique concrète, nous produisons les sons [...] comme des fragments de discours dont nous déterminons ensuite la place dans le puzzle de notre pièce." (Chion, 2009, p. 36)

[21] Rather than the term "acousmatic" which has taken on a stylistic connotation over the years.

[22] Varèse refers to the concept of "organized sound" to describe his music ((Varèse & Wen-Chung, 1966))

and its organization (Chion, 2009) will be defined by the term "sonic empiricism." The concept will thereafter enable me to specify the considerations in the selection of sounds.

2.1 Sonic Empiricism

How does one become aware of a particular sound's musical potential? This questioning is central to this research of a dynamic composition process. The creative process of *musique concrète* is not as linear as its original definition would imply; although the interest in sound in *musique concrète* is primordial, compositional judgment remains an important role in the design of successful music:

> One must not dissociate composition from sound determination. Both are closely related; but not in a univocal, redundant way in which either the material indicates the direction the composer should follow or, conversely, the composition imposes itself on the material creation. Composition is an act achieved both with and against the sound by antagonizing its natural movement via montage or superimposition with conflictual sounds.
>
> [...]
>
> A new kind of awareness is required during which the composer of *musique concrète* remains throughout his work in a constant state of perceptual availability and compositional activity. He must not consider his sound materials as pre-existent, nor relax his aural vigilance, since he is in a constant process of production and discovery until the last moment.[23] Chion (2009, pp. 46-47)

It is indeed true that the discovery of a sound as a result of sonic transformations may well inspire a musical segment. This was the case for several synthesized sounds in *désert*: sound exploration with my synthesizer *LucyL* has allowed me to discover unique sounds with a strong musical potential. It is also true that a musical intention can lead to the production of sound materials. For example, the composition of *Igaluk* was essentially realized by following the narrative thread of an Inuit myth. But mediation between sound production and musical intentions can only occur with great knowledge of the electroacoustic medium. Therefore, there is a third scenario in the *musique concrète* composition process: knowledge can generate musical ideas and/or sound experimentation. Improvisations produced with my instrument *fXfD* would fit into this scenario (see Section 3.3). This tripartite organization of the *musique concrète* creative process will be defined as "sonic empiricism"[24]. "Sonic empiricism" is the process of interaction between the "making," the "organizing" and the "know-how" by which the creation of *musique concrète* occurs (see Figure 2.1).

[23] Original quotation in French: "Il [ne faut pas] dissocier la composition de la détermination du son. L'une et l'autre sont étroitement liées ; mais pas dans un sens univoque, redondant, où le matériau indiquerait la pente qu'il suffirait dès lors de suivre, ou bien inversement où la composition soumettrait le matériel totalement et sans résidu. Si l'on compose, c'est à la fois avec et contre le son, en contrariant éventuellement, par montage ou par mise en conflit avec d'autres sons, son mouvement naturel. [...] Un nouveau type d'attention est requis, où le compositeur de musique concrète se maintient d'un bout à l'autre du travail en état constant de disponibilité perceptive et d'activité compositionnelle. Il ne doit pas penser à son matériau sonore comme existant déjà, ni relâcher sa vigilance auditive, puisqu'il est toujours en train de le faire et de le redécouvrir, jusqu'au dernier moment." Chion (2009, pp. 46-47)

[24] The term came to me after reading a passage from Eno (2008): "[...] the making of music [...] becomes empirical [...]. You're working directly with sound, and there's no transmission loss between you and the sound - you handle it."

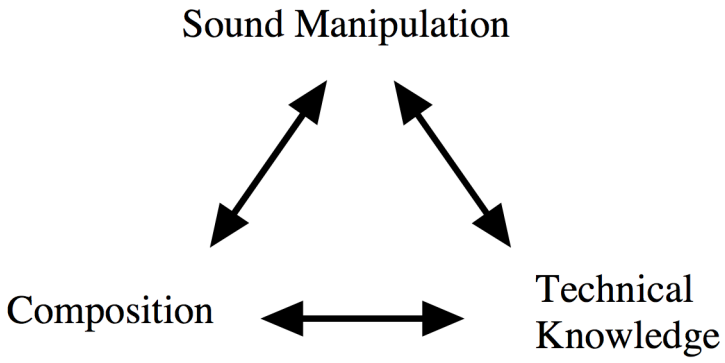

Figure 2.1: Interaction of sonic empiricism components

In an empirical process of trial and error, I refine and validate sound materials with a musical context in progress, thanks to an understanding of the sonic, technical, technological and stylistic possibilities available to me. The concept of "sonic empiricism" puts into perspective my composition process of *musique concrète*. Not only do I have to negotiate between the production of sounds and their organisation in a composition[25], I must also be an expert in techniques and technologies of the studio, have a vast knowledge of the electroacoustic repertoire and, above all, have an ear training specific to the electroacoustic medium. Those essential elements of the *musique concrète*'s knowledge will be discussed in the following subsections.

2.1.1 Technologies

Technological knowledge is the ability to utilise a set of tools in order to realize an intention, which, in this case, is musical. This is not an exhaustive list of these tools as they are numerous, with various functions and, most of all, are replaced at a tremendous pace (Tremblay, 2012a). Nevertheless, my practice is characterized by the use of programming tools as well as sequencers. The modular synthesizer and the mixing desk, as much as the electronic tablet and the MIDI controllers, are regarded as tools that help me create music. Not to mention that the characteristics of microphones can be exploited musically as well as the features of analogue and digital sound processors. In short, my musical journey has led me to develop a range of tools which can be used as required by the composition intention or the sound production.

An important requirement of the technological aspect of my approach is the need to understand and control multiple technological tools in order to include them as part of my musical language. By studying in depth the functionalities of a tool (and by knowing a variety of tools), one becomes aware

[25] Chion (2009) talks about the material/organisation pair.

of the creative potential it offers and the limitations it imposes on the sound production: "A sound device never is neutral, and that is for the best for the *musique concrète* composer whose range of possibilities is thereby expanded"[26] (Chion, 2009, p. 59). Thus, one can choose whether a tool is adapted for a particular task or whether it is more pertinent to search for another means. Also, when the limitations of a tool are understood, methods to corrupt or subvert its normal operation can be identified. The sounds resulting from corrupted operations are often more interesting than those obtained by the standard use of the tool (Cascone, 2000). In summary, technological fluency is a method I use in order to surpass the technological determinism which electroacoustic music is so often accused of.

2.1.2 Techniques

First, let me state the obvious: technique does not mean technology. A technique is a process applied to an object or a substance in order to obtain a result. Technology is the means (physical, mechanical or computerized) by which this process is employed. Consequently, a technique can be implemented in several different technologies. It is also true that a technique can be developed by the use of a particular technology. For the electroacoustic medium, a technique represents the means by which a sound can be produced, processed, edited or diffused (see Table 2.1). Note here that the table does not indicate specific software or effects. Instead it presents concepts that are put into practice in electroacoustic tools (hence the difference between technique and technology) (Verfaille et al., 2006). In the book *The Digital Musician*, Hugill (2012) provides an overview, although somewhat imprecise, of contemporary electroacoustic techniques. Albeit dated, the texts by Chion & Reibel (1976, pp. 203-250) and Schaeffer (1977, pp. 405-409)[27] on the production techniques are nevertheless still relevant in their remarks. It appears that the literature shows a lack of a proper description of electroacoustic techniques regardless of the technologies that engender them[28].

Traditionally, *musique concrète* has sought to use these techniques in a transparent manner, says Chion (2009). In order to achieve a stylistic ideal, one had to avoid at all cost any reference to the tools that were used in the production of the sound:

> Technological listening occurs when a listener 'perceives' the technology or technique behind the music rather than the music itself, perhaps to such an extent that true musical meaning is blocked. Many methods and devices easily impose their own spectromorphological character and clichés on the music. Ideally the technology should be transparent, or at least the music

[26] Original quotation in French: "Un appareil de son n'est jamais neutre, et c'est tant mieux pour le compositeur concret, dont la palette de possibilités s'en trouve d'autant élargie." (Chion, 2009, p. 59)

[27] Schaeffer entitled this section of his text *The electroacoustic chain* where an interesting table summarizing some of the techniques is presented.

[28] Observation made after a personal discussion with Robert Normandeau, professor at Université de Montréal, who teaches electroacoustic writing techniques in his course *Typology and Morphology of Sounds*

Category	Examples
Production	- Sound recording/capturing - Synthesis - Sampling
Processing	- Delay - Filter - Transposition - Reverse - Distortion - Dynamic
Editing	- Montage - Mixing - Looping - Micro-montage
Space Design	- Reverberation - Spatialisation - Diffusion - Re-amplification

Table 2.1: Electroacoustic writing techniques by category

> needs to be composed in such a way that the qualities of its invention override any tendency to listen primarily in a technological manner. (Smalley, 1997, p. 109)[29]

Certainly, this ideal of transparency can be linked to the concept of reduced listening, which seeks to discriminate a sound from its source. In such an ideal, music offers the listener a purely musical sound, devoid of its production history. I will argue in Section 2.2.4 that this insistence on concealing the technical production of sounds leads to the lack of a human presence in music. In fact, the detection of a tool's usage in the fabrication of a sound equates to the disclosure of compositional choices made by the musician. Giving a greater importance to "technological listening" could produce a more physical and embodied *musique concrète*.

This does not mean that any technique creates music if applied to a sound. The discovery of the "beautiful" sound does not form music instantly. As a matter of fact, one must be cautious when using electroacoustic techniques: "Not only have most of the basic techniques been explored a thousand times, but hundreds of archetypes have been created since the beginnings [of electroacoustic music]"[30] (Normandeau, 2006, p. 39).

[29]Smalley's use of the term *technology* conflicts somewhat with the previous definition. Still, the concept of "technological listening" remains relevant to the current discussion as it implies the perception of a tool or technique embedded in a sound.

[30]Original quotation in French: "Non seulement la plupart des techniques de base ont été explorées mille fois, mais des centaines d'archétypes ont été mis à jour depuis les débuts [de l'électroacoustique]" (Normandeau, 2006, p. 39).

2.1.3 Repertoire

To avoid repetition and to demonstrate originality in the use of such techniques, there is only one solution: be familiar with a vast electroacoustic repertoire. Here I not only refer to an academic music that developed as a result of *musique concrète* but all kinds of music that utilize electroacoustic means in order to thrive. Hip hop and IDM are part of that list, as well as noise, electronica and acousmatic music. Each of these genres has exploited properties and techniques specific to the electroacoustic medium. They have collectively developed a sensitivity that is specific to the medium. The composer must now be able to take advantage of these developments of the medium by borrowing them freely in order to develop a sonic personality. After all, one never creates in a vacuum.

And what could be easier than finding music to listen to in our hypermodern time? The internet is an inexhaustible music library that has reached a size unimaginable just ten years ago. For example, my discovery of Krautrock[31] through the digital channels was a revelation that revitalized my practice toward the end of my Bachelors degree. Every day new quality music confronts me, comforts me, motivates me in a personal approach to making music. This is especially true now that instant and free distribution on the internet, in conjunction with home-studio technology (see Chapter 1), has multiplied the number of music productions (Homer, 2009). It is more than ever essential for a musician to have a strong personality that acknowledges musical advances made by an impressive repertoire of electroacoustic music.

2.1.4 Ear Training

Finally, ear training is an essential knowledge in the process of "sonic empiricism." The very nature of *musique concrète* requires the development of a specialized mode of listening[32]. One must recognize in the sound the references that it conveys, perceive its intrinsic attributes, identify the tools and techniques that have enabled its production and recognize the psychoacoustic limitations of the human ear. In short, the notion of a specialized ear training for electroacoustic music plays a major role in the selection of sounds that compose a music (see Section 2.2).

An example involving technological listening can demonstrate this type of listening specialisation. It seems quite natural for an electroacoustic composer to hear a filter sweep or the density of granulation. Yet here is a knowledge that has been acquired through practice and that few listeners can recognize. This ear training is so specific to the electroacoustic discipline that it can even be a barrier to sharing our sound experimentations with the most skilled musicians.

[31] As defined by Cope (1995).

[32] Schaeffer (1977) refers to this mode of listening as "écoute praticienne," translated to "practical listening" by Landy & Atkinson (2002)

The concept of ear training specific to electroacoustic music will be thoroughly discussed later in this text. Among other things, it will support an argument on the development of dedicated performers for live electroacoustic music, justify many choices in the design of my instruments and facilitate the appreciation of the "trace of physicality."

2.2 The Selection of Sounds

The legacy of *musique concrète* is, as we have seen, significant for composition. Influenced by this music, I state that my work of sound production and transformation is what triggers the development of my music. Therefore, if sound is the basic unit of *musique concrète*, it is appropriate to detail the factors that motivate the selection of sounds that will form the composition. First, the role of referential and anecdotal sounds in my compositions will be discussed. Sound selection accomplished on the typological and morphological basis of the sound attributes will then be addressed. In a similar manner, the musical functions played by a sound as a decisive factor in its selection to be discussed. Finally, a section will be devoted to the description of a "trace of physicality" embedded in sound. This set of factors will highlight the cohesion between the various works of my portfolio. A better understanding of this sound selection process will develop further the observations made in Chapter 1 and will guide my future research.

An essential aspect of my work requires the acceptance of *sound for what it is*. Sound has a personality that should be enhanced rather than reduced by forced sound manipulations. In Huddersfield, my encounters of several composers interested in post-Cagean sound indeterminism changed my perception considerably on that matter. I had until then a tendency to control sound in order to impose a meaning on it. Considerable energy was spent trying to shape a sound to match a given music. More than ever, I restrain this obsession with counter-productive work of sound shaping, instead valorising the intrinsic qualities of a sound to develop musicality.

2.2.1 The Anecdote

It is human nature to hear a sound and listen for its cause. Schaeffer (1977) speaks of "natural listening" to describe this identification process. Regardless of the anthropological reasons for this behaviour, "natural listening" implies that the listener of *musique concrète* will seek the causality of a recorded sound that is presented to him (Smalley, 1997). My music uses this predisposition to causal listening in order to create a cohesion at the formal level of the work.

On a first level of causal perception, sound refers to physical, natural and human phenomena. Smalley (1997) uses the term "source bonding"[33] to describe the mental association between a

[33] "the *natural* tendency to relate sounds to supposed sources and causes, and to relate sounds to each other because they appear to have shared or associated origins" (Smalley, 1997, p. 110).

sound and its source. The suggestion of acoustic spaces through "source bonding" is a common practice in my musical research. *Comme si la foudre pouvait durer* offers a striking example of such a reference to an acoustic location. The sound recordings of rain and thunder were produced in a reverberant courtyard. Their selection became obvious when I decided to evoke a stormy tumult in the piece. Such recorded sounds would refer immediately to natural phenomenon. This sort of sonic landscape is reminiscent of the Vancouver soundscape movement popularized by R. Murray Schaefer and Barry Truax. Tout Croche's *Super Silent Gypsy* also refers to a sonic location. It is based upon an outdoor, along-the-canal improvisation performed with the guitar and harmonium, and accompanied by a hydraulic pump.

However, the reference to musical instruments is most prominent in my corpus. Each work contains sounds that refer to an instrument that inspired its composition. The reference to the electric guitar is clear in *Comme si la foudre pouvait durer*. The piano is omnipresent in *Igaluk* and whoever is interested in its extended techniques will recognize them on a first hearing. *désert* is based on the multiple sonorities that can be obtained with my modular synthesizer, *LucyL*. Even the studio is presented as an instrument (see Section 3.4) in my improvisations with *fXfD*. In short, sounds referring to musical instruments are predominant in my compositional work. It will be argued in Section 2.2.4 that this attraction to the instrument comes from a desire to find physicality embedded in the sound. As sounding bodies, instruments offer considerable sonic and acoustic possibilities that can be shaped efficiently via performance. Their use in my *musique concrète* is a way to purge my unsuccessful experiences with the acoustic instruments. The electroacoustic medium helps developing a virtuosity that I have not been able to obtained by practicing the acoustic instruments.

Furthermore, sound has an evocative power that greatly surpasses the reference to its source. It allows a complex, delicate and subtle narration; the sound is anecdote. Luc Ferrari is an influential composer of fixed-media music who exploited the anecdotal power of sound:

> For me, anecdotal music represented more than the affirmation of sound sources, it was also the basis [...] for narration. In my design, recognizing sound sources was equivalent to surrealist collage, in other words, to create a succession of recognizable sounds and unrecognizable invented noises [...][34] (Gayou, 2001, Interview with Luc Ferrari)

In my portfolio, the sound anecdote is recurrent. Already in my Master's thesis (Thibault, 2011), I reinterpreted the notion of "cinema for the ear" in order to explain my construction of musical tableaux evoking cinematic scenes. In my current approach, the anecdotal issue is still present but it is important only to the creator. The anecdotes sustained by my pieces are always clear at the

[34]Original quotation in French: "Pour moi, la musique anecdotique c'était plus que l'affirmation des sources sonores, c'était aussi les prémices [...] de la narration. Reconnaître les sources sonores équivalait dans ma conception au collage surréaliste, c'est-à-dire faire se succéder des bruits reconnaissables et des bruits inventés non reconnaissables [...]" (Gayou, 2001)

time of composition. Sometimes it is a story I narrate with sounds. At other moments, it is an image that I am trying to translate or a feeling that I evoke with music. Always, the anecdote is the extra-musical argument which suggests the choiceeand the organisation of sounds; the anecdote is transcended in order to structure sounds into musical ideas.

However, it is hard to know what is left of the original anecdote once it has been integrated in a musical piece. *Igaluk* was inspired by the Inuit creation myth of the moon[35]. A reading of the myth generated a set of images that I freely converted into sounds (refer to Sound Examples 2.2, 2.3 & 2.4). What remained of the narrative thread was a title, a sound bank, a structure for my piece and a reference in the program notes. The listener has no need of this poietic information in order to listen to the resulting music. The observation is similar in *désert*, which is inspired by the image of the desert and a questioning on asceticism[36]. In the absence of a narrative, the various anecdotes instead become movements that evoke both emotions related to asceticism and concepts attached to the desert. The titles of *désert*'s movements illustrate these anecdotal links. *Comme si la foudre pouvait durer* may be the piece of my portfolio that comes closest to anecdotal music. With complementary delayed guitar and thunderstorm recordings, the resulting piece evokes a romantic-kitsch cinematic scene. In summary, the anecdote remains an extremely important factor in the choice of sounds that compose my music.

Sound Example 2.2 (Anecdotal Sound 1)**.** *The following sound enunciates the starry firmament that is the backstory of the myth of Igaluk. Similarly, the sound acts as a background to the musical piece.*

Sound Example 2.3 (Anecdotal Sound 2)**.** *Those sound punctuations represent ghost melodies that haunts Malina, Igaluk's sister.*

Sound Example 2.4 (Anecdotal Sound 3)**.** *The rhythmical, machinic and accelerating sound was designed in reference to the race between Igaluk and Malina.*

Needless to say, then, that I am opposed to the traditional position in acousmatic composition that insists on the separation of a sound and its source[37]. Such a causal separation was originally intended "to ensure complete and exclusive devotion to the hearing phenomena, to happen upon instinctive pathways that lead from pure sound to purely musical"[38] (Schaeffer, 1977, p. 98). However, my vision of acousmatic composition is a complex and rich form of art that resembles sculpture in

[35]See Appendix B for a summary of the myth of Igaluk

[36]As a result of reading F. Nietzsche *On the Genealogy of Morals*

[37]The second commandment for *musique concrète* written by Chion (2009, p. 24) states that: "2. [The composer] completely distinguishes sounds and their original sound source."

[38]Original quotation in French: "[...] à se consacrer entièrement et exclusivement à *l'écoute*, à surprendre ainsi les cheminements instinctifs qui mènent du pur sonore au pur musical" (Schaeffer, 1977, p. 98).

that it produces a fixed, finished object that can be seen (or heard) from various angles over time. Sculpture does not have to reject figuration and embrace only abstraction in order to be art. This might have been true for a period of time but, after all those years of post-modernism, the opposition of abstraction and figuration in art is obsolete. I believe that we can perceive the beauty of a sound for itself even if we recognize the source that produced it, especially when it is out of context like on a CD or in a public listening environment[39]. This dual perception of the sound (anecdotal and interested in sound attributes) is exploited in *Comme si la foudre pouvait durer*. A dialogue with neighbours was unexpectedly captured during a recording session in the rain. It is found almost in its entirety in the piece except that it was smeared in order to conceal its meaning. What remains is a rhythmic and melodic sound material that retains its bond with the voice. Metaphorically, the dialogue, once inserted into the work, is the remembrance of a meeting where the meaning of each word was not really important.

Interestingly, one of the great theoretician of acousmatic, Chion (2009, p. 17), suggests that anecdote, after all, is a characteristic of the composition process in *musique concrète*: "A wealth of *musique concrète* lies in its ambivalence towards the issue of the anecdote, constantly dismissed then reintroduced."[40] Certainly, the anecdote is not the sole determining factor in the selection of a sound. The intrinsic characteristics of a sound also justify many choices during the composition process.

2.2.2 Sound Attributes

My musical training has familiarized me with Schaefferian phenomenological theories of sound perception. My goal here is not to summarize them[41]; Schaeffer's writings on sound perception constitute a vast ocean of knowledge that could hardly be shared in this document without changing its nature. Instead, I propose to analyse how such a theory influences my way of composing *musique concrète*.

To make my point clear, I nonetheless must address one of the most discussed concepts of Schaeffer's theory: reduced listening. Rather than redefining it here for the umpteenth time, let us look at what Michel Chion says about it:

> In Schaefferian theory, reduced listening is the attitude which consists in listening to the sound for its own sake, as a sound object by removing its real or supposed source and the meaning it may convey. [...] In reduced listening our listening intention targets the event which the sound

[39] A good example of that disconnect once sounds are on a medium would be *La Selva* (1998) by Francisco López.

[40] Original quotation in French: "Une des richesses de la musique concrète réside en effet dans son ambivalence par rapport à la question de l'anecdote, sans arrêt congédiée puis réintroduite." (Chion, 2009, p. 17)

[41] Landy (2007, pp. 73-105) manages to describe this theory in a concise and detailed manner in his book *Understanding the Art of Sound Organisation*. Also, a translation of Schaeffer's *Traité des objets musicaux* by John Dack and Christine North is available, although I personally always refer to the French version of the text. Finally, Chion (2012) has a glossary available on his website that defines the main terms of the Schaefferian theories.

> object is itself (and not to which it refers) and the values which it carries in itself (and not the ones it suggests)[sic]. The act of removing all our habitual references in listening is a voluntary and artificial act which allows us to clarify many phenomena implicit in our perception. [...] Thus, the name reduced listening refers to the notion of phenomenological reduction (Époché), because it consists to some extent of stripping the perception of sound of everything that is not 'it itself' in order to hear only the sound, in its materiality, its substance, its perceivable dimensions.(Chion & Schaeffer, 1983, pp. 30-31)

This "practical listening" focuses our attention on intrinsic characteristics of sound, of the sound object[42]. Now, the attributes of a sound distinguished with reduced listening can be described with Schaeffer's typo-morphology theory. Sound typo-morphology is a discipline that provides a vocabulary for classification (typology) and description (morphology) of the sound objects. It provides a method to discriminate sounds and evaluate their attributes with a set of criteria: mass, harmonic timbre, dynamic, grain, oscillation (allure), melodic profile, and profile of mass. The implementation of reduced listening in conjunction with sound typo-morphology offers a great tool to discern and exploit the full musical potential of a sound object.

In my music, this reduced way of listening to sound is omnipresent. If *désert* marvels at sound materials produced by my analogue modular synthesizer, it is primarily because these materials are attractive on a typo-morphological level. They are spectrally rich and have a variety of shapes suitable for the composition of *musique concrète*. Despite their electronica aesthetic and frequent use of tonality, *Igaluk* and *Comme si la foudre pouvait durer* offer much to the ear that is attentive to the sound attributes. Moreover, Tout Croche's production features a constant exploration of a variety of timbre, produced by fed back electronics. The following few sound examples (2.5, 2.6, 2.7 & 2.8)[43] will highlight the typo-morphological process used in the selection of a sound. Sound attributes which have been significant in the choice of each of the sound examples are listed below.

Sound Example 2.5 (Sound selected for its typo-morphology 1)**.** *This excerpt from* Comme si la foudre pouvait durer *was chosen because of its fragment typology. Sounds with artificial edges, the fragment reveals the techniques of edition and cutting in electroacoustic music.*

Sound Example 2.6 (Sound selected for its typo-morphology 2)**.** *The example taken from* Igaluk *suggests a formed note with a complex mass, even thought a fundamental can be perceived. Its sharp attack and exponential release has made it a prime candidate for creating slow rhythms.*

[42] "In Schaefferian theory the term sound object refers to every sound phenomenon and event perceived as a whole, as a coherent entity and heard by means of reduced listening which targets it for itself, independently of its origin or its meaning. [...] It is a sound unit perceived in its material, its inherent texture, its own qualities and perceptual dimensions. On the other hand, it represents a global perception, which remains identical through different hearings; an organised unit which can be compared to a 'gestalt' in the meaning of the psychology of form."(Landy & Atkinson, 2002)

[43] I could have chosen many other sounds as my pieces are filled with them, chosen for their sonic attributes.

Sound Example 2.7 (Sound selected for its typo-morphology 3)**.** *Taken from the* croire *movement of* désert*, this synthetic sound gives the impression that it emanates from a single source, exploring the possible articulations that can be obtained with that source. Hence, its considered as a sample in the Schaefferian typology and has a great musical value. Its grain helps it stand out from the lot when put into musical context.*

Sound Example 2.8 (Sound selected for its typo-morphology 4)**.** *The sound presented here was taken from* désert*'s movement* perdre*. It is characterised by its fixed mass (pitch), its iterative allure, its slow morphology and space movement. It is used at several occasions in the movement with variations over its pitch and speed of iteration.*

From the description of the sound examples, we first note that the evaluation process of sound objects is not as rigorous as Schaeffer's approach suggests. In my implementation of the typo-morphology, I do not dwell on describing all of the attributes that characterize a sound. Instead, I focus on a specific sound quality that inspires in me a potential musical use. In view of the examples given, the "grain"[44] appears as an important morphological criterion in the selection of my sounds. For a long time, the "iterative pad"[45] has been part of my musical vocabulary. It is frequently used to energize and add relief to a slow musical movement. The "sample"[46] is also a group of typologies that is valued in my music. This is because of a strong link between the "sample," as irregular and human as it is, and the search for a "trace of physicality" described in Section 2.2.4

Smalley (1997) proposes a descriptive theory of sound that continues the discussion initiated by Schaeffer: spectromorphology[47]. More than simple methods of analysis, these theories are both inspiration and validation for my sound choices.

> Although spectromorphology is not a compositional theory, it can influence compositional methods since once the composer becomes conscious of concepts and words to diagnose and describe, then compositional thinking can be influenced [...]. In the confusing, wide-open sound-world, composers need criteria for selecting sound materials and understanding structural relationships. So descriptive and conceptual tools which classify and relate sounds and structures can be valuable compositional aids. (Smalley, 1997, p. 107)

In its method of describing the sounds, Smalley succeeds in reinvesting the field of music; something that Schaeffer was not able to accomplish with his theory. With the concept of "structural functions,"

[44] "Grain is a microstructure of the matter of sound, which is more or less fine or coarse and which evokes by analogy the tactile texture of a cloth or a mineral, or the visible grain in a photograph or a surface." (Chion & Schaeffer, 1983, p. 171)

[45] "The name iterative is given to sounds whose sustainment is prolonged by iteration, i.e. by repetition of impulses at close intervals." (Chion & Schaeffer, 1983, p. 131)

[46] "a prolonged excentric sound, continuous but disordered, which is nevertheless perceived as a unit because we recognise behind the oddness the permanence of a cause, the persistence of a single agent in pursuing its aims." (Chion & Schaeffer, 1983, p. 152)

[47] " [...] the concepts and terminology of spectromorphology [were developed] as tools for describing and analysing listening experience. The two parts of the term refer to the interaction between sound spectra (spectro-) and the ways they change and are shaped through time (-morphology)." (Smalley, 1997, p. 107)

spectromorphology gives a perceptual importance to the context within which sounds are used. In other words, the composer also selected the sound object for its intended musical use.

2.2.3 The Musical Function

If Smalley's explanations on the "structural functions" are succinct, Roy (2004), in his book *L'analyse des musiques électroacoustiques : modèles et propositions*, develops a method of "functional analysis" intended for electroacoustic music. The author asserts that sound objects (sound units as he refers to them) have musical functions in the context of a work that can be revealed by means of analysis:

> The function [of a sound unit] forms through a network of relationships between units in a local context as well as in the global context of a work [...]. These networks of relationships set up relations of both opposition and referral between units. They confer a great meaning to some short units as they are articulations that delimit larger units. Some units are assigned driving roles because of their inner movement [...] while layered textures generate a hierarchical organization that assigns specific roles to specific units/layers.[48] (Roy, 2004, p. 344)

He lists and describes the possible musical functions of sound objects as part of four categories: orientation, stratification, processes and rhetoric. This theory, originally conceived as an analytical tool, is an integral part of my training and has made me aware of the functional vocabulary. In retrospect, it is highly influential in the process of making compositional decisions. The functional theory is a much needed help in the organization and structuring of the sounds that compose music. Most importantly, it allows me to connect typo-morphological characteristics of a sound object to its use in a musical context. In short, the concepts introduced by Roy (2004) in his functional analysis raised awareness to processes that are highly useful to electroacoustic music composition[49]. I now use it abundantly in the design and composition of my *musique concrète*.

In the light of Roy's functional analysis, we understand, for example, that thunder is a disruptive element that structures *Comme si la foudre pouvait durer*. Often, it introduces or interrupts the musical flow by its dynamic morphology as well as its irregular and complex mass. The movement titled *contempler* in *désert* is a clear example of the layering work suggested in the functional vocabulary. In the background, a sustained note serves as an "axis of tonal polarisation"[50] while a

[48] Original quotation in French: "La fonction [d'une unité sonore] prend forme grâce au réseau de relations qui se tisse entre les unités dans un contexte local comme dans un contexte global d'une œuvre [...]. Ces réseaux de relations mettent en scène des rapports d'opposition et de renvoi entre les unités. Ils font de certaines unités brèves d'importants lieux d'articulation qui, en définitive, constituent des indices pour la délimitation de plus grandes unités. La présence de progressions concentre sur certaines unités des rôles moteurs [...] tandis que les textures stratifiées génèrent une organisation hiérarchique qui attribue à certaines unités/strates des rôles spécifiques." (Roy, 2004, p. 344)

[49] Although functional analysis was developed with electroacoustic music analysis in mind, its use is not limited to a particular genre. Roy (2004, p. 386) himself proposes "to extend its use to very different musical repertoires that include contemporary instrumental music, or non-Western repertoires which require the most unbiased approach possible [...]"

[50] The "axis of tonal polarisation" function (*axe polarisateur tonal* in French) is attributed to a sound unit with an homogeneous and stable morphology as well as a perceptible mass. It acts as an attracting tonal centre for other units that tend to disturb its homogeneity (Roy, 2004, p. 354).

bouncing sound acts as "figure"[51] with its precise attacks and variable-speed iterations. This "figure" is supported[52] by a distorted and erratic texture which is noticeable mainly in its interruptions. In the first half of its structure, the movement also presents an orientation process which has greatly influenced the production of sound objects: the intensification[53]. Meanwhile, the movement titled *perdre* is organized around a deceleration[54] process that suggested the morphological changes of my sounds during composition. The movement titled *vouloir* of the same piece offers some striking examples of rhetorical relations between sounds. The sudden rupture[55] of the rich sound texture (1:35) is followed by some brief sound reminders[56] of the density that was previously there; these reminders follow a dispersion[57] pattern, becoming shorter and shorter until they are forgotten.

In summary, the functional classification of Roy is omnipresent in my music. It is an efficient tool to discern the musical potential of a sound. Although the previous examples shed some light on my argument, the analysis of functional relationships within music can be extraordinarily complex. I therefore leave to the curious listener the pleasures of a more thorough analysis of my music.

2.2.4 A New Concern: The Trace of Physicality

In the light of the observations made in Chapter 1, a new criterion seems to impose itself in the quality of a sound: the "trace of physicality." In order to understand that notion, first we must state that a recorded sound is the unaltered result of its production. In a more or less concealed manner, sound testifies to the manipulations that led to its conception. Schaeffer (1977, p. 413) refers to the term "facture" to describe the traces of a sound's manufacture present in the sound. I argue that one can perceive humanity and a sense of physicality in this *facture*. For the composer of *musique concrète*, the trace of physicality has the potential to dynamise its rigid and slow practice; it accelerates the workflow by giving performance[58] a place in the composition process, thus giving the sound fluidity:

> This trace of a human presence on fixed media works, and captured embodied gestures as a mean of testifying that the music is alive, brings an interesting perspective on liveness. [...] The perceived liveness of a performance over a recorded media is a fascinating problem, defying

[51] The "figure" function is a sound unit featuring an unstable morphology which allows it to be prominent, to be in the forefront of a layered texture (Roy, 2004, p. 354).

[52] A "support" (*appui* in French) is a subordinate function of the "figure" that features similar morphologies yet has a distinctive timbre. (Roy, 2004, p. 355)

[53] The "intensification" function describes sound units featuring dynamic, spectral and melodic profiles that increase in time. (Roy, 2004, p. 357)

[54] The "deceleration" function describes the sound units organized according to a progressive stretching of time between the attacks that form it. (Roy, 2004, p. 357)

[55] The "rupture" function is a dramatic cutoff in the sound accentuated by a previous intensification. (Roy, 2004, p. 364)

[56] The "reminder" function (*rappel* in French) reiterates at various locations in the work a prominent musical moment. (Roy, 2004, p. 359)

[57] The "dispersion" function is attributed to sound units which feature a gradual disappearance of its perceptible components. (Roy, 2004, p. 357)

[58] "Performance" is here used in its broadest musical sense, signifying the action of "playing" a musical instrument. Such a form of performance can be accomplished in studio without the presence of an audience.

> taxonomy, yet is too important a concern for the current generation to be ignored. (Tremblay, 2012b, p. 7)

For Aldrovandi (2000), the act of listening is sensitive to performative musical gestures. He argues that this perception can have a major impact on our way of composing electroacoustic music:

> We may intend to listen to a certain behaviour in sound with an intentional body movement, or, we may discover macroscopic properties of sound while manipulating with attentive listening. [...] We may imagine that control of gestural performance can underlie the development of a composition. (Aldrovandi, 2000)

In other words, it is possible to compose a music that incorporates musical gestures by methodically exploring the sonic possibilities of a sounding body[59]. However, Aldrovandi applies the argument almost exclusively to the creation of *séquences-jeu* using acoustic sounding bodies during recording. *Variations pour une porte et un soupir* by Pierre Henry is a classic example of the trace of physicality achieved from the recording of a sounding body. It takes little time to understand that the creaking door is played expressively by the composer who exploits a range of subtleties from that sounding body. My use of recorded guitar (in *Comme si la foudre pouvait durer*) and piano (in *Igaluk*) were clear attempts to confer a sense of liveness and physicality to my music. "The use of extended passages of 'performed' instrumental phrases in a fixed media work [...] changes our perception of the instrument as a site for sounds to one that implies a performing presence, no matter how disembodied this presence is" (Adkins, 2012).

However, my search for a trace physicality is not exclusively limited to the perception of a sounding body performed in studio. It is also possible to recognize a physicality specific to electroacoustic music which is heard in the manipulations and processing of the sound: "When a sample or processed sound gives a sense of the journey of that sound [...] could this be what we call "live" in the age of technically enhanced performance" (Milutis, 2008, p. 72)? Here Milutis raises the question of the recognition of a musicality specific to the electroacoustic tools. A practitioner ear can recognize a large number of sound archetypes developed by studio tools (see Section 2.1.4). Furthermore, the musician's ear of the practitioner can recognize a musical performance with those tools. It can recognize, for example, the gradual opening of a low-pass filter in the first moments of *Comme si la foudre pouvait durer* as presented in Sound Example 2.9. This sweeping of the spectrum is articulated in an organic, fragile and restrained way that suggests the performance by means of a rotary controller. The use of edited automations to compose this gesture would have produced a more dramatic, sudden and explosive articulation. By rehearsing a performed articulation, I developed a more contained gesture relevant to the opening of the piece. In *Igaluk*, a granulation process is performed to create a varying texture as Sound Example 2.10. A trained ear can recognize the change of index in the granulation process in addition to hearing a parallel filtering process.

[59] Schaeffer (1977) uses the term "sounding body" to describe any physical object capable of producing sounds.

Sound Example 2.9 (Lowpass filter performed on thunder recording)**.** *In this example, we can hear a lowpass filter sweep being performed as the thunder rumbles. The performance aims to amplify the explosive character of the natural thunder sound. One does recognise both the morphological changes imposed by the filter that sweeps the spectrum of sound and a form of physicality specific to the electroacoustic medium.*

Sound Example 2.10 (Granulation performed in *Igaluk*)**.** *The performance of this granulation process consists of changing its index position with an expression pedal, as explained in Section 3.2.*

Smalley (1997) proposes the concept of *source bonding*[60] to describe the phenomenon of correlation between a sound and its cause. He also argues that sound can reveal the gesture that conceived it: "When we hear spectromorphologies we detect the humanity behind them by deducing gestural activity, referring back through gesture to proprioceptive and psychological experience in general" (Smalley, 1997, p. 111). As a result, he classifies the perceptual distance between a sound and its cause in terms of *gestural surrogacy* levels:

> *First-order surrogacy* [...] is concerned with sonic object use in work and play prior to any 'instrumentalisation' or incorporation into a musical activity or structure. It is here that musical potential begins to be recognised and explored. [...] First-order surrogacy includes recordings of sound-making not intended for musical use. On the other hand, first-order surrogacy may involve more developed gestural play purposely used as compositional material, a sort-of personalised, nascent 'instrument' which never achieves, or can never achieve full cultural, instrumental status. But we can only award such sounds first-order status if we can recognise source [sic] (the type of material) and type of gestural cause. [...]
>
> *Second-order surrogacy* is traditional instrumental gesture, a stage removed from the first order, where recognisable performance skill has been used to develop an extensive registral articulatory play. An acousmatic music which, for example, uses only recordings of identifiable instruments remains in the second order. Much music which uses simulation of instrumental sounds can also be regarded as second order since, although the instrument may not be real, it is perceived as the equivalent of the real. Commercial synthesizer usage is of this type when we recognise both the gesture involved and the instrumental source simulated.
>
> *Third-order surrogacy* is where a gesture is inferred or imagined in the music. The nature of the spectromorphology makes us unsure about the reality of either the source or the cause, or both. We may not be sure about how the sound was made to behave as it does, what the sounding material might be, or perhaps about the energy–motion trajectory involved. [...]
>
> *Remote surrogacy* is concerned with gestural vestiges. Source and cause become unknown and unknowable as any human action behind the sound disappears. The listener may instead be concerned with non-sounding extrinsic links, always, of course, based on perceived spectromorphological attributes. But some vestiges of gesture might still remain. To find them we must refer to tensile, proprioceptive properties, to those characteristics of effort and resistance perceived in the trajectory of gesture. (Smalley, 1997, p. 112)

In short, the higher the level of surrogacy of a sound is, the more distant and independent it appears to be from any source or cause. In our quest for the "trace of physicality," we would like electroacoustic manipulations to be perceived as second-order *gestural surrogates*, in a similar way

[60] "the natural tendency to relate sounds to supposed sources and causes, and to relate sounds to each other because they appear to have shared or associated origins" (Smalley, 1997, p. 110).

as any other instrumental gesture. However, the author warns us of the insistence of a direct link between sound and its cause:

> I venture to suggest that an electroacoustic music which is confined to the second order does not really explore the potential of the medium, while a music which does not take some account of the cultural imbedding of gesture will appear to most listeners a very cold, difficult, even sterile music. (Smalley, 1997, p. 112)

Consequently, a well-balanced *musique concrète* composition will feature only a few second-order surrogates that emphasize a direct trace of physicality. The majority of sound objects will be closer or more remote from their cause depending on the musical context.

Comme si la foudre pouvait durer contains several sound materials that could be perceived as second-order surrogates. However, the presence of acoustic instruments, and their palpable physicality, relegates the sound objects resulting from electroacoustic manipulations to a third-order surrogacy. For example, the guitar recordings highlight a perceptible hesitation in the guitar playing. The superb bass part played by Pierre Alexandre Tremblay also imbues a physical and human character. In comparison, the performance of the filter described above can only take on a subtle accompaniment role that represents a barely perceptible level of physicality. In short, the level of perception of a trace of physicality is greatly dependent on its musical context. In contrast, *désert* presents synthetic sounds that maintain, more or less, the same distance from their source, my modular analogue synthesizer. The sound materials feature perceptible traces of physicality as the Sound Examples 2.11, 2.12 & 2.13 shows. Of course, the relevance of these examples is debatable as I am the musician who crafted them and can therefore easily identify the musical gesture embedded in them. I will therefore not speculate on their level of surrogacy.

Sound Example 2.11 (Sound featuring a trace of physicality 1)**.** *The sound example taken from the movement* contempler *features a simultaneous performance of the rate of a synthesised pulse and its filtering. The result is a physical sounding material used in its present condition in* désert

Sound Example 2.12 (Sound featuring a trace of physicality 2)**.** *In the* croire *movement, the quantized pitch of two oscillators is performed to create this synthesised sound. The result, by its irregularities and surprises if embedded with physicality.*

Sound Example 2.13 (Sound featuring a trace of physicality 2)**.** *In this example taken from the movement titled* vouloir*, a chaotic system implemented with the modular synthesizer is performed by changing the parameters of various modules. The link between gesture and sound result is here more abstract. Yet, it features a certain physicality that is showcased in the sense of timing and decisiveness that the sound material required in order to be performed.*

In electroacoustic literature[61], we assume that the electroacoustic manipulations are third-order (even remote) surrogates because their sonic results are multiple and little known to the public. However, as Adkins (2012) declares, "the idea of live-ness in contemporary art is one in which traditional notions of the bodily, presence, actuality and artifact are continually being redefined." It is true that the order of a gestural surrogacy is dependant on the socio-cultural context. In fact, however, it appears that the means of electroacoustic music production are increasingly known by a large group of listeners, thanks to the democratization of the studio (Homer, 2009). We can therefore contemplate the idea that, once the studio is fully integrated in our common conception of music, this trace physicality will be perceived by all, not only practicing musicians. I now value the trace of physicality in my *musique concrète* in the hope of cultivating this connection between a musical gesture and its musical result specific to the electroacoustic medium. Hence an avid interest for live electroacoustic music has developed.

Furthermore, embodiment theories seem to confirm the gradual acceptance of electroacoustic gestures. Already, it has been proven that a listener is able to recognize trajectories in electroacoustic sounds (Godøy et al., 2006). The development, already well under way, of a culture of live electroacoustic performance will give the listener the mental images necessary to decode this trace of physicality:

> The idea of mental re-coding of sound into multi-modal gestural images [...] rests on the idea of embodied cognition. Embodied cognition means that there is an incessant mental simulation going on in our minds of whatever we perceive, so that perception is not a matter of abstract processing of sensory data, but rather a process of re-enactment of whatever we perceive. (Godøy, 2006, p. 155)

With his notion of "gestural-sonorous objects," Godøy (2006) even combines Schaeffer's typomorphology and gestural theories. In fact, his intention is to describe musical gestures using typomorphological vocabulary. Van Nort (2009) will even use this idea of "gestural-sonorous objects" to rethink the manufacture of digital instruments.

Throughout this discussion, a definition of what is meant by "trace of physicality" seems to take shape. The trace of physicality appears to be an embodied perception of an interaction between a musician and a sound-generating process that was recorded as part of a composition (see Figure 2.2 for a visual representation). The interaction between a musician and a sound-generating process (regardless of whether it is acoustic or electroacoustic) is the site where the original physicality occurs. The recording of this physical performance and its usage in a composition confers on it the status of a trace; it is a reproduction of the gesture (rather than the original) which is presented to the listener. The listener perceives the particular gesture because he is able to conceive that the resulting sound was produced in response to a gesture. This embodiment is informed by his

[61] (Smalley, 1997; Young, 1996; Landy, 2007)

electroacoustic knowledge and, most of all, his past experiences. Ultimately, my use of this trace of physicality aims to offer the listener a more lively, less rigid *musique concrète*, which takes into account the characteristics of fixed-media music.

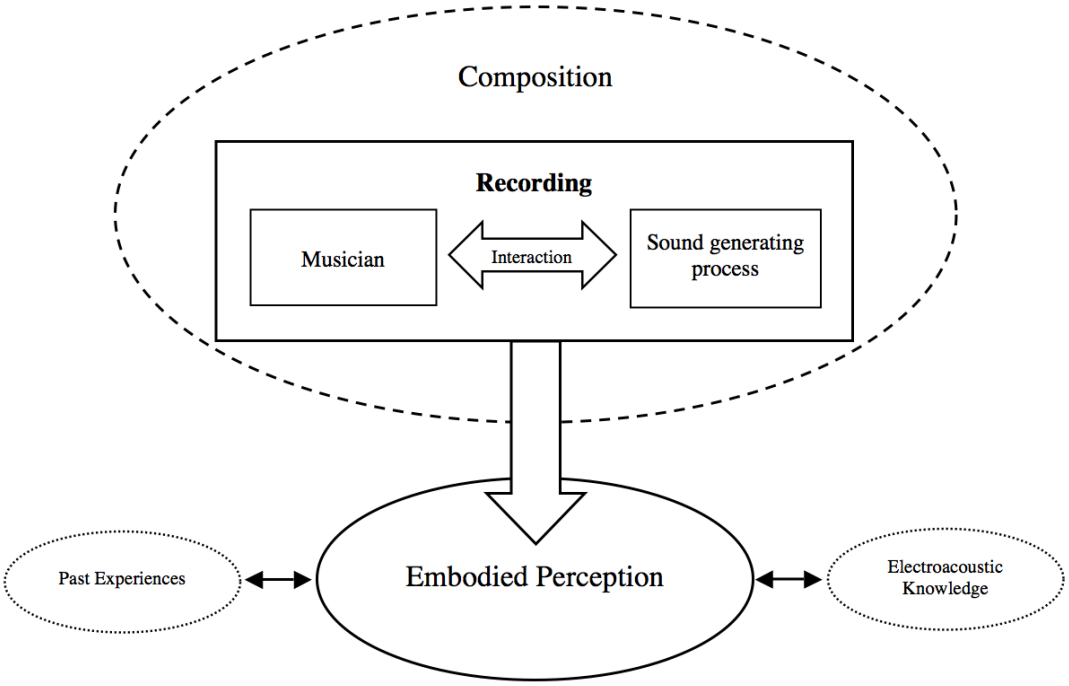

Figure 2.2: The concept of "trace of physicality"

Chapter 3

Digital Instruments to Perform Sound – A Case Study

> *The instrument is not just a tool but an ally. It is not only a means to an end, it is a source of material, and technique [...] is often an exploitation of the natural resources of the instrument.*
>
> Derek Bailey

As discussed in Chapter 1, the doctoral period was initiated with observations on my electroacoustic music production. In order to overcome the slowness and rigidity of the home studio practice, I immediately turned to the design of musical instruments. The instrument seemed to allow spontaneity, fluidity and musical performance that was sorely lacking in my practice. My very first impulse was to return to the guitar, an instrument I had cherished during my teenage years and studied intensively in a college degree. But after a few unsuccessful attempts, I reaffirmed the observation made at the beginning of my musical journey: the guitar no longer corresponds to my musical sensibility. It must be said that over the past decade, I have mainly focused my practice of the creation of electroacoustic music, developing a *solfège*, techniques and, most importantly, a sensibility specific to the medium. In short, it seemed to me that I already had developed a form of virtuosity with electroacoustic tools. Consequently, research was initiated to develop direct interaction with the electroacoustic medium. I was confident that the integration of the instrument into my practice would renew my composition methods.

The realization of the present portfolio provided the framework for this research of an instrument suitable to my needs. It now appears that this research was accomplished naively, without a prior identification of the instrumental needs to fulfil. Through trial and error, instrumental instances were developed to meet the needs of specific musical projects. While this may seem like a flaw in the research methodology, I believe that this wandering has allowed me to define the parameters and limits of my music creation. Through this instrumental development, I have not only found

specific solutions to particular musical projects, I have also understood the attitude that I wanted to maintain in relation to performance in electroacoustic music.

The case study present in this chapter highlights the path of my reflection on the concept of the instrument in electroacoustic music. Three instrumental instances will be analysed in order to reveal their impact on my various projects. In a first working hypothesis, a *composed instrument* was developed specifically for the performance of *Igaluk*. In parallel, an interest in electroacoustic improvisation initiated the development of *fXfD*. The instrument also integrated functions for more efficient composition. In retrospect, the three practices of improvisation, composition and performance are all essential to my instrument research. These concerns are central to the study of a third case: the studio. The studio is presented here as a polymorphic instrument which facilitates the performance of electroacoustic music. To avoid any ambiguity, the definition of "instrument" will be reviewed first.

3.1 A Definition

If "'[m]usical instrument' is a self-explanatory term for an observer in his own society" (Wachsmann et al., 2014), then this observer has been considerably challenged in his definition of the instrument in recent decades. In view of the developments in computer music, the notion of instrument has taken on a new meaning, freeing the sound production of its physical constraints. Research in the fields of sound synthesis and interface has helped develop the concept of the "digital instrument": "digital musical instruments can [be] divided into a gestural controller (or input device) that takes the control information from the performer(s), and a sound generator that plays the role of the excitation source." (Jordà, 2007, p. 96)

The "digital instrument" is composed of three founding components chosen by the creator: a gestural controller, a sound generator and mapping strategies. A gestural controller captures the gestures of a performer via an interface, transforming them into discrete values and transmitting them to a music system. Many types of controllers can transmit various gestural values[62]: biometric sensors, keyboards, augmented instruments and joysticks are to name but a few. The sound generator is the computing device that calculates the resulting sound produced by an instrument. It implements processes based on various synthesis, sampling and signal processing techniques. Finally, the mapping strategies form "the connection[s] between gestural parameters [...] and sound and music control parameters." (Jordà, 2005, p. 141). Those connections can be convergent, divergent or one-to-one and often use the concept of energy (Rovan, Wanderley, Dubnov & Depalle, 1997).

[62]Wanderley (2001) distinguished three types of controllers: instrument-like controllers, extended controllers and alternative controllers.

The definition of digital instruments has always been inclusive, embracing personal visions of how a musical instrument can be implemented. This is evidenced by an imposing literature that covers the development of countless instruments, each with its peculiarities. This chapter is not intended to provide a description of yet another in a long line of digital instrument (see NIME)... Instead, it emphasizes that the instrument has become a malleable concept that fits the needs of the designer. On a personal level, the instrument has become a way to energize my *concrète* approach to musical creation. It provides a gestural and musical control over electroacoustic sound manipulations; sound production, editing, processing, diffusion, in short, electroacoustic techniques (see Section 2.1.2) could now be performed with the virtuosity that an instrument implies.

Because the computer is central to my practice, it is through the prism of the "digital instrument" that the various instrumental instances developed will be studied. Each instrument will be analysed in the light of the three components of the digital instrument (gestural controller, sound generator and mapping strategies). The case studies of the software instrument for *Igaluk* and the integrated instrument *fXfD* will lay the groundwork for a discussion on the studio as a polymorphic and versatile instrument.

3.2 *Igaluk*, the Composed Instrument

Igaluk – To Scare the Moon with its own Shadow is a piece that was initiated during a residency at the Technische Universität Berlin in the summer of 2011. During my doctoral studies at the University of Huddersfield, I had the opportunity to visit the German capital for two months, during which time I met weekly with the pianist Sebastian Berweck[63]. The project was at that point to develop a mixed music piece for piano and electronics. However, during our meetings, we found a common interest in electroacoustic music played live. Thus the commission became one for a live electroacoustic piece.

The composition process of *Igaluk* was characterized by a constant exchange with Berweck that made possible the development of a digital instrument specific to the piece. In order to validate the software development of the instrument, instrumental drafts were repeatedly submitted to the performer for an experimental evaluation. Through this process, I wanted to submit design ideas for the approval of Berweck, who had strong opinions on performance concerns. In the past, I had already developed such a collaborative process with percussionist João Catalão in the piece *Enfant Robot au cœur fondant* (Thibault, 2011). However, this was a first experience of sharing my electroacoustic composition process with a performer. I was still the sole composer but someone was now overseeing my electroacoustic decisions under a new perspective, that of performance.

[63]His personal website: `www.sebastianberweck.de`

The sonic signature of *Igaluk* emerged during an improvisation session in the studio with my collaborators Berweck and Harvey (member of duo Tout Croche). This recording session was organized around a series of *séquences-jeu* and improvisations on a prepared piano. It became a pivotal step in the development of the project. Exploring extended piano techniques with the help of such an endlessly resourceful musician as Berweck, a set of sound materials was collected which provided a direction and a unity for the following compositional work (see Sound Examples 3.1, 3.2 & 3.3). Only then could I begin the design of a dedicated instrument for the performance of a composed piece[64].

Sound Example 3.1 (Improvised Sound Material for *Igaluk* 1)**.** *Sound recorded during the improvisation session. This sequence has provided the sounds for a micro-instrument that was later automated.*

Sound Example 3.2 (Improvised Sound Material for *Igaluk* 2)**.** *Prepared piano improvisation that has provided the* PrepPiano *sounds.*

Sound Example 3.3 (Improvised Sound Material for *Igaluk* 3)**.** *Improvisation with an ebow and a slide directly on the piano strings. The sounds obtained were integrated also as is in the piece.*

After defining the sound materials that would be used for the composition of the piece, I was able to develop a series of micro-instruments that provide a specific manipulation over a subset of these sounds, presented in detail in Section 3.2.3. The micro-instruments developed with Max (Cycling '74, 2014) were, in fact, prototype instruments developed to test a design with the help of Sebastian Berweck. Together, we could evaluate the best suited gestural controller for a sound generator given of the various mapping strategies. The Max patch titled *Piano Painting* in the appendix is a micro-instrument that was tested by Berweck and me. It consists of a playback engine that can read a piano improvisation by Berweck. It is controlled with a toggle button that activates the looping of a short fragment of the improvisation and a rotary potentiometer to set the length of the loop. Although it offered interesting sonorities, the micro-instrument was rejected as it could not provide a precise control or notation. Another, more successful example of this selection concerns the micro-instrument titled *GranulaChords*, also found in the appendix. A linear potentiometer would determine the position of a granulation index that would return to a stable position following the physical properties of a spring-mass system. Although the micro-instrument *GranulaChords* was not used in the final version of *Igaluk*'s instrument, it inspired the creation of another micro-instrument, *DarkScratch*. The latter has retained the concept of a granulation controlled by a linear interface while adding some processing functions.

[64]Note that at this stage of the composition, the concept of the piece was to ask the performer to manipulate his own recordings with electroacoustic techniques. Controlling multiple recordings simultaneously, the performer was becoming a sort of contemporary one-man band.

Upon agreement on the relevance of a number of micro-instruments, a simulation inside Ableton Live (Ableton, 2014) was designed, thanks to the Max4Live module, to allow composition with these micro-instruments. Ableton Live's sequencer provided a simulation environment for the gestural data that would cause the sound generator of the instrument to produce sound. Thus, this simulation environment provided an efficient method to compose a music that respected the instrument's design. Once satisfied with this simulation, I had to develop an instrument specifically designed for the performance of the piece in concert. To that effect, it was necessary to build an instrument that met the enabled the live performance of such a set of micro-instruments: "Over the years while performing and composing [...], I have come to create MaxMSP patches that are not meant to work for all occasions, but often work only in a 'case-specific' way in terms of musical context" (Kimura, 2003, p. 294).

The next step in the creation was to develop a concert instrument. The concert instrument described here can be labelled a "composed instrument" in the sense intended by Schnell & Battier (2002, p. 156): "The term [...] 'composed instrument' underlines the fact that computer systems used in musical performance carry as much the notion of an instrument as that of a score, in the sense of determining various aspects of a musical work." I was to integrate a complex set of musical information together into a single musical system, the concert Max patch. In this patch, all gestural controllers had to be connected to the sound generators by a series of mapping strategies. Also, structural information regarding the music had to be managed by this patch along with live mixing data. The whole had to be packaged with a technological transparency that is required by most professional instruments (Berweck, 2012; Tremblay, 2012a). Here again, the intervention of Sebastian Berweck helped validate and adjust the instrument design before a final version of the instrument was produced. The result is the Max patch pictured in Figure 3.1 which allows the performance of *Igaluk* after a few initialisation mouse clicks.

In parallel to the development of the concert instrument, the score required a considerable amount of work. The notation for the gestural controllers was divided into 4 standard staves and a continuous staff to match the interaction with the micro-instruments. This configuration of the score is a compromise between readability and understanding of what is played for the performer. The technical description attached to the partition accurately describes the relationship between gestural controllers and written parts. A translation from the simulation to discrete musical values was necessary to produce the score. Fortunately, the MIDI norm has allowed an easy transfer of much information between the DAW and the score editor. Nevertheless, several manipulations had to be completed manually. Moreover, the interface of the concert Max patch shown in Figure 3.1 is organized according to the staves so that the performer can understand the links between the score, his playing and the mechanisms triggered in the Max patch.

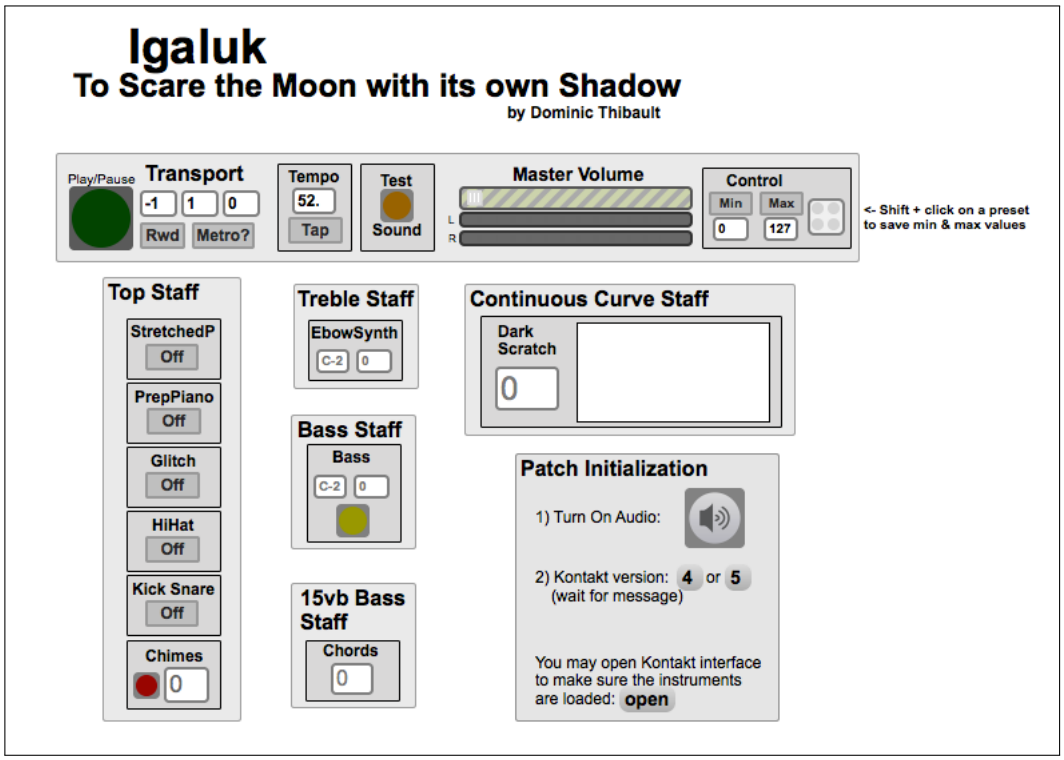

Figure 3.1: *Igaluk*'s concert patch in presentation mode

3.2.1 Gestural Control

In the development of the instrument, a constant preoccupation was the adaptation of the design to the skills, sensibility and virtuosity of the performer. For Sebastian Berweck, a concert pianist, it seemed important to preserve the keyboard in the design of a gestural controller adapted to his experience, "thus recycling the virtuosity acquired on the [...] instrument with a trivial learning curve" (Tremblay & Schwarz, 2010, p. 447). After all, he had had thousands of hours of practice with this interface. The gestural controller for *Igaluk* was therefore built around a keyboard. To the keyboard were added a series of MIDI pads providing visual feedback (on/off toggles) and an expression pedal. These controllers were added to the configuration because some of the sound generators required a different interaction from the performer with the keyboard. Figure 3.2 depicts the gestural controllers used by Sebastian Berweck for the performance of *Igaluk*

Note here the exclusive use of MIDI interfaces, which uses a protocol that has remained relevant to electroacoustic music despite its 30 years. Its advantages are clear for the integration of interfaces in the development of a draft instrument. It provides a standardized format of 7-bit resolution discrete values and is compatible with numerous programming environments. For more details on the implementation of MIDI in *Igaluk*, the technical requirements sheet provided in the appendix

Figure 3.2: Gestural controller configuration for the performance of *Igaluk*

describes the MIDI assignments required to connect the gestural interfaces to the concert Max patch.

3.2.2 Sound Generation

The sound generator of *Igaluk* consists of a set of micro-instruments, a set of limited instrumental instances that performs a single sound function. Overall, the concert instrument contains ten micro-instruments organized in parallel. They each receive the gestural information concerning them and emit an audio stream accordingly. Audio streams are mixed down to stereo following automated mixing controls. This mixed down stereo signal is forwarded to the speakers diffusing the musical piece.

Each micro-instrument has a different sound signature which contributes to the polyphony of *Igaluk*. Most of them base their operation on sampling to generate a sound result. The samples[65] used all originate from the recording session presented above. Hence the sampler Kontakt (Native Instruments, 2011) is loaded during initialisation of the Max patch. Synthesis and digital processing

[65] "A sample is a portion of sound locked in digital memory, which can be played back, transposed and undergo several other transformations which are possible in a dedicated device such as a sampler or on a computer's hard disk. Most of these functions can be triggered either by the sampler's controls, by a MIDI instrument or through other digital interfaces: computer software or hardware, MIDI data boxes." (Landy & Atkinson, 2002, see the "Sampling" topic)

also play a role in the manufacture of some micro-instruments. However, the mapping strategies will bridge the gestural controllers and sound generators of *Igaluk*. Their analysis will enable a more detailed description of each of these micro-instruments.

3.2.3 Mapping

Each micro-instrument implements a mapping strategy to connect the gestural interface to the sound generator. These mapping strategies were also decided in collaboration with Sebastian Berweck. We sought to determine an appropriate mapping for ergonomic keyboard playing. Some micro-instruments seemed destined to be played on a keyboard; their mapping was then obvious. Others required a large number of keys for triggering the different samples; a space was also kept for them on the keyboard. Similarly, melodic micro-instruments were mapped to the interface. This is also how we determined that micro-instruments played frequently should be mapped to the central section of the keyboard while those requiring infrequent use could be assigned to the extremities of the interface. In the end, the keyboard was divided into three zones controlling three different micro-instruments.

It is also in this perspective of instrumental ergonomics that we added a series of MIDI pads, used to start and stop binary processes. The pads also serve as triggers for one-dimensional micro-instruments. The expression pedal was selected to control a micro-instrument requiring uninterrupted values while both hands were already occupied. At this point, it seems difficult to determine whether gestural controllers determined which sound generators were valid or vice versa if the sound generators dictated the gestural controllers in the development of the piece. It appears that the design of the instrument was accomplished through a dynamic approach of cross-pollination between the development of sound generators and their testing with various gestural controllers.

Table 3.3 summarises the mapping strategies that have been implemented in the concert instrument of *Igaluk*. In the interest of clarity, the names of the micro-instruments are those found in the Max patch. Also, audio examples are provided to contextualize each micro-instrument while listening to the entire piece.

3.2.4 Observations

The creation of *Igaluk* allowed me to make several observations on the development of electroacoustic instruments. First, a "composed instrument" encompasses significantly more components than a mere digital instrument that clearly fits the tripartite model of gestural controller, sound generator and mapping strategies: "[...] computer-based instruments can surpass the sound and note levels,

Micro-Instrument	Gestural Controller	Sound Generation	Mapping Strategy
StretchedPiano	MIDI Pad (toggle)	Piano sequence with delay applied - very slow attack and release	The MIDI Pad in toggle mode turns on and off the piano pad that slowly appears and disappears
PrepPiano		Series of 7 prepared piano sounds that are step-sequenced	The MIDI Pad attached to each micro-instrument starts and stops the respective step sequencer, creating a beat. The step sequencer are linked to the general tempo and their pattern evolves automatically through the piece.
Glitch		Series of 7 glitch sounds that are step-sequenced	
HiHat		Series of 4 "hi-hat" sounds that are step-sequenced	
KickSnare		Kick and snare sounds that are step-sequenced	
Chimes	MIDI Pad (trigger)	Distorted piano sample	The MIDI Pad triggers one of the 23 piano sequence played in rotation.
EbowSynth	Keyboard	Samples of a piano string played with slide, doubled melodically with additive synthesis	The keyboard (range Bb3 to Bb5) note transpose a sample and its synthetic double according to the pitch selected.
Bass		Synthetic bass samples and played back trough a sampler	The keyboard (range F1 to F#3) notes play back the correspond synth bass sound. Sustain pedal holds the note until released
Chords		Serie of 16 piano chords	The keyboard (range A-1 to E1) notes triggers an attached piano chord
DarkScratch	Expression Pedal	Granulated piano sound with processing	The expression pedal controls the index position of the granulation process. The sound granulated having a percussive morphology causes a loud and agressive sound as the granulation index gets closer to the the attack of the sound. Simultaneously distortion and the frequency of a lowpass filter follows with a lag the movement of the pedal.

Figure 3.3: *Igaluk*'s micro-instruments presentation

flirt with composition and respond to performers in complex, not always entirely predictable ways, even acting not only as instruments, but almost as performers, composers or conductors" (Jordà, 2007, p. 91). In fact, the concert Max patch holds much of the personality of the musical piece, simultaneously realising the capture of gestures, the sound generation and the automated mixing. *Igaluk* has also made me rediscover the power of the sampler as a tool for sound design. The functionalities it offers enable a great creativity through sample programming that is reflected in the performability of the instruments designed.

It seemed to me that the most successful micro-instrument in terms of performance control and subtlety was also the most daring micro-instrument in its design: *DarkScratch*. Undoubtedly, the choice of a gestural controller has a significant impact in the creative potential of the instrument developed. In the case of *Igaluk*, the determination of the gestural controller early in the creative process had a considerable influence on the design of the instrument. The keyboard is a restrictive interface both stylistically and in terms of mapping strategies that it can implement (Miranda & Wanderley, 2006). I must add that Sebastian Berweck, the collaborator in the design of the instrument, is a pianist specialising in the performance of mixed and electroacoustic music. Without a doubt, his role was decisive in the selection of the gestural controllers for *Igaluk*. However, I am not trying here to lay blame on my collaborator for a certain disappointment in the design of the instrument. Quite the contrary. The interface was deliberately chosen to match the skills of the performer; I wanted Berweck to make use of his virtuosity in order to perform a pleasurable and challenging piece of music. Somehow, I think that goal was achieved as he has performed *Igaluk* several times since its creation in November 2012.

The fact remains that, due to the choice of interface, some bolder, more daring micro-instruments were discarded because of their difficult implementation on a keyboard. In preliminary tests, it was observed that a high level of abstraction in the gestural control–sound generator mapping made it difficult for the performer to understand the interactions established. This observation had already been made in the above presentation of the micro-instrument *Piano Painting*. In the design of the instrument, the abstraction level of mapping was a constant cause of rejection for various micro-instruments. A micro-instrument called *Bell Ringer* found in the appendix allowed the creation of bell-like patterns through the cyclical playback of a number of sounds. The last notes played on the keyboard would periodically be heard and fade until they were replaced by other notes input. The intervention offered by this type of micro-instrument seemed too atypical to be kept in the final version of the instrument. Of course, the level of abstraction of mapping is dependent on the electroacoustic knowledge of the contributor. For example, the control over variations of a rhythmic pattern in a step sequencer seemed too abstract for Berweck while the concept seemed clear to me. In order to limit this level of abstraction, in recent versions of the piece I established

that a sound would be played when the performer interacted with a controller, hence obtaining an audio-visual concomitance (Chion, 2012). In short, technical and technological knowledge as well as ear training discussed in Section 2.1 play a significant role in the performative approach of an electroacoustic piece. In fact, the composition of *Igaluk* enticed my interest for more original electroacoustic performances that are closer to the sound manipulations made in the studio. We will see in Section 3.4 that the studio is a polymorphic instrument offering many opportunities for performance that benefits from my knowledge of the electroacoustic medium.

The composition of *Igaluk* was a first experience of live electroacoustic music. The realization of such a project was significant for the progress of my research on instrument design and physicality. Following this project, I chose to pursue my research in a different direction as my practice had not been energized by the approach used. This is to say that *Igaluk* was a project that focused primarily on the performance aspect of the electroacoustic music. The instinctive choice of involving a performer in the creative process did not resolve the observations of slowness and rigidity discussed in Chapter 1. In this context, my involvement in the creative process remained the same; I still was the composer sitting behind a computer. For the following projects, I would choose to have a much more active and physical involvement in the realisation, one that did not necessarily implicate the live performance of my music. I would develop an instrument adapted to electroacoustic improvisation – *fXfD*, and would consider the studio as a definitive instrument, full of potential.

3.3 *fXfD*, an Electroacoustic Improvisation Instrument

fXfD is a digital instrument originally designed for the practice of electroacoustic improvisation. Through its use, the instrument was also found to have applications for composition and live performance of my music. Its development is based on the concept of feedback, in this case digital feedback created within a DAW. *fXfD* was designed throughout the doctoral period, passing through different stages of development. Recently, the musical results obtained with the instrument have become conclusive. As a matter of fact, I have developed a form of virtuosity with the instrument as I practiced it. The production realised with *fXfD* is included in the portfolio as a series of improvisations. My wish is to port this type of electroacoustic improvisation to the live context of concerts. Already, I have performed using this setup in a concert at Collège St-Laurent on February 1st, 2014. In the near future, I intend to present this kind of performance to the experimental music scene.

In order to explain the development of the discussed instrument, it is necessary to investigate my ever growing interest in feedback. As a result of the rigidity and slowness described in the beginning of this text, I undertook the development of a digital instrument similar to Casserley's (1998) DSP instrument to perform sound processing in real time. Designed in Max, the early versions

consistently became convoluted due to the several connections between its constituents: the MIDI management, the design of a GUI[66] and recording system presets, the development of a modular audio engine, etc. In short, the concept imagined required a considerable amount of programming, which reinstated the slow work in the studio in addition to disengaging the *concrète* manipulations of the sound. Those early versions of *fXfD* are available in the appendix for reference. However, note that none of them is fully functional for the reasons stated above. At this point, the development of *fXfD* was suspended until I transitioned to Ableton Live as a host for my instrument. But before continuing this discussion on the development of *fXfD* in Ableton Live, it is necessary to make a digression and explain my interest in feedback.

3.3.1 An Interest in Feedback

The reason for my interest in feedback is first and foremost the resulting sounds. Sounds obtained by means of feedback have compelling morphologies that meet the desired sound attributes discussed in Section 2.2.2. As described in Section 2.2.1 these sounds are also references to "glitches" and " failures" in digital technologies (Cascone, 2000). The term feedback has multiple meanings in regards of my research. In its most inclusive audio definition, feedback is established when an audio signal is introduced recursively in an amplification system. For example, when a microphone picks up the signal emitted by a speaker to redirect to the same speaker, an audio feedback occurs. Improvisations included in the portfolio illustrate the type of sounds that can be obtained in *fXfD* through feedback. Sensorial feedback also has a particular significance in music as it is an important factor in the design of an instrument: "Auditory feedback concerns the learning of musical quality; visual, tactile and kinesthetic feedback concerns the integration of relationships between gesture and produced sound, which help to understand the behaviour of the instrument as well as rules and limits induced by gestures" (Jordà, 2005, p. 139). Through auditory feedback, a musician adjust his/her playing on an instrument to reinforce musicality. In my search for the instrument, this notion of auditory feedback is particularly relevant.The objective is to manipulate the sound gesturally in realtime with the help of auditory feedback. Auditory feedback is therefore an essential factor attaining a spontaneous "sonic empiricism" (see Section 2.1) for *musique concrète* composition.

In an early phase of sonic experimentation, Tout Croche began to connect all kinds of processing modules together to manipulate Stephen Harvey's guitar sound. To obtain a certain flexibility in the configuration of the effect modules, the signal was routed through a DAW so that the processing paths could be made dynamic and variable. The method enabled signals to be easily sent from one effect to another. At that time I created, probably by accident, my first feedback loops between

[66] Graphical User *I*nterface

effects. I immediately found that these feedbacks offered stimulating sonorities and a surprising freedom in terms of control:

> Once you start really playing with feedback it almost begins to feel like a living entity. It is something that speaks to your intuitive side more than your intellect, because even with fairly simple setups, the behaviour of the fed back sound goes beyond what you can easily understand, and it simply boils down to how you interact with it in the moment. (Lumens, 2013)

The research was then made more insistent and we incorporated more and more equipment in this type of experiment[67].

Concurrently, I was discovering the "no-input mixer" practice through artists such as Toshimaru Nakamura and Marko Ciciliani who have widely explored the musical possibilities of a fed back mixer. As Lumens (2013) explains, the no-input mixing technique consists of feeding back the output of a mixing desk into its inputs, hence creating a feedback loop that can be controlled with onboard gain, eq and faders. Outboard effects can also be inserted in the feedback loop to produce more creative sounds with added controls. But the use of a mixer seemed restrictive since a fairly large console was needed to develop multiple routing options. By contrast, the software DAW option offered great flexibility in terms of routing and did not require an large — and thereby difficult to obtain – console; a sound card with multiple inputs and outputs was sufficient. In this context, I have developed and refined what is still today my main instrument when I play with Tout Croche: *The Rack*.

The Rack pictured in Figure 3.4 constitutes a set of effect units[68] packaged together with a sound interface into a transport case. Each effect unit has its inputs connected to outputs of the sound card and, vice versa, its outputs connected to inputs of the sound card. Using Ableton Live and its send and return functions, the signal is routed from one effect to another without restriction[69]. Not only is complex processing layering made possible from this configuration, one can potentially create complex feedback loops that offer great musical control. Tout Croche's music (found in the appendix) exhibits the character of the sounds produced by this feedback instrument, *The Rack*.

[67] The creative use of feedback is definitely not new. One can think of works like *Pendulum Music* by Steve Reich, *Mikrophonie II* by Karlheinz Stockhausen or the playing techniques put forward by Jimi Hendrix. However, the idea here is not to present the history of the creative use of feedback.

[68] The case contains: one Ibanez HD1000 harmonizer/delay, one Zoom 1201 multi-effects, one Lexicon MPX 100 multi-effects, one TC Electronics M300 multi-effects and one Drawmer DL251 dual-channel compressor and a MOTU 828mkII sound card.

[69] One restriction of audio signal routing through software would be that a latency is introduced due to the sound card analogue-to-digital and digital-to-analogue conversions.

Figure 3.4: Tout Croche's *Rack* of effects

3.3.2 Development

At this point, I restarted the development of a digital instrument intended for solo electroacoustic improvisation. On the one hand, the hiatus had confirmed the benefits of pursuing the development of *fXfD* within Ableton Live: a solid audio engine, a well laid out routing scheme, numerous effects already programmed, the integration of MIDI, a responsible GUI, etc. On the other hand, my current considerations on feedback had confirmed the direction in which to pursue my instrumental research: the digitisation of the entire feedback chain. An almost literal translation of Tout Croche's *Rack* was therefore attempted within the Ableton Live environment. But Ableton Live functionalities helped to further develop and expand the concept of an instrument based on digital feedback. In addition to the advantages of a DAW[70], Ableton Live offers attractive features for the development of an

[70] A DAW allows easy routing, mixing, editing of a patchwork on the timeline, etc.

instrument: the "Session View"[71] redefines the triggering of sound files, "Audio Effect Racks"[72] can create amalgams of variable and interactive effects and the Max for Live module gives access to several hidden parameters of the application by direct commands to the API[73]. All these functions allowed the design of an instrument that benefits fully from the intrinsic characteristics of the host software.

However, it should be noted that Ableton Live is not my instrument even though many of its functions are used. *fXfD* is much more restrictive in its design than the software that hosts it: "It is necessary in an instrument for improvisation to give oneself both sufficient freedom and sufficient limitations. The palette of available processes must be rich enough to encompass many situations and controllable enough to adapt to them quickly" (Casserley, 1998). In fact, *fXfD* comprises an Ableton Live session, a set of controllers and programmed extensions to the host program. To that effect, *fXfD* is symptomatic of what we will later define as the *bastardisation* of digital instruments:

> In digital music there are no fixed instruments [...] there is only *bricolage*, or instruments constructed from a range of available software and media. Digital musicians are always responsible for building their own instruments. [...] The choices digital musicians make, and their ability to handle what results, will do much to define both aesthetic of music and their musical expertise. (Hugill, 2012, p. 139)

In *fXfD*, specific digital feedback processes are implemented to create a music that has a strong aesthetic: the no-input DAW[74]. Perhaps it is time to analyse the constituents of this digital instrument in order to understand the creative potential of *fXfD*. To illustrate its functioning, a screencast was also added to the appendix.

3.3.3 Gestural Control

On the gestural side, *fXfD* is composed of a fairly standard set of commercial interfaces. Since Ableton Live is the tool that has to be controlled, the gestural controller should use interfaces that connect efficiently and embody the paradigms contained in the software application. Linear and rotary potentiometers, encoders and buttons remain the best interfaces to control a DAW. And this is exactly what is proposed with *fXfD*'s gestural controller as Figure 3.5 shows.

A Novation Zero SL Mk II controller[75] was chosen as the central interface for *fXfD*'s gestural controller as it offers a wide range of controls assignable to Ableton Live parameters. The lack of motorized faders may be the missing functionality that would make it an excellent interface.

[71] "[...] the *Session* is a real-time-oriented 'launching base' for clips" (DeSantis et al., 2014, p. 18).
[72] "A Rack is a flexible tool for working with effects, plug-ins and instruments in a track's device chain. Racks can be used to build complex signal processors [...] and more" (DeSantis et al., 2014, p. 239).
[73] Application Programming Interface
[74] In reference to the no-input mixer practice
[75] Referred to as Zero SL hereafter

Figure 3.5: *fXfD*'s configuration including gestural controllers

Still, it is quite light and portable for a controller. In a previous development of *fXfD* evident in the improvisation titled *take_02*, a Behringer BCF2000 was used instead of the Zero SL. It advantageously offered motorized faders but was considerably heavier. As Richards (2006) asserts, weight and portability are non-negligible factors in the choice of digital interfaces. Moreover, the "page" function of the Zero SL is useful to assign multiple functions to a single controller.

The Novation Launch Control offers 16 MIDI-compliant rotary potentiometers. The controller is used to control sound processing parameters. In this context of sound processing, I prefer rotary

knobs over infinite encoders as their limited range offers a much better sensory-motor perception of the controller's position. Perceptual awareness of the current position of a controller is a definite advantage in the performance of sound processing. In contrast, encoders offer more control for tasks that require precision. Indeed, their increment is proportional to the acceleration applied to the controller. One can thus obtain a wide range of control according to the speed and energy with which the encoder is turned. However, a visual contact with the interface is necessary to know the current position of the controller.

An Android tablet with the application TouchOSC (hexler.net, 2013) installed and customized is also included in the gestural controller of *fXfD*. A multi-page TouchOSC template offers control over a variety of non-musical and abstract functions. We shall discuss the functions that are assigned to the interface in the Mapping Section. Finally, the computer is within easy reach in order to visualize and control certain parameters that are essential to the performance. VU meters[76], the state of DAW, interface configuration, etc. are parameters controlled directly with the computer. But as a general rule the computer is not used to input gestural data during improvisations.

3.3.4 Sound Generation

It now goes without saying that feedback is central to the design of the sound generator *fXfD*. The audio signal circulates repeatedly in a network and creates a self-oscillating system that produces a sound. The network and all its components will be designed as the *feedback system*. The implementation of the concept in Ableton Live will be examined. After a series of tests, the use of *return tracks* proved to be the most versatile and flexible method to produce digital feedback. In the paradigm established by Ableton live, the return track is the digital equivalent of an auxiliary bus in an analogue mixer. One or more audio signals are routed to an auxiliary send in order to assemble a signal processing chain that is parallel to the original signal (Izhaki, 2013). The advantage with the return track in Ableton Live is that the processed signal can be forwarded to another track return using the *send* function as Figure 3.6 shows. The output of a return track can even be routed to its own input. Thus, the implementation of a feedback loop is fairly straightforward. Sends in *fXfD* are set to pre-fader mode, allowing the creation of feedback systems in which the signal flow can reach values above its unitary level (0dBFS). This use of pre-fader send also has the advantage of offering an independant control over the output levels of each track without changing the nature of the feedback system. Considering that Ableton Live can have up to twelve return tracks, one can easily design complex feedback systems with the combined send and return functions for all of these tracks. In *fXfD*, the number of return tracks that constitute the network of digital feedback was set to eight to allow efficient mapping with the gestural controllers available.

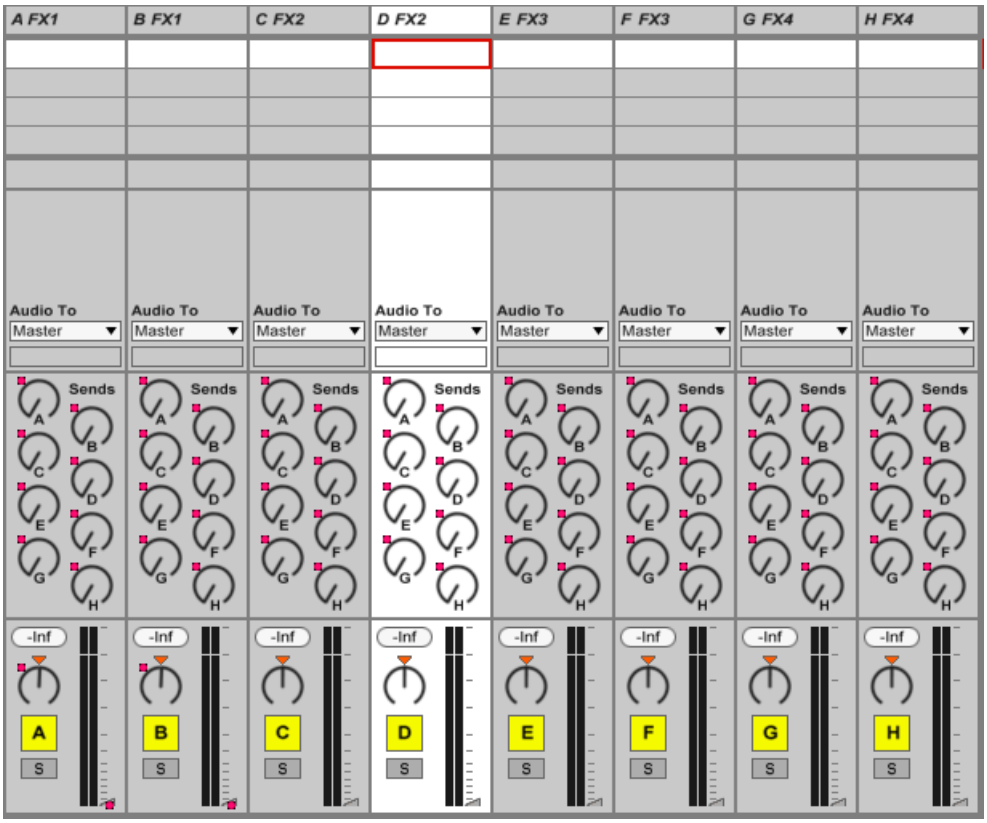

Figure 3.6: Setup of eight return tracks in *fXfD* organised for feedback.

In order to enrich the sonorities produced by a feedback loop, an effect module is added to each return track. The effect module processes the input signal and therefore changes the nature of the feedback. Inspired by the use of multi-effects units in Tout Croche's *Rack*, *fXfD* in fact offers a bank of effects that can be dynamically loaded on each return track in order to process the incoming signal. The "Audio Effect Rack" shown in Figure 3.7 in conjunction with the Max for Live module is used to load an effect without clicks and a crossfade of a variable duration. With Tout Croche's *Rack*, a change of processing meant a cut in the sound. The internal functions of Ableton Live help overcome such technological problems and further develop a digital feedback instrument. Four different banks of effects are assigned to the eight return tracks of *fXfD* so that every bank of effects is found on two return tracks. These two return tracks contain the same processing options but remain fully independent with regard to the selection and control of the processing.

Furthermore, as feedback is a recursive amplification phenomenon, a minimum signal is required to initiate the physical phenomenon. In an analogue system, the noise floor of the equipment is

[76] Volume Unit Meter

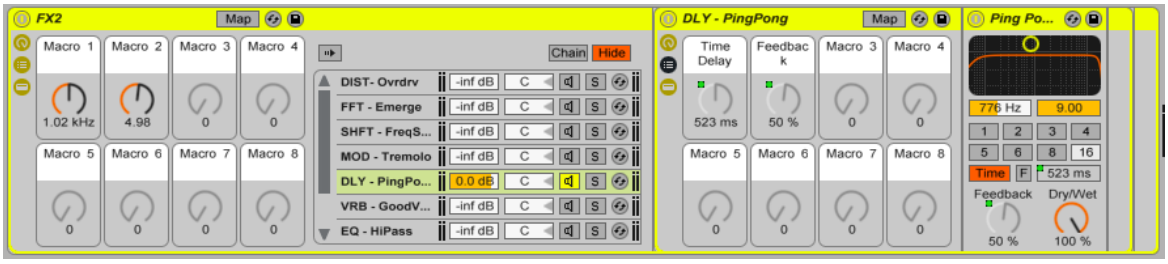

Figure 3.7: *fXfD*'s Audio Effect Rack containing a bank of predefined and switchable effects.

sufficient to trigger the sound intensification process. But this is not the case with the digital calculations of a DAW, which, as long as there is no noise dithering, has a noise level equivalent to $-\infty$dB when the system is idle. It is therefore necessary to insert an external signal in the feedback system in order to initiate the amplification process. This definitely changes the nature of the no-input practice. However, I see it as an advantage since the insertion of different sources in a feedback system changes its sonority. Sound Examples 3.4a & 3.4b present the impact of variable sources on the sound produced by a feedback system. In my present use of *fXfD*, I favour my analogue modular synthesizer as a trigger source for the feedback. *LucyL* is an instrument on its own that can be analysed in terms of its gestural controls, its sound generators and mapping strategies as we discussed in Section 3.4. Nevertheless, in the context of the discussion on *fXfD*, we will only say that the synthesizer acts as a sound source fed into the feedback system in order to trigger and influence the sonority of the process. In a future development of the instrument, the implementation of methods to trigger sounds with the "Session View" of Ableton Live will increase the possibilities of sound sources intervening in the feedback system. In the observations made at the end of this section, we will justify these future developments from a perspective of composition and performance.

Sound Example 3.4 (Variable source input in *fXfD*'s feedback system 1)**.** *This example presents two different sound sources input in an identical feedback system created with fXfD. In both cases, the sound source is first heard alone then the feedback system is unmuted. One can notice the impact of the sound source in the timbre produced by fXfD.*

A tendency in the no-input practice appears to be the limiting of the fed back signal after each recursion. Thus, the signal is reinserted in the effect at a nominal level, emulating the clipping that would happen in an analogue system and avoiding digital distortion. But after a series of tests, I noticed that the addition of a limiter in a feedback loop would prevent the desired gain structure that would overload the feedback system and bring out its best intrinsic qualities. Therefore, my digital

feedback method does not limit the signal between the different stages of system feedback; signal feeds back at levels above unitary, tapping into the dynamic overhead of the software (Katz, 2007). I am in search of sounds specific to digital feedback, and digital distortion is part of these sonorities. In any case, I found that the limiter had a negative impact on the sounds produced, making them less interesting in terms of their attributes. Still, the dynamic level of Ableton Live's master output is controlled: a digital overdrive limits and clips the output signal before its digital-to-analogue conversion. The purpose of this procedure is to obtain a consistent sound result by decreasing the gain of the signal output, ensuring that the distortion is consistent rather than dependent on the converters of the sound card[77]. The bounces of pieces therefore retain the same sonorities as when they were first recorded.

3.3.5 Mapping

NIME is a major music conference that brings together a community of researchers dedicated to developing New Interfaces for Musical Expression. This community seems driven by a digital *lutherie* that continuously reinvents the interaction of the musician with the machine. However, such concerns are far removed from my views on digital instrument design. In general, the NIME community seems to value complex convergent and divergent mappings as well as devalue one-to-one mapping which they see as unfit for music:

> The total effect of all these convergent and divergent mappings, with various weightings and biasing, is to make a traditional acoustic instrument into a highly non-linear device. Such a device will necessarily take a substantial time to learn, but will give the user (and the listener) a rich and rewarding experience. Many computer interfaces concentrate on simple one-to-one mappings and, though easier to learn, can give an impoverished experience to the player and listener. (Hunt & Kirk, 2000, p. 235)

Through the example of *fXfD*, I will argue that one-to-one mappings give access to great musical possibilities. One of the main interests of the no-input practice resides in the exploitation of the creative potential of a standard studio tool (in our case the DAW) to turn it into an instrument: "[...] the tools themselves have become the instruments, and the resulting sound is born of their use in ways unintended by their designers" (Cascone, 2000, p.16). By directly controlling the parameters of the DAW, we change the configuration and the routing of the feedback system. By extension, the resulting sound is simultaneously modified. The practice requires a deep understanding of the paradigms established in a DAW. Consequently, most gestural controllers are assigned directly to DAW functions through a one-to-one mapping. I believe that the direct transformation of the feedback system offers the most efficient and musical way of controlling the sound:

[77] By sending a distorting signal to the sound card's converter, one rely on the individual converters to reproduce the sound as accurately as possible. However, it cannot be guaranteed that the result will sound identical from converter to another. By clipping the signal at -6dBFS, we ensure that the intersample peak does not distort when translated by any converter (Lund, 2006).

> The overriding goal of conventional human-computer interface design is to reduce the inevitable distance between agent and medium, ideally to the extent that the user comes to conceive of the task domain directly in the terms of the representations that comprise the interface. (Armstrong, 2006, p. 18)

One-to-one mappings are made using the internal function of Ableton Live which allows to link a MIDI controller to be linked to a GUI function.

An obvious mapping strategy concerns the binding of the Zero SL linear potentiometers to the volume sliders of the return tracks. However, the signal in each of the return tracks can reach high levels due to the nature of the feedback; it is sometimes necessary to reduce its volume significantly in order to obtain a balance between the different tracks. The 127 values of a MIDI controller offer too little resolution to control a volume slider correctly in its lowest range. In Ableton Live, a direct assignation of a linear potentiometer to a volume slider results in large dynamic jumps of 3 to 6db at the bottom of the slider range. To address this problem, the scaling of the potentiometer was readjusted with the help of a Max for Live device (see Figure 3.10) so that it provides a better resolution in the lower part of the GUI slider. We can therefore precisely adjust the volume of a return track even if its level is very low e.g. -60dB.

In Tout Croche's *Rack*, effect sends were directly controlled with the mouse. This gestural controller sorely lacked the precision required to adjust and carefully perform the feedback around its point of generation. In *fXfD*, the return tracks' sends were assigned to the eight Zero SL encoders in order to provide precise control over this parameter. The assignation of the eight sends for each of the eight return tracks requires the use of the "page" function on the Zero SL in order to reassign the encoders dynamically. For example, when page 1 is loaded on the Zero SL, the encoders display and control the eight sends of the first return track. By switching to page 2, the encoders are automatically updated to display and control the sends of the second return track and so on. The eight rotary potentiometers of the Zero SL have been directly mapped to the eight panning controls of the return tracks. Finally, eight toggle buttons alternately mute and unmute the return tracks.

The selection of the currently active effect on each of the return tracks is achieved through the custom TouchOSC interface on the tablet. In the first page of this interface shown in Figure 3.8, eight columns corresponding to the eight return tracks each contain eight effects that can be activated in *fXfD* with the touch of a finger. The transition between the previous and the new effect is accomplished without click and pops, thanks to an automatic crossfade of variable duration. On the second page shown in Figure 3.9, the TouchOSC interface gives access to the preset functionalities of the instrument. It is possible to save, load and interpolate between saved configurations of the

Figure 3.8: *fXfD*'s TouchOSC interface for the selection of the loaded effects.

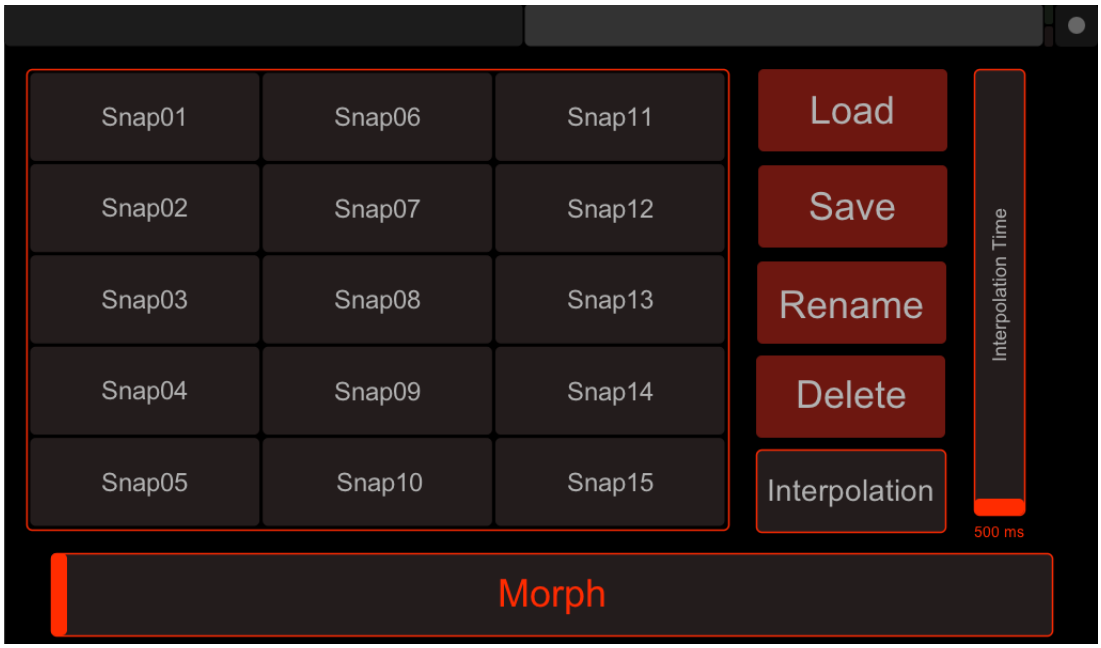

Figure 3.9: *fXfD*'s TouchOSC interface for the control of preset creation and callback.

feedback system. Both the effect selection and the preset system are managed via a Max for Live device (illustrated in Figure 3.10) developed to communicate directly with Ableton Live's API.

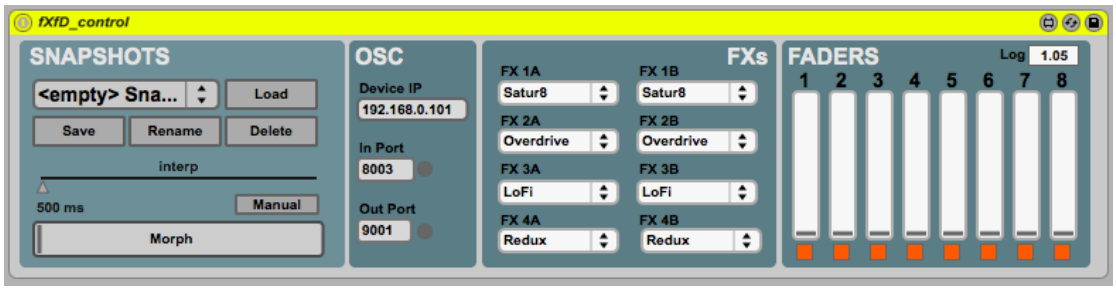

Figure 3.10: *fXfD*'s Max for Live Device that enables more complex or abstract mappings

The mapping strategies used to control the processing effects in *fXfD* are heavily inspired by the use of multi-effects in Tout Croche's *Rack*. These multi-effects usually offer a control limited to just a few buttons on their interface. In fXfD, this minimal design was adapted by restricting control uniquely to processing parameters that are musically relevant. Using the "Macro Controls"[78] of the "Audio Effects Rack," the gestural information from two rotary potentiometers is forwarded to two parameters of the active effect of each return track. Thus, the sixteen rotary potentiometers of the Novation Launch Control are dedicated to controlling sixteen parameters of the eight effects on the return tracks. The two potentiometers offer a limited control over each effect, forcing design choices regarding the controlled parameters. Mappings between potentiometers and effect parameters are always one-to-one but their range has been adjusted so that they offer interesting sonic results. Also, the potentiometer maintains its position even if there is an effect change. It therefore gives its value to the new effect loaded. This transfer of the controller value surprises the musician who can hardly predict the resulting sound that the effect change creates. This phenomenon is confronting but also inspiring for the improviser.

3.3.6 Observations

The development of *fXfD* came in direct response to the criticism of computer music enunciated in Chapter 1. In order to energize my practice, I developed an instrument that exploits my electroacoustic knowledge by subverting the functions of a common studio tool, the DAW. The resulting instrument relies on the concept of digital feedback and is designed for electroacoustic improvisation. The portfolio includes a series of improvisations performed using *fXfD*. The improvised pieces informed by a noise aesthetic feature a double research on spontaneous, articulated and virtuoso musical control as well as on unheard sound material. On the one hand, I developed an interest for glitch and noise sonorities which had a considerable repercussion on my music production. On the other hand, my practice with *fXfD* has offered a direct and musical control over sounds generated

[78] "The Macro Controls are a bank of eight knobs, each capable of addressing any number of parameters from any devices in a Rack. [...] Macro Controls keep things manageable by taking over the most essential parameters of a Rack" (DeSantis et al., 2014, p. 241, 254).

by feedback thus meeting the criteria of musicality and physicality in the selection of sounds, as discussed in Sections 2.2.3 and 2.2.4.

The experience of *fXfD* has brought to my attention the importance of routing in creativity and musical expression. Playing with *fXfD* is sensitive and subtle as it has a direct impact on the sound produced. A complex feedback system is set up with which I interact without fully controlling the finality of the sound. In other words, the feedback system, i.e. the machine, has a musical character that I take into account when I improvise with it. This interaction with a chaotic feedback system forces me to assume each of my improvisation gestures. I have to accomplish them with confidence, memorize them, vary them and transform them in order to develop a musical meaning that corresponds to sound fluctuations. Pete Swanson cleverly summarizes the interaction of the musician with his instrument in electroacoustic improvisation:

> There's a serious push-pull relationship that occurs when musicians are improvising and I developed my setup to reflect that sort of relationship without involving another human. My gear pushes back and makes me make decisions I wouldn't otherwise make. There's some ego-crush going on there even though everything I'm doing is something that I've built up. I'm a bit of a control-freak in certain regards, but I find control to be awfully boring. If I always knew what every change I would make to my gear would result in, I'd get so frustrated. I like a lot of push-back. (Myers, 2013, Interview with Pete Swanson)

Therein probably lies my discomfort with the attitude of the NIME community which wants to confine the machine to their musical aspirations rather than play with the machine. It is for this reason that I consider *fXfD* a successful instrument, since it brings me such enjoyment when I perform and play it. Thanks to its chaotic nature, *fXfD* is continually surprising. Each improvisation reveals a new character of the instrument and the music it allows me to produce is unique.

Of course, such an instrument has a limited type of manipulation which suffers from a lack of articulation, as Casserley (1998) notes:

> While I could frequently contribute much to the musical development, I envied my collaborators' capabilities of articulation and nuance. It was always a challenge to find a satisfactory middle ground between a series of 'effects', a secondary layer of the musical argument, and an over-dominating texture of complex sound.

Aesthetically, the music created therefore tends to be drone-like and have a slow evolving structure. The improvisation titled *take_02* is symptomatic of such a slow, drony evolution. The recursive nature of the feedback process creates sounds characterised by their slow morphological contours. In the current version of *fXfD*, the functions enabling recording, loading and interpolation of presets were developed to fight this lack of articulation: "The solution to slow individual control of parameters and loops was to implement dynamically-created presets interpolated by a single pedal" (Tremblay & Schwarz, 2010, p. 447). With the added control offered by presets, it is possible to recall a particular soundscape and therefore articulate a musical discourse. Even if the functionality

adds more flexibility to the performance, further research is warranted to enable the articulation of sound materials.

fXfD is an instrument that is in constant evolution. The practice of the instrument not only aims to develop a virtuoso control over sound, it also informs the programming work to refine and extend the instrument functions. The more it is used, the more implementation ideas emerge. The most significant and promising idea is to transform *fXfD*, an instrument for electroacoustic improvisation, into an instrument for composition and performance. With *fXfD*, the Ableton Live sequencers can record audio streams as well as control parameters of the improvisation. All the improvisation data are therefore available to the composer for edition. Consequently, improvisation becomes a founding material for the composition. Any successful articulation or sensitive segment can be developed into a composition by techniques of overdub, expansion, compression, variation, etc. Thus, fXfD may also become a composition instrument. Exploitation of this feature was one of the original reasons for the transfer of the instrument design to Ableton Live. One thing led to another and I never was able to implement the idea but I intend to do it soon. Furthermore, *fXfD* is currently used as an improvisation instrument for the live context. With minimal adaptation, it would be possible to make it an instrument for prepared improvisation and composed performance. The "Session View," together with the preset function in *fXfD*, offers the possibility of preparing and structuring a set of materials that can build a reproducible soundscape. I propose in the near future to compose pieces using these functions in order to enable their performance in concert.

In summary, the development of *fXfD* has had a significant impact on my practice, giving way to an instrumental practice specific to the electroacoustic tools and giving importance to improvisation. The implications of *fXfD*'s development can be traced back in all of my recent production. Also, *fXfD* has been the instigator of a reflection on the possibilities of the studio as an instrument. The studio as an instrument is the subject of the next section.

3.4 The Studio, a Polymorphic Instrument

Since the slowness and rigidity of my solitary practice of *musique concrète* in the home studio was revealed, a considerable amount of research has been accomplished in order to develop an instrument that would dynamise my method of composition. In a first attempt, programming was abundantly used to conceive a "composed instrument" that would allow the live presentation of my piece *Igaluk* by a performer. *fXfD*, a DIY instrument[79] that takes advantage of the DAW functionalities, was designed to perform electroacoustic improvisations. In this last case study, I will

[79] A Do It Yourself instrument (Richards, 2006).

submit the hypothesis that, in fact, the studio itself is the real instrument that allows me to energize my practice of *musique concrète*.

Before the beginning of the doctoral period, my definition of the concept of instrument would have been similar to the one given by Schaeffer (1977, p. 51) in his *Traité des objets musicaux*:

> Any device that makes it possible to obtain a varied collection of sound objects – or various sound objects – while keeping us aware of the permanence of a cause, is a musical instrument, in the traditional sense of an experience common to all civilisations.[80]

Having always been a composer before being a performer, my attention focused first and foremost on the sound production of said instrument. With a growing interest for improvisation, my practice as a "digital native composer" has proven deficient, just like Schaeffer's definition, of the concept of performance. It is precisely the research and development of that same instrument that was presented as the solution to integrate the concept of performance to my solitary, slow and rigid practice.

With the piece *Igaluk*, my work focused on the development of a "composed instrument" for the performance. Simultaneously, a preliminary version of *fXfD* was developed to meet an uninformed instrument ideal that reflected my lack of practice. Both projects have highlighted recurrent difficulties in relation to the programming of virtual instruments. When programming consumes a large part of the time in the design of an instrument, it is difficult to obtain a balance between practice (repetition) and development (programming) of the instrument. At the slightest challenge or difficulty, the programmer will be tempted to find a software solution to the problem rather than to develop an instrumental practice through repetition that will overcome it:

> [...] the programmability of computer-based musical systems often make [sic] them too easy to configure, redefine, remap, etc. For programmers and composers, this provides an infinite landscape for experimentation, creativity, writing papers, wasting time, and never actually completing any art projects or compositions. (Cook, 2001, p. 2)

Another problem with virtual instrument development lies in the infinite design possibilities that computer processes offer. The interaction between a musician and the virtual instrument can be constantly redefined. For each new instrumental instance, the musician must relearn how to play every control as it may have a different impact on the sound. In short, the virtual instrument in no way encourages the development of a musical practice based on the control:

> New digital instruments conceived holistically and not as a conglomerate of several interchangeable components are scarce; even worse, in most cases they are only performed by their creators. This situation complicates any progression in the field, both from the design and from the performance perspective. It is not only that electronic music controllers evolve so rapidly that it is rare for a musician to work long enough with one to develop virtuosic technique; it is that every new incarnation seems to come out of the blue. (Jordà, 2007, p. 100)

[80] Original quotation in French: "Tout dispositif qui permet d'obtenir une collection variée d'objets sonores – ou des objets sonores variés – tout en maintenant présente à l'esprit la permanence d'une cause, est un instrument de musique, au sens traditionnel d'une expérience commune à toutes les civilisations" (Schaeffer, 1977, p. 51).

Through my projects, I realized that my programming skills should be an asset rather than a final solution. More than ever, I can put them to use in order to customize existing tools with personalized functionalities. This is the case, for example, of *fXfD*, in which programming played a limited role in development, serving as a helpful tool to extend certain functions of Ableton Live. Yet, I consider *fXfD* worthy of the time and energy that I have put into it in order to develop an instrumental practice. Thus I understood the futility of developing an instrument in its entirety in the hope of appreciating its instrumental qualities. This statement may seem insignificant but, in today's digital culture, a great value is placed on the development of new instruments rather than on the use of available resources. To that effect, I subscribe to the post-digital instrumental development trend:

> What would seem more central to a post-digital aesthetic is the bastardisation of technology. This certainly goes beyond the digital (this will be discussed in more detail later). Bastardisation implies forcing a system in to a state in which it was never intended, or appropriating something for a use other than what it was initially designed for. [...] The process of bastardisation is as much about success as it is failure, where the musician is able to find a latent 'music' inside the technology. (Richards, 2006, p. 2)

In any case, I have discovered that the appropriation of existing tools is an acceptable means to develop an electroacoustic instrument that suits my needs.

In practice, my solution to overcome the problems of "time-consuming tasks" and "infinite possibilities" has been to reappropriate existing tools in order to use them as legitimate instruments. More often than not, this appropriation of the tools was accomplished by feeding the tools back into themselves. The fed back tool would start "singing," giving the sound a particular tone that is unique for each tool. This discovery of the creative potential of feedback was made through my instrumental research. The originality of the sounds feedback produced and the immediate control it offered encouraged me to research new methods to make electronic music. After completing rudimentary experiments, Tout Croche developed *The Rack*, a first instrument that used commercial effect units to create feedback systems. Using that same principle of tool reappropriation, I developed an analogue modular synthesizer that I called *LucyL*. *LucyL* revealed its full creative potential through the connections and chaotic systems it offered. Above all, this reappropriation of tools drove me to exploit existing software applications further as though they were instruments. Thus, I developed *fXfD* as a particular instance of the generic concept of DAW. My research focused on transforming the DAW into a digital feedback instrument. *fXfD* is particularly satisfying because it is flexible and allows a virtuosity specific to electroacoustic music. It provides a direct control over the sound morphologies, thanks to an interface that matches my electroacoustic knowledge. In addition, the instrument provides a conducive environment for the perfectibility and mastery of performance through rehearsal and practice. Its versatility, complexity and richness encourage the development of a vocabulary specific to the instrument.

As we have now seen, the appropriation of studio tools as instruments was thoroughly investigated in my portfolio. In fact, this insistence holds the main argument of this thesis: the studio is an instrument characterised by the variety of its tools and techniques. First and foremost, the studio is a location where high creativity enables the production of music. It gathers tools, techniques and means that enable the production of electroacoustic music[81]. These tools and techniques are ways to control, process, transform, capture, produce and influence the sound that will be added to the composition. Individually, they can hardly be seen as instruments since their sonic possibilities are limited and their functionalities are very prescriptive of the possible usage. Collectively, these means of production offer a variety of interesting gestural control for the production and processing of sounds. This multiplicity and complementarity of means available in the studio is what enables the development of a complex and rich instrumental practice. Therefore, when Chion (2009, p. 60) questions the existence of an instrument adapted to the electroacoustic music,

> the tendency has been, in the field of electroacoustic music, to dream of a universal machine, the 'sounds organ,' a kind of Swiss Army knife to do everything from recording to electronic montage [...] without forgetting the processing. This machine still does not exist [...][82].

would this instrument not be, quite simply, the studio and its many sonic possibilities?

In the following sections, we will consider the studio as an instrument characterized by its polymorphism; that is to say, the studio takes a different form depending on the purpose of its use. We have seen that it offers a variety of methods and tools to manipulate the sound and reach musical expression. To that effect, the studio is not different from any other instrument:

> The instrument is not just a tool but an ally. It is not only a means to an end, it is a source of material, and technique for [the] improvisor is often an exploitation of the natural resources of the instrument. He might develop certain aspects of the instrument that appeal to him, that seem particularly fruitful. The unorthodox technique is commonplace, its function being to serve only one man's purpose. (Bailey, 1992, p. 99)

The studio is the instrument of the *musique concrète* composer just as the orchestra is the instrument of the orchestrator[83]. The composer of *musique concrète*, just like the orchestrator, utilizes the parts that constitute the whole of his instrument to achieve a desired musical result. Both the composer and the orchestrator employ techniques and means to compose a music that takes advantage of the rich colours offered by their instrument. The studio is my instrument because it constitutes the collection of means and methods that I have developed over years of practice in order to play with the sound and to compose music.

[81] I would like to recall the broad, gender-agnostic definition of electroacoustic given in the Introduction, Note 1.

[82] Original quotation in French: "[...] on a eu tendance, le champ de la musique électroacoustique, à rêver de la machine à son universelle, de l'"orgue à sons", sorte de couteau suisse permettant de tout faire, de l'enregistrement au montage électronique [...] en passant par les traitements. Cette machine n'existe toujours pas [...]" (Chion, 2009, p. 60)

[83] Berlioz et al. (2003, p. 293, original publication in 1844) says in his *Grand traité d'instrumentation et d'orchestration modernes* that "[the] orchestra can be considered a grand instrument capable of producing at once or in succession a multitude of sounds of various kinds [...]"

Now the studio can hardly be viewed through the paradigm of the digital instrument in a similar way to *Igaluk* and *fXfD*. Due to its complex polymorphism, it is difficult to analyse the studio in terms of gestural controls, sound generators, mapping strategies without falling into an over-simplification. In turn, some important components of my studio production can be considered gestural controllers, sound generators or mapping strategies:

> In [...] digital musical instruments, we talked about the independence of gestural input and sound production units. Electronic music studios then, fit perfectly well in these definitions. Knobs, faders and switches constituted the gestural input unit. The mapping layer was the patching bay and the cables that connected the unit generators, modulators to speakers or to the magnetic tape. (Oliver La Rosa, 2008, p. 21)

The studio appears to be an instrument suited for the implementation of "sonic empiricism," offering an environment where one can efficiently go back an forth between sound manipulations and organisation, thanks to immediate access to electroacoustic techniques and technologies. In the following section, I will focus specifically on the potentiometer, the sound capture, the modular synthesizer and routing as key components of the studio, a polymorphic instrument. The discussion will highlight the particular importance of these examples in my approach to *musique concrète* composition. The tools and techniques discussed are presented for illustrative purposes only; they do not form an exhaustive list of all the resources available in the studio. They constitute a series of examples that illustrate my argument on the polymorphism of the studio as an instrument. It should be emphasized that the means of production in the studio are multiple and they respond to personal approaches to music playing. Through this analysis, the studio will be identified as the instrument that unites all the parts of my portfolio.

3.4.1 Gestural Control

I am not a digital *luthier*, therefore I have little interest in the research and reinvention of gestural control interfaces for the performance of electroacoustic music. On a theoretical level, new interfaces often are interesting as they redefine the interaction with sound. But rarely are they attractive to the outsider musician as they require that one relearn its interaction with electroacoustic processes that were already assimilated. In contrast, the studio is, in my opinion, perfectly controllable with the standard controllers it features:

> Simple means like pedals, keyboards and faders may be less attractive and more limited than the latest multidimensional sensor, but their sublimation by years of experience, working with the same interface, within the same limits, allows a deeper and subtler expressivity, in the manner that a guitar player reaches a level of seamless musical fluidity. (Tremblay et al., 2007, p. 3)

The assumption is that the studio as an instrument requires that we, for the most part, accept the interfaces it provides. Therefore, I prefer to explore the expressive potential offered by standard controllers such as the linear and rotary potentiometers rather than seek to redefine my relationship with electroacoustic processes implemented in the studio.

Strangely, it appears to me that standard controllers are underestimated by the digital *lutherie* community. The connection between standard controllers and sound is perhaps too direct. For example, these two quotations discusses the use of the linear potentiometer in a pejorative way:

> 1) "In electrical terms, mixing implies the adjustment of variable-resistance controls (faders or potentiometers), which are standard components for electronic devices. Thus, these are the controls which have been traditionally used in mixing desk design. This potentiometer-based interface design has been used up until our days, even if it is not necessarily ergonomical or adequate." (Carrascal, 2011, p. 100)

> 2) "Being that live electronics and laptop music is so widespread [5] it is symptomatic and frustrating that so many performers prefer to still rely on the mouse, or at the most, on generic and dull midi fader boxes."(Jordà, 2004, p. 59)

On what basis does one assumes that these "dull" controllers are not ergonomical or adequate? Perhaps it is time to restore the credentials of interfaces that have now become classics, controllers used so regularly that they are hardly perceived as valid interfaces for musical expression. For example, few interfaces are as used in the electroacoustic music as the potentiometer. Over the past sixty years, the potentiometer has become indispensable in the control of electroacoustic processes.

3.4.1.1 The Potentiometer

The potentiometer has been used as an instrument for numerous musical purposes. It is the instrument of choice for diffusing electroacoustic music on a loudspeaker orchestra in concert: " [...] the interface adopted for sound diffusion has been the mixing desk and the 'fader' has become the diffuser's instrument"(Richards, 2003, p. 2). The potentiometer is an essential gestural controller in the practice of the previously described "no-input mixer" practice. It is also found in my adaptation of the no-input practice: *fXfD*. Additionally, those who still doubt that the potentiometer or the mixer is an instrument should watch the documentary titled *Here is What is* featuring Daniel Lanois playing the mixer and stating the following:

> [...] about technology and consoles, I found that because of the size of my hand I can reach a lot of faders at once. [...] because of my musicality, I can move faders in a musical way. So I don't see the console as a piece of technological equipment particularly. I see it as a musical instrument. (Lanois et al., 2008, 42 min)

The digital potentiometer is particularly interesting for the digital native composer as it is coupled to the automation functions of the DAW. In *L'envers d'une oeuvre* (Mion et al., 1982), Parmegiani (1975) explains that the mixing of *De Nature Sonorum* movements was realized in one go, performing the faders for all of the tracks at once and recording the results directly on a master tape. The result is an inspiring piece of music characterized by a mix impregnated with this trace of physicality described in Section 2.2.4. With the automation functions of a DAW, not only is it still possible to accomplish such a performative mix, it is also possible to develop the work further by recording, replaying and perfecting each gesture captured by the fader:

> [automation recording] is also very potent, as it allows keeping the performance of the music within the DAW session for future reference and modifications. Performing as many parameters as possible, on faders or other physical control devices, is also a very good practice: a very subtle physical sensibility can be developed, and then mapped to many parameters, therefore recycling the acquired virtuosity. (Tremblay, 2012b, p. 13)

Thus, we take advantage of the physical aspect of performative mixing whilst also benefiting from the editing capabilities of the DAW. For example, the piece *Comme si la foudre pouvait durer* was the subject of a performative mix. Sound Example 3.5 presents a segment of the piece in two versions: a pre-mixing stage and a post-performative-mixing stage. The project has allowed me to improve a technique that I now consistently reuse in my projects.

Sound Example 3.5 (Performative mix of *Comme si la foudre pouvait durer*)**.** *This sound example is in two part, before and after the performative mix. In Sound Example 3.5a, a section of* Comme si la foudre pouvait durer *is presented before the performative mixing process. Sound Example 3.5b shows the same section of the piece after the performative mixing process. The difference between the two versions is considerable because many aesthetic decisions were taken during the mixing process. Performative mixing gives rapid access to many combinations of sounds, hence changing the nature of the work importantly.*

3.4.2 Sound Generation

3.4.2.1 Sound Capture

In French, the term "prise de son" describes the activity of sound capturing realised by the placement of microphones. In contrast, the term "sound recording" seems vague, referring more broadly to the concept of recording in the context of studio work. To clarify the notion of "prise de son," Chion speaks of it in terms of shooting, like in cinema:

> [...] the act of fixing a sound for which we claim partial or total authorship – either we have created sounds by rubbing, hitting, agitating, shaking, blowing, etc. on and in diverse materials and objects, or by operating the controls of a synthetic source – or we have appropriated, by choice and framing, the recording of an existing phenomenon [...] Cinema does not hesitate to combine desired actions which are staged, dressed, lighted, etc. with natural elements of light and decor. Nothing prevents *musique concrète* from doing the same thing.[84] (Chion, 2009, p. 53)

Chion thereby highlights two important constituents of the "prise de son": the subject of and the technique employed (he calls it framing) for the sound recording. The term "sound capture," a literal translation of "prise de son," aims to emphasize the activities of staging a sounding body and

[84]Original quotation in French: "l'acte de fixer quelque chose de sonore dont on s'intitue l'auteur partiel ou total – soit qu'on ait créé les sons soit-même, en frottant, heurtant, agitant, remuant, soufflant, etc. sur et dans des matériaux et objets divers, ou encore en actionnant les commandes d'une source synthétique – soit qu'on se soit approprié, par choix et cadrage, l'enregistrement d'un phénomène déjà existant[...] Le cinéma ne se gêne pas pour combiner des actions voulus, mises en scène, habillées, éclairées, etc. à des éléments naturels de lumière et de décor. Rien n'empêche la musique concrète de faire la même chose [...]" (Chion, 2009, p. 53).

the placement of microphones in a recording[85]. In other words, the "sound capture" is a creative act that creates a biased, artistic representation of the subject recorded. It is an electroacoustic technique full of potential as it plays a vital role in the electroacoustic chain and greatly influences the sound characteristics obtained:

> [...] all sorts of musicianly initiatives are possible, which have nothing to do with musical registration, or acoustic measuring. From the studio point of view, a host of sound bodies can be made to vibrate in all sorts of different ways. From the listening-booth point of view, as we have seen, the sound recorder can make an original 'take' of the sound object by adjusting the position and the setting of the microphones [...] This apparent economy of means conceals immense potential.[86] (Schaeffer, 1977, p. 413)

The subject observed by the "sound capture" may have been staged in studio or caught in the act. For the recording of an ephemeral sonic event, the appellation "field recording" is used to describe the practice. In such scenario, the creative contribution of the composer is then mainly oriented towards framing, as Chion (2009) explains. The composer establishes a subjective vision of the phenomenon by creatively positioning his microphones. Such a creative work of sound capturing initiated the composition of *Comme si la foudre pouvait durer*. While the storm raged, several subjective recordings of the thunder and rain were realized. For some recordings of the rain presented in Sound Examples 3.6 & 3.7, I benefited from the microscopic feature of the close miking. With the sound captures of the thunder found in Sound Example 3.8, I attempted to record the reverberant space that amplified such beautiful rumbles. After the recording session, the subjective sound captures were so powerful that they inspired the subsequent composition.

Sound Example 3.6 (Field recording of the rain in *Comme si la foudre pouvait durer*)**.** *By placing the microphones near an umbrella, I obtain this click-y rain sound that was really useful in* Comme si la foudre pouvait durer*. The close miking of the drops falling on a canvas has a microscopic effect on the sound.*

Sound Example 3.7 (Field recording of the water running off in *Comme si la foudre pouvait durer*)**.** *This sound example features a particular framing of the sound capture. Microphones were placed to mainly record the sound of water running off a drain.*

Sound Example 3.8 (Field recording of the thunder in *Comme si la foudre pouvait durer*)**.** *This third sound example of the recording of a storm present a general sound capture that tried to bring forward the reverberant qualities of the courtyard amplifying the thunder.*

[85] The choices and settings of the preamplifiers and recording equipment also play a significant role in the sonic qualities of the "sound capture."

[86] Original quotation in French: "toutes sortes d'initiatives musiciennes sont possibles, qui n'ont rien à voir avec la registration musicale, ni avec la mensuration acoustique. Du côté studio, une foule de corps sonores peut être mise en vibration de bien des façon diverses. Du côté cabine, nous l'avons vu, le preneur de son peut réaliser de l'objet sonore une 'prise' originale en agissant sur la position et le réglage des microphones [...]. Cet apparent dénuement masque d'immenses possibilités." (Schaeffer, 1977, p. 413)

When the sound capture is organized and prepared, the composer enjoys the freedom of both staging the subject and controlling the recording technique. He first selects the sounding body to be staged. A guitar or a piano can be the sounding body if he is interested in acoustic instruments, like in the case of *Comme si la foudre pouvait durer* and *Igaluk*. However, a sounding body may actually be any object that can be excited to produce sounds. In a classical conception of *musique concrète*, the composer then focuses on the creation of sound materials through *séquence-jeu*:

> The classic séquence-jeu, as defined by the first generation of electroacoustic composers, allows the composer to get sound material out of an object or a piece of equipment by 'playing' with it, in a sort of improvisatory game. These composers tend to talk about composing in the studio as a two-part process: generating a pool of material, and then composing with it. We could define this approach as constructivist, as they use the studio itself as an instrument to experiment with their source material, before deciding what to use from this experience to compose the piece. (Tremblay, 2012b, p. 4)

But this constructivist approach of the *séquence-jeu* is often unidirectional; it is mainly considered by the *musique concrète* community as a step for generating sound materials that will be used as they stand in the composition. The nature of the microphone makes the "sound capture" an irreversible step in the process of composition. A search for more flexible methods allowing a back-and-forth process between the sound capture and the composition is pertinent in the context of "sonic empiricism." In comparison, popular music employs various techniques to develop a flexible workflow during the composition:

> [...] the popular music world has embraced an empirical back-and-forth approach to the environment, at least in the most daring and fortunate cases. The idea of brainstorm recording sessions, later edited, then re-performed, overdubbed or re-arranged, then re-edited, is not uncommon. The idea of multiple versions of a piece is not rare either, starting back to the bare idea. (Tremblay, 2012b, p. 6)

Such methods were used extensively in *désert*. The creative process for most movements was initiated by an improvisatory stage where the basic elements of the music were defined. Then, using overdub techniques, sound materials were crafted as the composition was constructed in order to complement pre-existent improvisations. I could then develop, in a minimum amount of time, articulations and musical gestures that were adapted to the current state of the composition. In the refinement process, multiple versions of a movement were created to test sound hypotheses. For example, Sound Example 3.9 presents an unfinished alternative version of the *désert* movement titled *contempler*. It is my view that techniques used abundantly in popular music should be exploited more intensively in the experimental practice of *musique concrète*. As my experience with *désert* shows, it would provide greater efficiency in the process of "sonic empiricism."

Sound Example 3.9 (Alternative version of *désert*'s movement *contempler*)**.** *This unfinished alternative version of contempler, bizarrely, includes a melodic voice, some microphone feedback sounds and percussive hits. These extra sounds were not kept in the final version of the piece.*

Of course, the definitive aspect of the "sound capture" should be taken as a creative advantage, forcing the composer into a process of definitive and confident decision making. When Chion defines the notion of framing, he states that the "sound capture" choices are definitive and will have an impact on the final composition of the work. The microphone is a transducer that invariably colours the sound it captures. Its positioning also plays an important role in the timbre of the sounds captured by the microphone. The idea here is not to describe the microphones and their use in the studio[87] but to emphasize the creative potential and impact of the sound capture in the production of electroacoustic music. This is even truer for a generation of "digital native composers" who have overlooked this step in the creative process, often resorting to (impersonal) sample packages to create their music. There is a lot to gain from the personalisation of the "sound capture" process.

3.4.2.2 Modular Synthesizers

Modular synthesizers were another important discovery for my musical practice during my doctoral period. As I began to research ways to energize my practice, I had the chance to play with two amazingly expressive machines – an EMS synthi VCS3 and a double Roland System 100m – that convinced me to explore this area further. The modular synthesizer is an instrument developed in the late 1960's characterized by the design of audio circuits using an interface that physically connects parameters of the different modules with specific functions to process the sound. During numerous hours of experimentation, I eagerly discovered the operation of each of the components and experimented with complex circuits in order to develop an expressivity specific to the instrument. As the above Bailey's (1992) quotation explains, understanding the limitations and constraints of the modular synthesizer motivated me to create a music that takes advantage of the specificity of the instrument. My early synthesis work on these borrowed synthesizers can be heard in the musical production of Tout Croche and a duo with Ryoko Akama.

This interest in modular synthesizers inspired the development of my own system, which I called *LucyL*. In a first development stage shown in Figure 3.11, *LucyL* was limited to a single row of modules. The choice of modules was largely motivated by an interest for digital sounding components. I wanted to put forward a post-glitch digital aesthetics within an instrument that has analogue roots. However, the development of a modular synthesizer sometimes seems like an endless task as its expansion gives access to more variations and synthesis voices. I am now in the process of expanding my system in order to answer some of the needs identified by the performance of the first version. Among other things, the system needs more modulators, envelopes and amplifiers while

Figure 3.11: A first version of *LucyL* as rendered by modulargrid.net

it should also provide some additional sonic possibilities i.e. filters and oscillators. The upcoming second version of *LucyL* is illustrated in Figure 3.12.

Figure 3.12: A second and upcoming version of *LucyL* as rendered by modulargrid.net

My practice is inspired by artists who play modular synthesizers in concert: Pete Swanson, Keith Fullerton Whitman, Ben Vida to name just a few. Also, the development of *LucyL* is in line with a resurgence of interest in modular synthesizers in the current musical culture. The phenomenon is discussed in detail in the documentary *I Dream of Wires* (Fantinatto, 2013). The field of research

[87] Many works describe microphones and their use in the studio including Rumsey & McCormick (2005); Owsinski (2005); Eargle (2004) to name but a few.

is progressive, with passionate and original manufacturers[88] producing modules that continuously challenge the practice of modular synthesis. The advantage of such an effervescence for the composer is the constant confrontation of his practice to new concepts and, most importantly, the development of a community. In that sense, I believe that my integration of *LucyL* into my no-input DAW instrument *fXfD* brings a certain novelty to this community.

Within the framework of a studio, a modular synthesizer first is a sound generator. The range of sounds and noises that can be produced by this instrument is astonishing; the most varied timbres can be constantly refined by a possible modulation. Listening to *désert* offers a sample of the broad range of timbres that can be obtained with *LucyL*, a modular system that is, after all, quite limited. The creation of original timbres is, more often than not, made possible by the very nature of the modular synthesizer. Its open circuitry allows the implementation of complex inter-modulations and feedback systems. These chaotic systems are characteristic by their non-linearity that produce surprising sonorities:

> [...] analogue modular instruments provide two significant advantages: (1) the modular analogue systems can be patched into a wide range of nonstandard topologies, including various classes of chaotic systems; and (2) modular analogue systems provide multidimensional wide-range, wide-bandwidth, high-resolution (continuous) parameter control. (Slater, 1998, p. 18)

What has struck me the most in such machines is the instant musical potential offered by the different controls of a modular synthesizer's interface. The simple and straightforward controls, often in the shape of rotary potentiometers, provide access to a wide range of sounds by changing the parameters of an inter-modulating system. The musician discovers a unique sensibility to each of the inter-modulation systems he develops. Thus the experience of playing with a modular synthesizer is constantly surprising for the musician who wants to improvise in reaction to sound discoveries he makes:

> 'Composing' in this situation meant setting up the connections and parameters of the synthesizer so as to set in motion the processes one had designed, and 'playing' the composition involved listening to the output and intervening in the evolution of the process one had set up by fine-tuning parameters and connections as things progressed. (Ostertag, 2002, p. 12)

This interaction with the synthesizer described by Ostertag corresponds to my empirical method of manipulating the sounds in order to compose music. It is a refreshing mode of interaction that puts to use similar performing skills that were developed for *fXfD*.

The goal here is not to explain the operation of the analogue modular synthesis[89] but simply to acknowledge the creative potential of the synthesizer as a component of the studio. Although the synthesizer can be seen as an instrument in itself, it can also be considered as one of the multiple

[88] Amongst others, Makenoise, Harvestman, Intellijel, Malekko, Modcan etc. are manufacturers that are particularly active.

[89] Many works explain modular synthesis in great details including Cann (2011); Strange (1983); Welsh (2006) and others.

tools available in the studio for composition. The rich sonorities it produces and the control it offers of sound morphologies make it an ideal tool for the development of a *musique concrète* that has an embedded trace of physicality. The composition of *désert* focuses precisely on this research of a physicality through the performance of *LucyL*. Improvisations with the synthesizer are refined by the editing, montage and mixing functionalities of the DAW. Ultimately, the piece takes advantage of both the sounds of the synthesizer and the control of the DAW. In short, the musical potential of the synthesizer is increased tenfold by the studio's other tools.

3.4.3 Mapping

As we noted earlier, the studio is characterized by its polymorphism. Emphasis should now be placed on the fact that this polymorphism is obtained, first and foremost, by the modularity that the studio enables. The studio is a modular environment that offers creativity through the connectivity of its individual parts. A unique network of connections between carefully set tools can render a vast range of sounds. The mastery of mapping and routing in a studio is a key element in the development of a performance practice with this polymorphic instrument.

When breaking the studio down into its components, the concept of mapping strategies is omnipotent to the operation of each one of them. Historically, creative work in studio has evolved in parallel to its technological advances. The current reality of the studio being computer-centric, the interfaces and the mapping strategies nevertheless frequently emulate the technological paradigms of an analogue era (Homer, 2009). The notion that the DAW is a software adaptation of analogue technologies (mixer, reel-to-reel recorder, etc.) has already been discussed. The interfaces that control the DAW are often digital imitations of their analogue ancestors. For example, the control surface almost integrally assimilates the concept of the mixing desk. It is normal to see a lot of one-to-one mapping between a controller and a computer process that emulates both the different parts (physical control and audio manipulation) of an original analogue technology. It is therefore common to observe one-to-one mappings between a controller and a computer process that emulates the different parts (gestural controller and sound generator) of what was originally an analogue technology. Furthermore, this observation was already noted in the design of *fXfD* within Ableton Live; the majority of the gestural controllers were mapped directly to the functions of the software. In short, the studio implements simple mapping strategies that enable direct control of the electroacoustic processes.

3.4.3.1 Routing

The routing functionalities of the studio are an important asset for the *musique concrète* composer. I believe an important part of the studio creativity comes from the connection of multiple electroacoustic processes in order to develop personalised sounds. The routing in studio constitutes the set

of possible mappings between the various tools. Various routing strategies, through the patch bay or with a software application, carry the audio signal from one electroacoustic process to another. One can thus create a series of processes that colour the sound according to the parameters of each effect and the order of effects in the chain. Several options are available to the composer: the signal can be forwarded directly to an effect, multiplied in order to create parallel processing signal paths, recorded in the intermediate stages of the processing chain, used as a control signal to affect another signal, etc. In my studio work, the creative potential of routing is used abundantly. *Comme si la foudre pouvait durer* provides a striking example of creative work in the studio obtained through routing. The recording of the guitar that is heard in the piece was obtained by transferring the instrument signal through a series of processes. Figure 3.13 illustrates the routing schematic devised in order to develop the unique timbre for the guitar. Individually, the processes of this chain are not overly creative but their arrangement, thanks to routing possibilities offered by the studio, is a demonstration of the creative potential of routing. The processing system developed was a unique setup that was highly motivating for improvisation and performance purposes. The result was a recording session where the founding sound materials of *Comme si la foudre pouvait durer* were crafted through the performance of not only the guitar but a whole electroacoustic chain. The multitrack recording of every stage of the process has given me a subsequent freedom of action in terms of the sound captures to use. In fact, the routing has allowed me to create variations of the same material, which has proven very useful for composition.

Of course, part of the potential of routing resides in the quality of the components available to interconnect. I have been spoiled during my doctoral period as the University of Huddersfield has well-furnished studios containing all sorts of equipment that could be interconnected. Tout Croche developed a creative process involving collecting a large quantity of equipment in a studio in order to develop our albums. The access to all of these pieces of equipment by routing facilitated the development of complex systems with which we could improvise during long exploratory sessions as pictured in Figure 3.14. The matter of routing is not exclusive to hardware equipment, however. DAWs provide important functionalities to route a signal between internal and external processes. Jack is a software application that is particularly useful for transporting digital signals between independent software applications. For example, it is possible to route the outgoing audio stream of Cecilia directly to Max in order to overlay effects on a sound. The particular case of Max is interesting since it offers intra-application routing capabilities. Over the years, it has proven very useful in my creative process, helping me understand many concepts of hardware routing as well as developing new routing possibilities within the digital domain.

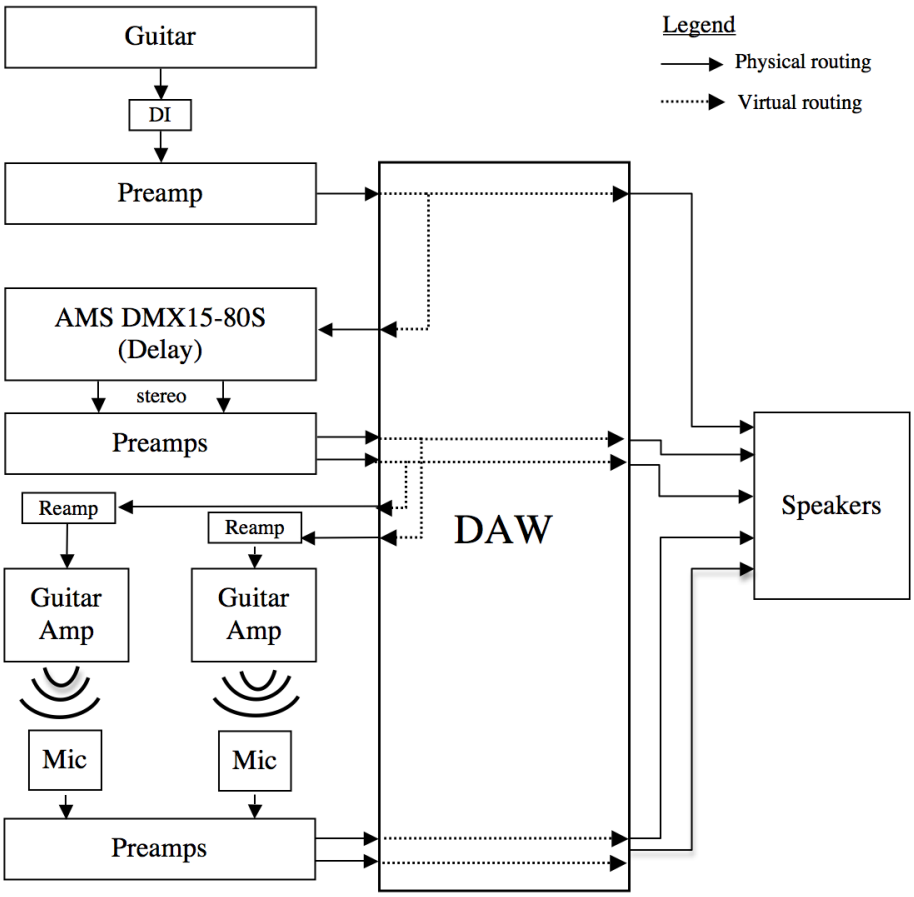

Figure 3.13: *Comme si la foudre pouvait durer* - Routing of guitar during recording

3.4.4 Observations

The concept of "digital instrument" has been extremely useful to describe the various instrumental instances developed within the context of my doctoral research. At this point, however, the tripartite reality of the digital instrument proves to be unsuitable for my post-digital musical practice. In the analysis of *fXfD*, we could already detect an incompatibility between the simplicity of the mapping strategies implemented and the current trends in the NIME community. Indeed, in my design of the instrument, the gestural controllers directly control simple functions of the DAW. When observing the studio through the prism of the polymorphic instrument, the demarcation between my own definition of the instrument and the concept of digital instrument is even more unequivocal. The components of the studio analysed have proven to be too complex to be clearly categorized into the digital instrument without some friction. The modular synthesizer is not just a sound generator. We saw the importance of its interface in the embodied control of sound and its routing capabilities in creating complex mapping solutions. Sound capture is not solely a sound generation

Figure 3.14: Tout Croche improvising in a studio session

technique either. The microphone is the interface that modifies the sound captured while the various positioning techniques can be viewed as the mapping strategies. In fact, it now appears that the development of digital instruments is irrelevant to me, a musician looking for spontaneous ways to play and perform *musique concrète*. Like many post-digital composers, my interest instead lies in the appropriation of existing tools and instruments in order to develop an "anything goes, hybridization, approach" to music creation (Richards, 2006). In this context, the studio is the ultimate instance of the post-digital instrument as it encompasses all possible solutions to not only generate but also to control the sound.

We have seen in the previous analysis of the studio components that the production of *musique concrète* can be freed from its characteristic slowness and rigidity. By performing in the studio, the sonic empiricism becomes effective, spontaneous and stimulating. In other words, performance provides fluidity in the back-and-forth negotiation between sound production and organization in a composition. Of course, the development of such an instrumental practice with the studio requires a thorough electroacoustic knowledge as my doctoral experience has taught me. Tools of the studio are creatively exploited by the composer who understands the functions they involve:

> [...] the first technical recommendation is to develop virtuosic knowledge of the studio and of the musical performance of all its apparatus. Nowadays this implies the obvious musical manipulation, routing and subversion of hardware equipment, but also its virtual counterpart

> in the realm of the multi-application workflow, as well as the design of custom virtual instruments to fit a given musical need. (Tremblay, 2012b, p. 12)

Studio practice has always involved the direct manipulation of technological pieces of equipment that were not necessarily designed for musical purposes. The magnetic tape, the oscillator, the mixer and the computer all were technologies designed to address non-musical technical needs that in the end were adopted to make electroacoustic music. Through practice, a virtuosity specific to these tools has emerged, raising them to the rank of instrument:

> Through repeated performances, a set of implicit assumptions as regards the elements and structure of the task domain begins to solidify, and through a chain of subtle reciprocal influences, the repertoire of meaningful performance actions becomes more or less fixed in bodily habit. (Armstrong, 2006, p. 20)

We have already discussed how the console became an instrument through its various uses. In a similar way, *fXfD* strives to develop a musicality specific to the DAW. Virtuosity in the context of the polymorphic studio requires a specific ear training. In terms of technological listening, one must first understand the impact a tool has on sound. To that effect, Schaefferian reduced listening helps focus on the attributes of the sound. Most importantly, one must correlate changes in the morphology of a sound with his gestural input. Once this embodied relation is established, it is possible to exploit a sound material over which we have control musically. A large vocabulary of musical functions then becomes a precious knowledge that helps structure and further develop a musical discourse. In the studio practice, I have found that improvisation offers a vast creative potential as it enables spontaneous and embodied interaction with electroacoustic processes.

It now appears to me that the technical aspect of production is an integral part of *musique concrète* art. As the embodiment theories in Section 2.2.4 showed, it is important to promulgate the use of technology in our music in order to ensure its reception. Thus, I create with the studio a music that in turn promotes the studio as an instrument, or more precisely, the performance of the studio. My contribution to the field resides in the music produced. My composition process arises from both the studio as an instrument and myself as a physical being who performs this instrument - the gestures I make, my size, my movements are fundamental to the creative process. Therefore, the music I produce is unique. The studio as an instrument is not a revolutionary concept. It has now been sixty years since varied artists promoted it through their musical practices: Bernard Parmegiani, Brian Eno, Daniel Lanois, Pan Sonic, Radiohead, Björk are artists who have made the studio their instrument. They accepted the polymorphic reality of the studio in order to produce an electroacoustic music filled with humanity and physicality. For the generation of "digital native composers," there is now a necessity to rediscover the concept of physicality in our music. We are in the process of reclaiming it by dint of sound experimentations and musical creations.

Conclusion

This concludes the presentation of a practice-based research focusing on the performance of the studio as a polymorphic instrument in order to create a *musique concrète* impregnated with physicality. Initially, a series of creative challenges which had marked my composition work triggered my doctoral research. My practice as a "digital native composer" was characterised by a slow, rigid and solitary process, in part because of the home studio culture that nurtured my development as a musician. This observation prompted me to renew my compositional practice through the reassessment of founding elements of my musical creation.

The musical potential of sound is central to my composition process of *musique concrète*, as the "sonic empiricism" concept has elucidated. Although the portfolio submitted features stylistically different musical works, sound and its creative potential have acted as the founding and unifying element to all my music. Ultimately, the musical potential of a sound is measured according to a set of criteria: the anecdotal aspect, the sound attributes, the musical function and the trace of physicality. In fact, I was looking for an approach to composition that would stimulate a lively interaction with sound. The much-needed impetus to such a sound-centric method of composition was provided by the development of instruments, an important element of the portfolio presented.

In a series of case studies, three instrumental instances have been analysed in order to understand the needs and attitude required for electroacoustic music performance. My work on *Igaluk* was a first attempt to address the concept of electroacoustic performance through the development of a "composed instrument," which would be played in concert by pianist Sebastian Berweck; the mixed results of the instrument design nonetheless revealed the importance of a specific training for the performance of electroacoustic music. To that end, I would suggest that live electroacoustic music requires performers who are dedicated to the rendition of such a repertoire and who have a thorough understanding of the electroacoustic process featured in the pieces they perform[90]. The recourse to my electroacoustic knowledge in the design of *fXfD* ensured the development of an instrument that was suited to my needs. However, this also implied that I was to play the role of performer in my music. From that moment, improvisation played a large role in the development of my

[90]Berweck (2012) makes a similar observation on the importance of a performer devoted to mixed music in his Ph.D. thesis entitled *It worked yesterday - On (re-)performing electroacoustic music*

practice. The knowledge and experience cultivated with *fXfD* was eventually exported to the studio in order to integrate a performance aspect into my compositions. With a multitude of tools, the studio is a polymorphic instrument that infuses a sense of physicality into the created sounds and stimulates the creative process of *musique concrète*. through my doctoral projects, I have discovered approaches and methods to compose music that are both centered around sound and highly physical, performable.

At the heart of my many discoveries, improvisation is the one that has most definitely changed my musical practice. As evidenced by my portfolio, I have already benefitted from its creative potential through many of my solo and collaborative projects. But I have a lot to learn and, most importantly, to practice in order to become the improviser that I aspire to be. So far I have mainly directed my attention to improvisation in the context of the studio. In the near future, I will strive to perform with *fXfD* in a live context. It appears that the current musical environment is conducive to the development of noisy electroacoustic performance; a look at the performances of Tim Hecker, Pete Swanson, Ben Frost, Holly Herndon, etc. demonstrates that a vibrant musical scene is interested in such performances. Of course, I will also continue to produce studio works that promote an embodied electroacoustic music. Finally, the development of my instruments will eventually be directed towards computer-assisted performance in order to augment the simultaneous controls it would offer. In short, I am firmly committed to the research of a performative and vibrant electroacoustic music.

Appendix A

Package Contents

This appendix explains the structure of the package (UoH_DThibault_Studio.zip) submitted along with this written document

[2012] Comme si la foudre pouvait durer

In this folder, you will find both the piece and its program note.

[2013] Igaluk – To Scare the Moon with its own Shadow

This folders contains the soundfile and the program note of *Igaluk* as well as the score and the technical requirements for the performance of the piece. Il also contains two subfolders:

Igaluk - Concert Max Patch

This folder contains the concert instrument for the performance of Igaluk. When loaded, the main Max patch (*Igaluk_ScareTheMoon.maxpat*) will utilize all included dependancies. Please note that Kontakt is required to correctly load the concert instrument.

Igaluk - Performance videos

This folder contains two (2) videos of the performance of *Igaluk* by Sebastian Berweck. However, please note that both versions are imcomplete for different reasons. *Igaluk_ZKM_2012_11_23.mp4* presents the first half of the piece as it was created at ZKM, Karlsruhe on November 23rd, 2012. *Igaluk_Huddersfield_2013_01_08.mov* presents the complete version of the piece but technical difficulties with the camera cause intermittent disruptions of the image.

[2014] désert

This folder contains the piece *désert* divided in its six (6) movements as well as the program note for the piece.

[2014] fXfD

fXfD v1.0

Folder containing the most recent version of fXfD. In addition to the Ableton Live template, other dependancies relating to the interfaces have been included.

Improvisations

Folder containing five (5) improvisations realised with fXfD. They are representative of the genre of piece created with the instrument

Previous Versions

This folder containing three (3) previous versions of fXfD. The incomplete instruments are titled *PedalBored* as it was the working title for fXfD. Each version consist of a Max patch and its many dependancies.

Video Tutorial

This folder contains a two parts video explaining the functioning of *fXfD*. The first part explains the design of *fXfD* in Ableton Live while the second part shows the development of a feedback system with the instrument.

Sound Examples

Folder containing all Sound Examples presented in the above text. Number in the file name matches the Sound Example number in this document.

Supplements

In this folder are productions that have been mentioned in the text but that are not part of the portfolio submitted.

Dominic Thibault

In this folder are pre-doctoral pieces that are mentioned in this text.

Thibault Akama

The pieces included in this folder were produced in collaboration with Ryoko Akama. They were improvised on the EMS VCS3 synthesizer and later edited.

Tout Croche

Two releases are included in this document. The album *Super Silent* consists of studio works composed by the duo in 2012-2013. *zero dBFS* is a short album containing two tracks that were improvised in 2013.

Appendix B

Myth of Igaluk

The following Inuit myth has inspired the development of my piece *Igaluk - To Scare the Moon with its own Shadow*. The summary of the myth was taken from the *Igaluk* entry in Cotterell's (1986) *A Dictionary of World Mythology*

Igaluk (America)

One of the names of the Eskimo moon god. In Alaska Igaluk is the supreme deity: he directs natural phenomena. Under his authority are all the creatures that elsewhere belong to the sea goddess Sedna.

The Eskimo people of Greenland say that the sun and moon are brother and sister. Once in the winter, long ago, during the Arctic night, people began to sport in the igloos, with the lamps out. Then one by one the men took outside the women they had been with, and lighted torches to see who they were. Thus it was that the moon man discovered his playmate had been the sun woman, his own sister. In horror the sun tore off her breasts and threw them down in front of the moon. Then with a flaming torch in her hand, she rose into the sky. Her brother chased after her, but the torch he carried went out, so that it only glowed. Now they have a house in heaven, divided into two rooms; and the moon has not the brilliance of the sun.

References

Ableton (2014). Live (version 9). http://www.ableton.com.

Adkins, M. (2007). Schaeffer est mort! Long live Schaeffer! In *EMS07 - Electroacoustic Music Studies*, Leicester, UK. De Montfort University.

Adkins, M. (2012). Issues of live-ness in fragile. flicker. fragment. *Journal of Music, Technology & Education*, *5*(1), 5–16.

Aldrovandi, L. (2000). Gesture, facture, allure: the sculptor molds the clay. In *VII Brazilian Symposium on Computer Music*, Curitiba, PR. Brazilian Symposium on Computer Music.

Armstrong, N. (2006). *An Enactive Approach to Digital Musical Instrument Design.* PhD thesis, Princeton University.

Bailey, D. (1992). *Improvisation: Its Nature and Practice in Music.* England: Da Capo Press.

Bates, E. (2004). Glitches, Bugs, and Hisses: The Degeneration. *Bad Music: The Music We Love to Hate*, 212–225.

Berlioz, H., Bloom, P., & Macdonald, H. (2003). *Grand traité d'instrumentation et d'orchestration modernes*, volume 24. Bärenreiter.

Berweck, S. (2012). *It worked yesterday - On (re-)performing electroacoustic music.* PhD thesis, University of Huddersfield, Huddersfield.

Bowers, J. (2002). Improvising machines: Ethnographically informed design for improvised electro-acoustic music. Master's thesis, University of East Anglia, Norwich, UK.

Cann, S. (2011). *How to Make a Noise: Analog Synthesis.* Coombe Hill Publishing.

Cardew, C. (1971). Towards an Ethic of Improvisation. In *Treatise handbook, including Bun no. 2, Volo solo.* Peters.

Carrascal, J. P. (2011). Multitouch interface for audio mixing. In *Proceedings of New Interfaces for Musical Expression*, (pp. 100–103). NIME.

Cascone, K. (2000). The Aesthetics of Failure: "Post-Digital" Tendencies in Contemporary Computer Music. *Computer Music Journal*, *24*(4), 12–18.

Casserley, L. (1998). A Digital Signal Processing Instrument for Improvised Music. *Journal of Electroacoustic Music*, *11*, 25.

Chion, M. (2009). *La musique concrète, art des sons fixés*. Number 7 in Entre-deux. Lyon: Mômeludies Éditions.

Chion, M. (2012). Audio-vision : Glossary. http://www.michelchion.com/glossaire/michel-chion-glossaire.pdf. [Online; Accessed: June 12th, 2014].

Chion, M. & Reibel, G. (1976). *Les musiques électroacoustiques*. Aix-en-Provence: Ina/Edisud.

Chion, M. & Schaeffer, P. (1983). *Guide des objects sonores* (1995 translation by John Dack/Christine North. ed.). Buchet/Chastel.

Cook, P. (2001). Principles for Designing Computer Music Controllers. In *Proceedings of the 2001 Conference on New interfaces for musical expression*, (pp. 1–4). National University of Singapore.

Cope, J. (1995). *Krautrocksampler*. Head Heritage.

Cotterell, A. (1986). *A Dictionary of World Mythology*. Oxford University Press.

Cycling '74 (2014). Max (version 6). http://cycling74.com/.

de Reydellet, J. (1996). Pierre Schaeffer, 1910-1995: The Founder of "Musique Concrète". *Computer Music Journal*, *20*(2), 10–11.

DeSantis, D., Gallagher, I., Haywood, K., Knudsen, R., Behles, G., Rang, J., Henke, R., & Slama, T. (2014). *Ableton Reference Manual Version 9 for Windows and Mac OS*. Berlin, Germany: Ableton AG.

Dhomont, F. (1996). Is there a Québec sound? *Organised Sound*, *1*(1), 23–28.

Dudas, R. (2010). "Comprovisation": The Various Facets of Composed Improvisation within Interactive Performance Systems. *Leonardo Music Journal*, *20*, 29–31.

Eargle, J. (2004). *The Microphone Book*. Focal Press.

Emmerson, S. (1998). Aural landscape: musical space. *Organised Sound*, *3*(02), 135–140.

Eno, B. (2008). The Studio As Compositional Tool. In C. Cox & D. Warner (Eds.), *Audio Culture: Readings in Modern Music* chapter 22, (pp. 127–130). New York: Continuum.

Fantinatto, R. (2013). I Dream of Wires. DVD. Jason Amm (Producer).

Fazenda, B. M. & Davies, W. J. (2001). The views of recording studio control room users. *Institute of Acoustics*.

Fehrenbach, G. (2002). Twilight music: Interview with fred frith.

Gayou, E. (2001). Avec, de, sur... entre. In *Portraits polychromes*. INA-GRM.

Godøy, R. I. (2006). Gestural-Sonorous Objects: embodied extensions of Schaeffer's conceptual apparatus. *Organised Sound*, *11*(02), 149–157.

Godøy, R. I., Haga, E., & Jensenius, A. R. (2006). Exploring Music-Related Gestures by Sound-Tracing. A Preliminary Study. Leeds, UK. 2nd ConGAS International Symposium on Gesture Interfaces for Multimedia Systems,.

Hamman, M. (2002). From Technical to Technological: The Imperative of Technology in Experimental Music Composition. *Perspectices of new Music*, *40*(1).

Helsper, E. & Eynon, R. (2009). Digital natives: where is the evidence? *British educational research journal British educational journal*, 1–18.

hexler.net (2013). Touchosc. http://hexler.net/software/touchosc.

Homer, M. (2009). Beyond the Studio: The Impact of Home Recording Technologies on Music Creation and Consumption. *Nebula*, *6*(3).

Hugill, A. (2012). *The Digital Musician* (Second edition ed.). Abingdon, Oxon UK: Routledge.

Hunt, A. & Kirk, R. (2000). Mapping Strategies for Musical Performance. In M. M. Wanderley & M. Battier (Eds.), *Trends in Gestural Control of Music*. IRCAM.

Izhaki, R. (2013). *Mixing audio: concepts, practices and tools*. Taylor & Francis.

Jordà, S. (2004). Digital Instruments and Players: Part I - Efficiency and Apprenticeship. In *Proceedings of the 2004 conference on New interfaces for musical expression*, (pp. 59–63). National University of Singapore.

Jordà, S. (2005). *Digital Lutherie - Crafting Musical Computers For New Musics' Performance and Improvisation*. PhD thesis, Universitat Pompeu Fabra.

Jordà, S. (2007). Interactivity and Live Computer Music. In N. Collins & J. d'Escriván (Eds.), *The Cambridge companion to electronic music* chapter 5, (pp. 89–106). Cambridge University Press.

Katz, R. A. (2007). *Mastering Audio: The Art and the Science* (2nd ed. ed.). Focal.

Kimura, M. (2003). Creative Process and Performance Practice of Interactive Computer Music: A Performer's Tale. *Organised Sound*, *8*(3), 289–296.

Landy, L. (2007). *Understanding the Art of Sound Organization*. Cambridge, Mass: MIT Press.

Landy, L. & Atkinson, S. (2002). Electroacoustic Resource Site. http://www.ears.dmu.ac.uk/. [Online; Accessed July 25th, 2014].

Lanois, D., Samuels, A., & Volick, A. (2008). Here Is What Is. DVD (120 min.).

Lewis, G. E. (1996). Improvised music after 1950: Afrological and eurological perspectives. *Black Music Research Journal*, 91–122.

Lumens, M. (2013). Feedback (No-input Mixing). http://electro-music.com/wiki/pmwiki.php?n=Articles.FeedbackOrNoInputMixing. [Online; Accessed March 24th, 2014].

Lund, T. (2006). Stop Counting Samples. In *Audio Engineering Society Convention 121*. Audio Engineering Society.

Milutis, J. (2008). The Biography of the Sample: Notes on the Hidden Contexts of Acousmatic Art. *Leonardo Music Journal*, *18*, 71–75.

Mion, P., Nattiez, J.-J., & Thomas, J.-C. (1982). L'envers d'une œuvre – De natura sonorum de Bernard Parmegiani. *Buchet/Chastel, Paris*.

Miranda, E. R. & Wanderley, M. M. (2006). *New Digital Musical Instruments: Control and Interaction Beyond the Keyboard*, volume 21. AR Editions, Inc.

Moorefield, V. (2005). *The producer as composer - Shaping the Sounds of Popular Music*. Cambridge (Massachusetts): MIT Press.

Myers, O. (2013). Pete Swanson - Punk Authority. http://www.dazeddigital.com/music/article/15820/1/pete-swanson-punk-authority. [Online; Accessed June 30th, 2014].

Native Instruments (Ed.). (2011). *Kontakt 5*.

Nattiez, J.-J. (1990). *Music and discourse: Toward a semiology of music*. Princeton University Press.

Normandeau, R. (2004). Le studio personnel, la véritable innovation du second cinquantenaire. In V. Tiffon (Ed.), *La musique électroacoustique : un bilan* (pp. 65–71). Lille: Université Charles-de-Gaulle Lille 3.

Normandeau, R. (2006). Typologie et morphologie sonore. Lecture notes.

Oliver La Rosa, J. E. (2008). To Un-Button: Strategies in Computer Music Performance to Incorporate the Body as Re-Mediator of Electronic Sound. Master's thesis, University of California, San Diego.

Ostertag, B. (2002). Human Bodies, Computer Music. *Leonardo Music Journal*, *12*, 11–14.

Owsinski, B. (2005). *The Recording Engineer's Handbook*. Hal Leonard Corporation.

Parmegiani, B. (1975). De natura sonorum. [CD], Ina-GRM.

Prensky, M. (2001). Digital Natives, Digital Immigrants. *On the Horizon*, *9*(5).

Richards, J. (2003). Performance-controlled Sound Diffusion. In *Conference Music and Gesture, University of East Anglia*.

Richards, J. (2006). 32kg: Performance Systems for a Post-Digital Age. In *Proceedings of the 2006 conference on New interfaces for musical expression*, (pp. 283–287). IRCAM—Centre Pompidou.

Rovan, J. B., Wanderley, M. M., Dubnov, S., & Depalle, P. (1997). Instrumental Gestural Mapping Strategies as Expressivity Determinants in Computer Music Performance. In *Proceedings of Kansei - The Technology of Emotion Workshop*.

Roy, S. (2004). *L'analyse des musiques électroacoustiques: modèles et propositions*. Editions L'Harmattan.

Rumsey, F. & McCormick, T. (2005). *Sound and Recording*. Focal Press.

Schaeffer, P. (1977). *Traité des objets musicaux*. Paris: Éditions du Seuil.

Schnell, N. & Battier, M. (2002). Introducing Composed Instruments, Technical and Musicological Implications. In *Proceedings of the 2002 Conference on New Instruments for Musical Expression (NIME02)*, (pp. 156–160)., Dublin, Ireland.

Slater, D. (1998). Chaotic Sound Synthesis. *Computer Music Journal*, *22*(2), 12–19.

Smalley, D. (1997). Spectromorphology: explaining sound-shapes. *Organised sound*, *2*(2), 107–126.

Strange, A. (1983). *Electronic Music: Systems, Techniques, and Controls* (2nd Edition ed.).

Thibault, D. (2011). Vers une musique numérique vivante : Regard sur le processus créatif de quatre œuvres musicales. Master's thesis, Université de Montréal, Montréal.

Tremblay, P. A. (2012a). Considérations pragmatiques en musique mixtes : Une approche systématique de l'inter-influence entre la composition, l'interprétation et la technique. In *Actes du colloque: Soixante ans de musiques mixtes*. MINT-Université Sorbonne.

Tremblay, P. A. (2012b). Mixing the Immiscible: Improvisation within Fixed-Media Composition. In *Meaning and Meaningfulness in Electroacoustic Music*, Stockholm. Electroacoustic Music Studies Network Conference.

Tremblay, P. A., Boucher, N., & Pohu, S. (2007). Real-Time Processing on the Road: A Guided Tour of [iks]'s abstr/cncr Setup. In *International Computer Music Conference '07*, (pp. 27–31)., Copenhagen.

Tremblay, P. A. & Schwarz, D. (2010). Surfing the Waves: Live Audio Mosaicing of an Electric Bass Performance as a Corpus Browsing Interface. In *Proceedings of the 2010 International Conference on New Interfaces for Musical Expression*, volume NIME10, Sydney, Australia. NIME.

Van Nort, D. (2009). Instrumental Listening: Sonic Gesture as Design Principle. *Organised sound*, *14*(02), 177–187.

Vande Gorne, A. (2008). Personal communication.

Varèse, E. & Wen-Chung, C. (1966). The Liberation of Sound. *Perspectives of new music*, 11–19.

Verfaille, V., Guastavino, C., & Traube, C. (2006). An Interdisciplinary Approach to Audio Effect Classification. In *Proc. of the 9th International Conference on Digital Audio Effects*, Montréal, Canada. DAFx.

Wachsmann, K., Kartomi, M. J., von Hornbostel, E. M., & Sachs, C. (2014). Instruments, classification of. In O. U. Press (Ed.), *Grove Music Online* (Web ed.). Oxford Music Online. [Online; Accessed June 30th, 2014.

Wanderley, M. M. (2001). Gestural Control of Music. In *International Workshop Human Supervision and Control in Engineering and Music*, (pp. 632–644).

Welsh, F. (2006). *Welsh's Synthesizer Cookbook* (3rd Edition ed.). Fred Welsh.

Young, J. (1996). Imagining the Source: the Interplay of Realism and Abstraction in Electroacoustic Music. *Contemporary music review*, *15*(1-2), 73–93.