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Expressiveness and interaction in live electroacoustic improvisation

Gustavo Costa

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Advisor: Dr. Carlos Guedes, Associate Arts Professor of Music, New York University Abu Dhabi

Co-Advisor: Dr. Bruce Pennycook, Professor of Music, Department of Theory and Composition at the Buttler School of Music of the University of Texas Austin

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Dedicated to Vicente and Patrícia

Keywords

Improvisation, electroacoustic, expressiveness, interaction, performance.

Abstract

This thesis proposes an approach to musical expressiveness and interaction in improvised or partially improvised contexts, with an emphasis on electroacoustic performance. Several points of view over the new possibilities of computer-based instruments musical production are analysed, either from the perspectives that relate these instruments to a continuation of the acoustic musical practice, or to disruptive views that associate electronic and digital instruments to radically new composition and listening modes. This thesis is grounded on the hypothetical possibility of an enhancement of expressiveness and interaction between musicians, listeners and technology by a clear delimitation on the compositional, performative and technological fields. For this, on eleven musical works were implemented several of possible answers for the identified problems, producing clear results that can be broadened to many domains of the performance of electroacoustic music.

Palavras Chave

Improvisação, electroacústica, expressividade, Interação, performance.

Resumo

Esta tese aborda os temas da expressividade e interação musical em contextos improvisados ou parcialmente improvisados, com particular ênfase na performance electroacústica. São analisados vários pontos de vista sobre as novas possibilidades de criação musical através de instrumentos digitais centrados no computador, quer sobre as perspectivas que relacionam estes instrumentos a uma continuação da prática instrumental acústica, quer sobre perspectivas mais disruptivas que associam os instrumentos electrónicos e digitais a formas de composição e audição radicalmente novas. Esta tese parte da hipotética possibilidade de um aumento de expressividade e interação entre músicos, ouvintes e tecnologia através de delimitações claras nos campos composicionais, performativos e tecnológicos. Para tal, foram concebidas onze criações onde foram implementadas possíveis respostas para os problemas identificados, produzindo resultados claros e cujas conclusões se podem alargar para vários domínios da performance de música electroacústica.

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List of Acronyms

AACM	**Association for the Advancement of Creative Musicians**
CAU	**Control and Unpredictability**
CDM	**Casa da Música**
ESART	**Escola Superior de Artes Aplicadas**
FIMP	**Festival Internacional de Marionetas do Porto**
IDM	**Intelligent Dance Music**
IRCAM	**Institute de Recherche et Coordination Acoustique / Musique**
MEPM	**Música Electrónica e Produção Musical**
MEV	**Musica Elettronica Viva**
NIME	**New Interfaces for Musical Expression**
NYUAD	**New York University Abu Dhabi**
SMP	**Stochatic Music Program**
TMG	**Teatro Municipal da Guarda**

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Chapter 1

Introduction

"One showing is worth a hundred sayings"
(Chinese proverb, in Nyman, 1999, p. 2)

1.1 Motivation

I have been deeply interested in what can be described as experimental music for many years. Having grown in a musical environment that included a variety of genres, from baroque music to punk rock, there was a constant desire to discover new music, strange sounds, weird instruments and crossing borders. The intensity of listening for the first time at a young age to a record of John Cage, Naked City or Napalm Death, was an experience that had a deep impact on my musical path. This thesis, some 30 years after these first extreme and fascinating musical experiences, still reflects my desire to discover and explore new territories, learn and share new musical possibilities. This unconditional passion for what can still be described today as *Experimental Music*, is definitely the main personal motivation behind this thesis.

The expression *Experimental*, sometimes mistaken with an unfinished artistic product, has multiple meanings. It was used initially to describe music associated with the New York School from the late 1950´s[1], and gradually evolved into a wider expression that can include free improvisation, composed improvisation, electronic, and electroacoustic music[2]. It is an expression that reflects a desire to discover new musical directions, and in this text I will use it regularly as a general terminology.

Of the musical fields mentioned within the term Experimental, free improvisation

[1] The New York School is usually defined as the group of composers that used indeterminate and aleatoric methods for composition. Among the notable composers were John Cage, Morton Feldman, Earle Brown and Christian Wolff (Rich, 1995).

[2] A precise definition of these terms under the Experimental Music field is beyond the scope of this work. A contextualization of the terminology used will be made on chapter 2.

and contexts where improvisation is a structural element seem to present additional challenges. It is an area with scarce scientific literature, at least compared to other types of improvisation, such as Jazz[3]. By being personally involved in structurally grounded improvisation contexts, it is my desire to translate some of the ideas, aesthetics and current problems into the academic community. It is my intention to draw a blurred line between practitioners and researchers, establishing connections and ramifications to a complex network of agents in this field. This thesis expresses the current problems in the musical area it is circumscribed to, from the perspective of the musicians themselves. As an active musician in this area, I am constantly performing in concert venues and festivals. Also, over the last years I have been involved as an organizer of experimental / improvised music concerts, which makes me fully aware of the current trends and problems in the musical areas debated here. This places me in a privileged situation, but obviously one of higher responsibility.

This thesis also reflects a personal research for some compositional and performative problems I have been facing over the last years. Being an improviser requires a constant renovation of musical language, expressive instrumental techniques and interaction methods. With this research I intend to gain a deeper insight into some of my working areas, as well as attempt to create music, musical instruments and musical texts that would be of a more profound theoretical and practical knowledge.

Finally, it is also a continuation of the work developed in my master´s thesis, focused mainly on control strategies over indeterministic processes. This research focused on musical problems around computer-generated music, and presented some individual approaches to humanize machine music.

1.2 Problematic issues and research questions

Having initiated my first musical experiences and education around percussion instruments was decisive in the development of my conception of musical instrument, performance and composition. It had always been clear to me that music production consisted on a system involving the translation of ideas, sounds, gestures and time through the mediation of a musical instrument. This system consisted of a well-defined mechanical-physical apparatus, driven by a human induced force that excites a column of air, a string, a membrane or a solid body (Henriques, 2002). With the development of my musical experience, I started to incorporate electronic and digital media to expand the musical possibilities of the acoustic instruments I was using. Under these circumstances, I had to be confronted with new conceptions of music instruments, music production and music

[3] Jazz improvisation is used here as a generic representation of a well defined harmonic, melodic and rhythmic variation under established musical standards.

listening. If, in a strictly compositional environment, the new possibilities offered were mostly experienced as a fascinating development of the past, in live improvisation contexts many problematic scenarios emerged, resulting in expressive limitations and interaction problems. These two aspects became then the central problematic elements, and can be described briefly as:

Expressiveness:
Efficiency in the materialization of musical ideas through a musical instrument
Interaction:
Efficiency in the communication between musical agents

As a consequence, I passed through many years of experimentation, trying new software, combining electronic devices with acoustic sound sources and presenting my works in other listening formats other than the typical stage performance. It was in the conception and performance of these works that I begun to identify specific personal problems:

. There is a general slower response time with most computer-based instruments when compared to acoustic instruments
. Taking decisions on what needs to be performed in real time and what needs to be automated can produce a limitation on the expressed musical content
. Constant changes in the interfaces and gestural mapping implied performative insecurity
. An absence of performative routines led to discomfort and uncertainty
. Discomfort and uncertainty can clearly be perceived by the audience, producing a negative mental effect on the performer
. Technical obsolescence and continuous software transformation implied a constant adaptation to a new environment
. The pre-definition of certain computer-based environments could become restrictive in free improvised contexts
. The hidden cause of some sound sources led to over abstraction in some cases
. The optimization of timbral combinations between acoustic sounds and amplified sounds was frequently hard to match
. The visual information from the computer screen induced a mesmerizing effect that led to a sense of isolation in ensemble improvisation

Over the years, I realized these problems were also experienced by many other

composers, musicians and by the audience. Kim Cascone defined many of the computer-based performances as highly problematic, since the expressive possibilities were being mostly blocked by a medium, the computer. According to him, it is not suited at all to the performance of music due to its associations as a daily and common object used by the majority of the people (Cascone, 2002).

However, if computer-based instruments can be perceived as performativelly problematic due to the lack of standardization principles, physical routines and compositional maturity (Eigenfeldt, 2010; Barrett, 2006; Jordá, 2002), these factors can produce positive effects in different musical contexts or be used as a reinforcement expressive possibility by other musicians and authors. It is precisely the flexibility, constant transformation and almost infinite technical possibilities offered by digital instruments that make them so appealing for new forms of musical composition and expression (López, 1996; d´Escrivàn, 2007; Wanderley, 2001).

Still, either the perspective of computer-based instruments as logical continuations of the past or as radically new forms of music production imply a necessary question, that resumes the research presented here:

How do we increase expressiveness and interaction between computer-based and acoustic instruments in improvised music contexts?

In order to reach a wider musical community, it is necessary to reformulate my personal problematic issues and translate them into clear and universal problems. These problems are grouped into two main problematic areas, the redefinition of computer-based musical instruments and the interaction between electronic and acoustic musicians in free improvised music. A generalized perspective of these problems can be pointed to three principal areas:

1. *Composition*
2. *Performance*
3. *Technical implementation*

More precisely, these problems can manifest themselves in the:

1. Definition of musical material

Contrary to acoustic instruments, whose musical output is confined to its technical possibilities, the mechanical and creative competence of the performer, digital instruments are designed on the theoretical premise of an infinity of possibilities. The appropriate definition of the musical content will be directly related to the contents of the output.

2. Conception of digital musical instruments

Defining a digital instrument implies a limitation of its musical possibilities (Dudas, 2010). The type of audio processing, compositional and performing functions will define music limits can be similarly compared to those presented by acoustic instruments.

3. Gestural control

The lack of expressiveness can derive from the simple fact that the computer-based environment is constantly changing, or some standardized elements may not be the most appropriate for musical performance, such as a mouse (Jordà, 2002). The lack of routine procedures can produce incoherent and insecure gestures, which naturally has an impact in the response time of the digital musicians and the interaction between them.

4. Type of musical output and presentation format

Electronic music is a privileged medium for new listening presentation formats. Apart from the traditional stage presentation, sound installations, interactive pieces, acousmatic performances or transdisciplinary complements are possible. It is then necessary to define adequately a presentation format that will accordingly translate the artistic intents into practice.

5. Spatialization formats

Despite its powerful expressive possibilities, loudspeaker amplification and sound diffusion can create some problems regarding the directionality of the musical sources. Perceptually, hearing sounds from directions opposed to the place where it is being generated can result in problematic real time interactions, and eventually lead to an undesired un-identification of the sound sources.

6. Timbric relations

Combining acoustic and electronic sounds can create distinct perceptional sonic levels. Since most electronic sounds need to be amplified with loudspeakers, the differences in directionality, vibration and sound propagation between acoustic and electronic instruments can lead to confusing timbric combinations.

7. Theatrical and visual complementations

Even in cases where a theatrical aspect is meant to be minimized, to restrict the attention to the sonic realm (López, 2004), any type of public musical representation is connected to sociological codes and meanings. It is then a delicate matter to define the balance under which complementary musical parameters will interfere positively in a musical piece or improvisation.

The definition of these problems around the main research questions led to the construction of the following hypothesis:

Hypothesis: Expressiveness and interaction can be increased by the definition of compositional strategies, performative routines and technical limits.

This hypothesis will be proven with the development of eleven original music pieces. Each of these pieces will address one or more of these specific problems and an evaluation of the results obtained will be discussed in order to provide artistic and scientific knowledge.

1.3 Methodology

Defining an appropriate methodology for a thesis based on the development of musical contents represents a challenge and is a subject that has been widely discussed in recent years (Candy, 2006). Traditional methods of evaluation such as statistics and questionnaires are most of the times inappropriate for a validation of the results obtained with a musical composition. In this case, since a creative artifact is the basis of the contribution to knowledge, the methodology used can be described as practice-based research. This method, as Linda Candy defines it, "is an original investigation undertaken in order to gain new knowledge by means of practice and outcomes of that practice" (Candy, 2006, p. 1).

The research conducted for the purpose of this thesis was developed having in mind highly practical scenarios, in forms of musical concerts, sound installations or lectures given in public spaces. During this research approximately 250 presentations were made in more than 10 different countries. A significant part of the works presented was commissioned by renowned public institutions, and presented in international festivals, music venues, universities or conferences for a difficult to estimate, but undoubtedly large audience[4]. According to George Dickie's *Institutional Theory of Art* (Dickie, 1969), a scientific validation can be obtained by these commissions, since they reflect a highly sophisticated choice from specialized people in specific areas. These commissions also reflect a complex combination of factors, such as audience reception, economic viability or artistic innovation. These works were then presented in professional situations, dealing with realistic problems that present challenges far beyond the laboratorial estimation.

Audience feedback also provides significant information for reflection. However, since most of the presentations involve a direct proximity with the public, questionnaires or inquiries would hardly be neutral or unaffected by a large number of subjects outside the

[4] Some presentations were held at music festivals attended by large numbers of people. For example, Phobos, one of the pieces developed for this research, was presented at Serralves em Festa, a festival attended by nearly 200 thousand people during two days. Since Phobos was presented in a part of the gardens where the festival took place, an exact number cannot be specified.

exclusive musical realm. The relationship between musician and the audience has been deeply discussed throughout the years, and still to this day no exact formula has been discovered to prove the effectiveness or not of a musical composition. Personally, I honestly believe and hope this formula will never be found. So, for the purpose of this work, audience considerations, reactions and suggestions were highly valued and contributed to broaden discussion on each of the pieces presented here.

The personal works presented here were extensively documented in textual and audio-visual formats. Each piece has been documented throughout different stages of the creative process, in order to access information that could lead to detailed discussion and further developments of each piece. Since most of the pieces presented here include complex visual components, a significant effort was made on the preparation of video formats that would translate in a more effective way the closest artistic intention of the piece. The video format is also extremely effective in the description of these pieces, leading to a simplified textual description that would otherwise become extensive and inaccurate.

A significant part of this thesis was done at Sonoscopia[5], a cultural association based in Porto that was my research lab for the last years. Being one of its founders in 2011, I conceived it as a way to develop artistic, educational and scientific projects in the areas of improvised, experimental and electroacoustic music and its interdisciplinary crossings with other genres and artistic fields.

The most important aspect of Sonoscopia is that it was planned as a research center, with the particularity of being independent from a direct institutional link. Ever since its conception there was a clear idea of gathering music thinkers from different areas and backgrounds, crossing borders between academic thinking and diy[6] music practice. There is a constant flow of ideas from artists living permanently or temporarily in the space, and the endless hours of discussion with hundreds of different artists working in the field of experimental music were highly inspirational and educational. For the purpose of this thesis, this rich environment and confrontation between different modes of operation was fundamental to achieve the works that have been developed throughout these years. The functioning model has been highly inspired by similar artistic collectives, such as the Musica Elettronica Viva, a group of musicians, composers and artists, among them Steve Lacy, Alvin Curran or Frederic Rzewski, which gathered in Rome in the late 1960's. Steve Lacy recalls the creative environment:

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[5] Sonoscopia's main activities can be accessed on their website: www.sonoscopia.pt

[6] DIY is a popular acronym for Do it Yourself. It is a term used to describe an aesthetic and ethic behaviour based on artistic independency from institutions or corporations. Despite its typical association with the punk culture, it is also a common practice in the underground experimental music scene, whose specificity relies on the mutual aid of the musicians.

"We lived in an old warehouse space that had a good sound. The same group every day, and we'd play for hours. Some amateurs and a few professionals: the music free of all restrictions. The form only as it happens. Nothing forbidden. We would change instruments sometimes and play objects that made sounds (walls, windows, tin cans). There was nothing to say about the music, it was the thing we did, that's all. We wanted to really cook the material among us until it came out nice. Never a question of doing it in public for money. Music like that, completely crazy, most people aren't interested (now a bit more, perhaps). For us that research was a necessary pleasure." (Steve Lacy in Sound Commitments, p. 109)

1.4 Structure of the text

Organizing years of information in a single summarized document is a challenging task. It involves a huge amount of determination to overcome the intense moments of satisfaction, frustration and anxiety that are constantly orbiting the writing of a thesis. A process that lasts years under which everyday a person absorbs new texts, facts and results can be easily compared with a roller coaster ride, with drastic changes in direction, speed, height and emotions. In a thesis too, we face unpredictable changes that create in us an illusion of going too fast, too slow, in the wrong direction and, eventually, of never surviving the ride. Eventually, the ride comes to an end; we look back and realize all the intricate connections that led us to where we are.

The present text represents an effort to summarize in a clear and concise way all the complex connections surrounding the theme of my thesis. As it is reflected on its title, this thesis focuses on four keywords:

1. Expressiveness
2. Interaction
3. Electroacoustic Music
4. Improvisation

The title of the thesis also mentions the *live* factor, which can be almost a condition when combining the four mentioned keywords. However, because it is not an absolute condition, it is still included to clearly connect this study with live performances.

This thesis is organized in three parts, preceded by an introductory chapter. Part one includes the necessary theoretical and historical connections to contextualize this work. It is comprised by two chapters, being the first this introductory part. Chapter two establishes the aesthetic borders studied here, dealing with improvisation and indeterminacy as two different conceptual styles. The contents in this chapter are

presented in chronological order, although in some cases there are inevitable and natural historical overlaps.

Chapter 3 proceeds with theoretical connections and historical contextualization, in this case under a wider stylistic musical style but on the specificities of live performance. As in chapter 2, it is presented under a chronological order, and deliberately presenting a mirrored structure around a proposed view on the evolution of electroacoustic music performances.

Part two features particular practical situations in the area of study, and it is also comprised by two chapters. Chapter 4 debates interaction problems in improvised scenarios, focusing on improvised musical speech and the exposition of pre conceived compositional material. For this purpose, a contextualization and discussion within the realm of note-based versus noise and acoustic versus digital instrument is made.

Chapter 5 focuses more on technological problems regarding live electroacoustic music. It also contextualizes some of these problems historically, confronting different perspectives and tactics from different authors.

The last part consists of personal views and strategies to provide answers or partial solutions to the problems and problematic issues debated on this thesis. Chapter 6 summarizes personal techniques and approaches based on the results obtained with the works presented on chapter 7.

The last chapter presents general and final conclusions, presenting new problems and directions for future work.

Part 1: Theory

Chapter 2

Improvisation and indeterminacy

"Nobody is free. It's impossible to be free. We are totally codified. Improvisation is a language; 'free music' means nothing. It's totally an adventure."
(Leandre, 2006, p. 561)

2.1 Overview

Improvisation is present in all musical cultures and has played a fundamental role in music production of all types (Bailey, 1992), from jazz and rock, to all kinds of popular music. Even in western classical music, improvisation was common in many situations. Figured bass, for instance, simply offered a harmonic guide to the musicians and the cadenzas in classical concertos provided the musicians with the opportunity to show their skills in the most appropriate form (Cope, 1987). However, in many musical contexts improvisation still seems to be confined to a secondary role, understood as a trial or a jam session and often regarded as a lesser form of artistic creation.

Indeterminacy, as a musical process, has also been present throughout music history, from aleatoric wind harps and automated music machines to the symbolic representations and compositional techniques in pre-tonal music[7] (Roads, 1996). It is, however, in the 20th century music of the western avant-garde that indeterminacy reaches the state of an aesthetical compositional style (Nierhaus, 2009).

For this work, it is important to contextualize these two principles. Since both terms can be applied to numerous and diverse musical situations, I will establish the desired aesthetical connections in order to clarify the meaning and applications of these terms in

[7] During the Middle Ages some compositional principles such as musical gematria, which consists on attributing a number to a letter, the symbolic representations of words with certain notes or musical timbres or musical compositions derived from graphical sacred representations are among the many examples encountered (Elders, 1994).

this thesis. Conceptually, I will contextualize indeterminism and improvisation under different backgrounds. Indeterminism, emerging as a consequence of several developments in the western classical music (Cope, 1987), and improvisation, emerging from the jazz tradition.

2.2 Improvisation as a compositional process

2.2.1 Contextualizing improvisation

Before musical notation and musical recording, most music had to be transmitted orally. In Indian culture, for example, it is still transmitted through a long learning process that seeks to preserve in a very similar form rhythms, melodies and compositions. The same orally transmitted principle can be found in numerous other musical cultures, from African to western folk music (Bailey, 1992). In all these cases, however, a variable degree of improvisation is always maintained, not only as a natural way to deal with the limitations of the human memory, but also to enhance the music itself. Improvisation is thus considered as an art form where the musician can demonstrate his knowledge, not only in terms of the technical mastery of the instrument, but also on the exceptional personal and emotional view he can have on a specific piece of music.

It is far beyond the scope of this thesis to provide a detailed historical background of the presence of improvisation in music, nor it is intended to provide an exhaustive list of musical examples. However, in order to contextualize some of the ideas expressed here, it is absolutely important to stress the importance and omnipresence of improvisation in music practice, and to define certain limits under which the terminology will be used.

In this thesis, improvisation will be associated with the aesthetic legacy of jazz, and consequently, to free jazz, free improvisation and exploratory music. Naturally, it is not my intention to use these terms as hermetic types of music. My focus will be directed towards the principles of musical organization, instrumentation and ethics that, as a whole, define improvisation as a representation within defined aesthetic codes.

2.2.2 Free Jazz

As with any musical genre, an extensive exploration of the similar techniques and aesthetics can drastically lead from a refreshing sense of novelty and curiosity to a turning

point where predictability becomes frequent and the musical outputs become uninteresting for the majority of the listeners. Apart from the natural lack of surprising elements that frequently hold the listeners interest, there are also many other economic and socio-political factors that interfere and dictate the directions in music. Free Jazz is no exception, and as Steve Lacy stated, "when you reached "hard bop"[8] there was no mystery any more. It was like-mechanical-some kind of gymnastics. The patterns are well known and everybody is playing them.... It got so that everybody knew what was going to happen and, sure enough, that's what happened.... But when Ornette hit the scene, that was the end of theories. He destroyed the theories. I remember at that time he said, very carefully, "Well, you just have a certain amount of space and you put what you want in it"" (Steve Lacy, in Bailey, 1992, p. 55).

As seen, Free Jazz has its origins in Jazz, where a structural format became solidified through the first half of the 20th century. The definition of a language, form and instrumentation defined the basic improvisational principles on which Jazz still relies today[9]. Jazz musicians learned how to improvise according to particular rules of harmonic, melodic and rhythmic content, and improvisation became a common practice among them, which in many cases defined their main musical identity[10]. This legacy was transmitted to Free Jazz and its following musical derivations, but naturally with the correspondent transformations inherent to each style.

Free Jazz is also deeply connected with a new black identity that was emerging in the late 1950's. Racial problems were still highly present in the daily life of the American black community, and public figures such as Martin Luther King or Malcolm X were significantly important in the Civil Rights Movement[11] and decisive in the growth of the sense of freedom that was needed to liberate the people. It comes as no surprise that jazz followed this notion of freedom, evolving to an art form that was representative of an intellectual, spiritual and equally free society (Lewis, 2008). Free Jazz soon became the avant-garde cultural representation of the black community, with artists such as Ornette Coleman, Sun Ra or The Art Ensemble of Chicago. Many notable jazz musicians soon followed this aesthetic, including John Coltrane, Albert Ayler or Eric Dolphy, establishing and defining a new aesthetic that can still be traced today.

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[8] Hard Bop is a subgenre of Jazz, dating from the mid 1950's. Notable musicians from this period include Horace Silver, Charles Mingus, Miles Davis or Art Blakey.

[9] Standard Jazz improvisation is based on a musical theme constructed under a well-defined harmonic grid and rhythm (the swing). The improvisation occurs around the harmonic structure and form of the theme, varying the melodic contents according to the specified harmony.

[10] In many Jazz forms, the improvisation parts allowed the musicians certain demonstrations of their virtuosity of ability to express themselves in a more expansive manner.

[11] The Civil Rights Movement is a term that describes the actions, social transformations and emancipation of the black community against the racial segregation and discrimination that was still predominant in the American society of the 1950's (Lewis, 2007).

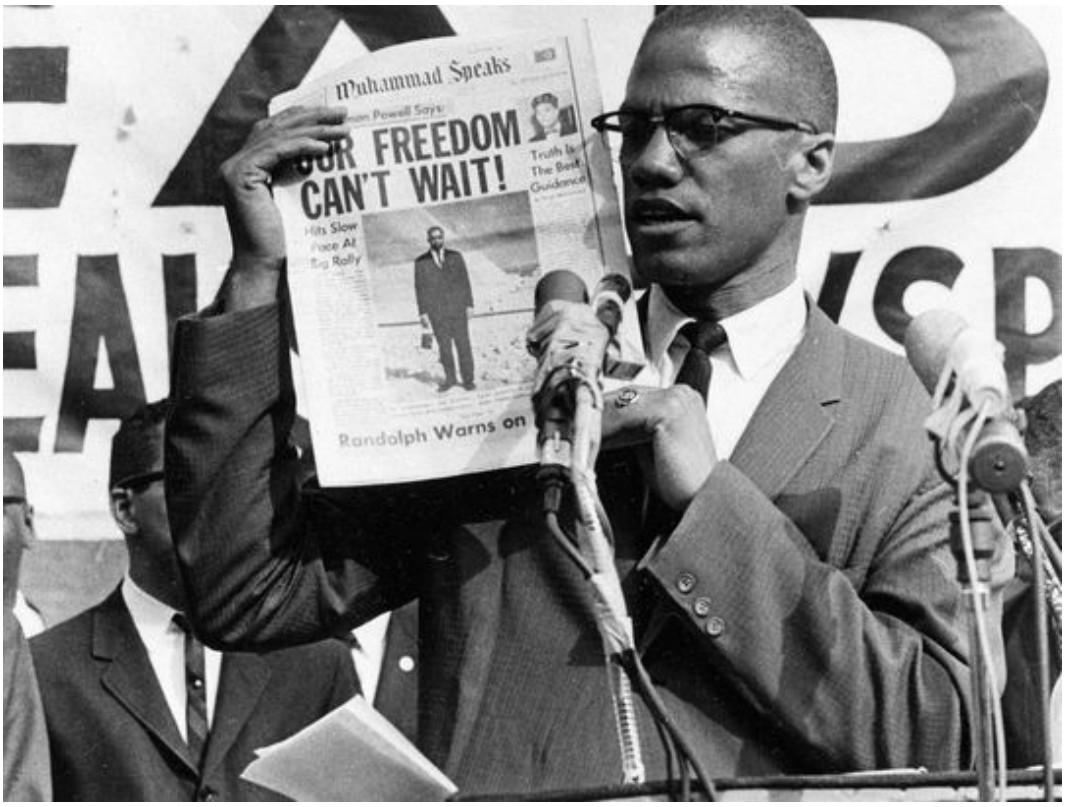

Figure 1: Malcolm X. Photo from archive.org.

Despite its tight connections with the black culture, Free Jazz expanded geographically to other parts of the globe and naturally evolved into new formats. New generations of musicians, such as Peter Brotzmann or Evan Parker explored new territories and possibilities within the genre. Almost simultaneously, in America, the emerging New York downtown scene, with musicians like Joe Morris, Sonny Sharrock or James Blood Ulmer contributed to the further development of ideas surrounding the aspect of freedom in music playing.

Nowadays, Free Jazz is still an important stylistic reference. Its ramifications are spread throughout a vast number of styles, and as jazz schools evolved, a younger generation of highly skilled musicians is also expanding the language. Musicians such as Peter Evans or Ken Vandermark are highly representative of the new trends in Free Jazz.

2.2.3 Free improvisation

The term free improvisation is usually used to describe a musical practice with its origins in American and European post-free jazz and some of the avant-garde techniques from the 1960´s. Derek Bailey, one of its early pioneers, describes this practice as being non-idiomatic (Bailey, 1992), due to its lack of reference to a particular musical idiom. In

its genesis, it was not expected to have any kind of prior definition on the music to be played, and it was supposed to be performed without any relation to jazz, rock or any other established music genre. Naturally, by denying such defined idioms, free improvisation gradually evolved to a highly linguistically formulated idiom (Hideki, 2014), which can be regarded by some as a contradiction, or as a new opportunity to evolve into new territories (Nihn, 2013). For Richard Barrett, a total rupture with any other previous musical language raises an endless number of questions, since "spontaneity is by no means something that "just happens". It depends to a crucial extent on external and internal conditions, which of course can include a very specific musical framework as in jazz. Improvisation cannot take place without a sense of situation, of situatedness, even if (as in the improvisational work I prefer) there is a constant feedback between the music and its framework, such that the shape of the framework responds to the music which it is itself shaping, rather than being fixed by tradition (Barrett, 2002, p. 1)".

As contradictory as this statement might seem within the terminology Free Improvisation, one should always have in mind the social context under which it had begun to be used. Free improvisation developed in a period where jazz was becoming highly institutionalized, being performed in mainstream music festivals and taught systematically at schools. For some of those that became afterwards the pioneers of free improvisation, these factors were antagonistic to jazz, which was meant to be performed with a revolutionary spirit, and whose language had always been in constant transformation. Crystallizing jazz was, in this perspective, the opposite of jazz. Free improvisation also emerged in the anti-authoritarian spirit of the late 1960´s, and it can also be regarded as a response or continuation of Free Jazz (Adlington, 2009).

Figure 2: May 68 street demonstrations. Photo from archive.org.

The term free improvisation, though, has been in use for nearly half a century. From its early advocates like Derek Bailey, Evan Parker, George Lewis or Keith Rowe to a newer generation of musicians like Lê Quan Nihn, Mats Gustaffson, Paal Nilsen Love, Otomo Yoshihide or Chris Corsano, free improvisation defined its own terrain, strategies and paradoxically, an idiom. Stylistically, there is an aesthetic that encourages musicians to arise outside any predetermined form, and not to know the ultimate direction of the music (Brown, 2014). But ever since there is a global network of musicians that record and perform together, the genre established its own identity and can be clearly identified today through specific phrasings, forms and instrument explorations. Giancarlo Schiaffini states that "experienced improvising musicians develop an original language, made of personality, style, study and memory, and it is this language that stands out, in a pure improvisational context" (Schiaffini, 2014, p. 576). The same point of view is shared by the violinist Jon Rose, who stresses that this language should be defined by the musician in the traditional process of repetition and test obtained with many hours of practice, in a similar process developed with written music and musical exercises. In free improvisation, this process will lead to the creation of a catalogue of sounds and physical gestures on the instrument that can be integrated in real time in a specific future musical situation (Rose, 2003).

A significant contribution to the theory and practice of free improvisation has been John Zorn´s Arcana Series[12]. The texts included in these books, that encompass manifestos,

[12] Arcana is a series of books edited by saxophone player and composer John Zorn. The series started in 2001, and so far eight volumes have been released.

interviews, scores, critical papers or notes are written by some of the world´s most significant practitioners in the fields of avant-garde, experimental and improvised music. By including contributions that range from the academia to the underground, these books offer a great global perspective and deep understanding of the music they portray. Contributors to these series include David Shea, Kaffe Matthews, Terry Riley, Frances Marie Uitti, Lukas Ligeti, Jose Maceda or Christian Marclay, among many other artists with a relevant work in this area (Zorn, 2007).

George Lewis has also provided important literature to the field. He has written about many subjects related with free improvised music, including the Association for the Advancement of Creative Musicians[13] (AACM) (Lewis, 2008), his work about his interactive pieces Voyager (Lewis, 2008) or about complex interactivity relations that may emerge in live electroacoustic improvisations (Lewis, 2006). Naturally, his work as a trombonist, improviser and composer is also significant to the field of free improvisation.

From this standpoint, it seems clear that a precise definition of the term would be outside the scope of this work. Considering an infinite number of approaches, categorizations and generalizations, this would "become really hard if not an impossible task" (Jorda 2002).

2.2.4 Exploratory music

In a broader sense, exploratory music expresses the present concerns of improvisers or composers dealing with improvisation when faced with the stylistic definition of their music. Since free improvisation evolved to a clearly defined musical style, and thus far from the initial conceptions of freedom, some musicians continued a legacy of searching for new musical territories, exploring new instrumental techniques, designing new instruments and searching for new musical languages. The term Exploratory Music is often used to describe such practice, but as in the case of many other definitions, it can be applied to many different contexts, improvisers, musicians and composers, and it is not a consensual or highly generalized term. However, in the context of this thesis it is important to mention some recent examples that will contribute to a better understanding of the discussion points addressed.

Contrarily to other definitions previously mentioned, the term Exploratory Music can be used to identify music that has such different origins as pop, rock or jazz (Licht, 2007). The relevant aspect in this case is the unusual musical solutions that usually are associated with the desire to create a unique voice and define new territories. So, the term can be applied consistently when referring to artists such as Jim O´Rourke, Harry Partch or Keiji

[13] AACM is a collective of musicians started in 1965 by pianist Muhal Richard Abrams, and focused on the development of new music, combining elements of jazz, modern and world music. Since its creation, notable musicians that made part f the group include Anthony Braxton, Wadada Leo Smith, Jack Dejohnette, George Lewis or Lester Bowie (Lewis, 2007).

Haino.

Naturally, the exploration process can take on multiple forms. In the case of pop music, it could be, for instance, developed by alternative tunings, as in the case of the Japanese duo Syzygys, that use a 43 tone scale organ[14] to compose exotic pop songs built up from a combination of microtonal Brazilian and Japanese fusion. Japan has been highly prolific in musical examples in this area, providing a large number of musicians and bands defying the borders of popular music, such as Boredoms, Melt Banana, KK Null, Otomo Yoshihide, Ruins or Gerogerigegege.

Crossing borders is also a common exploratory form, with combinations ranging from transdisciplinary arts to stylistic mixes. Charlemagne Palestine, for example, is a performance artist that combines a personal minimal music with elaborated visual elements, such as colourful clothes and toys. On a different approach, industrial music pioneer Genesis P-Orridge underwent a major project entitled "Pandrogeny", in which he and his wife Jacqueline Mary Breyer devoted themselves to a bodily unification to resemble each other. The transformation of both to a gender-neutral entity called Breyer P-Orridge is deeply connected to the longstanding confrontational and subversive musical vision of Orridge. Another example is the French trombone player Thierry Madiot, who uses several air driven instruments in his performances, including personal sound massages[15] that explore sound perception from multiple senses.

[14] 43 tone scale organ is a musical instrument conceived by composer Harry Partch. The tuning system is based on just intonation, and an octave is divided into 43 parts.

[15] Thierry Madiot´s sound massages include a variety of objects that are performed at a very close range of the ear, or that are physically in contact with the listener, that is lying on a comfortable bed. Among the variety of objects, we can hear combs, water drops, brushes or springs.

Figure 3: Thierry Madiot's aquatic sound massage. Photo from the author's website.

Ultimately, exploratory can also describe the process of the development of highly original musical voices that deify any possible classification. In these cases, a very personal combination of elements produces unique results, contributing to the renovation and re-definition of the vast world of improvised music. A few examples of such luminaries are Ghedália Tazartès, Z´EV, Christian Marclay, Keith Rowe or Moondog.

2.3 Indeterminacy as a compositional process

2.3.1 Contextualizing indeterminacy

As mentioned, and despite having many intersecting points, indeterminism has substantial differences from improvisation. With obvious risks of generalizing musical fields that in themselves are based on variety, one can state that the biggest difference lies in the musical background behind these two principles. Improvisation, as defined in section 2.2.1 derives from jazz. The aesthetic roots of indeterminism come from the western classical music tradition. Here, the highly specialized musical tasks that emerged after the baroque period, contributed to a separation of the roles of the performer, composer and

conductor. With the establishment of specific repertoire, the standardization of musical instruments and musical education principles, improvisation became a distant principle from many musicians, whose priorities were mainly directed towards the precise interpretation of a musical score. With remarkable exceptions, improvisation is not a common practice among classically trained musicians. This differs significantly, as I have pointed, from jazz trained musicians, who still dedicate a great part of their musical time to improvisation and the development of a personal sound and grammar.

In the 20th century, however, many social transformations led to multiple stylistic currents, and it is interesting to notice that "the further coincidence of the May events in Paris and of street demonstrations (especially of students hostile to the Vietnam War) with Kurzwellen[16] and the most libertarian music of Berio, Kagel, Globokar, and others is striking" (Griffiths, 2010, p. 225). With a clear link between indeterminacy and freedom, indeterminate musical elements became part of the musical lexicon of many avant-garde movements, producing singular results clearly distinct from those obtained by free jazz or free improvisation.

2.3.2 Automated music

The desire to create music that could be defined by actions not totally controlled by humans has been present throughout history. Eolic harps and several types of mechanical instruments[17] are some of the examples we can find from Ancient Greece until the Middle Ages (Ord-Hume, 1973). In the Classical and Romantic period, with the development of mechanical systems, instruments such as music boxes, musical clocks or hydraulic organs abound in different forms and shapes. Significant literature has been produced on this subject, and can be accessed in the works of Roads (1996), Nierhaus (2009), Chadabe (1997) or Rowe (2001).

[16] Kurzwellen is a piece by composer Karlheinz Stockhausen in 1968 that relies on shortwaves as its base compositional material (Griffiths, 1989).

[17] In his book Clockwork Music, Arthur Ord-Hume mentions the organ, stringed and wind instruments as the first mechanical driven instruments produced in Ancient Greece and "various types of instruments of music which could have been automatic" described by St. Augustine, who died in the year 430 AD (Ord-Hume, 1973, p. 15).

Figure 4: Max Eastley's wind harps. Photo from the author's website.

With the advent of the computer, however, the interest in automation took on different proportions. The first computer musical pieces reveal a clear focus on the possibilities of calculation. Digital calculating machines became available in the post World War II period, with credits given to Lejaren Hiller as the first composer to write a musical piece with the help of a computer. Illiac Suite was composed between 1955 and 1957, and consists of four movements where several composition techniques were programmed into an Illiac Computer. The output produced by the computer was then performed by a string quartet (Roads, 1996).

In a similar manner, composers such as Iannis Xenakis or Gottfried Michael Konig (see chapter 2.3.4) used the computer in order to formalize some of their techniques and assist the composer in the laborious process of generating musical material derived from mathematical principles. Although these principles of musical formalization may be regarded as a technological statement derived from a particular era, they are deeply rooted in the compositional tradition of the rationalization and systematization of musical processes. Most musical compositions from the pre-tonal period onwards were supported on highly defined systems to produce a desired musical output (Elders, 1995) and, from this perspective, the use of the computer as an assistant in the composition process is as natural or traditional as any other resource from the past.

Computer automated processes are also used for the simulation of musical styles[18], as it has been described by Roads (1996) and Maurer (1999). Style recreation can also be used to generate music for users without previous musical skills, which can be seen as a radical transformation of music making principles, freeing music creation from the technical mastery of an instrument (López, 2004)

Recently, automated music has been performed by robotic machines in a myriad of different musical styles. A remarkable precursor example is Beethoven's Wellington's Victory, for an orchestra of forty-two robots entitled Panharmonicon developed by Johann Nepomuk Mazel (Chadabe, 1997). In this case, the machine performed the composition automatically, in a deterministic manner similar to the process in music boxes, barrel organs or player pianos.

Currently, digitally controlled robots have seen exponential technological developments. Examples such as Logos Foundation´s Robotorkest[19], Pat Metheny's Orchestrion[20], Moritz Simon Geist´s Sonic Robots[21] or Gamut Inc´s Instruments[22] are representative of the current technical and aesthetic possibilities around robotic music.

Automated machines are also widely used in the field of sound art, providing new forms of musical expression through the combination of sonic elements with other non-musical resources (Licht, 2008). Further considerations on sound art are discussed on chapter 3.3.2.

2.3.3 New York School, intuitive and aleatoric music

According to many, John Cage´s presence at Darmstadt, in 1958, represents a turning

[18] Although most of these programs are developed to reproduce exact stylist forms, the principle of formalization and automation can be adapted to any musical context.

[19] Logos Foundation is a research and production center for experimental music, musical robots and audio art based in Ghent, Belgium. Its artistic director, Gottfried Willem Raes has produced a variety of new musical instruments and sound installations such as the Pneumaphones or the Singing Bicycles. The Robotorkestra is one of his main projects, consisting of 70 musical robots that use wireless gesture control, real time sound analysis, microwave radar, acceleration sensors, pyrodetectors, lightsensors, myoelectric devices or brainwaves as interfaces (from the website logosfoundation.org, accessed on 14th January 2018).

[20] Orchestrion is a large automated orchestra conceived to perform the music of Jazz guitarist and composer Pat Metheny.

[21] Sonic Robots is German performer and robotic engineer Moritz Simon Geist's alter ego. Under this name, he has been building musical robots and sound installations such as the MR-808 Interactive, Tripods One or Glitch Robot. (from the website sonicrobots.com, accessed on 14th January 2018).

[22] Gamut Inc. Was founded in 2011 by Marion Worle and Maciej Sledziecki to explore the interaction of electronic and instrumental music. Some of their automated instruments are the Cabasi, Specht, Trommel or the B2 BowJo (from their website gamut-ensemble.de, accessed on 14th January 2018).

point that lead to the rejection of serialism[23]. Although this is partially true, there are many registers that demonstrate that the direction towards indeterminism had been established some years before, mainly due to the problems that integral serialism faced in practical terms (Grant, 2001). These problems were essentially technical, since the musical complexity was frequently an obstacle, but also aural, because the output of some serial compositions was similar to that produced by totally random processes (Grant, 2001).

This paradigm shift was induced mainly by a group of American composers that gathered around Cage in the beginning of the 1950's: Morton Feldman, Christian Wolff and Earle Brown.

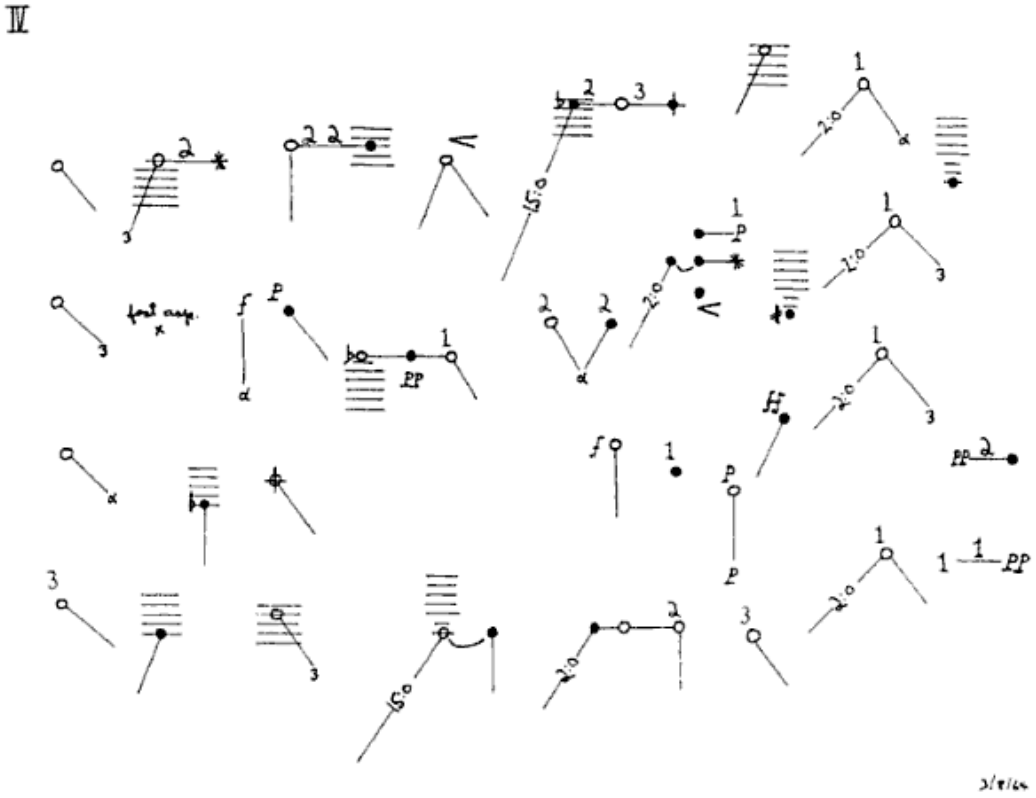

Figure 5: For 1, 2 or 3 people, by Christian Wolff. Photo from archive.org.

A key aspect in indeterminism was introduced in the beginning of the 20th century: noise. The collapse of tonality produced multiple reactions in music. Debussy incorporated extra European scales, Russolo and the futurists produced the intonarumori[24] and published The Art of Noise[25] and Varèse envisioned a futuristic sound-producing machine. It was

[23] Serialism can be briefly defined as a compositional technique and aesthetic that is based on various types of musical organization derived from the definition of a series of values. Usually, the values are the 12 notes of the tempered system, durations, dynamics and form (Whittall, 2008).

[24] A group of noise producing machines built by Italian artist and composer Luigi Russolo to perform the envisioned new sonic possibilities of the modern world (Holmes, 2008)

[25] The Art of Noise is a "manifesto of Futuristic Music published by Luigi Russolo that was a precursor of modern experimental music" (Holmes, 2008, p. 18).

Cage, however, that would summarize and consolidate all these ideas.

Influenced by Henry Cowell[26], of whom he was a student, he began by broadening the compositional horizons with the inclusion of different percussion instruments, objects and electronic devices, such as car brakes, turntables, oscillators or radios. By expanding the compositional palette from the 12 tempered notes to the infinity of available sounds - noise, Cage observes the limitation of the traditional composition systems: "the present methods of writing music, principally those which employ harmony and its reference to particular steps in the field of sound, will be inadequate for the composer, who will be faced with the entire field of sound. New methods will be discovered, bearing a definite relation to Schoenberg's twelve-tone system and present methods of writing percussion music and any other methods which are free from the concept of a fundamental tone" (Cage, 2008, p. 27).

Paradoxically, the opening of music to all sounds introduced new compositional and performative problems. The musical notes with definite pitch had been used for centuries, with a clear definition of pitch, spectra and harmonic relation. Duration and dynamics had been clearly defined by the characteristics of musical instruments. With certain sound sources, it is sometimes impossible to predict and control some of the aspects that had been considered the basis of musical compositions for centuries. Regarding unpredictability, Cage states that in his piece Inlets, that uses water filled conch shells, they "will sometimes gurgle and sometimes not. You have no control over it. Even if you try very hard to control it, it gurgles when it wishes to… when it's ready to" (John Cage, in Cope, 1989, p.162).

Dealing with such unpredictable musical material led naturally to musical forms that also incorporated randomness, chance or stochastic methods. In Projections (1950-1951), Morton Feldman specifies the form, duration, register and articulation of notes, but allows the performer to choose a specific pitch. In a similar manner, Lukas Foss, in Etudes for Organ, always leaves a compositional parameter open to a random choice of the performer (Cope, 1987). Some composers, such as Mauricio Kagel or Christian Wolff also opt to provide words or vague indications that would define an intention of the piece and produce a stimulus on the musicians (Griffiths, 1987).

This type of indications was more precise in the intuitive works of Karlheinz Stockhausen, such as Prozession or Kurzwellen. Stockhausen used the term intuitive instead of improvisation because this term "invariably suggests underlying structures, formulas, and stylistic peculiarities. (...) The intuitive adjective has the purpose of emphasizing that music proceeds from intuition, so to speak without any obstacle. I want to make it clear that the musicians' orientation, which I call 'confluence', is not a casual or merely negative

[26] According to Arnold Whittall, Cowel "already in 1912 had begun to question received beliefs as to how traditional instruments like the piano could be exploited, and to employ extremely dissonant clusters for which he devised a new kind of notation (Whittall, 1999, p. 275).

musical thought - in the exclusive sense - but a joint concentration in a text written by me, and which stimulates intuition in a way clearly defined" (Griffiths, p. 168).

Stockhausen referred to this approach as intuitive determinacy (Ritzel, 1970), as the result of a clear work that was developed regularly with a defined group of musicians that was meticulously oriented by the composer (Griffiths, 1987).

Indeterminism was also used as a conceptual compositional tool. Thousand Symphonies from Dick Higgins consists in several machine gun shots against a music score. The musicians should then play the pitches suggested by the holes in the score. Composition 1960 #9 from La Monte Young consists of a single line in a white sheet, and Listen from Max Neuhaus is a set of pieces where the listeners are led to a specific place where the word Listen had been previously stamped.

Soon there was a myriad of compositions, performances and happenings that would break all the traditional relations in music. Compositions such as Piano piece for David Tudor #1[27], by La Monte Young, As slow as possible[28], by John Cage or Piano Transplants[29] by Annea Lockwood are just a few of the numerous examples of musical pieces that pushed the limits of compositions. Eventually, indeterminism became also predictable by incorporating recurrent methods, which led to the natural urge for new forms of expression.

2.3.4 Stochastic music

Stochastic music is a term originally coined by composer Iannis Xenakis, referring to music composed through algorithmic processes that produce outputs with a variable degree of unpredictability and based on probability (Roads, 1996). Stochastic music is mostly associated with computers, although this is not a basic condition. It also associated with the term algorithmic composition, which in turn can be either stochastic or deterministic. There is a vast literature on this area, and detailed documentation on these subjects can be read in the works of Nierhaus (2009), Roads (1996), Essl (2007) and Manning (2004). For the purposes of this work, it is important to understand some of the basic aesthetic and theoretical principles behind stochastic music, in order to correctly contextualize the current computer strategies adopted by many musicians in live electroacoustic practice.

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[27] This piece is part of a cycle entitled Compositions 1960. The instructions for the performer are as indicated by the composer: “Bring a bale of hay and a bucket of water onto the stage for the piano to eat and drink. The performer may then feed the piano or leave it to eat by itself. If the former, the piece is over after the piano has been fed. If the latter, it is over after the piano eats or decides not to” (Nyman, 1999, p. 84).

[28] This piece intentionally has no tempo indication, so a performance lasting 639 years is taking place at the Halberstadt Church in Germany.

[29] This set of pieces include many untypical used of the piano, such as burning, drowning, exposing it to severe weather conditions or to just simply let it lying on a Garden (Lockwood, 2007).

The work of Iannis Xenakis is highly influenced by surrounding landscapes and natural behaviours that all have in common a principle of indeterminacy between well-specified borders. It can be the case of the sound of the cicadas at night, whose multiple layers of sound interact in ever-varying melodic lines and rhythmical patterns, the sound of war[30], with unpredictable bursts of exploding bombs, or the movement of the cloud particles, with unstable states where one can predict changes but not an exact direction.

In 1971 Xenakis designed the Stochastic Music program (SPM), based on formulas developed to describe the movement of particles on gas. A composition was presented as sound clouds, where particles corresponded to individual notes (Roads, 1996). The composer could define the average duration of each section, maximum and minimum density of notes, the classification of instruments on timbrical classes, the distribution of timbrical classes as a function of density, the probability of each member in a class to play and the length to be played by each instrument. The computer would make the calculation, being the result then transcribed to conventional notation and being subjected to the corrections imposed by the composer and the interpretation of the performers.

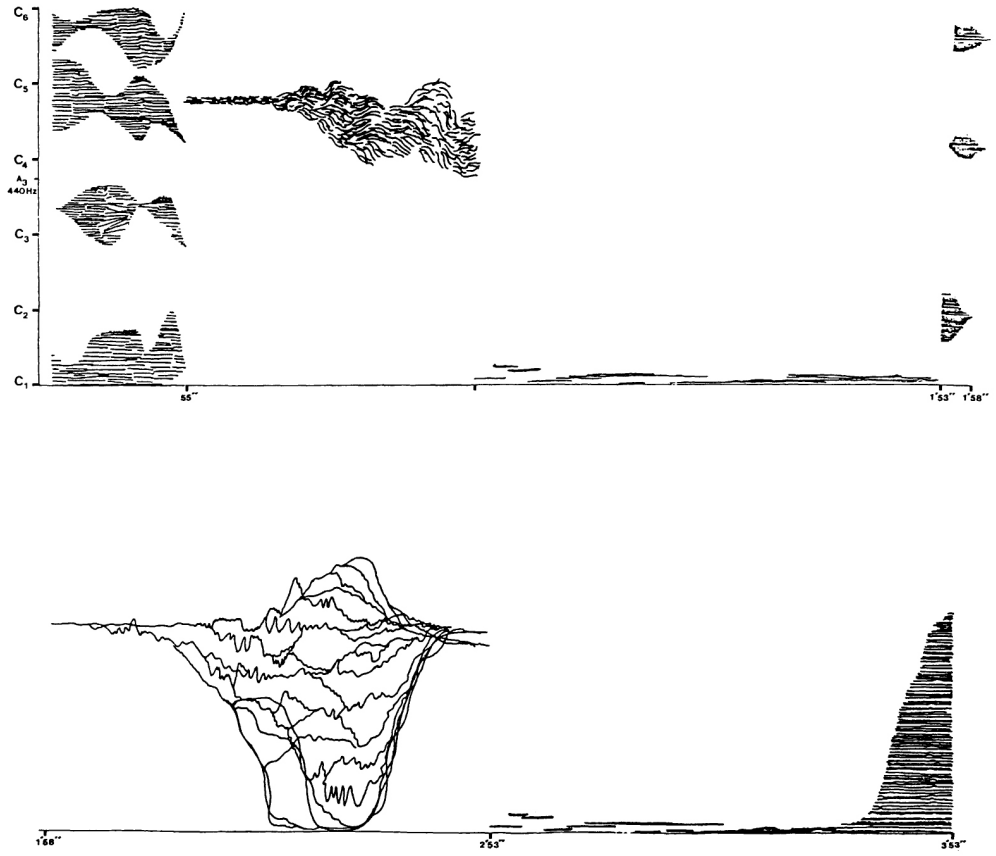

Figure 6: Mycenae alpha, by Iannis Xenakis. Photo from the author's website.

[30] Xenakis joined the Greek resistance against the German occupation of Greece during World War II. He would later join the student battalion of the National Popular Army, being hit by a shell while defending a building (Harley, 2004).

A similar compositional strategy was adopted by Gottfried Michael Koenig on the program Project 1 (1964) that generated musical events controlled by the introduction of specific data by the composer. Seven selection principles could be applied on a base of five musical parameters (instrument, rhythm, harmony, range and dynamics). The principles of selection varied between aleatoric and deterministic. The composer could introduce a set of weights for different sizes of the chords, the total number of generated events, the set of tempos and an aleatoric number that would be the base for the stochastic proceedings. One of the works Koenig created with this program was Output 1 (1979). Other notable composers working under stochastic principles include Barry Truax, Hugh Le Caine or Clarence Barlow (Roads, 1996).

Stochastic music eventually evolved to other genres of computer music, namely interactive and generative musical applications for iPhone such as Bloom[31], Node Beat[32] or Musyc[33].

2.3.5 Composed improvisation

As already stated, aiming for a completely improvised music may be seen as an utter incoherence, since each type of musical expression derives from a pre existing past. For many musicians and composers, composition and improvisation can coexist peacefully, creating not only a coherent ideological and aesthetical framework, but also reinforcing each of the components through the combination of the most suitable tactics for each moment in a musical piece. In fact, standard jazz may be seen as an example, since improvisation is based on a written tune, following clear rules of harmony, rhythm and even form. In this case, even with the slight changes that the reinterpretation of a theme may incorporate, it will always be recognized as the same piece, with its inherent artistic attributes. So, a similar approach might be taken with the composition of pieces that rely on improvisation under well-specified limit, such as the definition of form, pitch, duration or articulation. Figure 7 presents some standard symbols used in contemporary music notation for improvisation.

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[31] Application developed by Brian Eno and musician / software designer Peter Chilvers, focusing on the production of smooth ambient sounds.

[32] Node Beat is an experimental node-based áudio sequencer and generative music application for iPhone, iPod touch, iPad, Android and Playbook. It was developed by Justin Windle, Laurance Muller and Seth Sandler (from the author's website sethsandler.com, accessed on 14th January 2018).

[33] Musyc is an application to compose music with a simple and intuitive graphical and touch sensitive interface. It was designed by the company Finger Lab (from the company's website fingerlab.net, accessed on the 14th January 2018)

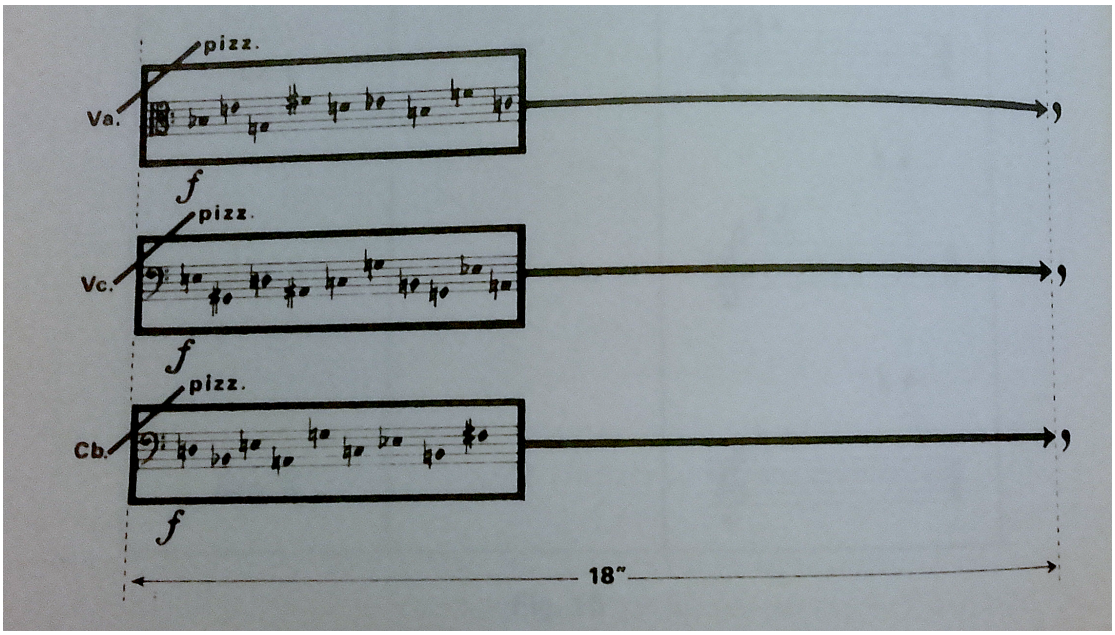

Figure 7: Music notation for an improvised section with given pitches (Antunes, 1989).

It is important to notice that the use of improvised elements in well-defined musical pieces will produce unpredictability only under certain limits, defined by the composer. This is a possible strategy for a composer or improviser that wishes to perform a musical piece, that independently from the improvised parts will always maintain the artistic identity. However, by having a certain amount of flexibility, it will be able to react in real time to the many variations that are present in a live performance.

Richard Dudas also speaks about the variable degree of improvisation and composition when dealing with the design of an electroacoustic instrument or software. According to him, this already implies a degree of control and definition of the future musical process. He establishes common points and solutions that also include the problems related with the incorporation of pre recorded electronic material within an improvisational setting. Dudas calls this process "Comprovisation" (Dudas, 2010), a term that seems to be particularly suited for most of the musical practice debated here.

Another important aspect in composed improvisation is the communal process of music making. Composer and former member of the group Musica Elettronica Viva Frederic Rzewski states that "an art form which aims for highest efficiency in times of the highest urgency must be based on dialog. It must reject the possibility of the impartial observer, present but not involved in the communication process, as contradictory to the idea of communication itself. . . . Such an art form must be improvised, free to move in the present without burdening itself with the dead weight of the past." (Frederic Rzewski, in Sound commitments; avant garde music and the sixties, p 99). Composing collectively has never been a common practice among western classical music, and some composers from the 1960´s envisioned this method as an empowering practice that would emphasize the

individual strengths of each participant involved. Notable groups from this period include MEV, AMM and Grupo Nuova Consonanza.

2.4 Conclusions and debate

As Richard Dudas states, "it is strange that the concept of improvisation—in spite of its being a core element of much traditional music around the world, common in art music from the Middle Ages through the baroque all the way to jazz and having been present in the realm of electronic music as early as the late 1950s — has been a much-maligned notion in contemporary western art music" (Dudas, 2010, p. 29). This connotation is deeply related to the sociological codes surrounding music production that can have complex implications in economy, politics or empowerment. In the western classical tradition, the dependence on the musical score and development of highly specialized roles also led to an education system where musicians are trained to perform instructions in an exact form. Despite the immaculate quality and accurateness of many classical trained musicians, many composers felt an urge to include musical elements that would be able to adapt to the real time circumstances of a performance. Composer Vinko Globokar mentions
" 'a need for liberation', followed by 'a search for a new musical aesthetic, a provocation, a wish to work collectively, to develop their instruments, to amuse themselves, a political or social engagement, the wish to belong to an elite capable of improvising, a way of evaluating themselves, a way of expressing themselves not only through sounds but through physical comportment [perhaps because musicians improvising can feel more completely that their instruments are extensions of their bodies, since there is no need to keep track of a score], a need to create a contact (and the most direct possible) with the audience, a need to give free rein to his imagination (without being obliged to spend hours of reflection at a worktable), and many other things.' "(Vinko Globokar, in Griffiths, 2010, p. 226)

The borders between improvisation and composition are also not absolutely clear, and "it's impossible to separate improvisation from any kind of live musical performance practice. Improvisation is an inherent aspect in all performance" (Brown, 2014, p. 571). Even in highly detailed written compositions, a live performance inevitably incorporates numerous variations of the piece. Factors such as the acoustics of the room, the reaction from the audience, the interaction between musicians, mistakes or emotions will be determinant in the final performance of the piece. If we add to this equation the subjective reception of the listeners, we can even extend Brown's statement to a wider approach, were even recorded music is, to some extent, an improvisation. In fact, even recorded music is dependent on highly variable factors, such as room acoustics, audio equipment, volume and psychoacoustic effects.

By accepting these factors as natural ingredients in music, in the context of this

thesis I can state that absolute improvisation and absolute composition do not exist, leading to a conclusion that all music has variant degrees of determined and undetermined elements.

Improvisation may also be considered as an art form in itself, dealing with composition in real time (Chiu, 2006; Coursil, 2008). During this process, and according to Chiu, three stages can be determined:

1) accumulation of information
2) processing of information
3) execution of information (Chiu, 2006, p.1)

It is then important to stress the important role of memory in the first stage of this process. Memory plays a fundamental role in the real time development of a coherent musical speech. The articulation of musical memory in real time will create musical contents that will have a definite mark of the substance of the improvisation. All the information stored in our brains is then recalled by a deep and complex process similar to that of composing, in which musical choices are made. The output could then be perceived in the same manner as a composed piece. The main (and substantial) difference is the inability to step back and rethink a musical motif. For this reason, skilled improvisers devote a significant part of their time to practicing and performing, in order to keep a coherent, flowing and musically meaningful discourse.

Chapter 3

Live electroacoustic music

"I believe that the mastery (if any) is spiritual and personal, not technical. More than ever before in the practice of music"
(López, 2004)

3.1 Overview

Detailed documentation on the history of electroacoustic music can be accessed on the works of Holmes (2008), Manning (2004), Supper (1997), Landy (2007), Roads (1996), Nierhaus (2002) or Collins and d'Escrivan (2007). For the purpose of this work, however, it is important to stress the relevance of some performative aspects, musical works and some composers, in order to contextualize some of the ideas defended in this thesis.

This chapter proceeds with an historical contextualization, with a focus on the live practice of music with improvised or indeterminate elements within the aesthetic limits defined in chapter 2. It intends to provide a relationship between the technological developments and their impact in the way we hear, perform and compose music.

This chapter proposes a historical perspective under which live performance has undergone significant changes, starting from the giant electronic studios of the 1950's[34], shrinking into laptop music in the 1990's and re-emerging as the multiple and personalized formats presented nowadays. Naturally, this perspective is not exactly linear, nor is the intention here in this chapter to be chronologically precise. It proposes a personal interpretation that is connected to the technical and aesthetical ideas presented here.

3.2 Getting smaller

[34] The first electronic music studios such as the GRM in Paris or the Studio for Electronic Music in Cologne would involve machines of enormous dimensions that were literally impossible to transport to a concert situation (Holmes, 2008).

3.2.1 Acousmatic music

Acousmatic music, a term that derives from Pythagoras and his lectures behind a curtain[35] (Dhomont, 2004), may be seen as an odd beginning of a chapter that deals with the idea of a chronological timeline that is related to the compactness and availability of electronic and digital technology. It is true that an acousmatic performance relies on not much more than a tape and a pair of loudspeakers[36], but one must not forget the gigantic devices behind its creation in the dawn of electroacoustic music. It is then important to stress here its function and reason within a context that is of utter importance in this thesis and in music history.

Despite being related to a recent activity, acousmatic music actually has more precedents than what might be imagined in a first glimpse. Wagner, for instance, spoke about the desire to dissociate any physical activity to the generated sound from the orchestral instruments. By confining the musicians to a pit, he not only managed to do this, but also created new psychoacoustic relations with the listener, that was receiving sound from indirect acoustic sources and focusing on other non-listening aspects (Holmes, 2008). Going back even further, church choirs or church organs are also representative of an acousmatic experience similar to a tape piece. Here too, the sound sources are frequently hidden, contributing to an enigmatic sonic environment whose abstraction might also complement its spiritual function.

However, electroacoustic music introduced new paradigms in the Acousmatic realm. With acoustic instruments, the sound sources, even if invisible, are identifiable and produce a clear correlation within our brains. Even with instruments that might not be totally familiar to us, the sound of a metal bar from a gamelan instrument or a bowed Chinese string instrument, for example, are recognized easily in terms of timbre and the way the sound was produced. In much of the western music, "the 'search engine' of our perception system is only minimally engaged" (Emmerson, 2007, p. 5) and our musical attention is focused on other musical parameters. Electroacoustic music, which is based on a variety of sounds that may be totally unfamiliar to the listener, may then be seen as an art form that explores accurately our listening mechanism, dealing with a purely imaginative form. As Dennis Smalley states, "the whole point of acousmatic music, expressed in the meaning of the word acousmatic, is that there is nothing to watch, no

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[35] The term acousmatic refers to a particular listening condition where, as in the case of Pythagoras strategy to teach behind a curtain to focus the attention on the message, an electroacoustic composition is diffused through a sound spatialization system without any visual interference derived from a direct human activity (Dhomont, 2004; Smalley, 2007).

[36] This situation can be regarded as a minimum condition. However, some acousmatic music also implied the use of large-scale sound spatialization systems.

observable activity to confirm how the sounds are made, and often no certainty about where the sounds originate (Smalley, 2007). This situation also "renews the way we hear. By isolating the sound from the "audio-visual complex" to which it initially belonged, it creates favourable conditions for a reduced listening which concentrates on the sound for its own sake, as sound object, independent of its causes or its meaning" (Chion, 1983, p.18).

The focus on a theoretically pure listening format might then be one of the explanations of the durability of acousmatic music performances. Despite its criticism by many, it has remained as a solid form for decades. One of the reasons might be that "the academic music community has engaged in Acousmatic music for many years without the need for "the social rituals prompted by the interaction of stage performer(s) and audience." There is no suspicion of counterfeit because this particular audience holds little of the expectations that pop music encourages; the aura this type of music presents is located in the musical content, not stage sets and costumes" (Cascone, 2002). Clear examples are the ZKM Sound Dome[37] and the Loudpeaker Orchestra[38] developed by Miguel Azguime and Miso Music. Here, a system of nearly 50 loudspeakers allows a complex sound spatialization. Sound can be distributed over the horizontal and vertical plane of an auditorium, engaging the audience in a performance that is perceived by its advocates as highly expressive.

[37] The ZKM Sound Dome is a sound spatialization system located in Karlsruhe, Germany, equipped with 47 loudspeakers placed in a three dimensional dome-shaped space. The spatialization can be made with the software Zyrkonium (from the website zkm.de, accessed on 14th January 2018).

[38] English translation for Orquestra de Altifalantes. This system is comprised by a group of approximately 50 loudspeakers, divided in six different sub-systems displayed along a concert hall. It allows a maximum of 32 channels for input and automation (from the website misomusic.com, accessed on 8th January 2018).

Figure 8: Miso Music's Loudspeaker Orchestra. Photo from the author's website.

Acousmatic music also emerges from the necessity of translating the studio´s compositional possibilities into the performative realm. Since, in the early stages of electronic music, most of the equipment was oversized, expensive and rare, a simplified version consisting on the playback of a recorded piece became a common practice and is still present in today´s electroacoustic concerts.

3.2.2 Live electronics

Parallel to the development of electronic music and loudspeaker performances is the attempt to present a lively version of this music. As a critical counterpart to many of the developments that were occurring at the Darmstadt courses[39] in Europe, John Cage's music and thinking was heading towards a different direction. The work developed with choreographer Merce Cunningham and pianist David Tudor soon led to the conclusion that loudspeaker music was not the most appropriate form for their artistic intentions. Works like Cartridge Music, from 1960, "in which phono cartridges were plugged with different styli and scrapped against objects to amplify their sounds" (Holmes, 2008, p. 377), demonstrate the direction live electronics would take over the next years.

[39] The Darmstadt International Summer Courses of New Music started in 1946 in Darmstadt, Germany. From the beginning of the 1950's, it acted as a gathering point to some of the most influential composers of the 20th century (Griffiths, 1989).

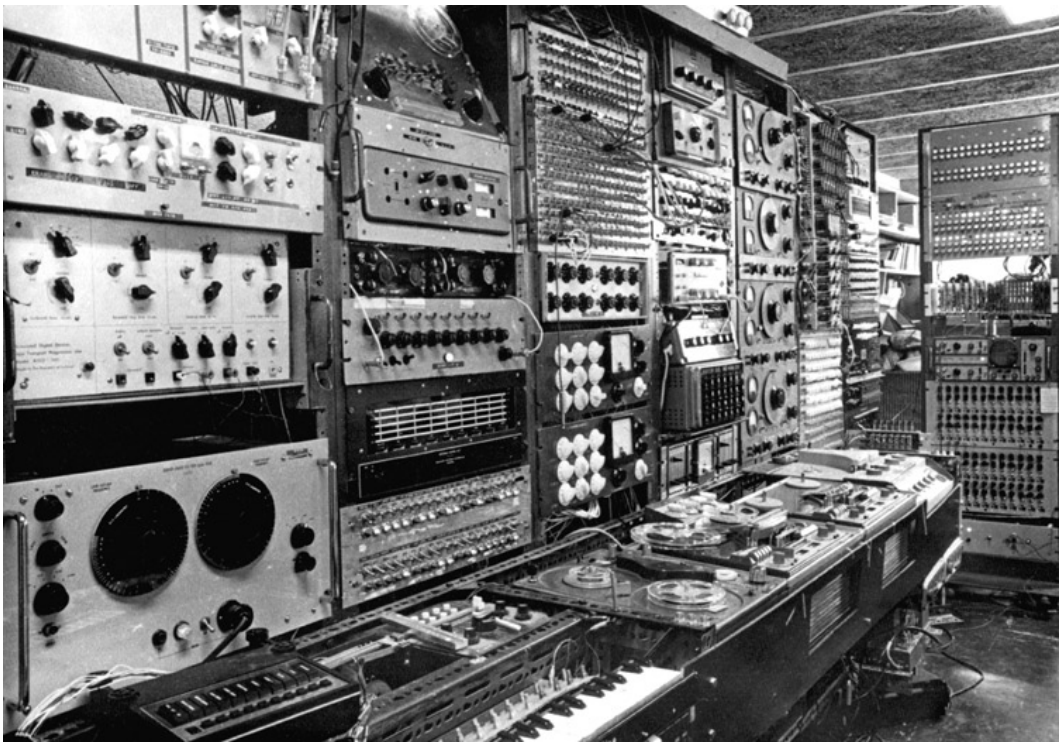

Figure 9: Electronic music studios of the Nordwestdeutscher Rundfunk in the 1950's. Photo from archive.org.

The intent to use studio equipment on stage was also being implemented by Robert Ashley and Gordon Mumma in the late 1950´s in regular performances at the Space Theater of Milton Cohen in Ann Arbor, Michigan. These performances rapidly evolved to the ONCE[40] festival of contemporary music, where a collective of artists took their individual efforts to create a gathering of artistic ideas that was mostly independent from any significant form of institutional control. Mumma and Ashley later would join forces with Alvin Lucier and David Behrman to create the Sonic Arts Union, a collective that would prove to be seminal in the history of live electronics (Collins, 2007).

An interesting aspect from this period, which is undoubtedly associated to the social context and ideals of the 1960´s, is the effort to create music collectively with new musical devices, a notion that was not compatible with the classical music definition of a composer. Two groups emerged in Europe around the year of 1966, Musica Elettronica Viva (MEV) and AMM. Despite being located in Rome at the time, MEV consisted of a varied number of members, but mainly American composers that somehow identified themselves with a libertarian ideology and a communal music practice, which naturally included improvisation. As one of its members Richard Teitelbaum recalls, "in early live electronic music, techniques of improvisation and indeterminacy were in many ways well fitted to the

[40] The ONCE festival took place from 1961 to 1966 at the city of Ann Arbor, United States. Some of the artists performing or lecturing at the festival include Pauline Oliveros, Roger Reynolds, David Behrman or 'Blue' Gene Tyranny (Holmes, 2008).

medium. Analog circuitry at that time was notoriously unstable and hard to control, so one was wise to expect the unexpected" (Teitelbaum, 2006, p. 501). Other notable members of this group were Alan Bryant, Alvin Curran, Jon Phetteplace, Frederic Rzewski and Steve Lacy. Working under similar principles, the AMM collective, which included Cornelius Cardew, Christopher Hobbs, Lou Gare, Eddie Prévost and Keith Rowe, was exploring the undiscovered possibilities offered by many new electroacoustic devices, contributing significantly to the establishment of what would soon become the roots of free improvisation and exploratory music.

During the 1970´s, the growing portability and economic ease of the computers gave rise to a series of new composers that faced the computer and digital interaction as a way to enhance the creativity of the composer and the performer. Among them we find John Bischoff, Jim Horton and Rich Gold, founders of the League of Automatic Music Composers.

The League, as it was commonly known, based its performances in network systems that could interact with one another in a musical way. Depending on the rules of interaction, the results could change between free improvisation and exact synchronism (Roads, 1996).

Live electroacoustic music also evolved into other formats and specific genres, such as interactive music. This term refers to a particular musical activity defined by Joel Chadabe as a process under which a performer and a digital instrument react and relate musically (Chadabe, 2007). Interaction has two interdependent aspects, the actions of the performer and the actions of the computer, that can be combined in many ways and in different complexity levels (Garnett, 2001). This interaction represents a new compositional paradigm, as Robert Rowe states: "this possibility expands the domain of composition. By delegating some of the creative responsibility to the performers and some to a computer program, the composer pushes composition up (to a meta-level captured in the process executed by the computer) and out (to the human performers improvising within the logic of the work)" (Rowe, 2001, p. 6).

In recent years, a particular case in electroacoustic improvisation derives from the laptop orchestras, which have become increasingly common in the last years, especially among universities in North America and Europe. Arne Eigenfeldt states that a major problem in these ensembles is the lack of repertoire and standardization of software and instrumental practices. This problem, he states, places musicality as the last aspect to be considered in these performances, due to all the technical hurdles (Eigenfeldt, 2010).

Ge Wang has responded to this problem by creating a repertoire and a fixed electronic set up for the Princeton Laptop Orchestra (PLOrk) and the Stanford Laptop Orchestra (SLOrk). He also developed software (Chuck[41]), and opted for a standardized interface (Teabox sensor interface) and a spatialization system (Hemisphere 6 speaker

[41] Chuck is a on-the-fly music programming language for real time sound synthesis and music creation (from the website Chuck.cs.princeton.edu, accessed on 10th January 2018).

array), in order to increase expressiveness and interaction between performers and the audience (Wang and Cook, 2010).

3.2.3 Laptop music

The 1990's was a decade of immense transformation in the computer industry. With the exception of simplified domestic versions that were used mainly for video games and entertainment, up to then, computers were mostly used by big companies and institutions. Looking back, it would seem highly utopian and futuristic to think that within a 20-year range societies would be utterly based and dependent on computer technologies. It is also very clear now that the same generation that was growing with video games on Atari or Spectrum computers would naturally grow surrounded by these technologies. As the 1990's evolved, and as soon as personal computers became more suitable for music production, it was then natural that this whole new generation would get much more involved into electronic music than with guitars, drums and rock and roll.

The mid 1990's marked the explosion of a large number of electronic dance music variants, from acid to techno, psychedelic trance, drum and bass, jungle or IDM[42]. Despite being initially confined to the DJ Culture, clubs and raves, some of these artists soon started to present it in more traditional concert situations. As the portable computer became accessible at the turn of the millennium, laptop performances became more frequent and became significantly present and representative of the more sophisticated music deriving from the pop culture.

[42] Intelligent Dance Music is an electronic music subgenre that emerged from techno, breakbeat and ambient music, referring to the music of artists such as Aphex Twin, Autechre, Boards of Canada or Venitian Snares.

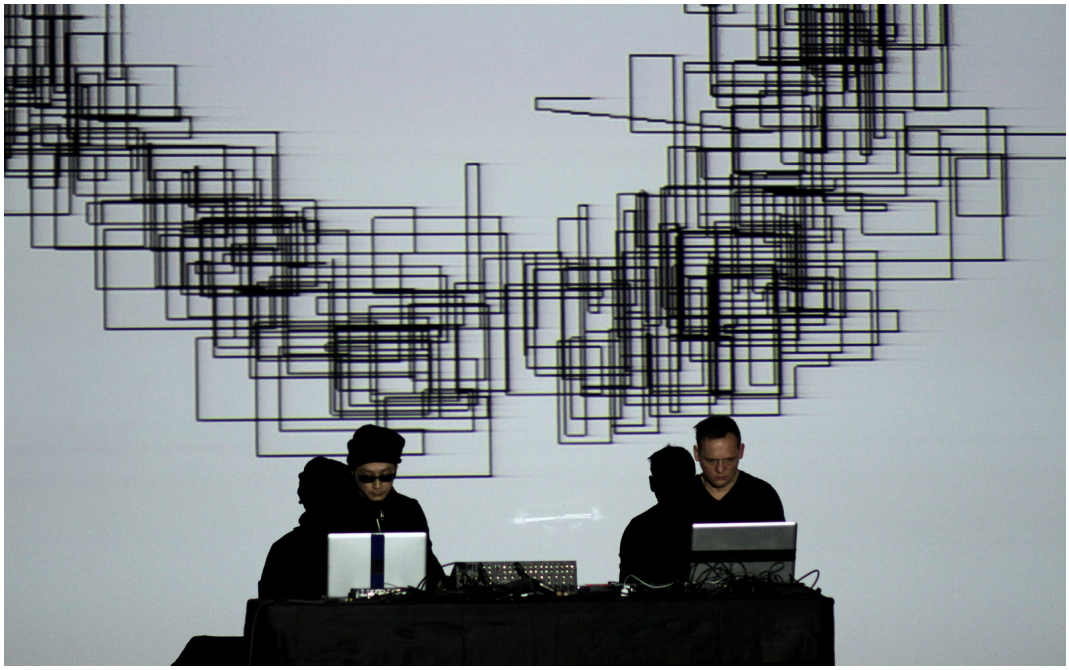

Figure 10: Ryoji Ikeda and Carsten Nicolai performing. Photo from the author's website.

Labels such as Mille Plateaux, Editions Mego, Warp or Kompakt became highly representative of the electronic music scene. Some of its artistic exponents included Pan Sonic, Oval, Alva Noto, Christian Vogel, Autechre or Monolake. A common characteristic in these performances was the expressive simplicity, since in most of the cases the only instrument on stage was a laptop, and mostly any physical actions could be perceived.

It is interesting to notice that this type of performance was always considered to be problematic by many artists. In their highly representative study of the electronic music scene from the 2000's, Barbosa and Joaquim concluded that "affected by the prospect of a *boring* performance, some laptop artists introduced (and are still introducing) several types of solutions to keep audiences interested. One of these solutions, is observed with the use of luminous controllers to 'interact' directly with the software and, indirectly, with the audience. By this way, the artist can generate also a visual feedback that facilitates the momentum of the performance by turning the result into something much *more pleasant and communicative*" (Barbosa and Joaquim, 2013, p.96). Another frequent solution was the complement with a visual projection, usually digital, that would act as a complement to the possible lack of expression in these music performances.

3.3 Getting bigger

3.3.1 Outside the box

If the tendency in electronic music until the late 20th century was heading towards the settlement of the laptop and digitalization of a large number of compositional and instrumental representations, the beginning of the 21st century was paralleled by the omnipresence of computerized technology in the daily lives of the technologically developed areas. In a short period of nearly 15 years, modern societies became utterly dependent on the internet and mobile communication formats, radically transforming our utopian idea of the computer as a futuristic and messianic saviour into a trivial technological medium that replaced books, music formats, communication, social bonds, information or even entertainment.

In music performances, there were natural consequences of the globalization of the computer. If a laptop music performance in the 1990's could be seen as innovative and challenging, nowadays it can be perceived as uninteresting and boring by many. Obviously, surprise and novelty does not directly imply good music, and the positive and negative aspects surrounding this paradigm shift are beyond the scope of this chapter, that has a focus on a historical contextualization of the computer-based instruments in live electroacoustic contexts. In any case, the growth of the computer-based instrument apparatus has become evident in many performative formats in current concerts and festivals.

From the multiple sociological possible explanations for this aspect, I will mention two facts that can, for example, be confirmed by market sales: the end of compact discs and the rise of analogue synthesisers. The link between them is the arguable myth that analogue sound is warm and digital sound is cold[43].

It is then interesting to establish a connection between these two facts and the evolution of computer-based instruments. The end of the compact disc can be directly traced to the availability of cd drives and replication ease. Simultaneously, internet connections became widely available and increasingly faster, transforming the cd into an easily reproducible format. Naturally, sales dropped drastically, and both musicians and the market had to find alternatives to maintain an interest in the music and also keep some money flowing. The least probable format - vinyl, re-emerged, in part due to a more difficult process of replication. Naturally, the justification from the artists and the industry is the sound, which is claimed to be warmer, fuller and of better quality.

A growing interest in the qualities of analogue sound would then produce an exponential development of analogue synthesisers. If the process until the 1990's was heading towards the direction of the digitalization of the synthesised sound, in the 21st century the reverse process could be widely stated. Many musicians, such as Aphex Twin, Kaytlin Aurelia Smith or Robert Lowe started to use analogue synthesisers on their

[43] It is not intended to draw a discussion on this subject. It is merely representative of some current directions and particular views.

compositional and performative routines. By doing this, not only could the sound produced be more easily connected with an individual and singular sound, but also the performative aspect would be significantly transformed into a more appealing format, which in many ways is closer to the typical performances of the past. Visually, the complexity and sense of novelty provided by the inclusion of analogue synthesisers may also be significant in a more receptive reaction from the audience which, ultimately, will also influence the musicians choices on their set ups.

3.3.2 Transdisciplinary sonic relations

With the development of interactive music and the growing availability of electronic mediums to a wider number of people, sonic relations with visual arts and other artistic disciplines became increasingly common.

Many of these manifestations are referred to as Sound Art. Regarding the terminology, Annea Lockwood says that "I apply it to the pieces I make using electroacoustic resources, and which I intend to be presented in galleries, museums, other places in which sound is, increasingly, conceived as a medium per se, like video, lasers, but not as performance." (Annea Lockwood, in Licht, 2007; p. 10). Alan Licht also states that "sound art belongs in an exhibition situation rather than a performance situation" (Licht, 2007; p.14). In short, a significant difference between a musical piece and a sound art piece is the lack of a typical performance, which creates a totally different perceptual apprehension regarding time and space. In a traditional composition, a clear timeline defines our perception, with a beginning, middle and end. A sound art piece, on the other hand, does not have necessarily a linear timeline, relying on listening properties deeply connected to the acoustic space where it is confined and also to the complementary visual components. In this sense, it is meant to be perceived more in a context of a painting or a sculpture, with the associated analytical codes from the fine arts. Figure 11 presents an interactive sound installation by the American duo MSHR (Brenna Murphy and Birch Cooper) entitled Cerimonial Chamber, where different types of lights provide control over their unique synthesisers. In their performances, this duo has developed a personalized approach to digital music, either by the singularity of their instruments or by their ritualistic gestures and posture on the stage.

Figure 11: MSHR's Cerimonial Chamber. Photo from the author's website.

The growing autonomy of transdisciplinary sonic arts as a stylistic movement can be traced to many musical events and artists of the 20th century, from Russolo to Cage and from the birth of electronic instruments to microprocessors. Significant literature on this subject has been produced over the last years, exposing factors and reasons contextualizing this development (Licht, 2007; Kahn, 2001; Landy, 2007; Labelle, 2008). For the purpose of this thesis, I will focus on the expressive aspects associated with these sonic art forms.

Transdisciplinary sonic art actually exposes in a very clear manner many of the problems encountered in electroacoustic expressiveness and performance. For many artists, a typical concert hall or acousmatic performance is simply not the best medium to explore the full potentialities of electroacoustic sound. Bill Fontana or Max Neuhaus, for instance, always tried to find ways to present in an expressive way their environmental sounds. Since a typical stereophonic experience did not translate in the most appropriate manner the intended listening experience, other presentation formats have been chosen. The formats could be sound installations, sound walks or audio-visual pieces. Similarly, our sonic perception of the music of actionist painter Hermann Nitsch would not be the same without the theatrical and ritualistic environment. Similarly, Nicolas Bernier's sculptoric sound devices could not be perceived correctly without the adequate lights and Ryoji Ikeda's music without his video projections. It is then undoubtable that these new formats for sound representation are extremely important and will present new possibilities for electroacoustic composition and performance, whose dependence on the legacy of western classical music has frequently introduced many habits and routines that do not apply to

these new expressive sound formats.

3.3.3 Re-defining computer based instruments

As societies became increasingly dependant on computer technology, its developments produced drastic changes in the way we perceive and use these devices in our daily life. Naturally, the computer as a musical instrument in live scenarios is also evaluated in a totally different context than in the reality of the 1960´s or 1970´s. It is neither a novelty nor exclusive, and many composers and performers have been opting for more and more personalized and dedicated digital environments. There are a large number of factors surrounding this change, and because each of them will be debated in different parts of the text, in this section I will only contextualize historically some examples that can be representative of this change.

One can state that the desire to achieve a personal sound and musical aura is a common denominator throughout music history. Most performers and composers aim for a unique and distinct sound that can clearly be identified with them. Computers actually represent a significant shift in this particular aspect. In fact, one of the most promising attributes of computer-based instruments is the flexibility and theoretical endless limitation of performative possibilities. The computer can be seen in radically different formats, from the simple sound file playing laptop to complex interactive hyper instruments[44]. Currently, the computer is also one of the most popular instruments on stage, but nonetheless "most computer music performers still seem shyly reluctant to consider the computer as a regular musical instrument" (Sergi Jordá in Collins and d'Escrivan, 2008, p. 89). Ironically, the reason behind this may be directly related to its mentioned endless possibilities. When using a tool as versatile as the computer, many musicians feel uncomfortable about considering its simple reduction as a musical instrument.

In recent years there has been a clear shift towards the disintegration of the computer into dedicated digital environments. Microcomputers and microcontrollers such as Raspberry Pi or Arduino have been increasingly more present in the last years. As the technology became more available and cheaper, a wider community of musicians and programmers developed musical instruments and sound installations based on this technology. Apart from the economic factor, these platforms present a highly attractive

[44] This concept was developed by Todd Machover at MIT. It is based on the exploration of the gestural potentialities of existing acoustic instruments in combinations of electronic extensions incorporated on the instruments themselves (Chadabe, 1997).

solution to the presentation of unique and personalised digital set ups. Dadamachines[45], for example, is an arduino based project that is able to control solenoids or dc motors, integrated in a music context that provides drums sticks or plectrums that can be connected to a variety of sound producing objects. It can be controlled by the arduino itself or by a standard midi input, allowing further musical possibilities. Another example of the use of microcomputers is the instrument / sound sculpture Ra, developed by Russian sound artist Dmitry Morozov, also known as V:TOL. In this case, a Raspberry Pi is used to create a highly personal musical device.

A representative example of the current direction of some computer-based instruments is Bruno Zamborlin´s Mogees[46]. Advertised as a "play the world" device that can be connected to a smartphone or tablet, this gadget was cleverly advertised and gained immense popularity. Despite being much more limited than advertised, it is nonetheless relevant of the current desires of many digital musicians, that demand distinct instruments and environments that can be referred to for their uniqueness and originality.

Figure 12: Bruno Zamborlin's Mogees. Photo from the author's website.

[45] Dadamachines is an automat toolkit developed by Johannes Lohbihler that allows the control of solenoids and motors through a Midi port. The toolkit is equipped with modular pieces such as drum sticks that can be easily incorporated into any percussive surface (from the website dadamachines.com, accessed on 14th January 2018)

[46] Gesture recognition sensor that allows the mapping of identified movements into different sounds.

3.4 Conclusions and debate

In the history of western music, electronic music, which also encompasses electronic and electroacoustic music, emerged as a natural promise for the expansion of sonic and compositional possibilities. The perspective of an unlimited source of musical combinations soon gathered the attention of the most prominent composers of the 20th century.

In the history of musical instruments, electronic means of producing sound are relatively new. Despite the actual frequent presence of loudspeakers and electronic devices, most of mankind´s relationship with sound and music has been achieved by acoustic phenomena. Throughout thousands of years, we achieved many forms of understanding acoustic transmissions through the auditory system and also with the sensorial complement that sometimes is achieved by the visual and tactile associations. Our psychoacoustic perception is then deeply embedded in these acoustic meanings, which might cause some perceptual uncertainties of electronic sounds. Our uncomfortable relation with some new ways of producing sounds may seem natural, and it is obviously clear that we are only in the early stage of music production with a new organological class of musical instruments (Eimert, H. in Holmes, T. 2008, p. 334).

Naturally, one should also have in mind that the first electronic and digital devices had its limitations, and its use for musical purposes was confined to a restricted number of composers and researchers. Accessing the first computers, for example, was expensive and also depended on a sophisticated knowledge on programming or at least a reasonably refined scientific background. It would take a few years before computers became widely available to the general public. Although this produced initially an effect of fascination for the theoretically unlimited possibilities of computer music, the generalisation of the computer as a trivial daily life object also produced an endless number of side effects, many of which are reflected here on this thesis.

A very important aspect in the affordability and generalization of computer-based instruments is its use outside privileged communities. This transformation produced a significant amount of musical examples that emerged from every type of music field, from spontaneous and naïve to complex and highly intellectual. This wide range of ideas is then a significant resource when it comes to this study, since what can be considered problematic in some music genres may already have been totally integrated in others. Concerning this generalization, it is interesting to note that there was a shift in the music domain of electronic and electroacoustic music. These terms, originally adopted by the classical legacy, where highly explored by notable composers such as Iannis Xenakis, Karlheinz Stockhausen or Luciano Berio. However, electronic music soon became more restricted to the specific field of electroacoustic music, which became an almost separate entity when it came to the study and practice among composers and composition schools.

There has also been a clear tendency in recent years to avoid minimalistic computer performances. As a follower of hundreds of concerts and festivals since the early 1990's, I could clearly see stages getting more and more minimal during the 90's. The typical laptop performance of those days consisted of not more than a laptop and, eventually, a visual complement. This was the case with a significant number of artists like Ryoji Ikeda, Oval or Mouse on Mars, whose performances were perceived as a novelty, since laptops were not so common in those days and certain kinds of instrumental music seemed to be losing representativeness. However, as laptops became widely available, enthusiasm soon was being replaced by boringness. As a consequence, many musicians developed more sophisticated and personalized environments, frequently combining the computer with other music sources and visual apparatus that could relate them to their own sonic identity.

Part 2: Practice

Chapter 4

Interaction

"For centuries, western music has talked about notes, almost ignoring what was inside of them." (Jordá, 2002, p. 2)

4.1 Overview

This chapter focuses on interaction in the improvised and indeterministic contexts aesthetically defined in chapter 2. For a clarification of the meaning of interaction applied on this thesis, I will re-state its initial definition in section 1.4:

Interaction:
Efficiency in the communication between the musical agents

I do not intend to provide extensive definitions for the meaning of interaction. Several authors, such as Rowe (2001) and Chadabe (2007) proposed several models for the definition of interaction in electronic contexts, which can be usefully applied to certain musical contexts.

In this thesis, interaction refers to the communicative process between the direct musical agents of a piece. These agents can de defined as human (improvisers / composers), and / or machines (improvisers / composers). The communication process, as suggested here, refers to the definition of a musical language, common to all the agents and that can be applied in compositional or real-time situations (Leandre, 2006).

Since the language of electroacoustic music relies on noise as much as in the continuation of the traditions of western classical music, it is important to discuss the impact of the openness of music to all sounds, and to its conceptual model as organized sound[47] (Landy, 2007; Hagarty, 2008). Even after more than 100 years, the transformations made by noise in music are still only partially understood. There is still a dominant presence of note-based music, either in the music education, the institutions and the socio-

[47] This term derives from Edgard Varèse's description of his musical approach (Varèse, 2008), and can be further explored in Leigh Landy's book 'Understanding the Art of Sound Organization'.

economical music system. Several considerations on the substantial difference between note and noise music performance will be made, implying possible implications in the further expressive possibilities.

The definition of a personal musical language will be discussed under the perspectives of improvisation and composition. It is important to understand how this language is recalled in performative scenarios in order to correctly relate it to the efficiency of expressiveness.

4.2 Note / noise paradigm

4.2.1 Notes, scales and standard musical instruments

At the end of the 19th century, with the expansion of the orchestral possibilities in compositional and instrumental means, what appeared to be a dead end for tonal music was in fact an enormous revolution that would generate a multitude of music styles, new instruments, new forms of musical expression, sound reproducing and recording devices (Griffiths, 2007). To fully understand this relation with the purpose of this chapter, we need to move back a bit further. For centuries, western music had been composed under clear rules, and mostly under two dimensions, time and pitch. The slow process of sedimentation of these rules took place in the development of well-defined musical instruments and performative techniques, music scores and composition systems.

Most of the music produced was based on the notion of musical note and scales, and their consequent placement in a bi-dimensional entity (the music score), where time is represented in the horizontal axis and pitch on the vertical. Here, a succession and superimposition of musical elements that could be precisely defined on its duration, pitch, timbre and dynamics would allow the creation of the basic elements of western classical music: melody, harmony and rhythm (Whittall, 1999).

Since the tuning system and the diapason had been almost completely settled since the 18th century[48], the musical output expected could be completely predictable. Playing simultaneously a C with a G would produce a well-known result, and even the combination in different ranges of instruments would have results that could be clearly controlled. The standardization was also reinforced by music schools, where common techniques, repertoire, and approaches solidified the whole music system. The conjugation of all these factors was of key importance in the development of some of the most notable music ever created in western history.

[48] This is a practical simplification to exemplify the settlement of the equal temperament and the attempt to stabilize a tuning pitch.

Naturally, the world changes and no musical system is infinite in its resources. By the end of the 19th century aspects such as chromatism[49] and the ever-expanding percussion paraphernalia behind the orchestras were indicators of a radical change to come (Griffiths, 1989). This clear shift could be summarized with the development of the twelve-tone system[50] by Arnold Schoenberg and the manifesto The Art of Noises, by Luigi Russolo and the futurists. These two events would clear grounds for composers like Henry Cowell, Edgard Varèse and John Cage, all of whom of extreme importance in the introduction of noise as a musical element, as I shall explain in the following section.

4.2.2 Noise

The history and impact of noise has been deeply documented in the recent years, and has been a source of intense debate in many artistic areas. Authors such as Hegarty (2008), Licht (2007), Kahn (2001), Landy (2007), Holmes (2007) or Labelle (2008) have produced significant work, and countless research was published around the works of Luigi Russolo, Edgard Varése and John Cage. Since it is not the purpose of this thesis, nor of this chapter to present a detailed insight into specific music styles or authors, I will focus on the subjects directly connected to the development of the framework proposed here.

As mentioned on chapter 4.2.1, Noise introduced a radical change in music thinking and music making. I frequently compare Noise to a musical Big Bang, since before Noise music was restricted to a limited to a well-defined number of notes and controllable durations. Personally, I do not see this as a total rupture with the past, echoing from Varèse´s perspective when he stated that "my desire for the liberation of sound and for my right to make music with any sound and all sounds has sometimes been construed as a desire to disparage and even to discard the great music of the past. But that is where my roots are" (Edgard Varése, in Cox and Warner, 2008, p. 18).

The substantial difference from the past is the introduction to an infinity of musical materials and possibilities. And among many of those possibilities, lie too many sounds with erratic and uncertain behaviours. Would it be possible to write a harmonic treatise about thunderstorms, traffic jams, destroyed pianos and malfunctioning electrical equipment, such as Rameau or Schoenberg did in the past on the with 12 chromatic notes? As absurd and naïve as the question might seem, there is actually a deeper meaning to it. Most of our

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[49] Composition technique that increasingly adds chromatic notes to a diatonic space (Griffiths, 1989).

[50] Composition system developed by Austrian composer Arnold Schoenberg focused on the development of the chromatic space with no particular emphasis on any note. The compositional basis would be based on the definition of a twelve-tone row, on which repetitions should not occur (Witthall, 2008).

music still relies on classical models from the past, from the educational system to sound producing and reproducing facilities, performance places and habits, economical and sociological behaviours. A significant part of our listening habits are still based on a linear timeline, essentially focused on time and pitch. Music has more than that, as we are slowly discovering, and the Noise revolution produced great impacts, not only on the music material do be used, but also on our listening modes.

4.2.3 Computer generated sound

Chronologically, digital sound generation appears among the first concerns in the electronic musical community. Composers such as Barry Truax, Jean Claude Risset or John Chowning made numerous attempts to generate new sound or to simply mimic digitally the acoustical realm (Roads, 1996). As with other technologies, this approach may be regarded as a logical continuation from the past, where sound and musical instruments adopt specific materials and techniques to constantly reinvent the future. The history of musical instruments is full of examples of myriads of sound machines that either expand the possibilities of the existent instruments, or simply represent the desire to innovate. From the pipe organ to the piano or to the prophetic visions of Edgard Varèse's sound producing machine[51] (Varèse, in Cox and Warner, 2008, p. 19), it is then clear that even tradition relies on constant revolutions.

The sound reproducing possibilities of the current computers may seem to realize Varèse's dream. As Sergi Jordá states, "while acoustic instruments inhabit bounded sound spaces, especially constrained in terms of timbre, tessitura and physical mechanism, computers are theoretically capable of producing any audible sound, either from scratch (through sound synthesis techniques) or by sampling existing sounds and altering them further through processing." (Jordá, in Collins and d´Escrivan, 2008, p. 89) However, and quoting again Varèse in his statement from 1962, "the computing machine is a marvellous invention and seems almost superhuman. But in reality it is as limited as the mind of the individual who feeds its material". (Varèse, in Cox and Warner, 2008, p. 20)

Having the human creativity as the limit, the new possibilities of digital sound production often lead to situations that may be regarded as problematic by some, and highly functional by others. This is the case with the psychoacoustic correlation between the sound and its source, or even the type of physical contact available in many computer-based instruments (Emmerson, 2007). This correlation may also be visual, since in many cases "there is no direct relation between the complexity of the gestural interface and the

[51] In his lecture 'Music as an Art-Science' from 1939, Varèse described a sound producing machine, capable of liberating the composer from the restrictions of the tempered system, the physical limits of the orchestral instruments (Varèse, 2008).

expressive potential of the resulting instrument" (Wanderley, 2006, p. 15). As stated, this aspect is not necessarily a restriction, leading eventually to listening forms closer to the definition of the sound object and reduced listening of Pierre Schaeffer (Schaeffer, 2008; Chion, 1983).

A significant differentiating aspect in computer-generated sound is its generation principle. Both in the digital and analogue realm, signal amplification and acoustic diffusion through loudspeakers is needed. Producing sound and being able to diffuse it to multiple points in space can consensually be perceived as a positive aspect, but on the other hand, the lack of vibrational connection between the musician and his instrument may be regarded by many as a performative restriction that goes against thousands of years of human relationship with the sonic perception. Figure 13 represents a performance by Lebanese artist Tarek Atoui, whose performances with digital instruments have been mediated through tactual interfaces.

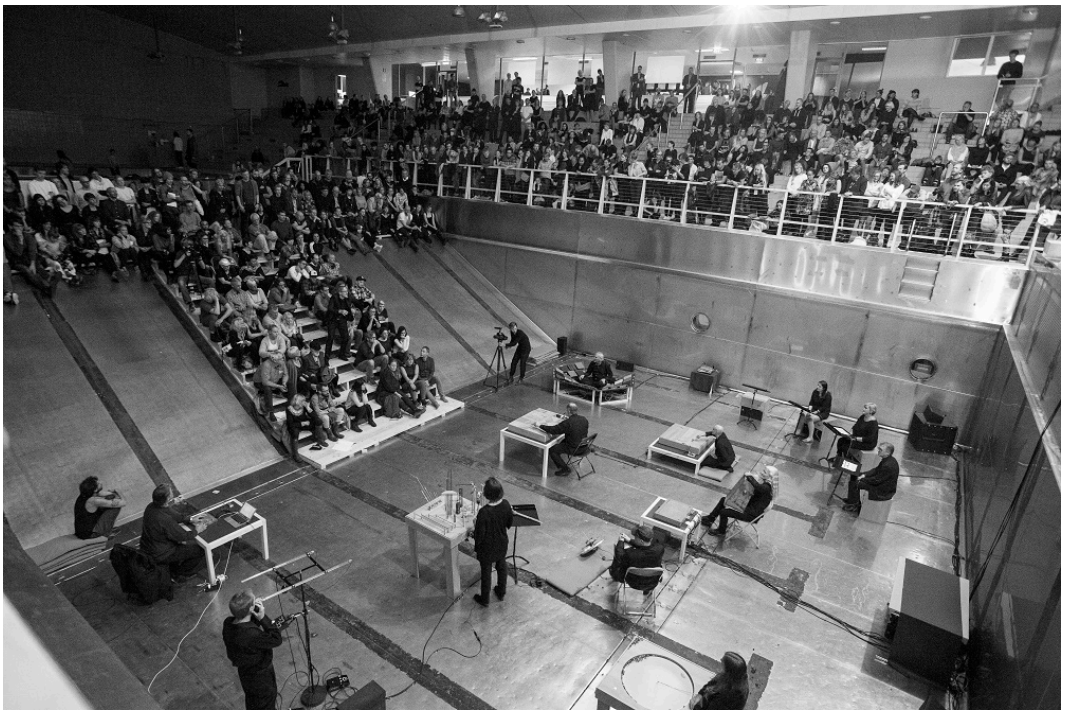

Figure 13: Tarek Atouie's performance Within. Photo from the author's website.

4.3 Musical grammar and discourse

As stated in chapter 2, there is no clear and distinct line between composition and improvisation. Also, the two concepts have been exposed as impossibilities as pure representations, since all compositions incorporate a minimum degree of indeterminacy, and all improvisations a minimum degree of composition (Barrett, 2002; Chiu, 2006). In both cases, the musical output cannot be detached from memory, be it mental or physical.

This memory is actually the core of improvisation and composition, since it is there that a musician recalls his musical discourse in a real or non-real time situation (Parker, 2006). Since the recalling processes are similar, which include musical phrasing, durations, harmonic relations or silences, the terminology real time composition seems to apply to a large number of improvisers (Chiu, 2006).

For an improviser dealing with an acoustic instrument, there are no other choices than deciding when to play or not. Playing, in this case, has a clear meaning, such as a succession of notes, a chord, a tone or a rhythm. However, for a computer-based instrument, playing could be all of the previous solutions, but also modifying the sound of the other performers, controlling acoustic instruments or playing a sound file of an orchestral excerpt. So, if one single gesture can perform incredibly complex musical results, we should naturally analyse carefully our decisions on what should or should not be automated.

Taking as an example real-time sampling[52], one could question, in some musical contexts, the need for doing it live or pre-record it. If in the first case one could benefit from the spontaneity of the act and a deeper connection with the audience, since the recorded cause could be directly related, the second option might liberate the digital performer to execute other tasks. Both options are valid, depending on the musical demands, which can only be determined by each performer for each individual case.

Such decisions actually end up determining an improvisatory act and can be described as compositional decisions. By limiting certain physical actions, determining what type of audio processing will be made, what type of program to use or what type of musical material to feed the computer with, we will produce results within a certain defined range (Dudas, 2010). Still, what might seem to be a restriction at a first glimpse may be no more than a similar process that also occurs in acoustic instruments, where improvisation is limited to the instrument possibilities, the performer mechanical skills, his musical ideas and his ability to express them in real time (Rose, 2006).

As said, the precise pre-definitions of what a digital improviser should or should not prepare for a performance, are individual options that should be made carefully for each musical context. It is important, however, that these decisions are based on the maximization of musicality inherent to the performance. As an acoustic and digital improviser myself, I have been fully aware of the importance of the identification of the limits proposed by each musical instrument. In the acoustic instruments, because we spend countless hours perfecting mechanical gestures and musical ideas, the limits are clearly defined. In digital instruments, our natural tendency to think that everything is possible acts sometimes as a constriction. In a musical improvisation, as in a musical composition, clearly defining materials, techniques and approaches will certainly produce better results for most musicians than to simple let things indeterminably open.

[52] Technique where an audio fragment is stored into the computer or any other electronic device in order to be consequently played or processed by a variety of sound signal processing methods.

4.4 Conclusions and debate

The musical transformations that occurred at the turn of the 19th century pointed an infinity of many new musical aesthetics and possibilities. Noise, particularly, produced some of the most significant impacts ever made on music (Hegarty, 2008). Composers such as Debussy[53], Russolo, Cowel, Cage or Varèse made significant contributions to a completely new perception of sound and music, that clearly goes beyond the longstanding western conception of musical instrument, composition and performance.

The advent of electronic music emphasised some of these changes, producing a new organological category of sounds, the electrophones. For the first time in history, sound was being produced by a variety of new devices, whose sonic principles were significantly different than those obtained by the vibration of air, strings, membranes or solid bodies. Naturally, new relations between the music idealization and materialization emerged, opening new creative possibilities and listening perspectives.

Many authors and improvisers also emphasise the importance of musical memory in the development of an improvisational speech (Rose, 2006; Barrett, 2002). In fact, it seems almost impossible to eradicate memory in the performance, since our muscles and our previous musical activities will eventually be recalled in a real time situation. Some musician´s may try to eradicate any conscious form of premeditation in their performances, such as Evan Parker or Derek Bailey (Bailey, 1992), or even Stockhausen´s intuitive piece Gold Staub[54] (Griffiths, 1987). Still, the need for a special concentration mode would be required, which might be suitable for particular musical contexts, but not for their majority.

The establishment of a well defined musical language that can be clearly identified by the other musicians or machines can also derive from many compositional decisions arising in the conception of the instruments themselves (Dudas, 2010). Here, since a definition of the musical material and possible transformations is made, a coherent musical speech can be obtained and deciphered by the other musical agents.

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[53] Paul Griffiths describes Prélude à l´aprés-midi d´un faune, from Debussy, as a clear starting point for modern music. Although aesthetically it can be obviously perceived as distant from the conceptions adopted by the futurists, for example, this piece, written between 1892 and 1894, clearly makes a rupture with tonal music, opening a infinity of possible directions in music (Griffiths, 1987).

[54] Gold Staub is one of the pieces composed by Karlheinz Stockhausen for his intuitive music cycle entitled Aus den sieben tagen. In this piece, the musicians are required to live alone for four days, eating, sleeping and talking or acting as little as possible. After this period, the musicians should play, according to the composer, without thinking (Griffiths, 1987)

Chapter 5

Expressiveness

"Human performers are always more interesting to look at than loudspeakers"
(Teitelbaum, 2006, p. 501)

5.1 Overview

In this chapter I will discuss the use of the computer-based instruments in performative contexts that were aesthetically defined in chapter 2. If in the previous chapter the focus was on the communication process of a defined musical grammar, on this one the technical aspects regarding the materialization of the defined language are debated, under the perspectives from different authors. As with the term interaction, expressiveness has been defined, or at least attempted to de defined, by a large number of authors and used in a variety of contexts and meanings (Jordá, 2005). It is not my intention to provide an exhaustive discussion about a terminology that certainly has different interpretations according to the musical context where it is circumscribed, but for the purposes of a clarification and definition of aesthetic and technical limits, I will re-expose the initial brief definition proposed in section 1.4:

Expressiveness:
Efficiency in the materialization of musical ideas through a musical instrument

It seems natural that measuring accurately the efficiency of a musical process can be a difficult, if not impossible task. Several authors such as Wanderley (2001; 2004) or Bongers (1997; 2000) have proposed and discussed this topic extensively. For this thesis, I will refer to expressiveness as the process under which a specific musical idea is transmitted through a medium, in this case a computer-based instrument. The efficiency can be determined by the amount of technical and physical restrictions offered by that medium. I will be referring to processes essentially based on improvisation, meaning that the level of efficiency can only be determined individually. Since the exact musical intents and the level of satisfaction achieved with a specific computer-based instrument are

processes that are determined by each improviser, I will focus in this chapter on the conditions surrounding these aspects, pointing eventual problematic or successful situations that can be universally debated. This approach will allow the interpretations of different works according to a wider perspective, from the potential expressiveness of an acousmatic or an operatic-like performance.

This chapter will introduce several views from the perspective of the computer as a musical instrument, either from an historical continuation of acoustic instrument tradition, or by a rupture with the past. Several technical aspects are discussed around the mediation process between the improviser and the computer as well as their implementation in live performances.

For further historical details on the history of electronic music instruments and digital music interfaces, further reading can be accessed in the works of Manning (2004), Roads (1996), Chadabe (1997) or Holmes (2008).

5.2 The computer as a musical instrument

5.2.1 Continuation of tradition

Defining a musical instrument is a laborious task that has been debated by many organologists [55], such as Sachs (2006), Kartomi (1990) or Henrique (2002). Classic classification systems such as Hornbostel-Sachs[56] can often be inappropriate when it comes to non standardized uses of some instruments or certain types of music practices outside the western classical legacy (Kartomi, 1990, p. 6). In this system, electrophones are clearly the most ambiguous category, which may be understandable considering the development of these instruments at the time of the development of the system. Computers in particular seem to provide a highly challenging task for classification. First, a computer can be many other things besides music. It has been conceived as a calculating machine (Mathews, 1963), and its actual format derives from the typewriter. Recently, it has been transformed gradually into a communication device, adapting ergonomically to the physical demands of the circumstances that surround mobile connectivity. So, a computer presents an additional challenge concerning its organological classification.

[55] Organology refers to the study of musical instruments from the acoustic, mechanical and historical point of view (Henriques, 1994).

[56] Eric von Hornbostel and Curt Sachs devised a classification system in 1914 that was based on the acoustic principles of each instrument. Despite its debated inaccuracy, it is still the most common classification system of musical instruments. The main principal categories are Idiophones, Membranophones, Chordophones, Aerophones and Electrophones (Henriques, 1994).

In its actual simplest form, the laptop, the computer generates sound from digital storage in electric components, which is then converted into acoustic energy through an amplifier and loudspeakers. According to Hornbostel-Sachs system, it can be considered an electrophone. However, computers can also be part of much more complex music systems, incorporating computational devices, interfaces and acoustic outputs. The computer can also be an extension of existing musical instruments, as in the case of hyperinstruments such as Tod Machover´s Hypercello or Sensor Chair (Manning, 2004). These examples are representative of the complexity of classification of the many different manifestations of the computer as a musical instrument.

Still, the computer is a device capable of producing music, so it can be considered a musical instrument. It is then interesting to follow Robert Moog´s statements regarding electronic technology, which can be also applied to digital devices. He states that "the idea that some musical instruments are more natural than others is pure nonsense. Except for the human voice, all musical instruments are highly contrived, wholly artificial, and utterly dependent upon the most advanced technologies of the time in which they are developed. When we view musical instruments this way, we see the widespread use of electronics in the production of the music of our time is not a break with tradition, but a clear continuation of it (Robert Moog, in Henrique, 1994, p. 385)".

So, considering the computer as a conventional musical instrument would lead us to the very same problems faced throughout music history concerning the materialization of musical ideas. From this point of view, computer musicians would need to practice around standardized physical and intellectual routines in order to develop coherent musical expression on a professional level (Wanderley, 1991). Music history has provided many examples on human determination against theoretical physical limits. For example, apparently simple instruments such as maracas or a jew's harp can be virtuosistically performed, and the same principle can obviously be applied to a laptop, a tablet or a cell phone. It is then undoubtedly true that time and a deep knowledge of the instrument is then fundamental in the development of digital musicianship.

On the other hand, this representation can also lead to a simplification of a complex system that actually has the potential to drastically change the way music has been made throughout thousands of years. As we shall see, new equations around the interaction and expressiveness of digital instruments can or already produced radical shifts with the past.

5.2.2 New paradigms in digital lutherie

Digital instrument design raises new questions when compared to the traditional functions each intervenient in the process has in the acoustic instrument builder. The

acoustic luthier[57] is usually not a musician. He is an artisan, specialised in the crafts of elements such as wood, brass, stone or metal. Most of this work has a slow and long tradition of hundreds, if not thousands of years, and most of the instruments we use today are an extremely long process that has gone through many generations of luthiers, musicians, composers, musical styles and performing spaces. Musicians, on the other hand, were rarely luthiers, and they simply acted as mediators in the process of music making, perfecting mechanical gestures to translate the compositional ideas into the real world.

With digital instruments the borders are usually more blurred. We can still trace a comparison between music software developers and acoustic luthiers, but often there are a large number of adaptations, modifications and personal combinations of hardware, software and controllers that make it hard to draw a strict borderline between each individual role in the process. And unlike in the past, digital musicians are commonly programmers or partially program and, from the point of view expressed here, can be described as luthiers (Jordá, 2005).

There are a few other issues worth mentioning in this comparison between acoustic and digital lutherie. Contrary to what was mentioned before for most of the acoustic instruments, there is not a continued tradition in digital music. It is extremely recent, at least compared to millennial instruments like a flute or a drum, and it is still dependent on technologies that are changing at such higher rates that do not leave, in many cases, enough time to develop music that is performed, mastered, analysed and matured compositionally. The following diagram represents a traditional music generation process.

[57] Lutherie derives from the word Lute, and was initially applied to the construction of Lutes and string instruments. Recently, the term has been opted for any kind of instrument building context, including digital instruments (Jordá, 2005).

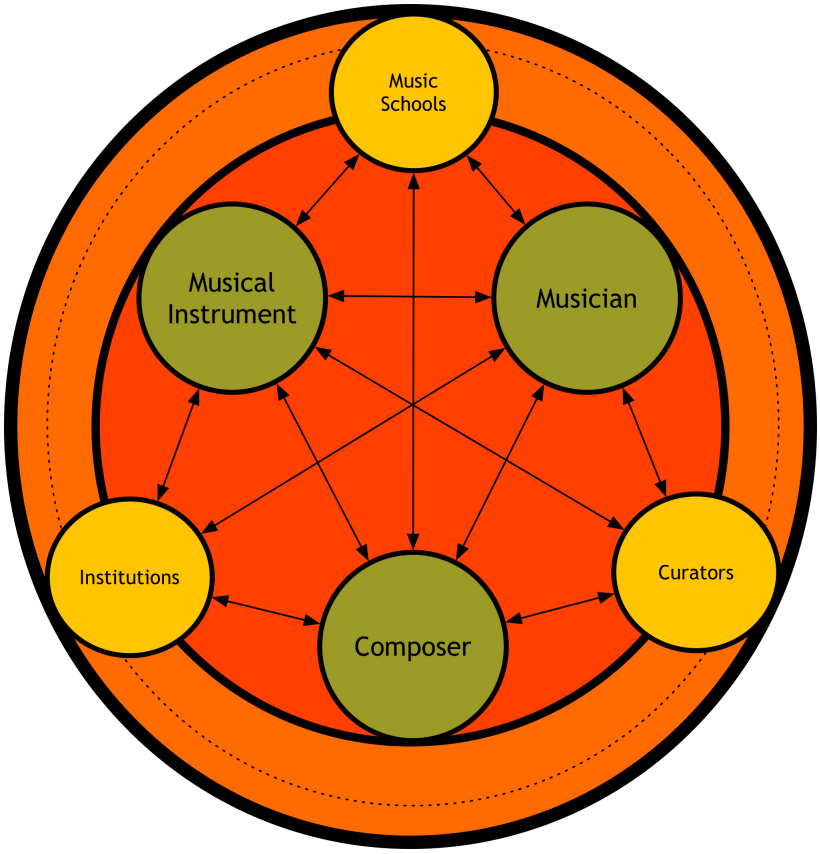

Figure 14: Music generation entity relationship.

Historically, the continuous loop between the musical instrument, musician and composer was the driving force in most western music. Although it was never clear where it was starting, the cycle between developing a musical instrument, adapting it to the demands of the musicians, which in turn are executing compositional instructions, allowed music to evolve in the way we faced in the past. Key factors interfering with this close cycle where music schools, where instrumental and compositional techniques could be mastered and introduce further developments in the process, and the role of the curators and institutions, acting as aesthetic and sociological intervenients that often dictate the direction of music. With digital instruments, it is in many cases difficult to create a musical instrument that can be mastered by a musician and consequently develop mature composition techniques for it, leading to a fragile balance that often produces results that easily tend to be forgotten in the multitude of variants of embryonic musical outputs.

A last element in this complex equation is the role of the programmers in music software development. There is a technological fascination with gadgets and fast consumption products that, despite not being necessarily a novelty, assumed nowadays bigger proportions, mainly due to our constant presence with computers and cell phones. Generally, gadgets seem to be more disposable and to last shorter periods of time, which can dangerously lead to a generation of useless products that have nothing to do with music.

Digital instrument design is based on two elements, a digital sound generator and an interface to communicate between the performer and the generator. Although some authors treat these two elements separately (Wanderley, 2001), for the purposes of this work we will treat them as a unique musical instrument. And, following Sergi Jordá´s line of thought, we will assume that it is not possible to develop highly sophisticated and efficient controllers without a prior knowledge of how the sound or music generators attached to them will work (Jordá, 2002). Although some exceptions might naturally occur, working under this principle should eliminate a few of the problems mentioned earlier and it should also draw a more precise strategy on the development of musically relevant digital devices.

In many of the cases, digital and electroacoustic instruments are also designed for a single piece, in form of a composition, improvisation or sound installation. Although in some cases the instrument comes first (Dudas, 2010), we will also assume that the prior definition of compositional material in this cases will produce more solid and coherent results.

5.2.3 The illusion of technology

Contrary to acoustic instruments, digital instruments normally don't have the same physical limitation for sound reproduction, which in many cases conditioned the ergonomy of the instrument and, consequently, its musicality (Jordá, 2002; Wanderley, 2001; Rose, 2006). A tuba, for example, needs long tubes and a considerable amount of air pressure from the musician in order to be played. Consequently, the musical output will be very different from a trumpet, a flute or a piano. With digital instruments, a single button can produce at the same time all these sounds combined, and sometimes it is exactly the supposed unlimited possibilities offered by digital instruments that end up restricting the instrument design of electroacoustic devices. Having been involved in the development of many new electroacoustic instruments in completely different contexts, this supposed infinity of possibilities could be a very difficult problem to deal with (Jordá, 2005; Bongers, 1997). If anything is possible, there is a subtle tendency to lose control over the limits of what each instrument can actually play. For this reason, as Marcelo Wanderley states, "strategies to design and perform these new instruments need to be devised in order to provide the same level of control subtlety available in acoustic instruments" (Wanderley, 2001).

A common problem in digital instrument design is the dominance of technology over musicianship. There is a general pressure to include new types of sensors, myriads of buttons and newly discovered technologies, which can have as a consequence a simple technical demonstration of devices (Wanderley, 1991). This pressure can also be stressed by numerous factors external to music, like the agenda of research centers, which is often

conditioned by academic results, economic restrictions and market trends. Some technology is also developed outside the musical field, leading to adaptations of existing tools designed for other purposes that end up being transformed into musical instruments. A very clear example is the use of the computer mouse as a musical interface, which has been opted for music purposes despite its original function as a type writing tool. Although this is not necessarily a problem[58], it can actually lead to many problematic situations regarding musical expression. In digital instrument design, we should not forget that technology is simply a tool to express new ideas and that expressiveness does not necessarily imply difficulty and that it can also be achieved by "easy to use and, at the same time, sophisticated and expressive systems" (Jordá, 2002).

The illusion of new software, new features or new interfaces has proven to be highly tempting for many musicians, that constantly seek new forms to fully express their ideas. Naturally, evolution will provide us new tools that will eventually solve parts of our problems, but establishing a frontier between the musical needs and the commercial fireworks surrounding us seems to be a delicate, but necessary task.

5.3 Software

5.3.1 Survival of the fittest

It is interesting to notice that among the millions of applications developed through the computer age, only a few survived the software updates that are frequently demanded not only by technical or creative needs, but also by marketing strategies or commercial purposes. Going back to the 19th century, Arnold Myers (2009) notices that many instruments were able to survive not only because they were musically and ergonomically suitable for the respective music period, but also because many of the instruments that survived were backed up by large companies able to mass produce, distribute and place the instruments on the market. It seems easy to create an analogy with the reality today, both in terms of physical instruments, controllers or software. Even though it seems odd that a great number of people use Microsoft Office, Adobe products or Google without questioning the existence of alternatives in the market, the reality is that most of us prefer to stay in a stable platform, able to keep up to date with the latest developments, rather than spending what can be seen as an effort to go against the grain in a lost battle.

In the sonic domain, the list of applications that lasted more than twenty years is very representative of the situation mentioned previously. Additionally, even in the cases

[58] Throughout history there are plenty of examples of musical uses of artefacts and tools that were not conceived for musical purposes, from buzzers, typewriters, pans, furniture, kitchenware and, naturally, computers.

where the software persisted, it is very likely that new versions are totally incompatible with older ones. The chances of being able to re-work on a project with more than ten or fifteen years are usually slim, either because plug ins or externals ceased to exist, recordings formats become incompatible, the required piece of hardware does not exist or function anymore or an additional endless list of other error messages that most likely will appear if someone tries to re-open an old project.

This situation has caused many problems in the performance of live electroacoustic music, leading in many cases to the recreation of the pieces in the fixed-media format, since "any technical requirement beyond "stereo audio in" is very likely to be problematic" (Pennycook, 2008, p. 206).

An additional problematic situation derived from the constant obsolesce of software and hardware is the constant learning curve demanded for the computer-based musicians. Faced with new features, configurations and compatibilities, a significant part of the computer-based musician´s practice is dedicated not to the music itself, but solving technical problems and learning, in some cases, completely new musical instruments on a regular basis[59].

5.3.2 Standardization of symbols and techniques

If we look back in history, the standardization of construction and performance techniques of some instruments took many decades before settling on a stable form. The stabilization occurred for a large number of reasons, like the technological development, discovery of new materials, new performative challenges, bigger performance spaces, compositional styles or educational demands (Sachs, 2006). Some of these reasons were merely practical, as in the case of a composer that writes for an orchestra and expects to find a very exact or identical reproduction of his piece. This would be very difficult to obtain with non-standard instruments and techniques, so the standardization process naturally evolved and settled some musical instruments and performance techniques.

The history of musical software can be seen as rather new, at least compared to other acoustic instruments. However, many facts lead us to the conclusion that the same standardization process has been partially set. Audio editing tools, for example, have become graphically standardized, despite some slight graphical changes from software manufacturers over the years. The same can be applied to keyboard shortcuts, layout organization, terminology, patching or the functions each application is supposed to perform. Most software developers are also aware of the marketing demands, so with the

[59] It may be interesting to compare this situation with a percussion player, that constantly needs to adapt to new configurations of his instruments (Henriques, 2004). However, some percussion instruments have become quite standardized, such as the marimba or the drum set, and common mechanical techniques can be applied to the performance of new set-ups.

exception of a few cases, applications are supposed to be intuitive, flexible and comfortable to work with, and this is also obtained with the use of familiar symbols, terminologies and environments.

A different example of the standardization process in musical software can be analysed with the evolution of Max/MSP[60]. In the 1990´s Max was mostly associated with the avant-garde electroacoustic music, and was mainly used by classical trained composers. With time, each version of Max became friendlier, with a vast documentation and a growing number of users, many of them outside the classical / contemporary school. Some tools and objects were already pre-made, and the graphical interface was adapted to a more conventional design, making it easier to learn and to become available to a wider number of people. Max was also introduced in many music schools, so many of its functionalities can be learned, like for example, a violin or a piano. The introduction of electronic music programs in many schools and universities has contributed significantly to the standardization process that has started with electronic music, providing not only theoretical background but also performance techniques and tools that in a matter of years will create specific repertoire and learning routines.

However, the vastness of the possibilities of electronic music and computer-based instruments is far from being stable. Among the challenging tasks in electronic music is the standardization of notation, since it is "inadequate to the task of encoding very much apart from what 'acoustic' instruments and voices can do, and because notation has been standardised in parallel with the standardisation of those instrumental and vocal practices (at least until the twentieth century), whereas the electronic 'instrumentarium' shows no sign of even heading in the direction of standardization (Barrett, 2002).

5.4 Interfacing computer-based instruments

5.4.1 Gestural controllers

Interfacing a digital instrument has been a topic for large discussions over the limits, functions and definitions surrounding its input source, the mediation and the output content (Bongers, 2000). A precise definition is far beyond the scope of this work, but it is still important to contextualize some of the actual possibilities and directions proposed in the conception of new computer-based instruments.

Currently, the international conference on New Interfaces for Musical Expression

[60] Max / MSP is an object oriented programming language developed at IRCAM, where many sets of modular, predefined functions and instructions can be assembled in personal and distinct forms (Holmes, 2008).

(NIME) has been gathering significant researchers and musicians around the topic of new instrument design. Over the last 15 years, it has produced a vast amount of new instruments, interfaces, sensors and software. Examples of research presented in the conference include Jeffrey Stolet´s Tokyo Lick (2004), Kanta Horio´s Particle (2004) or Bruno Zamborlin´s Mogees (2013).

Significant research in this field also continues to be conducted at STEIM (Studio for Electro-Instrumental Music), a Dutch independent studio founded by students of Henk Badings in 1969 (Manning, 2004). Notable instruments that have been developed by Michel Waisvisz, its artistic director from 1981 until 2008, including the Crackle Boxes and The Hands (Manning, 2004). Other institutes and research groups of higher importance in this field are the IRCAM, with a specialized research team on Sound, Music, Movement and Interaction, the Sonic Arts Research Center (SARC) or the Embodied Audio Visual Interaction Group (EAVI).

Over the years, interfacing the computer has been achieved by a variety of forms, through the aid of gestural controllers (Bongers, 2000). Ironically, the most common is still the computer keyboard and mouse, but piano-derived keyboards, faders, buttons and pads also became increasingly standardized. A refined list and appropriate nomenclature can be accessed in the works of Bongers (2000) or Wanderley (1991; 2001; 2004).

An important aspect regarding the amount of different technology available is the observation that we are currently at a stage where both sound generating models and input devices are in an advanced stage and matured enough to be used in concert situations (Wanderley, 2010). So, the main question regarding expressiveness lies not on the technical restrictions per se, but on "how to design and perform new computer-based musical instruments consisting of gesturally controlled, real time computer generated sound" (Wanderley, 2001, p. 1).

Enough evidence on the current technological achievements can be seen in the variety of new interfaces emerging daily. From the DIY arcade inspired Flipper DJ[61] by Gustavo Silveira to the sexually controlled synthesiser Friction[62] by Quimera Rosa, the amount of different possibilities clearly show that the technical barrier of communication with the computer has been dominated over a significant number of years (Machover, 1992).

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[61] Gustavo Silveira has been building modular and midi controllers that can be customized by each user, allowing different ergonomical possibilities for each desired musical situation (from the author's website musiconerd.com, accessed on 8th January 2018).

[62] Quimera Rosa is a duo focusing on cybernetic and transgender performance. Friction is a synthesizer controlled by the use of several sexual toys, reacting to the friction of sexual organs. (from the author's website quimerarosa.net, accessed on 8th January 2018).

Figure 15: Gustavo Silveira's Flipper DJ. Phot from the author's website.

Still, even with the present interfacing possibilities, many performers still opt to use less extravagant controllers. While some can be totally suited for some musicians or specific musical tasks, Ramon Bauer states that in a musical performance "keyboard and mouse are not adequate at all. Even with fancy external controllers, the laptop musician is still (often) stuck in a physical position that hampers the performer to actually perform (physically). This, in my opinion, hampers the communication with the audience, which (often) has no clue about cause and effect of what they hear (or/and see — in an (audio-)visual context)"(Barbosa and Joaquim, 2013, p. 101).

5.4.2 Acoustic and analogue extensions

Adding personalized sound sources to an improvisational electroacoustic set up is another form of expanding the sonic electronic possibilities and, at the same time, adding a livelier component to a laptop performance and enhancing the communication with the computer. As the pianist, improviser and composer Mark Applebaum states, "having the sound of a doorstop among the range of timbral possibility is, for me, a huge (and now indispensable) advantage. Being able to digitally reverberate that doorstop has its charms too. So in my recent research I have focused on modifying the sounds with a battery of electronic devices" (Applebaum, 2003, p. 3).

Applebaum´s instruments incorporate rods, nails, plastic combs and many other found objects that are then amplified and processed electronically. This produces a very personal sonic lexicon that is particularly appealing in improvised music (Essl, 2006).

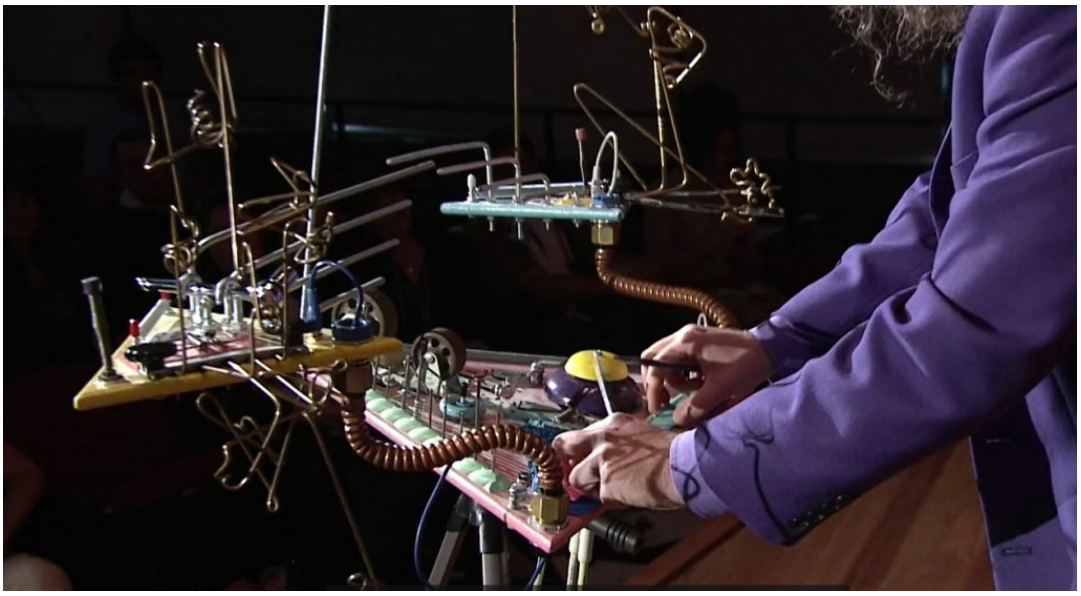

Figure 16: Marc Applebaum performing. Photo from the author's website.

A similar approach has been taken by Adachi Tomomi, whose instruments like the Tomoring (amplified objects) or the Tomomin (electronic devices in common Tupperware) share the same concern about personalized sounds and a highly physical electronic music instrument.

As in the case of the musical interfaces, there is a myriad of artists incorporating an enormous variety of instruments, synthesisers and objects as a complement of their digital set ups. A detailed list would be endless and unnecessary, but for the purposes of reinforcement of some ideas expressed here, further inspections on the Dutch platform Instruments Make Play[63] will provide significant information on some of the new directions taken in this field. One of the listed artists is Gijs Gieskes, whose dystopic technological automated devices are complemented with many found objects, waste and malfunctioning electronics.

[63] Instruments Make Play is a platform and festival for new musical instruments. Despite not being totally devoted to electronic music, many of the featured artists present electronic or computer-based instruments that are complemented with highly personal sound sources. http://instrumentsmakeplay.nl/platform/

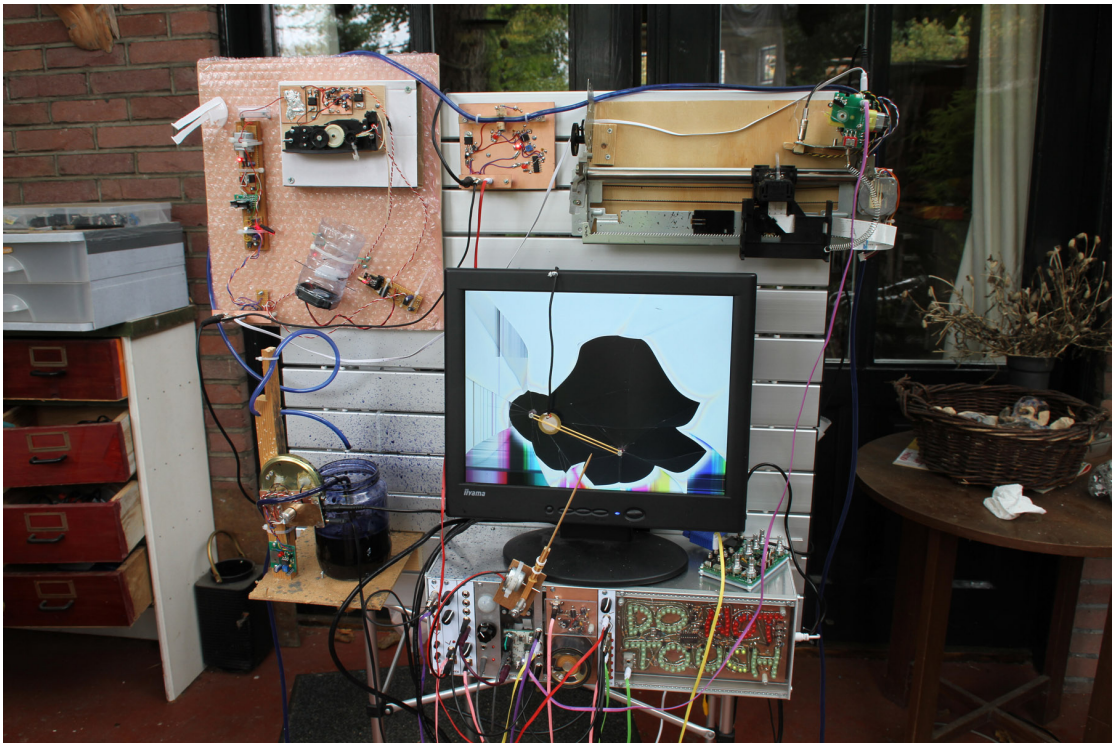

Figure 17: Gijs Gieskes instrument Perma-Patch/1 Groot. Photo from the author's website.

Expressiveness through physical emphasis on solid interfaces is also an aspect that has been deeply used by some computer-based musicians. Artist Tara Transitory (that usually performs under the name One Man Nation) complements her computer not only with her voice, but also with the acoustic amplification (through contact microphones) of the buttons and faders of the midi controllers. This allows her to not only use these sounds as musical sources, but also to create a closer relation with the causes and effects of her physical actions. A highly physical posture is also opted by Lebanese improviser Tarek Atoui. He uses exaggerated hypnotic gestures to control his personalized interfaces (Burkhalter, 2013) as a form of engaging the audience and himself in the performance. His approach is also a form of a self induced hypnotic state that can be translated in levels of concentration that are transmitted to the audience and produce a feedback loop between the musician and the performer that is extremely important in live situations.

5.4.3 Visual complement

Many artists have tried several solutions to complement the lack of expressive elements in the interaction between the human and the computer. One of the solutions is known as Live-Coding, that can be described as "the art of programming a computer under concert conditions" (Collins, 2005). Live coding emerged as a way of increasing expressiveness between electronic musicians and, on the other hand, to create a musical

bond with the public. Ge Wang and Perry Cook state that “it can be argued that many technical and aesthetic intentions are often difficult to discern in performance where they don't have to be or shouldn't be. The on-the-fly programming aesthetic help address this concern, for it provides a channel for the audience to see both the intention and the results” (Wang and Cook 2004). Currently, the TOPLAP[64] organization gathers significant information about the subject, from artists, software or research texts.

Another frequent solution is the inclusion of visuals with laptop performances. The visuals are frequently generated live, and often using the audio as the input for the visual generation or manipulation (d´Escriván, 2007). This method is used to complement the performance and clearly creates an external musical relation that is beyond the scope of this research. Significant artists like William Basinski, Tim Hecker, Mouse on Mars, Ben Frost, Alva Noto, Phill Niblock, Ryoji Ikeda, Janek Shaeffer or Pierce Warnecke have been using a visual complement on their performances, mostly at traditional concert halls and in important electronic music festivals like Sonar, Madeira Dig, Berlin Atonal, Sonic Protest or the Berlin Transmediale. The visual complement has become so standardized in this kind of musical performances that festivals like Semibreve (Braga, Portugal) demand a visual complement. This clearly demonstrates an intention to avoid "pure" laptop performances, that can be perceived by a significant part of the audience as uninteresting (Kopiez, 2012).

5.5 Digital performance

5.5.1 Visual and gestural absence dilemmas

A recurrent problematic situation in laptop performances is the lack of emotional feedback between musicians and the audience. This aspect can be related to the fact that during the last years the laptop has become not only an essential musical tool, but also one of the most versatile tools ever to be used by humans. It is everywhere in the daily lives of modern developed societies. So, if fifteen years ago a laptop musical performance could still be seen as a novelty, nowadays it can be seen as trivial or sensed as counter fake by the audience. Kim Cascone call this the Ghost Box effect (Cascone, 2002) and it can be anecdotally described as a “checking email” performance (Trueman, 2007). It is also interesting to compare today’s scenario with the early years of electronic and tape music. John Cage describes his experience in the 1950’s, stating that “I was at a concert of electronic music in Cologne and I noticed that even though it was the most recent electronic music, the audience was all falling asleep. No matter how interesting the music

[64] Toplap is an organization funded in 2004, to explore and promote live-coding. Additional information can be accessed on their website: https://toplap.org/

was, the audience couldn't stay awake. That was because the music was coming out of loudspeakers. Then, in 1958 - the Town Hall program of mine - we were rehearsing the *Williams Mix,* which is not an interesting piece, and the piano tuner came in to tune the piano. Everyone's attention went away from the *Williams Mix* to the piano tuner because he was alive (John Cage, in Holmes, 2008, p. 377)". So, despite the possible exaggerated effect one might have today associated to the trivialization of the computer, the descriptions of cold sound, emotionless, and uninteresting performances have been long associated to certain kinds of electronic music concerts. Even during the emergence of the laptop music scene in the 1990's, the lack of action and absence of gestural information is extensively reported since the first appearances on stage from many of those artists. Oswald Berthold, "one of the first musicians to go on stage with a laptop, at least in a consistent way, mentioned that standing in front of a computer "(no matter what type) is not an attractive mode of performing" (Barbosa and Joaquim, 2013, p. 99).

This problem, that persists after decades of performances and technological development, could be partially explained by the lack of physical presence of the performers. Improviser and pioneer of electronic music Bob Ostertag thinks that "most musicians working with electronics are probably not satisfied with the state of electronic music today, and the crucial missing element is the body" (Ostertag, 2002, p. 11). Computer-based instruments may be "also more complex for the audience to understand, due to the diversity of their components and the magical aspect of the musicians' actions when compared to acoustic instruments. This complexity results in a loss of liveness and possibly a poor experience for the audience" (Berthault et al, 2014, p. 164). In fact, the magical aspect mentioned by Berthault seems to be a crucial element, if we consider magick as something that will keep us interested and fascinated. Removing any kind of relation between the musical thoughts and their sonic realizations can create barriers of perception, simply because the fascinating magical element is not present at all; only disconnected audio-visual elements, perceived as dissociated and uninteresting by the listener.

5.5.2 Eradication of the performative drama

Visual and gestural absence also provides opportunities to create "music that no longer depends on performance, nor does it act as its substitute" (Dhomont, 1995, p. 2). It can be seen as a golden opportunity to focus on the music itself, without the interference of any performative drama (López 1998). Artists like Francisco López, who often performs in the dark or O.blaat, who prefers to sit behind the laptop so that the audience can abandon any expectation of physical action (Barbosa and Joaquim, 2013), are precisely exploring these new listening and performative capacities of the computer.

Figure 18: Francisco López performing. Photo from the author's website.

Still, a total eradication of any physical, sonic, visual, theatrical, sensorial or social aspect surrounding a public presentation seems hard to achieve. Taking as an example López performance from figure 15 we can clearly see many non-musical complements, such as audience disposition and a stage[65]. To enhance the aural aspect, blindfolds were given to the audience, whose listening experience is complemented with sound spatialization. Gathering a large number of people in a public performance also introduces listening capacities that are substantially different than a personal listening experience in each one´s privacy. In this case, despite the absence of physical gesture, a new performative model is proposed, with the inclusion of theatrical complements that merely try to emphasize the aural potential of the piece (López, 2004).

Physicality does not need to be seen exclusively as a form of entertaining audiences. Movement and gesture express essential qualities in creative performances like novelty, involvement, motivation or passion (Tsay 2013). The lack of expressive elements in some electronic performances just as a simple form of eradicating a theatrical drama can create interactivity and expressiveness problems to a significant part of the musicians involved in this kind of musical production. To some extent, the intent of any external musical aspect in a public performance that is not confined to the fields of entertainment is to enhance the music. From this point of view, assuming a public performance implies the inclusion of many non-musical elements that will, in variable degrees, influence the way we receive the sonic message. It seems then natural to think more profoundly on these relations, in order

[65] In his essay "Against the stage", López proposes new performative formats that deify the western classical definition of stage (López, 2004).

to provide listening experiences that are fully understood as a coherent and expressive musical piece.

5.5.3 Physical routines

As mentioned already in many points of this text, computer-based instruments flexibility offers tremendous creative and expressive possibilities that have been in exploration and development since the arrival of this technology. However, the apparent endless limitation is often mistaken by a never-ending process of renovation and incompleteness. While this in itself can be regarded as natural music process, since in many ways no musical artwork could be classified as a finished process, a common error in computer music performance are the embryonically developed instruments, which lead to the lack of comfort of the performer with its own instrument. Composer Richard Barrett states that "while the technology of live electronic music continues to develop and evolve at a vertiginous rate, the aesthetic thinking behind it has been developing less quickly, and performance practice seems hardly to be thought about at all, except as a barely relevant side issue. The result is that many if not most practitioners of live electronic improvisation are woefully behind their 'acoustic' colleagues as regards responsiveness, flexibility and what might be called musical 'presence' in performance. I think this is mainly the result of not taking two crucial areas seriously: firstly the discipline and focus of practicing, and secondly the unity between gesture and sound, which with acoustic instruments is a given, but with electronic instruments must be imagined and then realized" (Barrett, 2006, p. 404).

The problem mentioned by Barrett can be easily observed by most electronic music practitioners. Even in professional situations, there are endless examples of performers finishing their Max Msp patch, loading a new sound bank, addressing parameters on their midi controllers, or simply checking the physical connections between all the equipment a few days, hours or even minutes before their performances. Inevitably, these situations lead to many performative mistakes, discomfort and, consequently, to problematic performance situations.

It may seem almost contradictory in a thesis about the future of computer-based instruments, but many examples of consolidated acoustic instruments might actually provide useful insight on many performance subjects. Taking a pianist as an example, it would be unthinkable for a Beethoven sonata to be performed in an unfinished instrument, given just a few days beforehand to the performer. Not only physically impossible, but, most importantly, the mental connection with the music would not be clear and fluid. Given this principle, it seems like a logical solution for electronic musicians to dedicate a significant part of their study to the performance practice, creating routines that will establish connections between the brain, the gesture and the musical output (Wanderley, 1991). In a recent electronic performance I had the chance to attend, Alvin Curran was

playing an old sampler, which looked completely technologically outdated. However, it was obviously clear as a spectator that he had completely mastered that particular musical instrument for many years. The comfort in the gestures, whose sonic result reflected his deep knowledge of the musical material behind it, could be matched to the expressive qualities of any fully explored acoustic instrument.

Figure 19: Alvin Curran performing on his sampler. Photo from the author's website.

Gesture plays then a particularly important role in the materialization of a musical idea. Wanderley defines various types of gestures that may or not be executed by the hands or by physical manifestations. If, in acoustic instruments, a musical action is typically accompanied by a corporal, accompanying and auxiliary gesture, in computer-based instruments the gesture could be represented on a higher level, and not necessarily have a direct relation with the corporal movement (Wanderley, 1991). As Nicolas Collins states, "isn´t the purpose of electronics to do things for us so we don't have to do them live ourselves? (…) While there is no question that composers of tape music and computer music (and a fair number of pop music producers as well) have employed electronics to exactly these ends, electronic technology has another, and possibly more profound power: enabling new and volatile connections" (Nicolas Collins, in Collins and d´Escrivan, 2007, p. 38) However, once again, it seems clear that mastering these complex relations through hours of practice and control would provide clear answers to many problematic situations regarding expressiveness and interaction in live scenarios.

5.6 Conclusions and debate

Expressiveness is a complex terminology that has been used in different approaches by several authors (Jordá, 2005). As presented in this thesis, it can be resumed as the efficiency on the transmission of musical ideas through a musical interface. In the case of computer-based instruments, these interfaces can take multiple formats and rely on a myriad of technological products, such as buttons, faders, knobs, proximity, pressure and thermal sensors, just to name a few. From the immense solutions presented by many authors and digital luthiers, it is clear that the current technological state is not an obstacle towards digital expressiveness.

Despite the aspirations that some of computerized machines would replace human activity, it seems clear that, at least in performance situations, the human element is still desirable and fascinating. As composer Pauline Oliveros stated, "improvisation, in particular free improvisation, could definitely represent another challenge to machine intelligence. It is not the silicon linearity of intense calculation that makes improvisation wonderful. It is the non-linear carbon chaos, the unpredictable turns of chance permutation, the meatiness, the warmth, the simple, profound humanity of beings that brings presence and wonder to music" (Pauline Oliveros in Collins and d´Escrivan, 2007, p. 76). So, no matter how perfect a machine would perform, our attention is most of the times driven by the human input, and our fascination on the appreciation of notable human achievements.

In the fields of electroacoustic expression, there are also different perspectives concerning live performance. For authors such as Barrett (2002), Wanderley (1991; 2001) or Eigenfeldt (2010), expressive problems arise due to the lack of performative routines such as those present in acoustic instruments. From this perspective, electronic and computer-based instruments are regarded as logical continuations of the past, and proper interaction would derive from a deep knowledge of the musical instrument, both in terms of physical and mental relationship. Authors such as López (2004) or Jordá (2005) propose a significant shift with the past, preferring to focus on non-physical performative solutions or opting for completely new types of interfaces and sound reproduction mediums.

Part 3: Personal practice

Chapter 6

Aesthetic and compositional framework

> “I am concerned with "system-concepts": configurations which include sound sources, electronic modification circuitry, control or logic circuitry, playback apparatus (power amplifiers, loudspeakers, and the auditorium), and even social conditions beyond the confines of technology. I suggest that the most important creative aspect of live-performance electronic music technology is not this or that circuit innovation, but rather the total configuration itself.”
>
> (Mumma, 2015, p.45)

6.1 Overview

In this chapter, I will discuss several personal approaches and strategies used in the implementation of technical, performative and compositional elements in my works. A general framework is defined, focusing on eleven musical pieces that were developed in order to study particular problems defined in section 1.4.

This chapter will start with the definition of personal aesthetic borders, which are similar to those defined in chapter 2. However, a more detailed and personal approach will be defined, in order to clearly contextualize some options taken in the conception of the proposed musical works.

A general summary of the strategies adopted for each piece is presented, on which specific problems can be clearly addressed to specific musical works. Additionally, a generalization of compositional and performative principles is described in order to clarify some of the musical approaches taken in the development of the pieces. These approaches are based on many years of personal electroacoustic musical practice on diverse professional scenarios.

6.2 Defining borders

My work is clearly marked under a general terminology entitled Experimental Music.

As mentioned earlier in this thesis, the roots of Experimental Music today are still deeply connected to the avant-garde music from the 1950´s mostly associated with the composers from the New York School. Over the years many different ramifications of the term evolved into completely different musical styles, but as a matter of simplification, the term Experimental is perfectly suitable for my musical domain. Naturally, as it will be exposed in the next chapter, some works can be marked under more specific genres like free improvisation, sound art, composed improvisation, or algorithmic composition. A common aspect between all the works is a variable degree of indeterminacy and / or improvisation and the computer mediation. It is also important to stress that, despite this inevitable categorization that for practical reasons we end up falling into, it is my intention, like most artists, to have a singular vision over music and develop original artworks that can clearly define my musical thinking.

Since this thesis deeply connected to digital technology, it is important to mention that my work is developed under a musician's perspective, and not from a programmer. On several works presented here, new technology was used, but my contribution was merely conceptual and musical. It is my firm belief that a deeper connection should be established between musicians and technological developers, in order to achieve better and more sustainable results when it comes to the creation of music that involves technology, either in forms of compositions, new musical instruments or controllers. Personally, I have been trying to connect in artistic terms with the programmers I work with, and this seems to be an essential condition for me.

Finally, it is important to stress that despite all the pieces presented here were conceived by myself[66], a significant part of them were developed collectively. Works involving improvisation rely on the contribution of each individual, and this is one of the most fascinating aspects for me in this area. Being able to develop musical pieces that can bring out the musicality of each part, instead of a singular person, is a difficult, but rewarding challenge. The long process of discussion and evaluation of rehearsals, recording sessions and concerts was absolutely fundamental for many of the problems and strategies presented here in this thesis. I am also extremely grateful for being able to work with a regular group of musicians that share many of the musical ideas and intentions presented here.

6.3 Strategies for problematic issues

Section 1.4 defined the main problems at the core of this research. To provide some possible solutions to these problems, eleven music pieces were composed. These pieces,

[66] The only exception is the first version of INsono, which comes from an initial idea by Henrique Fernandes.

entitled Halcyonian, Variations on Tautotlogos III, Encode / Retrieve, Control and Unpredictability, Phonambient, Phonopticon, Peripatetic, INsono, Phobos, Tars and Transarkiv, are discussed in chapter 7. In this section a summary of the strategies used on the pieces composed for this research is presented.

1. Definition of musical material

In all the pieces debated in chapter 7 there was a clear concern on the definition of the input material for the computer-based instruments, as well as its complementary sonic material deriving from other sound sources. In the cases of performances, such as Halcyonian or Variations on Tautologos III, an acoustic set up that had been used extensively in previous live performances was used, in order to provide enough musical flexibility against the rigid pre-recorded background.

2. Conception of digital musical instruments

Specific software was composed for the performance of digital sound files (Transarkiv). The conception of digital musical instrument was broadened with Phobos, an automated music machine controlled by Midi. Digital instruments were also complemented with acoustic extensions, as in the case of Encode / Retrieve, Control and Unpredictability or Phonopticon. In these pieces, sampling techniques, sound processing, pitch and transient recognition or different types of triggering actuators were used to provide additional forms of interfacing the computer.

3. Gestural control

Particular emphasis was placed in the composition of musical pieces that reinforced the physical or mechanical gestures on a musical level. Phobos, in particular, reflected many gestural problems faced in computer-based performances. In the first version of this piece, which is a totally automatic machine controlled by a computer, it was also intended to test the total absence of the human presence in a performance, and still maintain an expressive potential. Further versions of this piece focused on the human-machine relationship, building complex gestural forms that include light design, video and puppet versions of musical instruments.

Other elements used were electronic triggers associated with the physical gesture on acoustic instruments (Control and Unpredictability) and digital sensors (INsono).

4. Type of musical output and presentation format

Some of the pieces included multiple presentation formats, such as many of the variations proposed on Phonambient, which included sound installations, acousmatic presentations or audiovisual works. The notion of stage was also reformulated with distinct placement of the musical instruments, sound spatialization systems and the audience in Phonopticon, Tars, Control and Unpredictability or INsono. Pieces such as Peripatetic or

INsono also presented flexible output formats, composed in order to provide particular responses to specific places.

5. Spatialization formats

Several pieces were conceived with particular sound spatialization formats. Halcyonian was written for a semi spherical system with 16 loudspeakers; Phonopticon for a variable placement of two circular layers of four channels each and Control and Unpredictability for four channels and portable small loudspeakers.

6. Timbric relations

The combination of amplified and acoustic sounds was a frequent solution or necessity, assuming different formats. In Phonopticon, acoustic sounds were amplified through loudspeakers and then acoustically modified again through the use of resonant tubes; portable and movable low fi speakers were used to place amplified versions against the original acoustic sound in INsono or Peripatetic. Several digital sounds were also represented with acoustic instruments, and acoustic instruments were digitally processed, maintaining timbric relations in Encode / Retrieve or Phonopticon.

7. Theatrical and visual complementations

With the exception of Transarkiv (software), all the pieces composed were conceived with strong theatrical and visual components. Some of the pieces, such as Phonopticon, Phobos or INsono, present large-scale musical instruments that produce a significant impact on the listener. The singularity of the musical instruments used, the inclusion of lights, customs, video or other scenic elements were introduced in order to emphasize the music being produced.

6.4 Proposed approach

6.4.1 Reliability

Reliability seems to be an obvious and basic topic to discuss at a higher level of work. However, even in highly professional scenarios, it is still possible to witness the embarrassing and musical disruptive moment when a computer crashes, controllers are not responding or software is malfunctioning. Computer musicians know this very well, and often the performances have a ghostly shadow of an imminent musical catastrophe. However, it is interesting to notice that similar issues also happen with other instruments. This phenomenon is not new, and it has been happening throughout music history. Rock

guitarists, for example, often have one or more spare guitars, in case a string breaks up or goes untuned[67]. Percussion players also keep extra drum sticks or mallets always ready to be picked if accidentally one skips their hand. Most professional classical musicians also spend large amounts of money on musical instruments that are physically reliable and robust.

These examples are clear enough to understand that computer musicians should have the same kind of precautions. Electroacoustic musicians Simon Vincent or Al Margolis, for example, use two computers on their live performances to generate sound, to have distinct and complementary electronic sounds and to lower the computation demand of each machine, thus reducing significantly the chances of a computer crash. Most computer musicians also use on stage the same computer they use for emails, write documents or edit photographs, increasing the risk of collateral damages induced by software updates, viruses or, as it has happened not so rarely, receiving sound notifications from social networks during a live performance. In theory, a dedicated computer just for sound should be more stable and reliable[68].

Commonly, electroacoustic musicians use on stage flexible computer programs that allow them to create unique personal expressiveness, as is the case with Max Msp, Processing or Super Collider. Frequently, musicians use small programs conceived or adapted by them, inducing errors that could lead to problematic situations. These programs sometimes are not tested enough, as in the case of standard commercial applications. These applications are developed by a large number of programmers and used by a large community that reports regularly all types of problems encountered in different machines, operating systems and software versions and can, theoretically, reduce performance risks. Choosing between highly personalized or commercial software is a delicate choice that each musician needs to make individually. Personally, and since I am not a programmer, I use mostly commercial software in live situations, which reduces the risk of computer problems in my performances. I do work closely with programmers on some works, and it is very clear to me that the correct artistic connection between musicians, composers and programmers leaves space for specialization for each part, and will produce highly interesting results.

However, even largely used applications like Ableton Live or Logic Pro eventually crash. In solo situations, particularly, being behind a computer screen producing dense layers of sound that suddenly stop is simply not acceptable. In some pieces I used what seems to be a completely conservative and outdated approach, using a pre-recorded

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[67] In mainstream rock concerts there is even a specialized technician taking care of an eventual problem with the instruments on stage. In this context, what seems to be an almost anecdotal story actually stresses the fragility of some electronic musicians' performance.

[68] One example is the dedicated computation system Pacarana / Kyma, developed by Symbolic Sound since 1990. It is designed for sound processing and live performance and works with an external processing unit.

electronic tape part played by the computer, and then performing the live acoustic elements along the fixed media. Since this approach has many possible limitations, I regularly combine the computer generated sound with other sources that could include acoustic instruments processed by external sound processing devices, electronic and analogue sounds generated by different instruments, such as circuit bent machines, radios, cassette players or electromagnetic devices. Works such as Variations on Tautologos III, Encode / Retrieve or Control and Unpredictability are highly representative of this. With this type of approach, even in the unlikely situation of an electric cut or a computer crash, some sound is still being produced and an experienced improviser should be able to deal with this situation naturally, developing a musical speech adapted to the apparent limitations of the moment.

6.4.2 Transdisciplinary sonic complements

Musical practice has always involved a high degree of specialization, demanding countless hours of work to master a gesture, a musical phrase or the quality of the sound. Performances offered the audience a unique experience of being in a special moment and space facing someone with a gifted skill (Kopiez, 2012). As an example, the difference between making music with a typewriter and pressing a button on a computer to make music is drastic. In the first case, the audience has the feeling that something special is happening, unusual or creative, since the typewriter is not a usual tool to produce music. In the second, the audience can have the impression that the musical output can be something everyone's capable of doing. In fact, everybody at home has used the computer to play music. There is no mystery or magic, which could lead to a lack of interest in laptop performances. The audience might also question the purpose of the public performance if there´s a complete absence of performative elements, because if it's supposed to be a completely individual experience, they could have it in their privacy. What might be seen as an opportunity to present music under excellent sonic conditions might also create some discomfort in an audience that does not relate with laptop performances or loudspeaker orchestras. The most problematic part is that under discomfort the listening experience is also conditioned by a large number of factors, many of which interfering in a negative way.

In my personal approach I usually avoid this type of performances, opting for unique manifestations, preserving and integrating the theatrical and sociological aspects surrounding a musical presentation. So, my approach is towards the reinforcement of the aural stimulation with complementary elements, such as the use of non-conventional instruments and an appealing visual stimulation that can be achieved either by the uniqueness of the instruments, the lights or the scenic environment. Figure 20 represents such a case, with a staged concert I performed in entitled (Des)Individuação, presented at Carlos Alberto National Theater. In this performance (not included as a direct source of

study in this research), lights, costumes, scenography, text or sound design acted as important elements that reinforced the musical message that was meant to be transmitted.

Figure 20: (Des)individuação: (des)concerto para Bernard Stiegler. Performance at Teatro Nacional Carlos Alberto, Porto. Photo by Susana Neves.

To provide a singular environment, I also build or customize instruments and sound sources. These instruments usually reflect a long period of sound collecting, incorporating found objects, materials with specific sound properties or visually appealing objects with appropriate sound qualities. These instruments may be seen as individual orchestral visions, materializing the inner sound imagined for each piece or musical situation.

As an essential performance element, a unique musical instrument will also introduce the elements of surprise, spectacle, curiosity and novelty (Teitelbaum, 2006). Naturally, these aspects in themselves will not represent a higher artistic value, but can definitely reinforce the expressive possibilities of computer-based instruments, if applied in the right manner. Of the works debated in the next chapter, Phonopticon, Phobos and INsono clearly demonstrate this approach. These musical works are presented as big scale musical instruments, whose visual complexity and singularity was conceived as a form of enhancing their particular musical goals.

One important aspect that has been deeply affecting most of the musical projects I have been working with is the size and cost of the whole scenic environment and the edification of large-scale musical instruments. Although this might seem at a first instance an external, non-musical problem, the fact is that it ends up being crucial in the establishment of the limits of a project. Specific commissions will frequently determine a

creative direction that would be unthinkable under normal conditions, and this can actually be a factor of evolution, since the creator is forced to leave his/ her comfort zone.

Another issue worth mentioning is the storage and transport of the previously mentioned scenic apparatus, and the set up time for each performance. Again, despite sounding like an irrelevant non-musical aspect, the fact is that among traveling musicians, set up time, weight and easiness of transport are extremely important factors. For a touring musician that performs everyday in concert spaces with large number of stairs, that travels all day in a van or a plane, having to carry heavy luggage and equipment can definitely condition negatively a musical performance after a few days. From a different perspective, a big instrument that needs a few days to set up in a theatre could end up as unviable. In most institutions, an extra day of work means that a whole team of workers should be on duty, which will raise the production costs significantly and eventually conditioning the presentation of certain musical works.

6.4.3 Reversing the process: analogue representations of the digital world

Many musicians, including myself, opt for performative solutions where at least part of the sound material being generated can be deciphered by the audience. Many musicians are including on their set up modular analog synthesisers, for example, not only as a sonic and aesthetic option, but also as a form of communicating with the audience, presenting them a unique instrument that is drastically different from a common object such as the computer.

A significant part of my approach focuses on acoustic translations of digital processes. By finding similarities between the sonic properties of some common sound materials in the acoustic and digital domain, an effective way of engaging the audience can be achieved. An example I find particularly interesting is an instrument called Acoustic Laptop[69]. These instruments, whose concept was developed by Norwegian artist Tore Boe, consist of amplified wood boxes that can be opened and closed in a similar way as a laptop, with a set of personal acoustic sounds inside. Each acoustic laptop changes in its configuration, according to the personal sound world defined by each laptop builder and performer. The examples presented in figure 21 include strings, springs, rods, rubber parts, surfaces to scratch with diverse materials, mechanisms and percussive objects. These instruments are also very representative of some of the digital lutherie problems. Here too, a previous definition of the musical content (the sound sources) and technical mediation (the gestural control) will determine the intrinsic quality of the musical output.

[69] Tore Boe introduced this term as a provocative yet inoffensive critique of the use of computers on stage performances. More information about the acoustic laptops can be accesses on the author's website: http://origami.teks.no/thb/1.2-al.html

Figure 21: Acoustic Laptop.

The digitalization process involved in the acoustic laptops does not confine merely to the curious name of the instrument. I have chosen particular sounds that mimic some digitally generated sounds. As an example, different types of sand are used to produce a granular synthesis like sound. Also, incorporated metal discs produce sounds similar to sine waves when bowed. This type of musical material allows me to interact with digitally generated sound with timbrical and aesthetical coherence. Additionally, these sound sources can be samples in real time, providing a visual reference to the audience that can identify the source of the sounds when manipulated digitally. Apart from the acoustic laptops, the method of mimicking digital sounds with acoustic objects can be obtained through other means. The amplification of different metal, glass or wooden surfaces on pieces such as Peripatetic, Phonopticon of INsono has proven to be highly effective in the fusion of the digital and acoustic sonic representations.

A similar process is obtained with the acoustic resonance of musical material deriving from loudspeakers. In this case, loudspeakers are attached to the end of a metal or PVC tube, producing a resonance according to the length of the tube[70]. On pieces such as Phonopticon, a set of six resonant tubes was used, working in a similar manner as the

[70] The fundamental frequency of a tube can be determined by the length of the tube (l). The corresponding wave length corresponds to 2l in the case of an open-open tube and to 4l in the case of an open-closed tube. Dividing the speed of sound by the wave length will determine the fundamental frequency of that tube. The corresponding harmonics can be calculated by the multiplication of the fundamental frequency by whole numbers (Henriques, 2002).

digital versions available in software such as Ableton Live (resonator) or Max MSP (resonators~).

Figure 22: Phonopticon's resonant tubes.

6.4.4 Gestural relationship

As a percussionist myself, the relationship between a physical gesture and a musical consequence is a natural process. Idiophones and membranophones imply a strong sense of movement in every sound-generating event. The energy of the impact, sometimes mediated by a drumstick, is deeply absorbed in the body and creates a tight connection between the brain and the body. In different degrees and modes, this is also valid for all kinds of musical instruments, including the computers.

Computers, like most electronic and electric musical instruments, present new forms of sound generation, when compared to acoustic musical instruments, as mentioned in chapter 5. In my personal approach, I have been developing musical environments where I can combine the expressive elements of acoustic and electronic instruments. This combination will translate into a deep physical and mental connection with the music being performed, an aspect of key importance in live performance. The physical bond with the musical ideas can also be determinant in the concentration during a performance. So, at least in my personal case, hitting, touching and vibrating is fundamental in the whole conception of music production. The inclusion of percussion instruments to complement digital instruments, for example, is a common feature in all the works presented in chapter

7, with the exception of the software Transarkiv. Other forms include physical controllers. Figure 22 shows a form of control over a set of robots present in the piece Phobos, based on the conduction of a small voltage through the physical contact with metal parts. A Makey Makey[71] interface was used for this purpose.

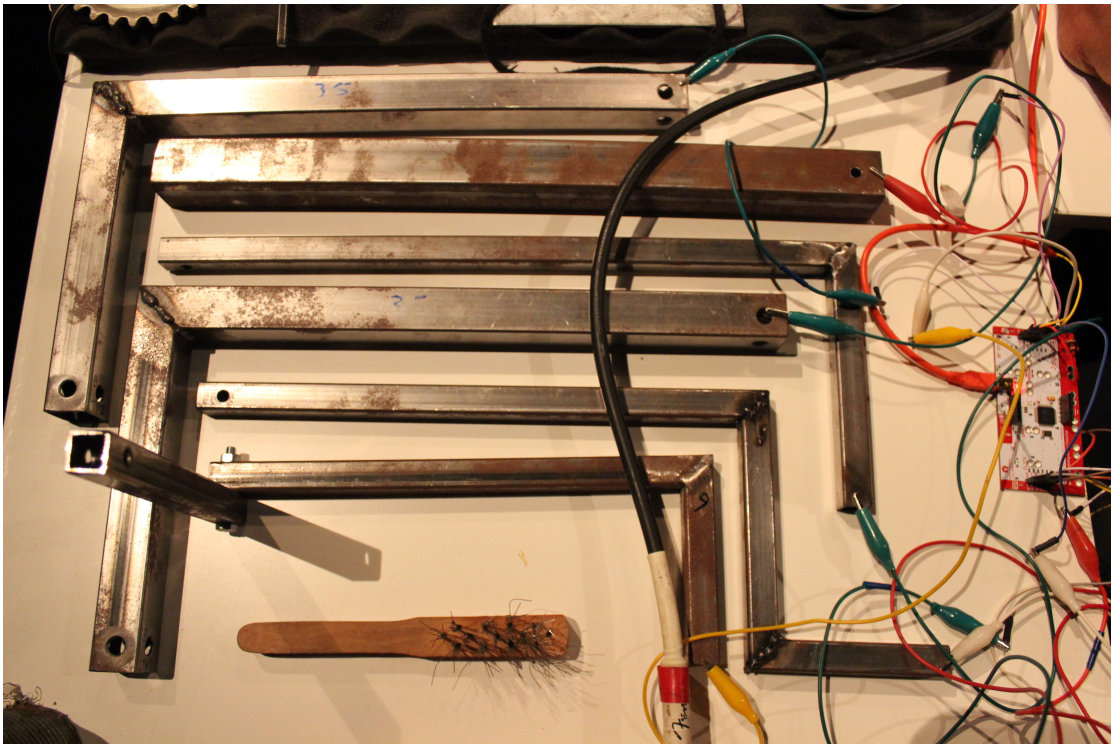

Figure 23: Controlling Phobos with Makey Makey.

Additionally, the physical gesture will establish a link between the musician and the audience, since it is possible to understand what sounds are being produced at the moment of the performance, something that in some computer music concerts does not seem to be clear at some points. The barrier of frustration induced when in some cases the audience cannot identify the source of the generated sound can thus be removed, or at least partially. Obviously, and in the same manner as similar aspects have been mentioned before in this text, this is not an obstacle for all computer musicians.

Over the last years, it has become very clear that physical posture and instrumental comfort can only be achieved by a large number of practice hours with the instrument and a large number of live performances. In the same manner as a pianist plays with closed eyes, for example, the same level of confidence with a new instrument needs to be achieved to guarantee a satisfactory performance. Although this seems to be quite obvious, there are many cases in electroacoustic music where a musician performs with new tools,

[71] Makey Makey is an interface that uses electrical conductivity to send signals to the computer. This allows a physical connection that can be achieved with everyday objects such as fruits, metal, water or any type of conductive element.

be it a new controller, new software of new musical material, and his stage performance then reflects his insecurity with the new environment.

In order to provide some solutions to these problematic scenarios, I have been working on a regular set of musical devices and software. Although they can be configured in different combinations, the basic elements are well known and will produce results within a musical region that has been mentally assimilated over the years.

6.4.5 Sound Microscopy

Traditional recording techniques commonly involve or aim at a precise and accurate translation of the sound waves into the analog or digital domain. It is usually expected from a condenser or a dynamic microphone to pick up the sounds of the musical instruments and sound sources as we usually listen to them, at a normal distance, on the full frequency spectrum and on our normal human frequency range. Apart from these traditional forms, there is a significant number of recording techniques and microphones that explore different acoustic properties of the sound sources.

Contact microphones[72] are a relatively common and cheap way used by many electroacoustic musicians, and a recurrent element in my instruments and works. Instead of capturing the vibrations of the air, a small ceramic disc translates the vibrations of the surfaces the microphone is in contact with, resulting in an extremely useful amplification of acoustic phenomena of very low amplitude. Despite the restricted frequency range and accuracy, these microphones are able to reveal many microscopic sonic details that would be very difficult to obtain with a condenser or a dynamic microphone. It is possible to hear a membrane being played by a feather, or hear complex vibration patterns of metal plates, for example. Also, because these microphones only capture small amounts of air vibration, the risk of feedback[73] in a stage is highly reduced.

On some of the instruments I have been using, a waterproof version of the contact microphones is used to amplify sounds generated inside liquids. Known as hydrophones, this type of microphones is used also for many biological researches, and can also be made with other types of transducers. The sound obtained with the hydrophones, apart from revealing details that are usually only listenable with our ears submerged in water, is also similar to some electronic produced sounds, leaving room for timbral optimisation and visual

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[72] Also know as piezo microphones.

[73] Feedback, or Larsen Effect, occurs when a sound signal is looped within its amplification and reproduction, resulting in a (usually) undesired emission of specific frequencies. Usually this is perceived by the audience and the musicians as a mistake in electronic performances (or acoustic, but with amplified sound). This situation can occur, for example, with live sampling, and it is a recurrent problem in many concerts.

relationship with the causes of the sound sources.

Figure 24: Amplified water mechanism with hydrophones.

Other forms amplification of normally unheard phenomena can be obtained with ultrasonic[74] and electromagnetic[75] microphones. As their name suggest, they capture and amplify ultrasounds and electromagnetic waves. In the case of the ultrasonic microphone, there is a circuit translating the ultrasounds to the audible human range.

Regarding recording techniques, the most commonly used in the works presented in this thesis are close miking and the use of resonant tubes attached to a standard microphone.

Close miking is commonly used with dynamic microphones to reinforce low frequencies. This produces a boost in the lower frequency range, known as proximity effect. With omnidirectional microphones, the proximity effect is not so present, meaning that low intensity sounds can be amplified without the usually undesirable proximity effect. Another significantly positive effect is the low level of self-noise obtained. Regarding this recording technique, I have been using Lom microphones[76] that have been specially developed for the amplification of low signal sounds with an extreme accuracy, allowing

[74] Ultrasonic microphones are able to capture sounds above the human frequency range, generally defined as 20 KHz.

[75] Some examples of electromagnetic fields that can be captured and listened with these devices include the emissions from fluorescent lights, computers or any kind of electrical circuitry.

[76] Lom is a small company from Slovak musician Jonas Gruska that develops electromagnetic devices, software and electret microphones.

me to work on the microscopic sound level.

Placing microphones inside resonant tubes is also another effective technique to combine analogue and digital sounds. Since the sound recorded is already altered by an acoustic resonator, a typical coloration resulting from the frequency response of the tube is added to the recording or amplification. In live situations, this can be musically explored by cutting tubes with lengths that will produce a desirable fundamental frequency and the resulting harmonics. The microphone, placed carefully at one of the extremities of the tubes will then produce feedbacks correspondent to the frequencies of each tube.

6.4.7 Building up a sound database

As debated in chapter 4, developing a personal musical grammar within a specified musical language can be determinant in the efficiency of the communication process that occurs among the musical agents involved in a musical situation. In this section I will explain my methodology to build my personal musical grammar and how it is organized in my brain and in my physical space.

During most of my life I have dedicated a significant amount of time listening, collecting and organizing thousands of records. Despite the horrible categorization as "record collector" and the apparent dissociation from this thesis, the fact is that it is absolutely fundamental for my musical speech to understand and study what other musicians have done in the past, and what they are doing in the present. Listening to so many different genres of music always made me more aware of the music that I do, and the music I want to do. Like most musicians and composers, I develop my inner sound based on the experiences around me, and records are a significant part of this.

I am also a sound collector. Being aware of the sounds surrounding me for most of the time, I am always fascinated when I hear a sound that I enjoy. It could be interesting simply because it´s a funny pronunciation of a vocal expression or because it is a sound with full potential to be part of a composition or a live performance. Historically, most of these sounds were difficult to "collect" and consequently archive and translate to musical uses. However, since the advent of recording technology these processes started to become part of the compositional possibilities, as is the case in *Musique Concréte*[77] (Holmes, 2008). Over the last years, some of these recording devices have become even more accessible and affordable, allowing a large number of musicians, composers and aficionados to record sound in an easy and comfortable way. Personally, I own several portable recorders with

[77] Musique Concréte refers to an electroacoustic technique and aesthetic that uses a variety of electronic machines to record, amplify, manipulate and re organize acoustic sounds in various forms. It was conceived in the late 1940's at the RTF studios, in Paris. Pierre Schaeffer and Pierre Henry are considered the main founders of this genre (Holmes, 2008).

different types of microphones, and this allows me to collect, in the form of a recording, a large number of sounds that I hear around me. A clear example is the piece Phonambient, where nearly 1000 recordings from different parts of the world are stored and archived.

Another form of my sound collection is the actual physical collection of sound sources. I might not be able to own the horn of a large ship, which in this particular case I would record, but there are many types of sounding objects that are portable enough to be stored physically. I collect physical sound sources usually for a particular sound that could be suitable for a live performance or for a composition. Being able to record some of these sound sources outside the environment they were found on, like a scrapyard, for example, also allows for a totally different sound quality of the object in question. Figure 21 presents a part of my personal sounding objects collection, with sources collected over many years that include, among many other things, metal scrap, springs, engines, kitchen tools, toys, malfunctioning electronic circuits, bamboo sticks, resonant tubes, rocks, ceramic vases or metal plates.

Figure 25: Personal collection of sound sources.

With an organized sound collection, it is possible for me to work on new pieces and instruments, based on a clear sound image that is present in my mind. As seen, this sound image can be comprised of sounds stored in my memory (the records), in my hard drive (the recordings of found sounds) and in my physical space (the sounding objects). It is from this musical material that I develop my musical grammar and consequently, my music production.

6.4.8 Touring

Tour[78], an expression generally known between musicians as a condensed cycle of concerts around a relatively vast area, is a fundamental element for most professional musicians. Tours can range from relatively short periods of one week to one year (or more), and can be geographically diverse, such as within a country, European, or the whole world. Condensing a large number of concerts in the smallest number of days breaks up several economic restrictions, first by limiting the number of days that one musical formation can be together, and then by maximizing the economic output derived from daily performances. However, the most significant part is the daily routine in different contexts.

Tours are usually organized around the promotion of a specific work, like a new record. Performing a similar musical content everyday allows the development of musical and mechanical gestures, empathy or cohesiveness. This is particularly valid in situations where musicians play in different cities and countries everyday, where the adaptation to a new performance space and audience requires high levels of flexibility.

Personally, and from my experience as a hard touring musician, the knowledge derived from the daily performance in different countries to audiences with different cultural backgrounds, is of highly importance, as explained in my methodological approach. Musically, a regular routine in sometimes completely different environments confronts the musicians with regular challenges, which are not easy to spot when performing in ideal rehearsal conditions.

There are a lot of factors that could be seen as barriers in the performance, like adverse acoustical conditions, bad monitoring or low quality sound systems. Additionally, there are many social, emotional and psychological factors that add numerous variations in this ever-varying equation. Travelling for hours, usually in a small van packed with musical gear, spending almost 24 hours a day with the same group of people, meeting people with different habits everyday and sleep deprivation are just a few of the many factors that make touring completely different from normal concerts. There are also other factors, such as being able to play without a sound check, or having to set up in just a few minutes between a change of line-ups in a concert. The combination of all these factors usually results in a diverse exposure to multiple and unexpected problems, which with time will be sorted out and solved. The process is intense, but definitely produces results that would be barely be possible with standard occasional concerts. Since touring is a reality for most professional musicians, it seems extremely important to develop computer-based instruments that could be suitable for this kind of musical practice.

[78] Despite its usual connotation with many pop / rock musicians, this type of presentation is a normal, if not essential practice among professional musicians of nearly all types of music.

For this research, two pieces were performed under these conditions, namely Peripatetic and Phonopticon.

6.4.9 Working collectively with a regular set of musicians

Composing music is a task whose conception, in western classical music, is associated with an individual form of expression that is then materialized by professional orchestras and musicians. This production format had produced some of the most complex and relevant pieces of music throughout the years, and it has been standardized in the form of musical education, performance and presentation format. With the music transformations of the 20th century, new forms of music production emerged. The collective composition groups that emerged in the 1960´s, as debated previously, introduced new compositional and performative possibilities that emerged from group interaction.

In a creative situation, working collectively is ideally done to maximize the individuals in each group. In a similar manner to an academic community, knowledge is shared among the various members of the group, contributing to a deeper form of knowledge that arises from different perspectives and approaches.

Personally, and possibly from my previous experience in many rock bands where the creative process was shared, I still opt, in the cases where it is possible, to work collectively or with a close group of musicians. I have never been interested in the conception of a musician as a mere physical mediator of a musical piece, preferring to work with musicians that improvise and compose. Additionally, improvisation is a communal process that requires certain music skills that not all of the musicians seem to have or be interested in. This factor implies an extra difficulty when composing a piece based on improvisation and delegating the performance to unknown musicians.

The advantages of working with a regular set of musicians are based on the precise definition of an aesthetic cohesion that is made over the process of many years. Being involved in such a particular musical genre as specific as experimental music has always presented me some barriers when dealing with musicians that do not master the aesthetic codes of this particular type of music.

Working collectively also produces instrumental and compositional routines that prove to be highly relevant in the communication process. As a consequence, interaction is usually more effective and precise when the musical process takes place among musicians that have worked together and share the same musical codes.

6.5 Conclusions and debate

Although many of the strategies presented here result from an individual perspective and are adapted to specific pieces, their main problematic areas are common to a large number of musicians, composers and improvisers. The conclusions driven from these works present clear results, and despite its direct relation with a specific musical piece can be regarded as multiple possible approaches and future directions. This array of possibilities can be identified, adopted and adapted partially or in various combinations according to many different musical contexts and to the individual approaches of each musician, composer and improviser.

The musical pieces composed also focused on specific issues, providing separate elements of evaluation that could be easily understood. These pieces were conceived in a specified aesthetic framework, whose specific codes and meanings are integrated in the artistic domain of experimental, improvised and electroacoustic music.

Chapter 7

Works

"*The composer (organizer of sound) will be faced not only with the entire field of sound but also with the entire field of time.*"
(John Cage, in Cox And Warner, 2008, p. 27)

7.1 Overview

I this chapter I will provide documentation on eleven musical works I conceived or have been profoundly involved, individually or collectively, where a practical implementation of specific problematic issues identified in section 1.4 was made.

All of the pieces were developed at Sonoscopia, the artistic collective I am a founder and member of, and in some cases the agenda of the association was paralleled to the development of the pieces. This allowed me not only to develop these works under proper technical and economic conditions, but also to present these works in professional contexts, that obviously produce more accurate results than a mere laboratorial scene. Some of these pieces also include a large number of participants that reflect different perspectives under the same unifying compositional principle. Due to the vastness of some of these works, only the directly related part with this thesis is debated here. As an example, the piece Phonambient has more than 100 different authors, and more than 1000 files, including field recordings, compositions, texts, software, video and sound installations.

The pieces are not presented in a strict chronological order. Instead, a sequence derived from a musical form typical in free improvised music was used.

All the detailed and additional information on the pieces can be accessed on the specified web links and in the digital attachment. All the works were documented in the forms of professional audio recording, photos and videos that illustrate the compositional process and can provide further information on each of the pieces debated.

7.2 Halcyonian

Halcyonian was composed in 2014 and commissioned by Rui Penha and Jorge Coelho for CARA Ano 0. This event celebrated the unofficial inauguration of Centro de Alto Rendimento Artístico[79], a creative artistic centre in the city of Matosinhos. It was performed on the 3rd and 4th December 2014, with myself on percussion and electronics, Eduardo Magalhães on sound spacialization and with the special guest appearance of trumpet virtuoso Peter Evans[80] on the 4th December.

Halcyonian is a piece for percussion, trumpet, electronics and sound spatialization, in which six episodes of the myth of Alcyon and Ceyx are translated into a musical narrative through the use of symbolic representations. The episodes are not presented in the original sequence, avoiding a linear lyrical narrative that could lead to a predictable and aesthetically incoherent piece. A musical tempo, a specific instrumentation and symbolic elements connected with the myth that were to be represented musically were attributed to each episode.

Episode	Duration	Instruments	Symbolic elements
Halcyon Days	1'00''	Turntables; metal plate; processed 43 tone metallophone[81]	Calm, distantly restless.
Ceyx apparition	0'30''	Trumpet; bass drum, metal plate; sine waves	Three long notes; descending movement from the sky.
Ceyx death	1'30''	Trumpet, water drops, drums	Death, water
Alcyon´s death	1'30''	Trumpet, processed water drops	Death, water, transition
Alcyon and Ceyx	2'00''	Trumpet, drums, objects	Earth, union
Metamorphose	0'37''	43 tone Metallophone, processed harp	Transformation, birds

Table 1: Halcyonian's music sections.

Concerning the live presentation, a system of 16 speakers and sound spatialization

[79] CARA is a project by Orquestra de Jazz de Matosinhos that focuses on the development of artistic contents based on a dialogue between art, Science and technology (from the website ojm.pt, accessed on 14th January 2018).

[80] Peter Evans is considered one of the leading improvisers and trumpet players of the present time. His work can be accessed on http://pevans.squarespace.com/

[81] This metallophone was built by myself in 2012, using steel bars tuned based on Harry Partch's 43 tone scale. The tuning system can be accessed on the archive of Wind World, the previous website of instrument builder Bart Hopkin: http://archive.is/Qh8Xa. A video of a performance of mine of this instrument can be accessed here: https://www.youtube.com/watch?v=OtMAj-6fnH8

developed by Rui Penha was used[82]. These speakers were displayed in a circle, with the audience placed in the center. The percussion set and the trumpet were placed in the peripheral area of the speakers. The speakers were placed under two distinct layers, one over the audience´s ear range, and another at approximately 3 meters high.

Figure 26: Halcyonian set up.

As in most of my pieces, there is a definition of a global form, elements and pre-determined musical material. On this specific piece, the predetermined and recorded material included the use of algorithms that were meant to be juxtaposed with the live output. These algorithms were based on probabilities such as exponential, Gaussian and beta distributions[83], and acted as a base improvisational direction for the human performance. The human interpretation of these algorithms, despite not being mathematically exact, provided musical interpretations that were dependent on physical and emotional constraints and were then substantially different than the computerized versions.

A common aspect in most of my pieces is also the importance of each musician´s contribution to the piece. Instead of providing very exact instructions, I usually choose musicians that have already worked with me on a regular basis, or at least whose work I

[82] Further information on Rui Penha's spatialization system can be accessed in the article Spatium: Tools for Sound Spatialization (Penha and Oliveira, 2013).

[83] These curves produce higher probability values at the initial or ending defined points (exponential), at the center (gaussian) or at the extremities (beta).

know very well. Naturally, this method would not be possible to achieve through the more traditional forms of composition, where the score is meant to be played by any kind of musician technically competent for that piece. However, since it is clearly not my intention to make music within this format, the choice to include only musicians with who I have emotional, musical and aesthetic affinity with has proven to be quite effective. In this piece, the percussion part was performed by myself, which obviously means I would know exactly which type of musical material was to developed. On the second day virtuoso trumpeter Peter Evans also performed. His highly developed skills both as an improviser and as a performer of written music make him a privileged choice for this piece. Since I had been following his work for many years, the only instructions that were given to him were the parts of the pieces he had to play or not.

The instrumentation of the piece included a big bass drum and metal plate, which were used to describe some of the dramatic parts of the episode of the myth. The percussion set and the trumpet, placed in opposite parts of the external circle, presented a complementary dialogue in between the sonic result reproduced in the loudspeakers.

Documentation and a stereo version of this piece can be accessed in the attachments and digital attachment.

7.2.1 Discussion

This work provided a typical scenario of electroacoustic music, with an electronic piece to be composed for tape and, optionally, for instruments. I opted to compose for tape and instruments, since, as is has been expressed so many times on this thesis, I am deeply interested in the human presence and expressiveness in this type of musical performances.

In this particular case, however, the highlight was the spatialization system, which allowed expressive possibilities that were significantly more complex than a traditional stereo or quadriphonic set. The intricate movements allowed in the space by the system provided a detailed positioning of the sounds, producing sonic results that would stimulate and surprise constantly the listeners.

Loudspeaker systems can also become dangerously misleading in the sound perception. Without the human presence, a higher degree of attention would be on the positioning of the sounds, and the listening experience could be dominated by the fascinating achievement of the sound spatialization. To avoid this, the human presence was meant to complement the activity on the loudspeakers, and also to provide an additional layer of sound. This layer provided a different spectral zone to the recorded sound, and also provided some audio clues to some of the fonts recorded on tape, leading to the connection of the listener with the causes of some of the sounds reproduced on the loudspeakers.

Compositionally speaking, the choice to include improvisational elements only in certain parts of the piece contributed to its clear definition as a singular entity. Since the improvisers in this case have a clear understanding of the musical aspirations and aesthetics of the piece, their interaction with the electronic background acted as a reinforcement element that contributed to the global cohesion of the piece.

7.3 Variations on Tautologos III

In 2014, I was asked to compose and perform an electroacoustic piece for the cycle Old New Electronic Music, commissioned by José Alberto Gomes for Digitópia[84] / Casa da Música. The challenge was to reinterpret in a very personal and open way some historical electronic music pieces. My choice was Tautologos III, a piece by French composer Luc Ferrari, whose work I profoundly admire and that has been deeply inspirational to me. This piece in particular reflected some aesthetic and compositional ideas that seemed to be ideal for an open interpretation of this piece, maintaining the original thoughts of the composer intact and at the same time giving me enough creative space to carve a personal touch.

Tautologos III was composed in 1969. Like most of his work, it is charged with a deep focus on the act of listening, using apparently repetitive motifs (tautologies) to achieve a meditative state where the physical gesture and the mind fuse and dictate the slow transformations of the piece. Also, like many of his works, Tautologos is very critical on western music, in this case on *Musique Concréte*, who the composer was associated with in the 1960´s. His criticism is also reflected on a peculiar sense of humour, as is expressed on the instructions of the three set of rules of this piece:

1. *Each musician freely decides on a theme and length of silence to be repeated for 21 minutes.*
2. *Each musician can fanatically stick to his choice or change according to what the other musician is playing.*
3. *Well, there is no third rule.* (Hinant, 2006, liner notes from the cd)

For my version of this piece, I chose instrumentation very close to the intentions of the composer at the time the piece was written. The instrumentation used consisted of piano, percussion and electronics.

The whole piece was based on the repetition of three chromatic motives on the piano, performed and recorded by myself. Each of the three motives evolves slowly and

[84] Digitopia is a part of the educational service from Casa da Música, focusing on the assistance and development of digital music projects, compositions and performances.

gradually, and each repetition of the motive has slightly different note orders, lengths of silence between each repetition, articulations and dynamics. The resonance of the piano is also constantly present, first because it will create a background layer of sound that has microscopic changes, and secondly because it articulates quite well with the electronic background. The recorded electronic background consisted of layers of synthesised sounds using Metasynth[85], providing a classical synthesis sound that seemed to be very suitable for this piece.

For the live performance, the three sections of the piece were complemented with a percussion set that consisted of a 26" bass drum, a 16" floor tom, a 13" snare drum, two woodblocks and a large metal plate, and also with a Mogees system connected to a cymbal. Due to the large reverberation time of the room where it was presented, short percussive sounds like the woodblock worked very well in the piece, since they provided a sustain of the sound that could be well interconnected with the pre recorded sounds on the loudspeakers. The percussion part consisted of repetitive motifs that were used to complement the piano part. However, since it was being performed live, there was a slightly higher degree of variations when compared to the piano.

As for the electronic live part, the Mogees system was used to emphasise the subtle differences obtained when playing a cymbal with different attacks, intensities and areas. At the time of this performance, Mogees was still under testing, being relatively limited in its possibilities.

The performance space was arranged in order to provide a comfortable listening condition for the audience. The instruments were placed in the middle of the room, with the audience surrounding it and seated on the floor with comfortable pillows. The loudspeakers were placed in the limits of the room. This strategy allowed me to have more control over the balance between the acoustic and electronic sounds, as well as to the sound that was reaching the audience, that in this case very similar to what I was hearing. As explained on earlier, the balance between acoustic and electronic sounds is very difficult to match, and in traditional stage dispositions it is mostly dependent on a sound technician who, in order to complement an electroacoustic work correctly, needs to understand the musical piece being performed and needs to adapt in real time to the ever-changing circumstances of the moment.

Further documentation on this piece can be accessed in the attachments and digital attachments.

7.3.1 Discussion

[85] Metasynth is a software developed by Ui software dedicated to the fields of sound design and electroacoustic music.

Being in a solo situation allows an apparent amount of freedom that in fact raises particular musical problems. In contexts where improvisation plays a significant part, especially, the notion of freedom and adaptation in real time to the specific elements can actually mean a higher degree of limitation points. When playing solo, a tendency to improvise on very clear elements that we choose and, consequently, we have a higher degree of control, can actually determine more rigid form structures and restrict the musical elements to be performed. On the other hand, when playing collectively, the directions taken by others frequently surprise us and lead us to uncomfortable, new or unpredictable directions, which could be translated into total unexpected results. In other words, a solo improvised piece will more likely transform itself to a composition.

However, the purpose of this piece was a reinterpretation of an existing musical work. It was intended to maintain its core identity, but also leave space for a personal vision and musicality. For this reason, clear musical elements were chosen to improvise or, in other words, produce variations on simple motifs that had been previously composed. It is important to mention that some of the recorded elements could have actually been performed live. The piano part, for example, would potentially work better if played by a skilled piano player during the live performance. However, the costs involved in rehearsals, and particularly finding a piano player that would understand clearly the intentions and silences of this piece would be time consuming. As simple as it may sound, each duration and space of the piano motifs recorded by myself has a very complex and personal meaning of time, and it was significantly easier improvising with my recorded sound.

The choice to use a pre-recorded electronic base had always been a delicate matter on some of my works. Obviously, there are many limitations with this option, particularly regarding the rigidity of a fixed time-line. One way to partially resolve this problem is the inclusion of sound signals in the background[86] that will guide my hearing and provide me information over the timing and parts of the piece. Usually, transitions are also marked with identifiable sounds, so my improvised material always gets its way into the composition. Naturally, performing everything live would be potentially better, but, as said before, practical reasons also dictate the way a musical work is conceived and performed.

7.4 Encode / retrieve

Encode / retrieve is a piece for piano, harp, percussion, flute, objects, electronics and video, and was premiered on the 23rd May 2015 at Centro Galego de Arte Contemporânea, Santiago de Compostela, on the occasion of the festival Musica e Arte:

[86] These sound signals are specified according to each composition, but need to be clearly heard and identified. Some examples are distinctive percussive sounds, a new class of sounds, silence or melodic or rhythmical indications.

Correspondências Sonoras. It was performed by Vertixe Sonora Ensemble, with the objects, electronics and video being performed by myself.

The principle behind the piece was to provide the musicians with a set of computer instructions, and then combine their responses with the computer generated result. This process was used to emphasise the difference between a human and a computer response. Since humans have a variety of factors that interfere with their decisions, like memory, ergonomic issues related with their instrument and expected and unexpected emotions, it is impossible, at least for our current technological development, to obtain human-like responses from a computer.

This piece, however, tried to take advantage of the musicality inherent to this difference. If, in the dawn of computer music, the direction was heading towards perfection and super-human capacities, nowadays the reversed process is also desired, with the ambition of humanized and erratic computer outputs.

This piece also intended to recall musical phrases within our memory. When a musical phrase is performed for the first time, it comes out with a lot of information from the performer, its musical activities and his state of mind. With rehearsals and the confrontation with the ideas that were being debated by the musicians, the phrasing changed slightly and re-adapted to a new musical meaning. From a compositional point of view, this is particularly interesting to me, since it is a way of preserving a compositional identity and also incorporating the musicality of the performer. It is also interesting to observe the changes in phrase articulation with other physical aspects, such as exhaustion and fitness, boredom and excitement, distraction and concentration or distrust and confidence.

Figure 27: Combining electronics with conventional instruments.

This piece was performed by a classically trained ensemble. All the musicians were highly trained in contemporary music techniques and had previously performed many pieces that included improvised parts, graphic scores or aleatoric choices. Contrary to most of the works developed within the spectre of this thesis, with the exception of the harp player Angelica Salvi, I did not have any previous musical contact with any of the musicians. Being trained as musicians that rely on a score to play a piece, it was a challenge to clearly pass some of the compositional ideas intended in this piece. A few emails were sent to the musicians, where links to my previous works could be heard and read, and I also made a point of knowing all the musical background behind each musician. It is extremely important in my music that each piece is not conceived in a hermetic and hierarchical way. Accepting creative contributions from anyone involved in the piece is one of the methods I choose for strengthening the body of my work.

Unlike most of my work, this piece included a video in the background of the performance. Since I was in charge of the contents of the video, basically to save money, time and incorporate another element in the equation, I had to opt for a simple solution that would be able to complement the musical speech, instead of re-directing the attention of the music to a visual element. It was clear that the video had to present some sort of musical content related to the piece, so I made the decision of using rhythmic patters (unheard) generated by water bubbles. The video also intended to provide a colour

background that would create a proper atmosphere for the music being performed, and listened.

The electronic part was conceived and performed with the software Kenaxis[87]. Several music contents were previously recorded by myself, such as sounds from glasses, rocks, resonances and many types of small amplified objects like pepper mills, sawblades, springs or tiny bells. I also used some previously synthesized sounds on Metasynth, where I used some algorithmic composition techniques to generate the material for the piece.

On the live performance, the defined musical elements were played in their predefined parts, leaving room for interaction in the sections that were idealized for improvisation within the defined parameters. These parameters could be range, density, texture, material type, interaction with a soloist or background to support other musical events. A conventional midi controller with faders, knobs and buttons was used to perform this piece. There was also real time sampling from sound sources that were identical to some of the pre-recorded sounds.

More information about this piece can be accessed in the attachments and digital attachments.

7.4.1 Discussion

On this piece some strategies previously debated in 7.2 and 7.3 were used, such as human interpretations of computer algorithms, pattern transformations derived from repetitions and the confinement of improvisation to specific parts and under defined rules. In this piece, however, there was a larger ensemble performing and interacting, leaving space for dialogue between the musicians and transforming the piece into a livelier organism.

With the exception of the harp player, none of the musicians had previous contact with my music. This was an initial obstacle, and to a certain extent there were a few limitations derived from the traditional notion of composer / musician that is still commonly assumed in classically trained musical ensembles. Despite the fact that Vertixe Sonora Ensemble was minimally experienced in improvisation, some of the musicians were not improvisers, which produced some slightly incoherent outputs at times.

Opting for a video background that was used only to create a general atmosphere for the piece contributed to the visual fusion of the traditional musical instruments and the electronics. In this case, the video was meant to be perceived as a secondary aspect of the music, providing only a few insights on the music but, more importantly, connecting all the musicians musically and spiritually.

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[87] Kenaxis is a software developed by Stefan Smulovitz developed for live electroacoustic performance. Some of its features include the implementation of some of Xenakis' compositional techniques.

7.5 Control and Unpredictability

Control and Unpredictability (CAU) is a set of works based on the definition of boundaries under which several unpredictable factors might occur. It is highly inspired by classic algorithmic composition techniques developed by Gottfried Michael Koenig described as tendency masks[88], but in this case with a clear distinctive aspect of placing humans, instead of machines, making musical and compositional choices. In these pieces different aspects are controlled, such as instrumentation, length of each section, compositional material, particular phrasings and form. In most of my works, and even in some collective improvisations, the definition of a form and the compositional contents within it are actually what makes a substantial difference between my compositions that incorporate improvised elements and "pure" improvisations. These composed improvisation works can be repeated, although sometimes with great differences, but conceptually they represent the same musical piece with the same artistic purpose. These principles derive from a direct inspiration from John Cage, that already in 1936 referred that with the introduction of noise, "form will be our only connection with the past" (Cage, 2008, p. 27).

CAU has been presented as five different versions. Since each version has different tactics and results, each piece will be presented separately.

7.5.1 CAU no. 1

CAU no. 1 was written for solo electronics and amplified objects, and was presented at Signal Festival, Sardinia, in December 2013.

This piece used a set up configuration I was using often in improvised music contexts at the time. Particularly, the acoustic laptop was a common presence in my live performances, and with time it had become clear that some gestural and musical routines had already been clearly defined. However, this particular set up was mostly used with abstract electronic elements, so it was important to study some possibilities and challenges presented with its interaction with material primarily deriving from field recordings.

It is important to mention that in this particular case the field recordings used were not done by myself. Danilo Casti, a citizen of Sardinia that had previously worked with me, recorded some sounds of the city having in mind a sociological representation of the city. These recordings were sent to me, and I worked on this material without any realistic idea

[88] A tendency mask can be briefly described as a probability range between specified limits.

of where the sounds actually belonged. This factor created a dual and interesting musical result, since for myself most of these recordings were abstract, but for the audience these sounds were familiar and recognizable, helping to dispose of some of the barriers that prevented the understanding and appreciation of this music (Drott, 2009).

As in all the versions of this piece, a previous musical form was defined, as well as some musical material for each section. An electronic trigger was used to combine acoustic and electronic sounds. In this particular case, each floor tom triggered a probability set of notes and chords that were produced under certain harmonic rules. A pair of woodblocks also worked as elements for section change, since each woodblock was providing indications to the computer to trigger specific field recordings after a certain defined number of times it was played. These definitions allowed me to work under these defined borders, but at the same time providing enough room for improvisation and real time adaptation to the particular time and space of presentation.

7.5.2 CAU no. 2

CAU no. 2 took the format of a sound installation, and was presented at Sonoscopia, Porto, for the Future Places Festival 2014.

The sound installation used audio recordings and URB[89], a system for automated analysis and storage of an urban soundscape developed by José Alberto Gomes (Gomes and Tudela, 2013). It explored the subjective interpretation of the listeners, especially when confronted with sounds that were embedded in their own particular geographical and social references. Since the parameters extracted from URB were highly objective, this piece relied precisely on the confrontation of objective and subjective data. This version of CAU consisted of a loudspeaker inserted into the resonant body of a floor tom, a drum membrane with sand over it and two loudspeakers playing processed field recordings.

Two URB parameters (centroid and amplitude) were used as input values for a Max MSP patch. These inputs acted as triggers for melodic and harmonic content. Centroid provided frequency values that were translated into pitch class sets (from 0 to 11), which were then transposed randomly to different octave registers to be played by a virtual instrument (a celesta). The values were then filtered to prevent the occurring of some undesirable intervals. Only notes from a whole tone scale would be played and unisons and octaves were blocked. Amplitude values provided a trigger for the processed field recordings after a defined threshold. Since the original values were triggering too many

[89] Detailed information on URB can be accessed in the article Urb: urban sound analysis and storage project (Gomes and Tudela, 2013)

sound events, a re-scaling of those values was made, in order to become musically adequate (Gomes et al, 2014).

The audio output was played by a loudspeaker inserted into a floor tom. Over the membrane of the drum was some sand that vibrated and produced resonant sounds when certain frequencies excited the vibration modes of the membrane. Since there was also a light inserted into the floor tom, the sand created different visual patterns according to different vibration modes of the membrane, as can be seen in figure 24.

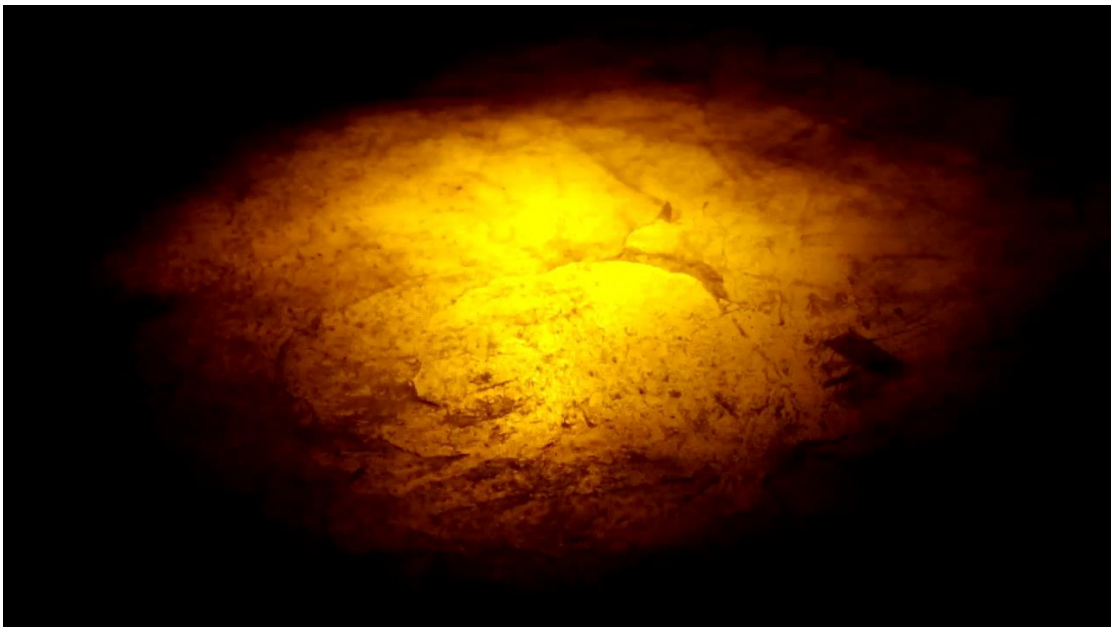

Figure 28: Sand vibrating over a drum membrane. Photo by Miguel Tavares.

There were many layers of transformation of the natural soundscape that acted the musical input for this piece. The natural sounds were analyzed by URB, audio recorded, digitally processed and recombined with a melodic layer provided by URB data. Finally, they were recombined again with its natural sounds, since the sound installation was on an open air space. Regarding URB, some of the values were translated musically in a way that became impossible for them to have a direct identification with the original sources. However, there was an extremely important level of conceptual coherence that was obtained while mixing the objective data of URB and translating it into a subjective, and sometimes distorted, musical reality.

7.5.3 CAU no. 3

The third version of this piece was presented in December 2015 at Festival Ecos, in Lisbon. It was written for electronics, percussion, acoustic laptops and objects, and performed by myself, Henrique Fernandes and Alberto Lopes, musicians with whom I work on a regular and almost daily basis. The performance space was an early 20th century greenhouse located in a beautiful garden that lies outside the main touristic attentions of the city of Lisbon. The circular shape of the building, along with the concentrical ceiling and the highly reflective materials on the walls produced interesting acoustic effects, such as a high reverberation time and echoes. Regarding the echoes, particular points of the room offered significantly sonic differences. In the center, where most of the sound energy was being directed to, there was a clear reinforcement of the sound, and multiple slap echoes could be perceived. In other parts of the room, due to the multiple reflections provided by the shape of the building, the directionality and location of the sound sources could be easily misunderstood, creating particular psychoacoustic effects that, in the case of this piece and the whole theme of the festival, were used as a compositional element.

Figure 29: Performance at Estufa da Tapada das Necessidades, Lisbon. Photo by João Bento.

This piece used partial instrumentation and compositional material from CAU no. 1 that obviously needed to be readapted for a new space and for a larger number of performers. Since the room had a circular layout, it was decided to place the audience in the center in an eccentric manner. This layout allowed the performers to move in the space and create many sonic illusions on the audience, based on the location effects inherent to the space. There were moments when the audience could see the sources of the sounds but perceive them from a different direction, and also the opposite, locating a

sound source but not the visual cue. This was achieved by acoustic sources and with the use of loudspeakers, since in both cases there were fixed and movable fonts. In the case of the movable loudspeakers, eight Earbees[90] (a small recording and playback device created by composer Sarah Roberts) were used to move in space freely without the physical constraints of cables. A very interesting aspect in the use of these devices is the ability to record a visible and easily identifiable sound and then relocating it to a new space. In this approach there´s still a reference to the source of the sound, but its intricate morphologies are perceived in a drastically new form by changing the timbre (due to the restrictions of the sound quality of the recording device), directional pattern, duration of the event and contextualization on a new compositional context.

Figure 30: Moving in space with Sarah Robert's Earbees.

A similar approach in terms of re-contextualization of compositional material was used with the field recordings. If, in version number one of this piece, I had used local recordings from the city of Sardinia, in order to achieve a direct relation of the sound with social and emotional references, in this version the same recordings were played to an audience from a different city and whose social and cultural references were naturally

[90] Earbees are a small portable sampling device that allows the storage of sounds with a total duration of two minutes. The simplicity and easiness of use makes it extremely reliable, practical and useful. It was developed by American composer Sarah Roberts.

different. In this case, there is a vague identification with the general theme behind some recordings, particularly those involving voices (the sound of a market, for example). However, the references become blurred, providing the listener with a new focus of attention in the abstract sonic qualities of the recording.

7.5.4 CAU no. 4

CAU no. 4 was written for electronics, percussion, objects, custom made chordophones and four speakers, and it was presented at Rivoli Teatro Municipal, Porto, in May 2015. It was performed by myself, percussionist Jorge Queijo and guitar player Alberto Lopes. As in version number three, regular work has been developed with both of the performing musicians.

This version of the piece was centered on a table where several homemade instruments and objects were placed. The dimension, variety and exclusiveness of the instruments had a significant visual impact, and it was a deliberate strategy to blur the presence of the computer on stage. Electronics, in this piece, were diffused on four speakers, placed in the corners of the room. Since there was no live processing of any sort, the electronic background had a similar approach to the classic electroacoustic pieces for tape and instrument. For this reason, it was decided to opt for instrumental paraphernalia that could minimize the possible negative impacts of the pre-recorded tape with a visual and sonic complement.

Figure 31: Set up for CAU no.4.

A significant aspect on this piece was the use of four speakers. Since the audience was surrounded by amplified sound that had movement in space, the performative impact was reinforced through the inclusion of spatialization as a musical element at the same level of the other musical instruments. The acoustic instrumentation included a large number of percussive instruments, and the rhythmic components were emphasized by polyrhythms reproduced at different tempi in each of the four speakers. Since the audience was listening in different points of the quadriphonic placement, each listener could perceive different rhythms and orchestrations.

7.5.5 CAU no. 5

The fifth version of this piece was conceived for electronics, percussion, harp and custom made chordophone. It was presented at Sons Creativos Festival, Lugo, Spain, on the 6th May 2016, with Angelica Salvi on harp, myself on percussion and José Alberto Gomes on electronics. This piece was performed a second time at Tripas Festival, Madrid, in March 2017, with Miguel Carvalhais on the electronics.

Contrary to the previous versions, that used many unusual and custom made instruments and sound sources, here the instrumentation was more conventional, with

harp, electronics (a computer and a synthesizer), a drum set and a chordophone developed by Dutch instrument builder Yuri Landman[91]. The stage placement was also conventional, with the performers aligned on stage and a stereo amplification system.

The novelty in this version consisted then of the combination of the compositional techniques that serve as base for the whole pieces with more conventional environments. Since I was not performing the electronics, my control over those elements was only confined to vague instructions that, as mentioned before, can be quite effective in contexts where musicians work together for a long time.

As in the previous pieces, a form was determined, and the musical material was organized under the same principles of defining ranges and elements that could then be organized freely by the musicians during the concert.

7.5.6 Discussion

This piece and its subsequent variations, despite being constructed around the computer, offer very different perspectives and possibilities of expressiveness and interaction between the musicians involved. In all the cases, there is a strong visual complement that blurs the presence of the computer as a trivial and daily object, integrating it in an intriguing scenario that contributes to the sense of wonder and fascination from the listener's point of view. Naturally, and as discussed before, this is not a condition for better music. Still, from the perspectives debated here, it is a highly effective strategy.

The unpredictability factor also contributed to the adaptation in real time to specified musical parameters. For example, the space between each musical phrase in CAU nº 3, was completely determined by the acoustics of the space. A different interpretation in another space would have produced different results, but the definition of specific musical ranges clearly contributed to a precise artistic content of that particular part.

The definition of the control parameters is obviously of great importance on these pieces. According to each specific instrumentation, place and event, different aspects were controlled and ranges defined. These ranges established a comfort zone among the musicians, whose actions were always taken with a conscious knowledge of the global form of the piece.

In CAU nº 3, 4 and 5 there were also visual cues between the musicians, mostly to dictate part changes. This form of communication, so common in many musical practices, also allows some changes to be decided according to the will of each musician. By doing

[91] Some of Yuri's instruments, such as the string instruments used in this piece, are based on Just Intonation and highly inspired by the work of Glenn Branca.

this, particular parts can be longer or shorter, according to the circumstances dictated by the live performance.

7.6 Phonambient

Phonambient is a project based on the documentation and artistic transformation of the contemporary sound heritage. It aims at recording and preserving on a digital database (www.phonambient.com) all the sounds that define a city or region, including soundscapes, specific sound sources, musical fragments, phonetics and phonology. It was developed by a large team under my artistic direction and conception, and credits for all the contributors for this work can be consulted in the attachments.

Phonambient was born as an expansion of a previously existing project, Porto Sonoro[92] (Costa and Magalhães, 2014), broadening its database (confined mostly to the historic center of the city of Porto) to several cities: Braga, Guarda, Tondela, Castelo Branco, Fundão and Abu Dhabi. It was also intended to share knowledge and resources gathered within the Porto Sonoro project, in order to create a wider and universal database. The shared resources include software developed by the team involved, namely POLISphone[93], by Filipe Lopes, URB by José Alberto Gomes and Manobrador[94] by George Sioros. Other knowledge and resources, such as field recording techniques, electroacoustic composition techniques, web servers, programming, design and audio equipment were also meant to be widely available to a general community working in the fields of music, arts and sciences.

[92] Porto Sonoro was a documentation project of the sonic identity of the historical center of the city of Porto. It was developed by myself for Manobras no Porto Festival during the years 2011 and 2012. www.portosonoro.pt

[93] POLISphone is a versatile sound map conceived by Filipe Lopes, with a flexible interface designed to induce a sense of instrumentality (from the website filipelopes.net, accessed on 15th Jnauary 2018).

[94] Manobrador is a software developed by George Sioros and myself for the documentation cycle Documente-se!, commissioned by the Serralves Foundation, Porto. This software allows the combination and transformation of multiple sounds sources combined with a video complementation.

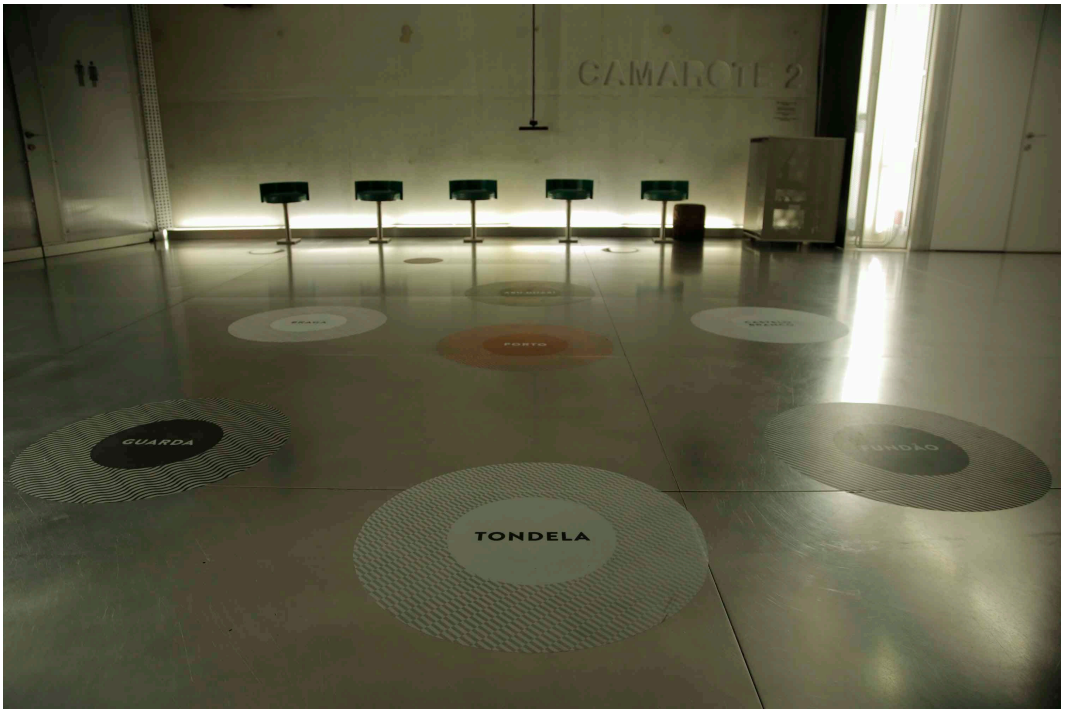

Figure 32: Phonambient presentation at Casa da Música, Porto. Photo by Miguel Tavares.

Phonambient was implemented in the different cities by the establishment of local teams under the supervision of a coordinator from Sonoscopia, transmitting the theoretical and practical knowledge to a local community that would become responsible for the further development of the project in each city. This strategy seemed to be the most appropriate for ethical and technical reasons, due to the fact that it was firmly believed that a sound heritage has stronger connections to each local community. With this project it was intended to provide the technical and theoretical means as a starting point, but with time it should become more and more autonomous and controlled by the people from each city. A diagram with the general functioning of Phonambient follows.

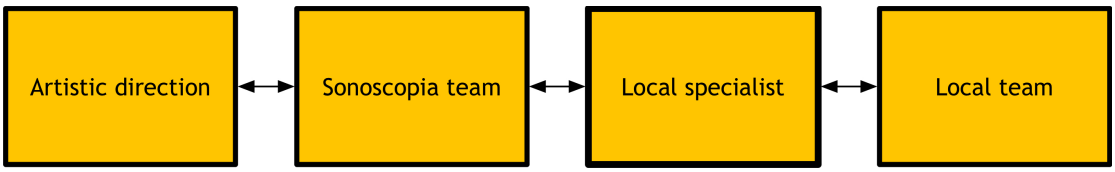

Figure 33: Work relations at Phonambient.

Regarding the practical implementation in each city, it was decided to opt for a methodology that would allow a local team with no experience in the field to develop

enough technical and theoretical conditions to produce satisfactory results. This team would have a first contact in the form of a laboratorial period[95]. Here, they would receive the basic information and have access to technical recording devices, followed by a period of approximately two months when they could develop individual projects and recordings. One last laboratorial period followed, when the results of their work would be compiled, summarized and presented publically in the last day of this period. The results varied from each city where the project was implemented, from field recordings, sound installations, performances or compositions. Figure 30 presents a diagram with the methodological approach.

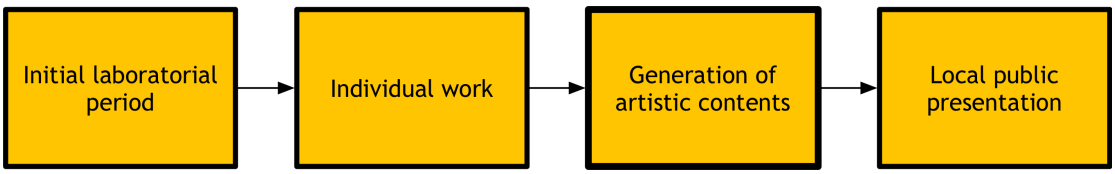

Figure 34: Methodological approach for Phonambient.

Finally, a last public presentation, held at Casa da Música, Porto, contained a global summary of the whole project. Detailed information about this presentation will be presented in section 7.6.8.

Since this project included many different practical outputs in each of the cities it was implemented, each of the following subsections will deal will the specific problems and solutions presented in each one. A first subchapter will contain information about the architecture of the website, where most of the information discussed here can be accessed by the public domain.

All the output contents can be accessed on Phonambient's web site:
www.phonambient.com

Additionally, the artistic contents produced for this work can be accessed in the digital attachments.

7.6.1 Website

[95] The laboratorial period was an initial phase of the project, on which a first contact with the local teams of each city was made. During a period of three days, this team would be introduced to the main concept of Phonambient. In this phase the local team would have access to the theoretical and practical means necessary for the further individual development.

Phonambient´s website is the core of this work, hosting a considerable amount of information related to the documentation and artistic recreation of soundscapes. More precisely, there are 987 field recordings, 21 compositions, 1 paper and 4 applications, from a total of 68 direct collaborators. Some of the contents migrated from the previous platform, Porto Sonoro, meaning that the time range from the archive is from the period between 2011 and the current time.

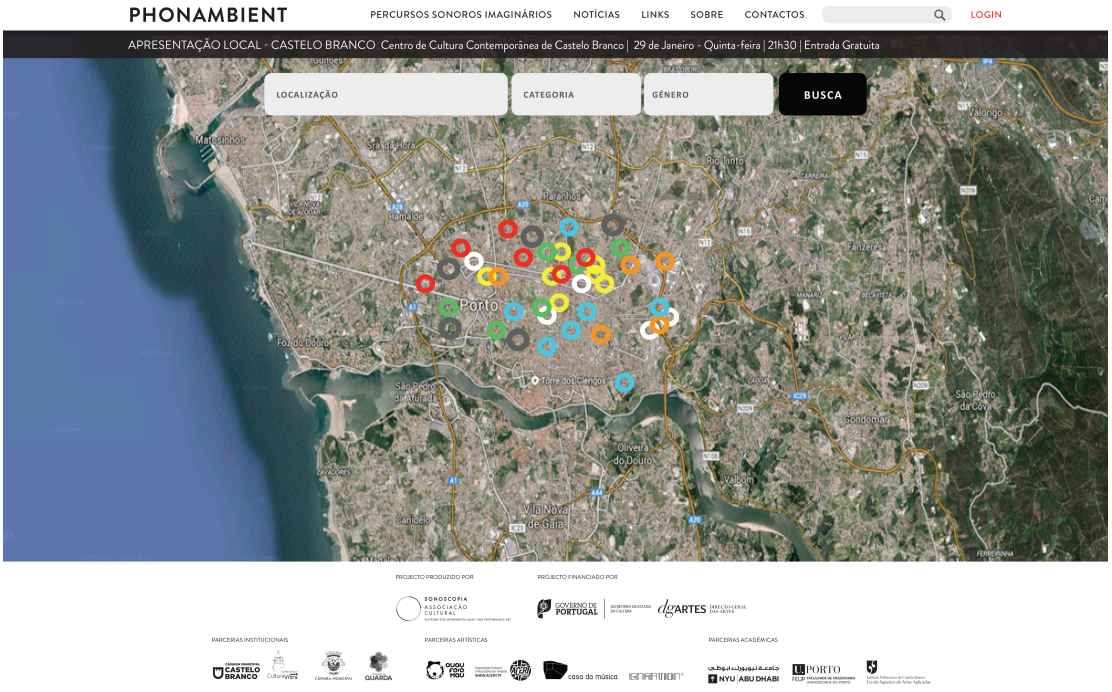

Figure 35: Phonambient's front page.

The front page of the website hosts the sound map, referred to as Cartografia Sonora, where sound files are displayed in the exact spot they were recorded. The map uses Google maps technology, fundamental for accessing to the visualization of the map and also for the search engine functions. Sounds can be accessed by clicking on each of the dots, enabling access to the basic information of each sound file like date, author, technical equipment and a short summary of the content. Each sound is archived on a dedicated server at 24 bit / 48 Khz[96]. Although this represents a significant amount of space on this server, the archive is not dependent on other services like Soundcloud or Bandcamp, where there is a specific sound compression of the sound files, and eventually these platforms could disappear in the future[97]. On the front page there is also a search filter, where sounds can be accessed by city or by author.

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[96] Standard recording format for high resolution audio.

[97] The loss of digital information is a current problem that has been creating interesting discussion. Platforms widely used ten years ago such as Myspace became obsolete with the emergence of other social networks such as Tweeter or Facebook.

Each sound file was organized in six different categories. Although many efforts have been made since the dawn of electroacoustic music to organize sounds according to universal criteria (Schaeffer, 2008; Schafer, 1977), a personalized taxonomy was used. The main reasons were easiness of use and access to a wider range of specialized and non specialized users by avoiding strict categorizations, that in the case of electroacoustic music would involve either a highly sophisticated taxonomy or a simpler, ambiguous one (Costa and Magalhães, 2013).

The six categories are *Vozes* (voices), *Identidades* (identities), *Características* (characteristics), *Especificidades* (specificities), *Celebrações* (celebrations), *Ressonâncias* (resonances). A brief description of all the categories can be seen below in table no 2.

Category	**Description**	**Examples**
Vozes	Short speech examples focusing on accent and local expressions	Funny expressions; Exaggerated accent.
Identidades	Contextual local stories	Daily stories; peculiar stories.
Características	General soundscapes	Traffic noise; streets soundscape.
Especificidades	Specific sound marks	Fountain; church bells.
Celebrações	Social events	Mass; football game.
Ressonâncias	Particular acoustic characteristics	Church acoustics; tunnels.
Percursos sonoros imaginários	Artistic reinterpestations	Electroacoustic compositions; sound design.

Table 2: Sound categories for Phonambient.

Complementing the documentation section of Cartografia Sonora, another section can be accessed on Percursos Sonoros Imaginários that corresponds to the transformation of the archive into creative and scientific products. On this section, there´s a subdivision into four main categories: Music, Audio Visual, Text and Software. There is also the possibility to use a search filter. This part offers a significantly different approach from other sound maps sound maps and similar projects like Escoitar[98], Sons de Barcelona[99], Aporee[100] or

[98] Escoitar is a Galician collective working in the fields of soundscape composition and electroacoustic music. A current interesting project is the elimination of their sound database. Every time a sound is listened it is programmed to disappear from the public domain and exist only on the memory of the last user.

[99] Sound map of the city of Barcelona. www.barcelona.freesound.org

[100] World sound map. www.aporee.org.maps

Montreal Sound Map[101], since it clearly stresses the importance of the creative and scientific approach under such soundscape archive.

7.6.2 Braga

Braga is a city in the North of Portugal that can easily be characterized sonically by a significant presence of bell sounds from the large number of churches that surround the city. Despite the recent loss of influence from the church, it is still very common nowadays to hear the church calls for particular religious celebrations, or simply as a reminder of the hours of the day.

Rui Dias, having a group of five people to work with, was the coordinator of this city. The presentation format chosen took the format of three distinct sound installations. Additionally, a cd was produced with several compositions developed by relevant musicians from the city.

The sound installations were held at GNRation, a place for residencies and public presentations that has been focusing on new music, including electronic music. Since there was only one room for the three sound installations, a black curtain was used to separate them.

The first sound installation included a computer with field recordings from the city. Users could choose to hear the different sounds on headphones, according to a specific category defined in Phonambient´s classification system. The second installation included a set of small stories that were recorded and played back in the room. The third installation was an interactive audio-visual system that allowed the users to modify an image associated to a particular sound with their physical presence in the space. There was a clear concern about over the physical presentation space, and the room where the installations took place was prepared with special lights and also informative posters and texts about the project were displayed.

In addition to this presentation, it was decided to make an audio CD with short electroacoustic pieces commissioned to some musicians from the city of Braga. The CD is entitled Phonambient Braga, and it also includes the stories recorded for one of the installations mentioned above. 200 copies of the CD were made, and it can be accessed digitally here: https://sonoscopia.bancamp.com/album/phonambient-braga

7.6.3 Castelo Branco

[101] Sound map of the city of Montreal. www.montrealsoundmap.com

The implementation of Phonambient in Castelo Branco had particular interest, since there was a close connection with some members of the project and the Música Electrónica e Produção Musical degree held at Escola Superior de Artes Aplicadas. I was a teacher there between 2006 and 2013, and since I had the privilege of knowing part of the acoustic terrain of the city, I became the coordinator for this city.

Phonambient was articulated with the program held at MEPM / ESART, and since the topic was related to many of the students interests, there were nearly 20 participants[102]. After the first phase with theoretical instructions and debate, a local team of 9 students became involved in the field recordings.

For the final presentation, and since all the students had previous knowledge of computer music, it was decided to make an electronic music concert, essentially with computers and midi controllers on stage. The concert took place at Centro Cultural de Castelo Branco, an auditorium in the center of the city.

For the concert, all the field recordings were analyzed collectively, and for musical coherence some of the sounds were not used. Each participant was responsible for their own sounds, playing or manipulating them freely, with any software they were comfortable with. The general organization of the piece was done according to general music principles (form and phrasing according to the rhythmical, melodic and harmonic contents available) and also to a non-linear narrative that included memory associated with particular sounds. The use of distinctive sounds associated with particular habits and routines from the inhabitants of the city was one of the solutions found to create a direct relation with some members of the audience that were not so familiar with electroacoustic music.

7.6.4 Abu Dhabi

Abu Dhabi is another city where there was a close affinity between some members of the project and the Music program held at New York University Abu Dhabi. Having the chance to make implementations of this project under an academic community was of higher importance, since it was expected to have contributions that would become solidified over the following years. The coordinators for this city were José Alberto Gomes and Henrique Fernandes.

For practical and economic reasons, it was decided to implement the project in only one week, contrary to what happened in the other cities, where there were two separate periods between the laboratorial phase and the artistic presentation phase. For this reason, we opted not to make a public performance, but instead to create some simple compositions that were developed during the one-week period where the project was

[102] The exact number is difficult to measure, since some students attended the classes and were not directly involved in recording or creative processes.

implemented.

Since the degree in Music held at the NUYAD has a broad range of interests, there were not so many students under the area of electronic music and technology. During this week a number of three students participated in field recording sessions and composed some pieces with the collected material, under the guidance of the defined city coordinators of Sonoscopia.

7.6.5 Fundão

The coordinator for the city of Fundão was Filipe Lopes. Fundão is a small city in inland of Portugal, that despite its size and relative isolation from the rest of the country has a significant institution, Moagem, that has been acting as a major figure in the decentralization of cultural offer. A group of six people joined the project, and apart from the local coordinator João Bento, none of them had previous knowledge about music or music technology.

The musical restrictions of some of the participants led to a musical output that had to deal with some limitations on the artistic use, in a live context, of the musical elements worked here. The final output was a concert, dominated by the presence of computers, but also with some external processing devices, such as analogue effects units. Contrary to the presentation held at Castelo Branco, where almost all theatrical approach was abandoned, here the lights, stage positions and musical gestures were included in the performance.

Musically, a similar approach to the one mentioned at Castelo Branco (7.6.4) was used. However, the non-linear narrative was replaced by a linear narrative that tried to recreate a physical path between points in town that were familiar to the audience. As in Castelo Branco´s case, there were some reports at the end of the concert identifying the sounds and correlating them to specific times and memories.

7.6.6 Tondela

Tondela is a small city in the center of Portugal, and like Fundão, it has been surviving the cultural dominance of the major cities due, in part, to Acert, a theater company that has been confronting its population with constant artistic challenges. The coordinators of this city were Eduardo Magalhães and Henrique Fernandes.

The team was small, and a total of six people were involved. The team included people with experience with sound and with other artistic forms of expression.

The final presentation product was presented in different shapes. There was an

initial lecture presenting Phonambient conducted by myself, and three sound installations were produced, named “Vertices I, II and III”. The first installation consisted of sounds from wood containers used to store wine being amplified in their own wood with induction speakers. There is an ancient art that is still traceable in the city, so this approach combined both the acoustic properties of the wood and a sound and image familiar to all the inhabitants of this city.

The second installation consisted of a six channel audio installation. Six speakers were placed in a circular layout, and the audience could be in the center and be exposed to different sound experiences according to their placement in the room.

Figure 36: Vértices III, by Henrique Fernandes and Eduardo Magalhães. Photo by Henrique Fernandes.

The third installation was a free visual translation of an audio content that was played on headphones and consisted on field recordings. The audience could sit and draw their own experiences and perceptions of the sounds.

7.6.7 Guarda

Guarda is a district capital in the province of Beira Alta. Despite its bigger size and importance when compared to other cities like Tondela or Fundão, it has nevertheless faced the same isolation problems as most cities of the Portuguese interior. The partner for

Phonambient was Teatro Municipal da Guarda, the biggest cultural institution in the city.

The team in Guarda consisted of five participants, and was coordinated by Alberto Lopes. This team was experienced in music and video, and had been performing together previously over the years.

The presentation format was a concert, with live visuals. The concert took place at Teatro Municipal da Guarda, in the small auditorium. The musicians and video manipulator were placed in two distinct tables, one on the left and another on the right side of the stage. Between them there was a big screen with a live projection that presented some images of the places where the sounds had been previously recorded. As it happened in other cities, the association of sounds to particular images was mentioned by the audience as an effective way to create musical and emotional relationships during the performance.

Figure 37: Rehearsals for the Guarda performance at TMG.

7.6.8 Porto

Due to the core of the people involved in Phonambient, and also because there was a previous work developed under the Porto Sonoro project, the final presentation of the first phase of Phonambient took place at Casa da Música (CDM), Porto. The amount of information, data and knowledge produced in the previous years allowed us to create a synthesis of the project under the optimal technical conditions offered at CDM.

The presentation here was intended to summarize the whole project, closing a first stage of development of the project and opening it to the future. For this presentation

there were several compositions commissioned and presented along three sound installations, three concerts, a performance and a lecture. This multiple format of presentation was representative of the whole principle behind this project, in which there was a clear focus on the performative possibilities offered by musical material based on field recordings.

The first sound installation acted as a general informative platform for the audience. Several computers at Digitopia were available for people to explore the website and hear the sounds. Additionally, a ten minute video was being displayed constantly to provide a visual complement on the project.

The second sound installation was an interactive system that allowed users to hear the sounds from each city according to their position in space. On the floor there were vinyl stickers with the name of each city, so it was very intuitive to explore the recorded sounds. The installation used a kinetic based system entitled Sonorium[103], developed by Tiago Ângelo for Digitopia.

The third sound installation was conceived by Filipe Lopes, and used CDM´s robotic gamelan and a disklavier[104] to complement the audio parts of the piece.

Figure 38: Memórias do Fundão, by Filipe Lopes.

[103] Sonorium is an application for space-sound mapping using a Kinetic camera. It was developed by Tiago Ângelo for Digitopia / Casa da Música.

[104] Disklavier is an automated piano system developed by the company Yamaha. A set of electromagnetic solenoids is able to perform automatically a conventional piano through the data sent by a standard Midi file.

The three concerts took place in different rooms. The first one, at Sala Roxa (purple room), was performed by myself and José Alberto Gomes. For the performance, each musician had a laptop only. The room was kept very dark, to induce a focus on the musical output. Each musician was operating in his chosen environment, and despite having fixed a general form, most of the piece was improvised.

The second concert consisted of an improvisation with a group of 12 people from the different cities where the project was implemented. Each musician was performing in his personal environment. The third concert was acousmatic, with pieces from João Mascarenhas (stereo) and Carlos Guedes (four channels). There was also a performance by Christina Ertl Shirley, Gretchen Blegen and Melodie Fenez, based on sound poetry and the translation of the sound of the plants to an audible domain.

The presentation ended with a small lecture conducted by myself where the project was presented and debated with the audience.

7.6.9 Further developments

After Porto´s performance, there was a two-year hiatus in the project. During this time, a substantial part of the information was treated and uploaded to the website.

In 2016, Phonambient expanded to another city, Ovar, repeating the previous methodology of a laboratorial period followed by a creative presentation. The coordination of the city was done by myself and Rodrigo Cardoso, and we worked with a group of four local people. The presentation took place at Festival Festa, on the 18th July 2016. The performance was held outside in the intersection of three streets. The streets were covered with artificial grass, and six speakers were placed along the street. The distant placement of the speakers allowed interesting spatial effects that were explored, for example, as an imitation of the movement of the waves with pre-recorded sound of waves. Together with fixed audio multitracks there were a few instruments that some musicians played. Among these were Derek Holzer´s Soundboxes[105], amplified water and a set of flowers that were used to control electronic sounds with the Makey Makey controller. In the final part of the performance, several blindfolds were given to the audience, and a few objects were performed very close to their ears. Since the blindfold blocked the visual information, most of the objects played were unrecognizable to the audience, inducing a surprise effect.

[105] Derek Holzer is an American researcher and electronic instrument builder. The sound boxes are a portable circuit bent amplifier with an attached loudspeaker, making it able to produce a variety of electronic sounds and also internal feedbacks (from the author's website www.macumbista.net).

7.6.10 Discussion

The vastness of this project by far exceeds the limits and focal points of this thesis. The musical outputs materialized so far would require a detailed study on this specific project. Despite the continuous development of the project, by myself and by many other contributors, its main focus is on soundscape composition, and not exclusively digital music performance. For the purpose of this thesis, we will debate only the performance related problems and strategies.

It is important to mention the variety of performative solutions presented in the cities of Braga, Tondela, Fundão, Braga, Guarda, Castelo Branco, Porto, Abu Dhabi and Ovar. Starting from the same principle, the archive and documentation of each city´s sounds, each coordinator and local team opted for different public presentations, from sound installations, concerts, video projections, lectures or compositions. Field recordings can be particularly difficult to perform, since they usually require a playback system that can be very restrictive in expressive content. Concerning these possible limitations, several different solutions included the playback of the sound files with the computer keyboard and mouse, through midi controllers, via multichannel sound spatializations, amplified by wood resonators, through graphical interfaces or with the inclusion of its original video content. The original field recordings were also transformed through many different processes, such as analogue modifications through pedals and effects units, digital combinations and processing through distinct and personal software such as Max MSP, Kenakis, Metasynth, Logic Audio or Ableton Live. In many cases, the field recordings were also complemented with other musical instruments and performed in acoustically challenging or altering conditions.

The chosen presentation formats also present new forms for sound perception that do not exclusively rely on the typical concert format. Although in a few cases the presentation was held at an auditorium with a typical stage performance, in most situations different tactics were used, such as multichannel diffusion, symbolic translations of the audio realm (the sonification of plants), visual complementation with scenic alternatives, interactive installations or non-linear audio narratives.

In short, the variety of these manifestations clearly demonstrates that the creative force behind many individuals can easily transform apparently limited conditions into expressive pieces of music.

7.7 Phonopticon

Phonopticon is a sonic model inspired on the Panopticon architecture, a building designed by Jeremy Bentham in the 18th century, where a control central tower has a 360

degree vision of the prisoners' cells. Conceptually, however, the ideas of control and power implicit in the Panopticon are replaced by sound representations, free and abstract in their essence, that find different meanings in the listening processes developed by each listener.

Phonopticon is a collective musical instrument / concert and / or sound installation in which new expressive and performative ways are explored in the areas of composition, performance and electroacoustic spatialization, gathering in a central point a set of new acoustic and electronic musical instruments. The audience, displayed concentrically, is also surrounded by several loudspeakers placed at the limits of the external circle.

The global concept was conceived by myself and, as in the case of Phonambient but on a smaller scale, included a large number of contributors and different performing outputs. Detailed information on the performers and composers involved can be consulted in the attachments section for this piece, and also on the following web link: http://www.sonoscopia.pt/works/phonopticon

If, conceptually, the piece intended to present each listener with a unique sonic perspective of the music being performed, technically the most significant challenge was to create a collective instrument that would be made of different individual contributions. Since the contributions would vary with time, the instrument itself would present ever-changing formats. However, in the definition of Phonopticon as a collective musical instrument there was a delicate balance between what would become standardized, and what would eventually change. In other words, it was desired to create a musical instrument with enough flexibility to change over time, but also to maintain some structural identity in order to establish routines, compositional maturity and ergonomic accessibility.

The first presentation was held at Casa de Serralves, during the festival Serralves em Festa, on the 30th and 31st May 2015. For this performance, a collective composition by myself, Henrique Fernandes, Alberto Lopes, José Alberto Gomes, Filipe Lopes, Ricardo Jacinto and Alexandre Soares was performed. This piece included 21 metal tubes and a metal plate suspended over a triangular central structure that was played by all the musicians. Some of the metal tubes included an arduino controlled motorized beater, that operated in specified programmable times. On a secondary layer, the individual set ups of each musician were placed in a circular manner. These set ups included amplified vases of water, a twintar, computers, an amplified and digitally processed circular glass, an iPad and several objects used to play against the central metal plate. In between these individual set ups there were six independent resonant tubes, each with a loudspeaker attached. The sound spatialization on these tubes was performed with the software Kenaxis.

In this first phase of the project, three other performances were held at the cities of Castelo Branco, Tondela and Braga. Despite changing slightly in the number of participants and, consequently, on the configuration of the instrument, a similar approach to the Serralves performance was taken. In all the cases, there was a central piece, either

a triangle or a cube, which acted as a communal performing point. The instruments placed in the center included amplified rectangular glasses, interconnected pieces of strings in nodal points[106], amplified bubbles of air on water[107], metal rods and metal tubes. The central point was also complemented with the individual set ups of each musician.

A second phase of the piece took place in June 2016, with a European tour of twelve concerts that was highly conditioned by two factors mentioned previously, size and transport. These concerts were performed on an almost daily basis in 12 different cities in Spain, France, Holland and Germany. A group of four musicians travelled in a van, meaning that the initial set up planned for Phonopticon had to be adjusted to the available size and to the set up time concerning long travel distances and short periods to assembly the instruments and the central structure.

For this tour, a smaller and easier to assemble central cube with common instruments was maintained, and due to practical reasons, on each face of the cube an individual set up of the four musicians involved was exposed. Since most of the concerts took place at small places, this apparent limitation over the expansion of the instrument actually worked as a unifying unit. Visually, the instrument evolved into a denser and more compact entity. Sonically, it contributed to a more cohesive interaction between all the performers, facilitated by the proximity of the individual instruments.

A different approach, also due to practical reasons, was taken in December 2016 at Festival Shiny Toys, in Mulheim am der Ruhr and at Extrapool, in Nijmegen. Here, the same four musicians that performed the European tour were involved. However, since there were only two concerts, we had to fly by airplane, which limited our big instrument size to four 20-kilogram suitcases. To achieve a similar visual impact, several plastic tubes were suspended over the room, creating connections between many of the instruments that were performed. So, an instrumental adaptation and, consequently, a compositional one had to be done, in order to keep the aesthetical and sonic characteristics of the project intact.

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[106] With this system, each plucked or bowed string will produce overtones on the interconnected strings.

[107] The water bubbles are produced with a tubing system that received a flux of air from a small aquarium air compressor. The air passes through a valve system that allows the control over the desired water recipient. The water flow is amplified with hydrophones, small lavalier microphones inserted in tubes or stethoscopes. The amount of air sent to each recipient, the air dispersion system at the end of each tube and the positioning of the air bubbles against the hydrophones produces a variety of different sounds.

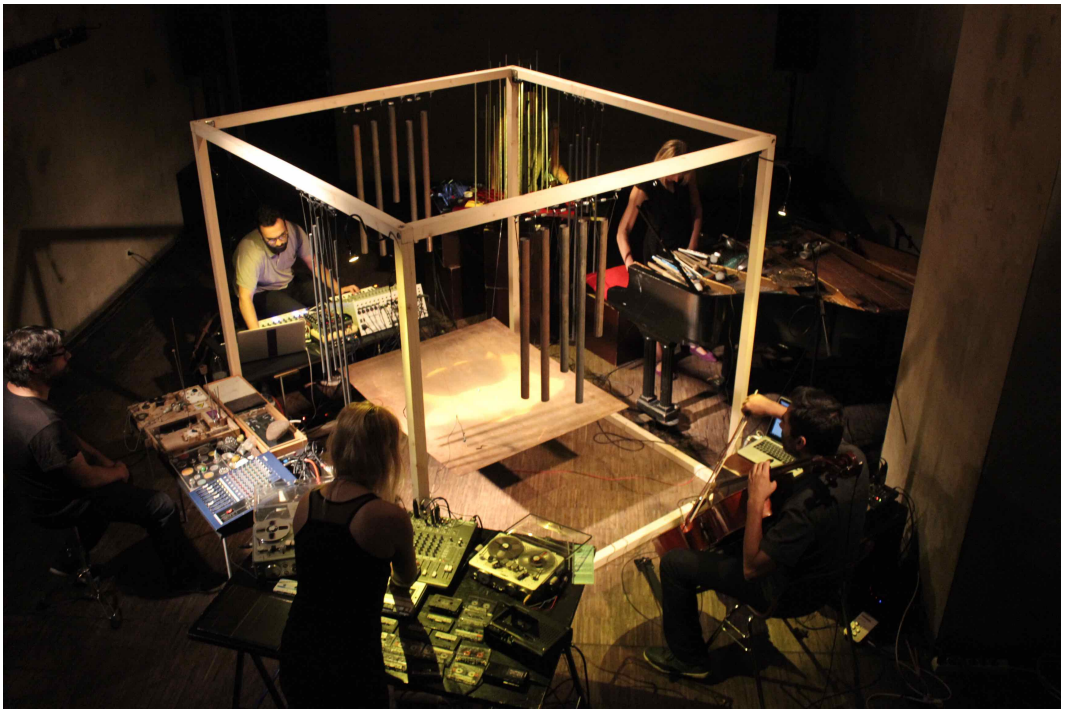

Figure 39: Performance at Ausland, Berlin.

7.7.1 Discussion

The central aspect in Phonopticon was the development of a new collective instrument that would be able to find a balance between a constantly renewable structure and a stabilized form. Naturally, the equilibrium point is very fragile, particularly at its initial point. Defining communal places in terms of composition, ergonomy, gesture and aesthetic coherence requires time, practice and patience. Since at the core of Phonopticon were several members of the Sonoscopia collective, the definition of some common sound sources and instrumental techniques was relatively easy. The inclusion of external elements to its core was aesthetically more difficult at times, since routines, interaction and common methodologies had not been developed completely.

Phonopticon reflects many of the performative problematic issues debated in computer-based instruments on this thesis. We have seen so far that the main advantage of these instruments is the flexibility and enormous range of possibilities offered. Paradoxically, these can also be their main restrictions. With Phonopticon, the balance point between flexibility and stabilization determines the frontier between the advantages and disadvantages of this collective instrument.

Composing and creating collectively also presents particular challenges. A definition of personal spaces has to be achieved to avoid creative restrictions and conflicts.

There is a significantly higher amount of time needed to mature aesthetic cohesion, but since a daily communal work has been conducted over many years, many routines and creative flows have been established collectively between the Sonoscopia members.

It became also particularly clear that the daily performance that occurred on the European tour produced excellent results regarding the expressive and interactive potential of the instrument. Performing everyday under changing circumstances presents the performers with many different approaches and, consequently, with a larger musical lexicon. Collectively, performative and compositional routines are established, leading to a more complex and deeper musical output.

7.8 Peripatetic

A common element in most of the work I develop is the constant re-adaptation of musical contents to an exact moment in time and space. As seen before, there is a large number of factors that are inherent to each performance, such as the acoustics of the room, socio-cultural context, emotional or physical conditions. I have been greatly interested in developing works that keep a conceptual integrity and can be perceived as a singular piece of music, but at the same time offer some flexibility to adapt to the new conditions that it faces every time it is performed. In this piece, I developed a set of composed structures that could be presented (or not) in different orders and whose contents could be developed in different individual and collective forms. As the title suggests, this piece was based on a transformation process derived from the daily experiences faced when traveling. During a period of two weeks, 13 concerts were held on an almost daily basis in the cities of Porto, Bilbao, Chateaubriant, Lille, Louvain la Neuve, Brussels, Amsterdam, Den Haag, Cologne, Essen and Paris. These concerts were held by a fixed number of five musicians, and in some concerts some local guest musicians were invited. The piece was performed by myself, Alberto Lopes, Henrique Fernandes, Rodrigo Cardoso and João Ricardo. The instrumentation, besides the computer, included acoustic laptops, portable synthesisers, bamboo sticks, glass plates, a metal plate and an amplified glass table with several objects.

As mentioned in section 6.4.8, one of the most interesting things when performing daily is the necessary adaptation to some factors that are most of the time forgotten by many musicians. Among these, for instance, is fatigue, which is rarely taken into account. During this tour, some concerts were preceded by long driving distances of more than 1000 km, and while one could think that the reasonable thing to do was simply not to play, a numerous amount of reasons involving economy or strategic significance emerge. As hard as it might seem, this is a common practice and reality for a large number of professional musicians and improvisers.

The performing places are also extremely important in the final musical result, especially in improvised contexts. In this tour, Peripatetic was presented in clubs, churches, anarchist squats or auditoriums, for such diverse audience as children, punks or devoted experimental music listeners. Naturally, the choices made in each performance were radically different every day, adapting to the audience, acoustics, physical space, set up time and mood of each scenario. Figure 36 shows a presentation at squat Txirbilinea, Bilbao. The concert was taken after driving for 700 km and fixing a broken water deposit in the van in between. At this concert, there were eight different bands and musicians performing, from crust punk[108] bands to improvised reductionism[109]. Due to the amount of line up changes, the set up had to be assembled in less than 10 minutes.

Figure 40: Performance at Txirbilinea Squat, Bilbao.

7.8.1 Discussion

As in the case of the previously mentioned Phonopticon tour, the compositional and performative routines derived from a daily performance provided a challenging and rich musical environment. In this case, particularly, and since it included presentations for

[108] Crust is a musical genre within the Punk culture, based on DIY and anti-authoritarian aesthetics and principles. It is highly critical of the mainstream Punk culture, considered to be a misinterpretation and capitalist appropriation of an original subversive culture. Musically, Crust is described as a faster and noisier form of Punk.

[109] Reductionism is a musical genre and aesthetic within Free Improvisation, characterized by silence, minimal musical interventions and the focus on microscopic sonic details.

diverse audiences from all ages, the strategies for contextualization had to be constantly readapted.

The concept of the whole piece was based on a constant transformation principle. Several musical fragments were defined, each with variable parameters for improvisation. Given the different places where the piece was performed, each concert provided different musical outputs. According to the reaction of the audience, the physical restrictions of the space, the acoustics and the desired musical direction the piece was taking in the real time decisions of the performers. This strategy is particularly useful under these circumstances, since performing daily the exact same musical piece can become an uninteresting task.

As with other pieces discussed here, the computer was highly blurred with the presence of diverse and unusual musical instruments and the physical gestures of five musicians.

7.9 INsono

INsono is a flexible and interactive piece that can be presented as a collective musical instrument, a sound installation or an interactive sound walk. It has been presented as two different versions so far, INsono and INsono: O ouvido secreto das plantas (The secret ear of the plants). INsono was artistically directed by Henrique Fernandes, and my contribution on this piece was as a instrument builder, performer and composer. INsono: O ouvido secreto das plantas, was artistically directed by myself and Henrique Fernandes. Full credits on this piece can be accessed in the attachments.

For a better understanding of this work, the two different versions will be described separately.

7.9.1 INsono

The first version, INsono, is an interactive sound installation. In a primary approach, it is a set of sounding objects of medium and large scale, capable of producing sounds, allowing different places of interaction with the audience that inhabits the space. INsono is a system of physical and human interaction focusing on the discovery and exploration of sounds from different listening perspectives. It was conceived for the Big Bang Festival at Centro Cultural de Belém, Lisbon, a festival that has a clear focus on younger audiences and families, and later presented at the same festival at the Onassis Cultural Center, Athens.

Figure 41: INsono, global view.

Having this specific audience to work with, INsono was developed under the following pedagogical and creative lines:

1. The discovery of sound as a physical and plastic element
2. Sound exploration through the development of new technologies, instruments and tools
3. Exploration of new performance techniques
4. The use of sound as a medium for enhancing human relationships and social interactions

The main theme chosen for this work was the listening perspective from someone inside a musical instrument. This theme allowed us to create a relationship with a childish imaginary, since it grasped this vision of how children, surrounded by objects that are usually oversized for them, perceive the world.

Being inside a musical instrument also stresses some issues worth mentioning. Traditionally, the sound source and the listener are well defined. An instrument plays, and, from a certain distance, the audience listens. Between this apparently simple equation there are many acoustic factors that will interfere in the process. Reflection and absorption, reverberation, early reflections, binaural difference, masking and a large number of acoustic and psychoacoustic phenomena add layers of complexity and can drastically transform the way we perceive sound. However, inside a musical instrument, these factors change, and the perception can be totally different from our usual listening method. In this case, some of the acoustic phenomena mentioned previously also occur, but

on a lesser degree, since the acoustic space is the musical instrument itself. Being inside a musical instrument induces then the listening experience to rely in other senses like vision, smell and tact. It is true that these senses are also used in traditional sound production means, but in this case the piece was conceived having that particular senses into account.

From a pedagogical level, it was also important to reveal the mechanical process involved in sound generation from each of the musical components of the instrument. Figure 39 shows a motorized form for controlling the vibration of springs, whose patterns could be seen against a light piece of wood.

Figure 42: Vibration patterns on springs.

The sound installation is spread around five main distinct areas, all of them interconnected. It is a big scale structure, 2.3 meters high, 15 meters long and 10 meters wide. The main structure is made from wood, which can be assembled in many different configurations.

In this version there was a central cube that acted as a listening point and where sounds from other areas were transmitted, both by acoustic and electronic means. This listening point was also a way of creating a dual relationship on the users, since they had one experience when they were in one part of the installation producing sounds, and another when they were just listening to it.

Three of the four lateral faces of the cube were covered with glass gongs that were used both as musical instruments and as acoustic reflectors from the exterior sounds. Using glass was also a way of preserving a visual contact with the rest of the installation. On the

upper part of the cube there were four plastic tubes coming from the other four main areas. These tubes acted as resonators, amplifying and modifying the tone of the acoustic sounds produced in each zone.

The central cube, depicted in figure 40, had also four amplified loudspeakers, transmitting the electronic sounds generated in other parts of the installation.

Figure 43: Central listening point.

In short, this area of the installation presented a three dimensional listening experience with several layers of sounds: a quadriphonic electronic layer, an acoustically modified version of the sounds that were traveling through the acoustic resonators, the direct sound from the glass gongs and the general soundscape of the room.

The other four areas were disposed as half cubes, producing interactive areas in and out of their defined zones.

Zone 1 included a variety of daily objects capable of producing unexpected sounds, like an old telephone dial wheel, a comb, clock mechanisms or old toys. All of these objects were connected in a complex tubing system, allowing the users to listen to the sounds in other parts of the tube system and in the central cube. The other face of this zone included a wall of flat metal plates that could be played manually or with rubber balls. This wall of metal plates was opposite a similar one in Zone 2, creating a gong tunnel with two areas, a higher for adults and a smaller for children. The proximity of the ear to the metal plates, and the constant variation in harmonic content as the users walk through the tunnel create a mesmerizing and surprising effect. Zone 2 also contained five wooden

boxes were children could walk inside. Each box had different musical instruments that were played or acted electronically by means of a proximity sensor. In these small areas everyone could have a very personal experience of each musical instrument.

Figure 44: Boxes with sensors. Photo by Miguel Tavares.

In Zone 3, there was a set of five long strings that were played by a small motor and a slider controlled by the users, a glass connected with the Mogees system, allowing the users to perform melodies as they were touching the glass, and a vibrating bed that would receive the string sounds and the melodies generated with Mogees. A user could be laid on the bed, receiving sound vibrations that were produced by other users as they interfered with the installation. Vibrational speakers were used on the wood surface of the bed, and a pair of two small loudspeakers was used to reproduce the Mogees sounds. Both the string sounds and the electronic sounds were also transmitted to the main central cube. Zone 3 is illustrated in figure 41.

Figure 45: Vibrating beds.

Zone 4 had identical functions to Zone 3. A set of five long springs with a motor to control the vibration of the spring, an acrylic panel with several small electronic circuits and devices that produce electromagnetic interference and could be controlled by the users, and a vibrating bed. The same actuation and amplification method was used as in Zone 3. These two zones also produced a corridor, similar to the gong tunnel in Zones 1 and 2, where the sounds from the long springs and long strings would create a similar effect.

In addition to these different zones, a few modified acoustic headphones were produced. These headphones were modifications of ear protection systems used in construction sites, with the addition of some objects that were connected directly to the plastic caging. This creates a drastically different sound perception from the sound sources, since all the sounds were magnified through the proximity to the ear and also through the vibrations induced directly in the head. The modified headphones can be seen in figure 42.

Figure 46: Modified headphones. Photo by Miguel Tavares.

A brief explanation of each of the modified headphones follows.

Headphone 1: Self-violin, with a string attached to the ear.
Headphone 2: Self-spring, with two springs attached to each ear.
Headphone 3: Wheels, with two rotating wheels attached to each ear.
Headphone 4: Sound microscope, with two funnels and tubes that can be placed on the desired sound source.
Headphone 5: Dizzy listening, with two funnels amplifying the exterior sounds, but redirecting the sounds arriving from the left to the right ear and vice versa, through a tubing system.

A new version of INsono was presented during February 2017 at Centro Cultural de Belém, Lisbon. In addition to the sound installation mentioned above, there was a second

room entitled *Experimentário Sonoro*[110], conceived by Henrique Fernandes. In this room several tables with different types of unusual instruments were available for small children to use.

7.9.2 INsono: O Ouvido Secreto das Plantas

The second version of this work is entitled INsono: O ouvido secreto das plantas. It was presented at Jardim da Tapada das Necessidades, Lisbon, on the Lisboa Soa Festival, September 2016.

In this version, there was a higher stress on the listening modes. It was directed to the general public, and it was presented outdoors, in a large open area in a city garden. Since Lisbon is a particularly noisy city, in part due to the proximity of its airport, it seemed relevant to adapt the original ideas of INsono to this specific presentation.

In this version, a central cube was kept, to act as a central listening point. Contrary to the previous version, in which each face of the cube was covered by transparent glasses, here most of the cube was covered by an opaque plastic, creating a sense of displacement to the rest of the garden. The only visual communication with the exterior was through a small window of red cellophane, which totally distorted the traditional image of a garden.

[110] In this room there were several tables with sounding objects where the children could express and explore some of the instrumental techniques observed on the main instrument.

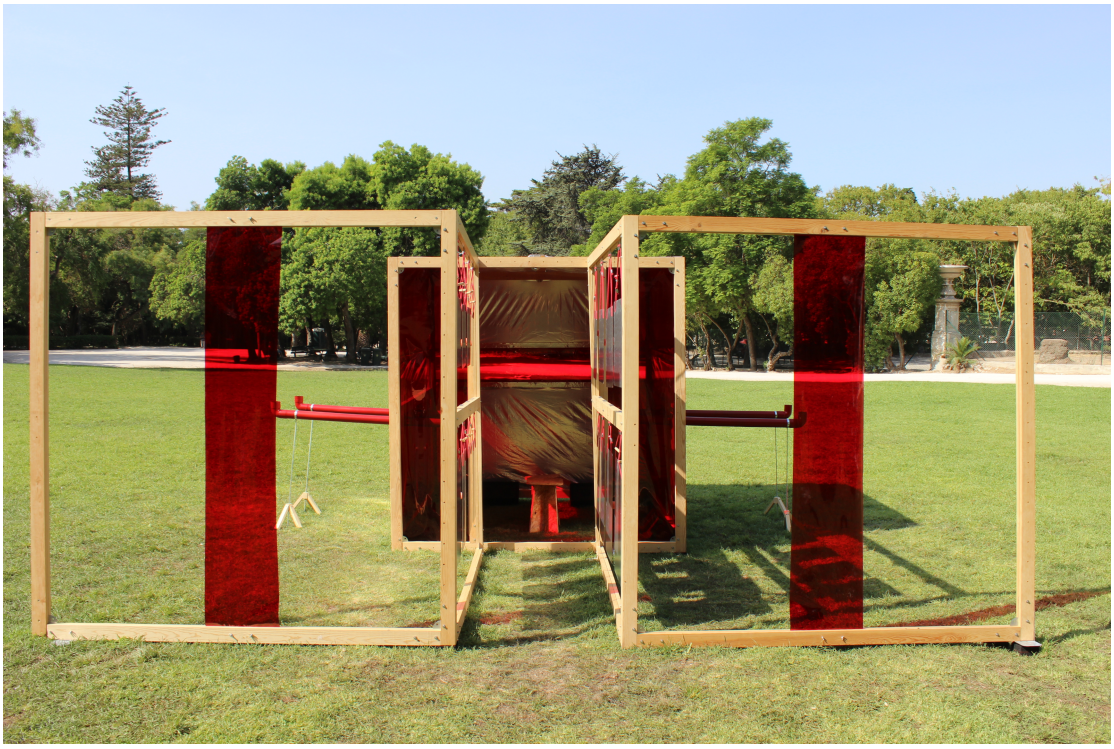

Figure 47: Main entrance.

The entrance to this central cube was done through a narrow corridor with metal plates on the sides, as had been done in the previous version of this piece. This gong tunnel also acted as a listening reset from the exterior sounds. Once inside the cube, the visitors could sit and choose if they would wear a blindfold, which most of them did.

Once inside the cube, the listeners were confronted with three levels of sounds:

1. Landscape sounds: natural sounds from the garden
2. Imaginary landscape sounds: computer composition based on the natural sounds from the garden. It was played on four loudspeakers, placed in each of the corners inside the cube.
3. Proximity sounds: performed by two musicians outside the central cube. The sound was transmitted to the inside through four plastic tubes that also acted as acoustic resonators.

Figure 48: Acoustic emission of the external sound sources.

The resulting musical piece presented in the imaginary landscape level was based on a combination of the following elements.

1. Natural: environmental sound and silence
2. Amplified: reinforcement and distortion of the environmental sounds
3. Displaced: sounds displaced from their original context
4. Complementary: artificial or modified sounds created from the environmental sounds

As an example, the sound of an airplane could be heard as a real sound coming from the sky, a recorded sound coming from the loudspeakers on the ground or imitated by the musicians performing. Since there was no visual contact with any of these sounds, many participants couldn´t perceive which sounds were real and which were not.

Apart from this listening experience, participants were also invited to discover a set of sounding objects, meant to be used individually or collectively to focus on the listening aspect. The set of sounding objects included:

1. Blindfolds, to block the vision and consequent audio-visual correlations and to increase the listening sensitivity
2. Instruments, small sound sources to be played close to the ears
3. Earbees, small devices to record and playback sounds

4. Modified headphones, as explained before in the previous version of INsono

7.9.3 Discussion

INsono is a piece that relies on different forms of sound perception, with a highly visual component expressed in the many sound sculptures and instruments. Being inside many of those instruments also produces new listening formats, either from the special environment created or from the other senses such as smell and touch. The vibrating beds, for instance, create a complex sensorial perception of the sound, connecting the vibration of springs and strings with the sight, smell, hearing and touch. Additionally, a sense of relaxation from the vibrations also contributed to an extension of the whole sound perception.

Despite the first version having been developed for children, it was intended to present new sounds and listening possibilities without relying on stereotyped conceptions of the expectations of the young. Generally, children are very curious and open to any kind of new sonic experience, so in this case the main challenge was to conceive a strategy plan that would organize their listening experience and continuously present them something new and unexpected. During the presentations, a group of four monitors conceived different sound paths, in order to establish musical sequences that would be presented according to the reactions of the listeners.

Regarding the electronic possibilities, adding proximity sensors and arduinos is a highly effective performative form in this case. Also, when dealing with recorded sounds, such as the environmental sounds from Lisbon used at INsono, o ouvido secreto das plantas, the absence of the computer during the performances also contributes to a sense of inhabiting special places, which ultimately also contribute to a more focused listening mode.

7.10 Phobos

Phobos is a set of small robots and automatic music generation devices that form a Dysfunctional Robotic Orchestra, an orchestra comprised of strange instruments with defects, genetic mutations and erratic behaviors.

Phobos represents a critique of the technological overlapping over human thought, the function of labor and modern forms of slavery, as well as a historical retrospective of the various attempts of human liberation through machines, its technological utopias, advances and retreats of freedoms. Its name comes from Greek mythology, where Phobos is the incarnation of fear, and is also the name of the largest moon of Mars, doomed to

disappear due to the proximity of its orbit to the planet. Phobos was conceived by myself as a collaborative creation between Sonoscopia and Teatro de Ferro. Full credits can be accessed in the attachments.

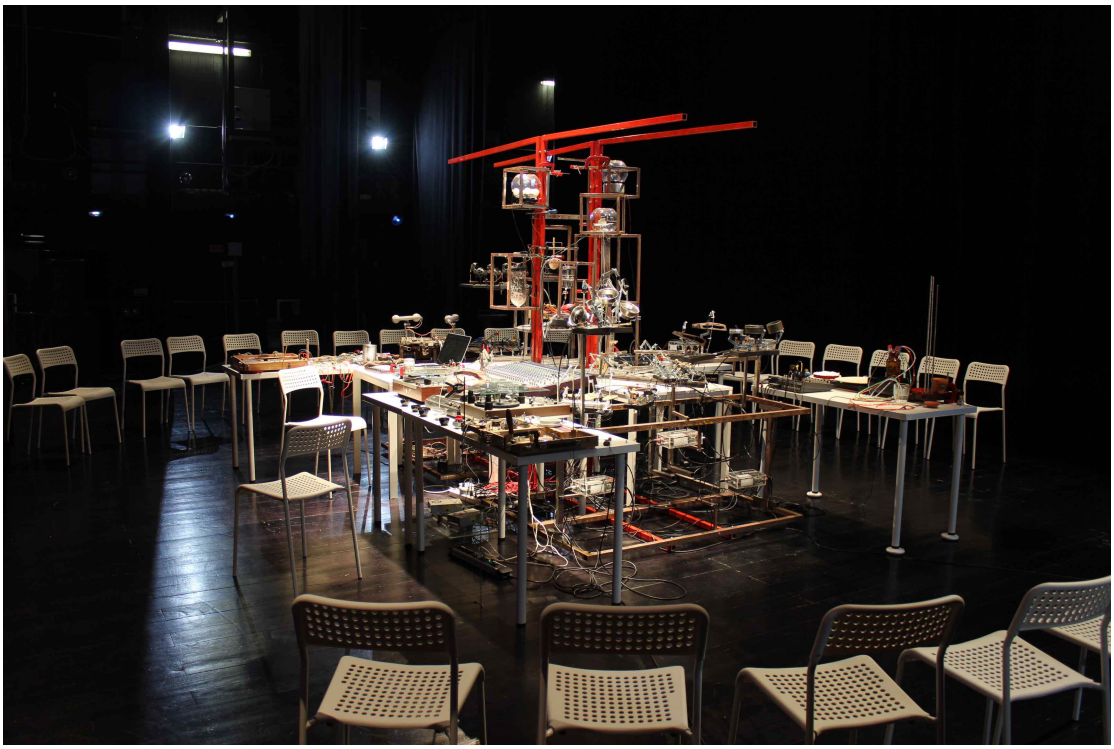

Figure 49: Performance set up with Hanna Hartman.

Phobos was conceived in 2016, as part of what would be the main final practical work on this thesis, and most of the year of 2017 was dedicated just to this project. Many of the problematic issues at the core of this thesis are presented here. Some possible solutions were developed, either through the correction of previous insights provided by other works or by the exaggeration of some expressive problems encountered previously.

The development of Phobos was planned carefully, with a time span that would overlast the period of this thesis. Four principal stages were defined:

1. Development of the technology and the orchestra as an autonomous entity
2. Development of interfaces and re-thinking human-machine relationships
3. Interaction of the orchestra in multidisciplinary artistic contexts
4. Interaction of the orchestra with larger musical ensembles including conventional musical instruments

These four stages were also planned in order to provide specific performative and compositional demands, that would gradually solidify the orchestra as a multi-instrument and emphasize its expressive and creative potential in multidisciplinary artistic works.

Three guest improvisers / instrument builders / composers were invited to work collaboratively on the piece, and three guest composers worked on three distinct musical pieces. For the purpose of a clearer understanding of all these stages, each of them will be treated independently in the next subchapters.

7.10.1 Technological implementation and instrument design

The initial concept of the orchestra involved an outdoor presentation on two big music festivals, Serralves em Festa at Serralves Museum, Porto, and Bons Sons Festival, at Cem Soldos, Tomar. Both of these festivals have an audience attendance of several thousands of people. Bearing this in mind, the first considerations taking into account were the dimensions of the piece, which should be of a significant scale in order to be perceived by a large number of people. Initially, the robotic orchestra would comprise a large number of different sized small automata. These objects would be placed in a structure approximately 15 meters long, 10 meters wide and 5 meters high, with multiple layers where people could actually step inside the structure and perceive all the smaller details contained. This option was gradually transformed into a smaller scale version, due to some factors that included economic viability, transport and logistic costs, adaptation to future spaces and set up time.

For the development of the instruments, a conceptual organological classification was made. Since the main focus would be on the function of work, slavery and freedom, the instruments were grouped into social functions, such as working class, entrepreneurs, retired, bureaucrats, prisoners or clerks. Although some instruments might be slightly allusive to their conceptual functions, such as a central golden pipe organ activated by compressed air, these categories were essentially used for compositional coherence and were not intended to be directly perceived by the audience. These instruments were developed by myself, Henrique Fernandes and Alberto Lopes. During this initial stage, two guest composers / improvisers / instrument builders were invited for a collaborative process, namely Thierry Madiot and Vincent Martial. Their specific knowledge under the fields of wind instruments and automated musical instruments was of higher importance in the development of the orchestra.

Figure 50: Central compressed air pipe organ. Photo by Rui Pinheiro.

Table 3 resumes the instruments conceived for Phobos. A brief explanation of the instrument as well as its actuator form is provided.

Instrument	Description	Actuators	Ensemble
Bronze medals	3 bronze medals played with a toy piano keyboard	3 solenoids	1
Woodblocks	2 blocks of ebony wood	2 solenoids	1
Shakers	3 metal boxes with sand, waste and small rocks	3 solenoids	1
Kitchenware	4 aluminium containers	4 motors	1
Bicycle parts	4 bicycle parts beaten with drumsticks	4 solenoids	2
Steel rods	4 construction rods with different sizes and pitch	4 motors	2
Steel tubes	4 construction tubes with different sizes and pitch	4 motors	2
Drums and gong	2 drums and one metal plate	3 solenoids	2
Typewriter	Modified typewriter	1 motor	3
Old telephones	Two old telephones with loudspeakers	2 servo motors	3
Modified turntables	Turntables with modified needles and prepared with magnets	2 relays	3

Modified walkman	Delay line with two walkmans	1 relay	3
Mecano station	3 cog wheel devices made from mecano parts	3 motors	4
Toys	4 modifies dog toys	4 relays	4
Springs	4 different sized springs	4 solenoids	4
Percussive string	String played in different zones with aluminium bars	3 servo motors	5
Loose strings	Amplified pieces of loose strings in a saw blade	1 motor	5
Prepared vinyl disc	Vinyl disc with holes and metal parts	1 motor	5
Christmas lights	Christmas lights with electromagnetic amplification	2 relays	5
Random pendulum 1	Loose spring hitting drums	1 servo motor	6
Random pendulum 2	Loose spring hitting strings	1 servo motor	6
Fluorescent lights	4 fluorescent lights with electromagnetic amplification	4 relays	6
Percussive harp	7 strings percuted and bowed	7 solenoids; 3 motors	7
Prisoners	9 boxes with amplified water bubbles, objects, toys and Styrofoam balls.	3 relays; 6 motors	8
Compressed air organ	6 pvc tubes of different lengths and pitches played with compressed air against a balloon reed; one drum with Styrofoam balls moved with compressed air.	7 solenoid valves	9

Table 3: Phobos's instruments.

As seen in table 3, each instrument was controlled by an Ensemble, an arduino controlled circuit that receives midi messages and communicates with a central computer. The hardware was conceived and programmed by Tiago Ângelo. During the process, many unexpected problems arose around the development of the circuits. The main problems were related with voltage, such as loss of power with distance or overpower consumption by some mechanical devices when faced with less predictable actions. Having most of the problems solved, the whole system was based on nine different Ensembles, controlled by a midi out from any midi device. The midi protocol was used due to its universality and easiness of use by a large number of musicians and composers. The complete code and circuitry developed by Tiago Ângelo is freely available at:
https://github.com/Sonoscopia/Phobos.

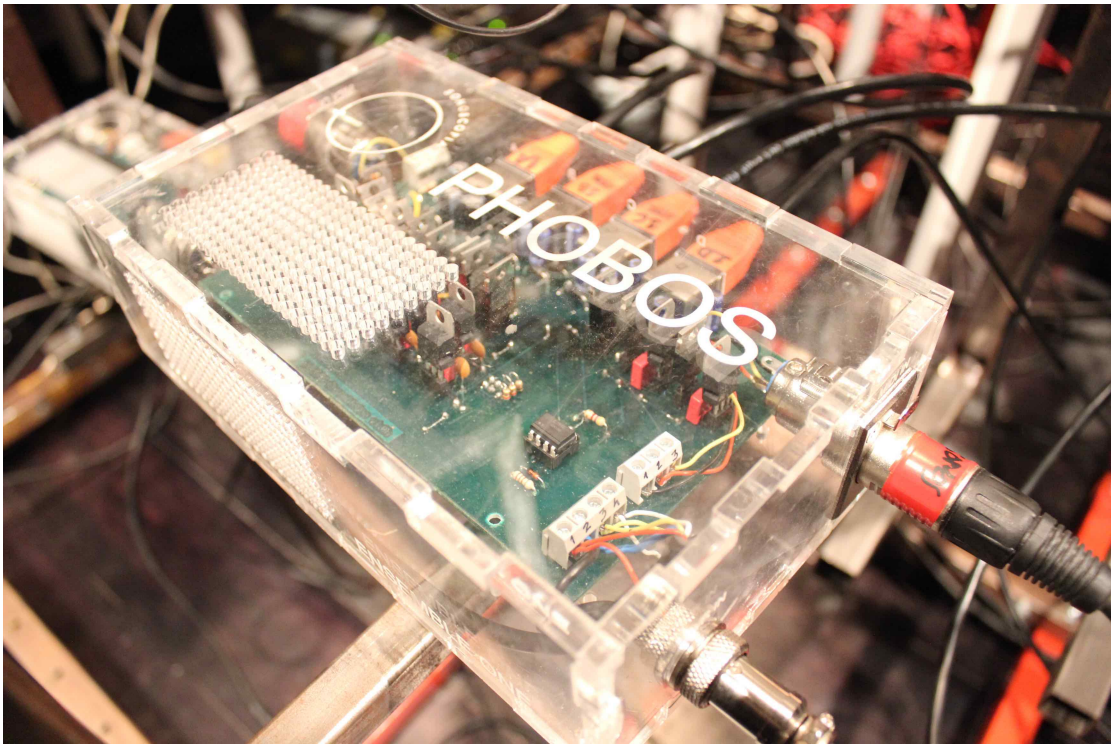

Figure 51: One of the nine ensembles that control the orchestra.

7.10.2 Composition

In order to have an external view on the musical possibilities of the orchestra, three pieces were commissioned to composers Rui Dias, José Alberto Gomes and Carlos Guedes. Despite not being directly connected with the development of the orchestra, the three composers already worked collectively with me on many different occasions, including the projects Phonambient and Phonopticon debated here in this chapter. Aesthetically, all of them knew the type of musical material and direction that was expected from this project.

Since some of these composers did not had access to the orchestra beforehand, a recording of all the sound samples from each instrument was provided to the composers. This allowed them to work comfortably in their computers and have a close idea of what the ultimate result of the piece would be when performed. Naturally, there are some differences in the final output, but since most of the sounds rely on controlled durations and intensities, the result became very similar with the idealized. The three pieces where entitled Phobia Robotica, by Carlos Guedes, Intelligent robots will take my job, from José Alberto Gomes, and Hands off!, from Rui Dias.

7.10.3 Human-machine relationship

During the second phase of this project, particular attention was given on the interaction between human performers and the automated machine. For this purpose, a third stage of work was conducted with guest improviser Hanna Hartman, whose work has always been a source of inspiration to many of the instruments developed at Sonoscopia. Since her work is focused on a highly visual complementation of a detailed sonic world, her contribution was of great importance in the development of this project. With Hanna Hartman, a one week residency period was developed at Centro Cultural da Gafanha, in order to create a final musical improvised piece that would reflect the main concerns on how to perform with a semi automated device.

The main goals were defined as conceptual, musical, and technical. Regarding the conceptual part, a choice to include objects that would complement the dystopic technological concept of the piece was made. These objects include rusty metal parts that were used as conductors for the Makey Makey controller, turntables with magnets, broken electrical parts, electromagnetic microphones and acoustic laptops that would also be used as metal conductors for the electronic control. Figure 48 presents one form of controlling parts of the orchestra with the physical touch of metal springs.

Figure 52: Springs connected to a Makey Makey to control the orchestra.

Musically, these objects intended to provide a more clear relationship between the gesture and the musical output. Since many parts of the orchestra are played by almost hidden solenoids or motors, it was deliberately chosen to add a visual gesture that would

reinforce the production of the sound. A physical connection between the performer and the machine was obtained, and potentially the audience would decode more easily some of the sound production means involved.

An additional step in this phase was obtained with a performance at Festival Internacional de Marionetas do Porto (FIMP). For this performance, I composed a 35 minute piece entitled 1999, for the orchestra and two musicians. The goal of this piece was to test some of the possible future possibilities regarding the inclusion of additional instruments and stage elements, such as lights. Some scenical solutions, such as the inclusion of a narrative and symbolical actions were also included.

The instrumentation included brass instruments played with clarinet mouthpieces over long plastic tubes, a twintar[111], soundboxes, rocks, woodblocks, turntables, floor toms and a bass drum.

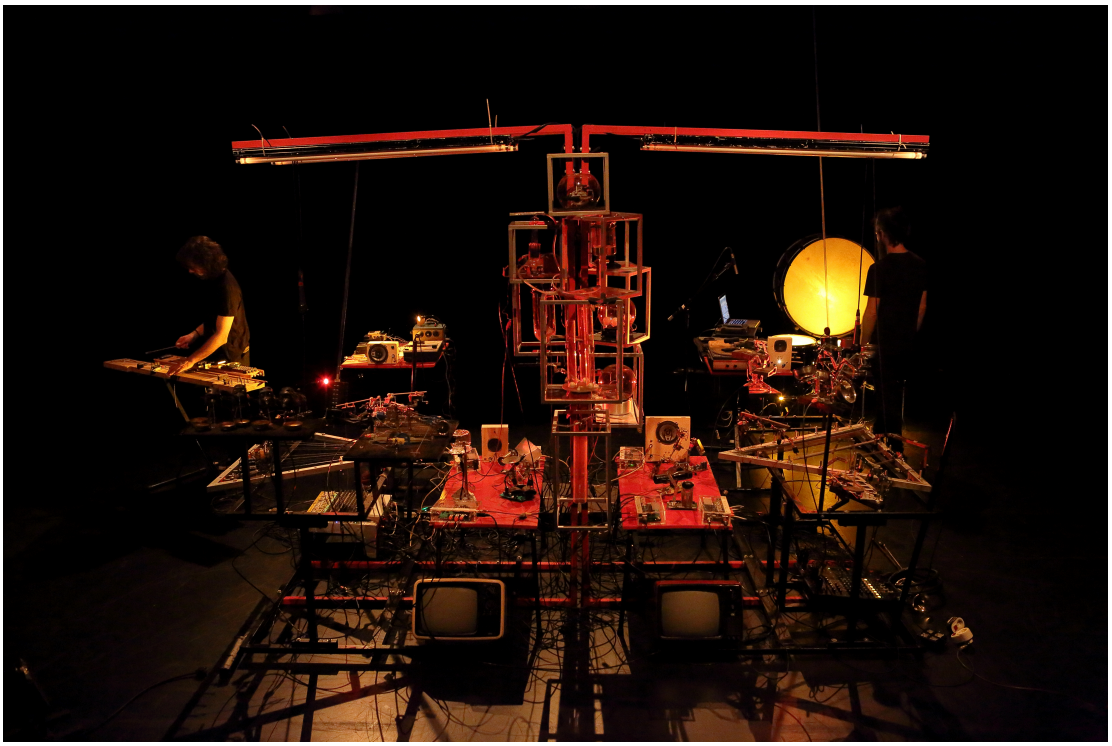

Figure 53: 1999 performance at FIMP, Porto. Photo by Susana Neves.

7.10.4 Multidisciplinary contextualization

Phobos was created to have a significant visual impact. As mentioned, this visual complement should reinforce the expressive and interactive possibilities of this computer-

[111] Twintar is an instrument developed by Alberto Lopes in 2001. It consists of a string instrument with two horizontal necks to be performed by two persons. As a result, the action of each musician influences directly the note the other musician is playing.

based instrument, without being a simple distraction to the music itself. Naturally, in an instrument with this dimension and visual impact, the music has to be considered carefully and articulated in a manner not to become secondary or ornamental.

It was well known since the conception of Phobos that a mere automatic reproduction of composed pieces would raise some performative questions. From the beginning, human and interdisciplinary interactions were planned. Since the conception of the scenography and structure of Phobos was developed by a director and puppeteer I have been working regularly over the last years, a piece combining Phobos, musicians, actors, puppets and video was conceived. The piece, entitled W, will continue conceptually the relation between human and machine, labour, modern slavery and freedom. Musically, this piece intends to provide a logical continuation of the previous work. Particularly, musical and physical gestures intend to be carefully analysed, since this was an obvious limitation with the fully automated instrument.

Besides the human interaction with the instrument, the complement with video and a lighting design will help to clarify some expressive problems encountered previously, and hopefully magnify some automated acts that have been obscured by the lack of physical magnitude of some motors and solenoids. By doing this, a deeper relationship is expected to be created with the listener, since it can be consciously decided to include cause and effect sonic relationships or not.

7.10.5 Further musical considerations

A new musical composition for the orchestra was commissioned to Austrian composer Lukas Ligeti for the year 2019. The decision to work with an external composer will contribute significantly to have a different approach to the musical possibilities of Phobos. The choice of this composer is related to his work with automated musical instruments, his career as an improviser and his compositional skills, which make him, at least theoretically, one of the best options to develop the proposed work with Phobos. By having his own musical techniques and creative aspirations, I expect to find new compositional and performative possibilities within the orchestra, since each composer has different aesthetic visions and consequently new paths will certainly be discovered. The piece commissioned is temporarily entitled Humanautomata and, as the title suggests, deals with the automation of musical processes and the humanization of machine musicianship. The instrumentation, besides the orchestra, consists of six other musicians. Three will perform non-conventional instruments that have been developed by the Sonoscopia collective, and the other three musicians will play piano, harp and cello. Additionally, Lukas Ligeti will also perform himself on the Marimba Lumina, a Midi controller developed by Don Buchla that was conceived for percussion players. This controller will be used to play parts of the orchestra, and also as a stand-alone instrument connected to a computer.

The purpose behind this instrumentation is to test the sonic possibilities of the orchestra when combined with conventional instruments. By doing this, I expect not only to complement the spectre of the orchestra, but also to test musical situations between improvised and totally composed parts.

7.10.6 Discussion

Being the latest and longest work developed under this research, Phobos synthesises a significant part on many of my personal considerations and expectations of live electroacoustic performances, particularly the ones including computer-based instruments. Its dystopic and dysfunctional conceptual character symbolize many of my concerns regarding electronic music. A theoretical limitless world of possibilities is often a source of many technical and artistic problems, and Phobos was conceived as a natural way of incorporating errors in a critical way.

There is a clear interest about presenting an outstanding and visually appealing result. The dimensions and intricate details of the whole object produce a surprising effect. Almost immediately, the spectator´s attention is turned into the decoding of the origins of the sounds. Since most instruments present unusual sound sources, or sounds that emerge from unexpected daily objects, a sense of surprise and curiosity from the listeners is frequently reported in the public presentations.

A major concern in the conception of the orchestra was the inclusion of mechanical gestures that would create a visual and conceptual relation with the music being produced. Since many instruments were actuated by small motors or solenoids, there was a need to include instruments with bigger gestures. To solve this problem, some instruments with bows, compressed air and randomly behaving springs were included. Still, the orchestra is lacking movement, particularly when it is presented in big outdoor spaces where many of the sound actuators cannot be perceived at a long distance.

Musical gesture is also meant to be complemented with live musicians and other non-musical parameters. This process has already started with the development of the pieces W and Humanautomata. At the present moment new interfaces are being planned to interact with the orchestra, namely a prepared piano keyboard that will be used to control digitally some parts of the orchestra and also to play additional acoustic sound sources. This option will make the orchestra a viable piece to be presented as an interactive stand-alone piece.

Another aspect that was planned from the initial conception and that is still not functioning properly is the dynamic equilibrium of the instruments. At the present moment the dynamic range in the instruments is very limited, due to the mechanical restrictions of the solenoids used. The instruments also produce acoustically different signals, from very low, as in the case of the magnet turntable, of very high, in the case of the compressed air pipe organ. Other instruments, such as the modified tape recorder or the Christmas lights,

require amplification in order to be heard. So, to balance the level of all the instruments, all sound sources have to be amplified and mixed properly, which can become problematic due to the large number of small instruments involved.

The long and exhausting development process also induced some errors in the hardware conception and in the development of the physical structure. Since most of the circuits were soldered manually, a few of the control boxes still need some correction. In terms of the practicability of the piece, the connection to each individual instrument, and the tuning system of each of the actuators also needs to be revised.

One of the main problems at the moment is related with composition issues. Dealing with a new instrument requires time, practice and listening, and since there are only four composition written for Phobos at the moment, there is still an enormous work to be done in this field.

7.11 Tars

Tars is sound installation and musical performance that was premiered in Braga, at the Noites Brancas Festival 2015. It was submitted as part of a public call for works and it was one of the selected by the jury. Like most of the works presented here, it was conceived collectively as Sonoscopia, and performed by Henrique Fernandes, Alberto Lopes, Alexandre Soares and myself.

This work consisted of the exploration of the strings as a compositional material, hence the word Tars, derived from the Persian meaning attributed to string instruments. In Tars the sonic explorations would rely not only on traditional forms of playing string instruments, like with a plectrum or with the pulp of the fingers, but on a combination of techniques that derive mostly from the legacy of musicians like Fred Frith, Hans Reichel or Keith Rowe. Among these techniques is the use of objects to transform the sounds obtained on a normal tensioned string, in a similar approach to the prepared piano techniques developed by John Cage in the 1940's[112]. Some of the objects used in Tars can be seen in figure 50.

[112] Preparing a piano consists of introducing objects like paper clips, rubber or screws on the strings of the piano, altering the original sound expected from a piano to sounds closer to percussion instruments (Griffiths, 1989).

Figure 54: Motors and sound sources.

Tars also differs considerably from traditional approaches to string instruments, because it is based on a single board that is performed by four musicians simultaneously. The strings are displayed in different angles and dimensions of the board, with some of them crossing at nodal points and thus enhancing the higher harmonics and not the fundamental frequency of each string. Since each string is also physically connected to another, each time a string is plucked, it actually plays more than one string at the same time, resulting in a sound resembling percussion instruments.

Figure 55: General view of Tars.

One of the interesting characteristics of this instrument is the possibility that each musician has to interfere in the sound production of another musician. A string played on one side can be in touch with another string played by another musician, altering the harmonics and possible combination of sounds. By manually placing objects or performing with different types of materials under each string, it is also possible to change drastically the timbre of each string. Another important aspect in Tars is the use of E-bows[113] and motors to play automatically the strings. On each motor there is a different mechanism to pluck the strings, ranging from thin wires to wood balls. Figure 52 depicts the actions of motors over the strings of the Portuguese guitars.

[113] E-bow is an electromagnetic string driver, invented by Greg Heet in 1969. It is a common tool among electric guitar players, particularly those involved in the fields of Experimental music, due to its eerie sound.

Figure 56: Motors controlling strings.

To complement the collective possibilities of this instrument, each of the sides of the central square board had a string instrument controlled individually by each performer. These string instruments were displayed horizontally and also designed by the performers to become fully integrated in the ergonomy of the general instrument.

Tars was complemented with the placement of several traditional string instruments in the surrounding rooms of the performance space, an old house that was chosen for its scenic possibilities. The strings chosen were mostly Portuguese guitars, but also some traditional string instruments from the Minho area, like the Guitarra Braguesa. These instruments were chosen mostly for their unusual use outside the traditional musical contexts in which they are normally performed. They were played automatically by motors, controlling several objects that would pluck, hit and bow the various strings. Since some of these objects were suspended, they produced indeterministic rhythmical results under a very well defined range.

Tars was mostly improvised, although three structures were defined to create three distinctive pieces. General parameters like duration, specific techniques and small musical motifs served as a guideline to control the general direction of the improvised sections.

7.11.1 Discussion

Despite using several electronic devices, Tars is not a computer-based musical piece. However, some parts of the piece acted as a starting point for other works, namely Phonopticon and Phobos.

A central technical aspect on Tars is the inclusion of dc motors, used to play on strings, either with special beaters, nylon parts, rods or wheels. The motors were used to control several Portuguese guitars, and also the central piece with the interconnected strings. Most of the motors were placed on fixed positions, but some were performed by the musicians, moving them along the strings according to the musical needs. During several times, the discussion about whether or not these motors should be automated and controlled by a computer arose. Naturally, the computerized control would have produced more complex possibilities, but for economic purposes and simplicity, the manual version with motors operated by batteries was chosen. During several occasions, the amount of technical problems related with arduino and computer programming was considered to be, in this particular case, more an obstacle than a liberating aspect.

7.12 Transarkiv

Transarkiv is a real time web application for automatic music generation, conceived as a complement of other works developed by the Sonoscopia collective. It was programed by Rui Dias and Tiago Ângelo and it was conceived by myself, with significant contributions from the programmers.

Transarkiv is a project for dynamic documentation, acting as a database for finished and unfinished artistic pieces, theoretical and practical connections and also work processes. Transarkiv also transforms itself, through a combination of algorithms applied to the contents of the archive, generating new contents from the original data. It is also possible to use this application in a manual mode, controlling a series of parameters that will be explained in the following lines.

Figure 57: General view of the software.

This project was developed to provide some compositional possibilities with the combination of previously selected categories of sounds. One of the goals was the articulation with another project mentioned earlier, Phonambient, and to allow the live performance of material based on sound files. As described, Phonambient stores a huge amount of field recordings, and it is particularly interesting for us to discover new ways of articulating these recordings in new compositions and creative artifacts.

The categories of sounds were chosen in order to present universal names that can be recognized by any user, as was made in Phonambient. Sounds were grouped in categories that, played simultaneously, would function as a composition. Due to the limitations of the current server, and also to preserve compositional cohesiveness, each category has presently ten sound files. It is possible to change the current database to a larger or different one. A brief description of each of the six categories follows.

Category	**Description**
Field Recordings	Selection of the recordings from the sound map Phonambient
Ambient	Sound masses, drones and general ambient
Textural	Textural sounds, ornamentation
Rhythmic	Detailed rhythmic contents
Melodic	Detailed melodic contents
Performance	Excerpts from finished and unfinished performances

Table 4: Available categories of sound at Transarkiv.

As mentioned before, Transarkiv has two basic modes, automatic and manual.

In the automatic mode, a group of sounds is automatically loaded. The functions Autoplay and Automove will play and move the sound files according to the specified rules of the algorithm applied. Each file will move freely on the X and Y axis, X representing

panoramics and Y volume. To each sound file is also associated a filter, that in this mode will be chosen automatically by the computer.

In manual mode (switching off autoplay and automove), a user can add or remove any sound from each category, moving them manually on the X and Y axis in order to have control over panoramics and volume. The filter can also be changed manually, by clicking over the filter area and then moving the track pad up or down. There is the possibility to change the bandwidth and the central frequency of the filter. There is also a spectrograph for the visualization of the output being generated.

It is also possible to record each performance or automatic generation, by clicking the record button.

Transarkiv can be accessed on the following web link:
http://www.sonoscopia.pt/transarkiv

7.12.1 Discussion

Transarkiv is a simple, yet very effective tool for sound generation based on samples and field recordings. Since it accesses a very well defined database, it is possible to have a coherent compositional control over the output produced. However, with the current limitations of the server where it is hosted, the results produced tend to be similar after a few performances with the application. The current sounds were created by myself, which may be inappropriate for other people to use in their own personal projects.

Future developments include the expansion of sound processing tools in real time, the possibility to work with personal databases and the optimization of the application for use with larger amounts of information.

7.13 Conclusions and debate

The pieces debated here present several strategies to solve some of the problems that are on the base of this thesis. Through many different output forms and through an enormous group of contributors and collaborators, a large body of work was produced, documented and analysed. Not only the content of these works will be significant in the definition of a consistent personal framework, but it can also be continuously studied and continued by others.

In the pieces conceived, it was of key importance to develop approaches of different types to provide wider and universal results. These pieces ranged from solo works to large ensembles and from sound installations to concert pieces. They were also presented for

many different types of audiences from all ages and social backgrounds, and in many different places, such as art galleries, auditoriums or underground venues.

A highly important aspect is the development of these works under the conditions under which professional musicians conceive and perform their music. As an example, a commission by a renowned institution or festival presents additional challenges that definitely should be taken under consideration when reflecting on music creation. Many aspects such as economical viability, transport, logistics, reliability or complex ramifications to a particular socio-political content are frequently forgotten in many academic studies, which can lead to a significant detachment from the reality of musical practice and, consequently, meaningless results and illusory conclusions.

A significant contribution on these pieces was made by some of the leading artists in the experimental music field, namely Peter Evans, Thierry Madiot, Vincent Martial and Hanna Hartman, and a new piece is being conceived with composer Lukas Ligeti. Their contribution introduced new perspectives from the works being developed, contributing to a solid musical output that has already undergone a revision from experts in the field under which this research is based on.

Chapter 8

Conclusion

"I have no fixed idea as to where all this is leading; I have no definite vision of the future, no overall plan; from one work to the next, I grope around in different directions, like a blind man in a labyrinth. As soon as a further step has succeeded, it's already gone in the past, and then there are any number of conceivable ramifications for the next step."

(Gyorgy Ligeti in Toop, 1999, p. 179)

8.1 Summary

This thesis was based on the hypothetical premise that expressiveness and interaction can be emphasized by the definition of compositional strategies, performative routines and technical limits. In order to provide some possible solutions to the problems encountered and defined, a review of the state of the art and the definition of eleven musical pieces was made. These pieces involved a large number of participants and were composed / improvised in order to gain some insight into some particular aspects that arose during the definition of the problematic areas. A significant part of these problems were felt in practical personal experiences, and to allow a global perception and communal discussion, were broadened into general problems grouped into three main areas: composition, performance and technical implementation. The pieces were developed under professional circumstances that included renowned institutions and festivals, providing realistic scenarios that produced clear results.

Defining and measuring expressiveness and interaction is a complex task that involves many aspects such as technical efficiency, intellectual communication, aesthetic and social codes, varying perceptually according to different authors and sociological contexts. In this thesis, it was circumscribed in the areas of live electroacoustic improvisation, whose aesthetics and goals have been defined in the first chapters and over the production of musical pieces. Providing exact and measurable results would have been impossible due to complexity of related subjects, as seen. So, a definition of the efficiency of the communication of artistic goals was used to relate the effects of each compositional and improvisational strategy with the enhancement, or not, in expressiveness and interaction in

live performances. The definition of a framework based on improvised or partially improvised contexts also provided significantly different observations from those in more conventional composed pieces. In fact, enough evidence was gathered that demonstrated the difference that occurs in the use of computer-based instruments in controlled composition environments and in improvised live contexts. Establishing these differences was fundamental to define precise problematic areas that restricted expression and interaction.

A significant aspect is the observation of the current technological state surrounding computer-based instruments. From the myriad of possibilities encountered in personal and commercial devices, it seems clear that there is enough technological development at the present times to allow any kind of expressive musical performance. Not only computers are powerful enough, but also available to a large number of people. Interfacing computer-based instruments also has been made with buttons, faders, knobs and sensors of all types, leading to a conclusion that technology is not the determinant constriction in live performances. As a consequence, a focus in composition / improvisation and performance needed to be established.

From the compositional / performance point of view, time seems to be a major problematic issue. The current technological state provides us a daily renovation of the existing products. Since our society has became so dependent on computers and digital technology, a marketing demand to create new products, new software versions and new gadgets keeps producing technical output that is simply faster than our ability to reflect, compose and perform consistently. Computer-based instruments, particularly, became dependent on the market strategies and social dictations of a product, whose function as a musical instrument is only residual when compared to the global uses of it. As a consequence, computer musicians often need to learn new instruments, new mechanical gestures and adapt to a medium that is heading in a technological direction that do not match most of the musical needs. Additionally, the apparent infinity of possibilities present in most computer-based environments can also lead to an endless unfinished process in the definition of artistic goals. Paradoxically, it is the illusion of the infinity of choices that regularly limits expression and interaction, due to a frustration dilemma with the confrontation of the limits of the human creativity.

Defining the limits of a computer-based instrument can then produce successful results. Once again, this apparent simple statement is related to a variety of complex connections. A first obstacle concerns improvisation, which by definition theoretically implies anything possible. If, in acoustic instruments the limitation is dictated by the physical constrictions of the instrument itself and the technical abilities of the performer, in digital instruments, a simple button can produce any possible sound. So, it is fundamental to derive a personal compositional reflection in order to clearly define the musical material, phrasing, dynamics and versatility of the instrument. An improper definition of these contents will negatively interfere with the development of the technical

component, the interface, the performance and, consequently, the expression and interaction.

Defining the musical boundaries and the technological needs for a particular piece or improvisation will then provide a well-defined musical instrument, whose performativity can be explored in similar manners to those in acoustic instruments. Many electronic musicians have established successful performative relations with their instruments based on routines and gestures that are perfected in the daily practice of the instrument. These procedures will then increase the confidence and comfort with the instrument, an aspect that is clearly perceived by the audience and that consequently feeds back to the musician as a signal of successfulness in the transmission of a musical message. This process, not distant from the mastery of an acoustic instrument, could also be perceived by other improvisers in a live context, resulting in theoretically ideal interaction formats.

In order to achieve the necessary comfort with a musical instrument, several tactics explored in the pieces presented in this research provided successful results. A discussed topic by many digital improvisers is the un-identification of the source of the exposed sounds, which can create, in specified conditions, a lack of communicative relation with the other musicians and the audience. The exploration of elements such as real-time sampling, complementation of the computer with acoustic instruments and the use of physical interfaces pointed some possible solutions for expressive enhancement. The introduction of physical elements, either in the form of acoustic instruments, processed or not by the computer, or with midi controllers where a determined gesture produces recognizable musical outputs, also introduces forms of instrumental engagement typically associated with acoustic instruments. The desire to obtain this type of biological response from a determined musical action might not be essential for all the performers, but it is nevertheless fundamental for the definition of a desired type of expression. Also, this traditional conception of musical instrument might be helpful for some musicians in the definition of goals and the feeling of achieving a particular difficult task, which might lead to a satisfactory performance condition. This condition does not imply a strict defence of virtuosity, since a musical definition of the goals would determine the limits between a musical interpretation and an entertainment act.

Despite the advantages of many of the processes of standardization that are debated here, it is fundamental to decide what should be stabilized, and what should be constantly evolving. In fact, one of the main potentialities in computer-based instruments is the ability to constantly transform and renew musical composition and performance. Over the last years, computers have produced musically diverse output forms, such as staged concerts, sound installations, interactive pieces, acousmatics, sound sculptures, soundscape compositions, sonic art forms or audio-visual pieces, and our conventional notion of how music should be made and heard has changed. If, in the past, music production was essentially related with a clear relation between time and pitch, nowadays new listening formats emerged, from non-linear musical representations to

transdisciplinary sonic complements. Computers are an excellent vehicle for many of these new manifestations, allowing the materialization of musical thinking that does not rely on the physical limitations of the human being.

In the pieces conceived for this research, significant emphasis is put on the singularity and visual impact of the instruments that served as basis for the music. This theatrical complementation is not seen as a distraction from the music itself, but as a distinct musical element that takes form as a physical object, a light source, a video, scenery or a costume. Presenting unique environments is definitely contributing to more varied expressive conditions, particularly when combined with sound spatialization formats and amplification techniques that rely on the concept of a performance as a spectacle involving many different creative components. It is not possible to totally dissociate a public presentation with the surrounding sociological embedded codes where it is presented. It seems then evident that a reflection and musical incorporation on the elements surrounding the music is necessary to fully enhance expressiveness.

Naturally, a correct balance between the many different elements discussed here will be dependent on personal choices according to particular musical situations. The conclusions arising from this research do not intent to provide one singular direction. Instead, they provide clear results that can be partially adopted, combined or transformed by a large musical community.

8.2 Original contributions

For this research, several original music pieces were developed focusing on specific problematic points, generating a large body of work that included not only my own creations, but also collective and parallel work developed by other artists. The most significant artistic contributions are the pieces Halcyonian (2015), Variations on Tautologos III (2014), Control and Unpredictability (2012 – present), Phonopticon (2015 – present), Phonambient (2013 – present), INsono (2015 – present), Transarkiv (2016), Tars (2015) and Phobos (2016 – present). A large number of these pieces are under constant development, since they rely on compositional strategies that transform them over time. The results obtained allowed me to draw conclusions that contribute to a communal discussion around the themes of expressiveness and interaction in electroacoustic music.

The works presented were conceived having in mind multiple presentation possibilities, taking the form of concerts, sound installations, collective musical instruments or transdisciplinary pieces, providing musical outputs with great diversity and in different degrees of complexity. Some of these works were based on electroacoustic musical instruments developed by myself or adapted to specific musical contexts.

The public presentations were held at auditoriums, bars, art galleries, public gardens

or squats, ranging from highly renowned institutional places to underground performance spaces. The presentations took part in several different countries, providing privileged information that far exceeds the results that would be obtained in perfect laboratorial scenarios.

During this research several lectures, publications, audio and video recordings were produced and documented.

8.3 Guidelines for future work

A significant part of the works presented here has been continuously updaded over the years. Pieces such as Phonopticon, Phonambient and Phobos, particularly, were developed having in mind a constant reconfiguration and complementation that will continue to produce results in the future.

The next years will be devoted to the consolidation of instrumental and compositional techniques. During this research, a large number of new instruments and new technology was developed, and it is extremely important to solidify the new possibilities offered by means of routinal performances and compositional exercises. This process requires a necessary amount of time that includes practice, performance, composition and reflection in order to fully mature the essence of these pieces, the music.

Three works of considerable dimensions are planned for the next two years, based around the development of many of the musical instruments and compositional strategies presented here. Atlas de Instrumentos Utópicos (Atlas of Utopian Instruments) is a set of new acoustic and digital instruments that rely on the development of new instrumental techniques and the creation of specific repertoire. Around Phobos, Dysfunctional Robotic Orchestra, two new works are being conceived. W, for robotic orchestra, small ensemble, puppets and video explores the physical interaction between human and an automated machine, complementing human gestures with robotic movements, lights, video and a staged puppet piece on the subject of work and its multiple forms of slavery. The second piece is entitled Humanautomata, composed by Lukas Ligeti and performed by the robotic orchestra and a small ensemble of traditional and unconventional musical instruments. In this piece, gestural movements and musical interaction between conventional and unconventional sound sources will be explored.

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Attachments: Works

1. Halcyonian

Credits:

Composition and performance: Gustavo Costa

Special guest appearance: Peter Evans

Sound spatialization: Eduardo Magalhães

Recording, mixing and mastering: Gustavo Costa

Video: Joana Domingues

Photos: Joana Domingues and Gustavo Costa

Executive production: Rui Penha and Jorge Coelho / Orquestra de Jazz de Matosinhos

Public presentations:

3rd and 4th December 2014 | Cara Ano Zero | Cine Teatro Constantino Nery, Matosinhos, Portugal.

27th May 2015 | Música Viva Festival | O' Culto da Ajuda, Lisbon, Portugal.

Web links:

www.gustavocosta.pt/works/halcyonian

2. Variations on Tautologos III

Credits:

Composition and performance: Gustavo Costa

Recording and mixing: Gustavo Costa

Mastering: José Alberto Gomes

Photos: Gustavo Costa

Video: Gustavo Costa

Executive production: José Alberto Gomes / Digitópia / Casa da Música

Public presentations:

20th December 2014 | Old New Electronic Music Sessions / NOS Club | Casa da Música, Porto, Portugal.

Web links:

www.gustavocosta.pt/works/tautologos

3. Encode / Retrieve

Credits:

Composition, computer and objects: Gustavo Costa

Flute: Alessandra Rombolá

Harp: Angélica Salvi

Percussion: Diego Ventoso

Piano: David Durán

Video: Gustavo Costa

Photos: Gustavo Costa

Executive production: Pablo Coello / Vertixe Sonora

Public presentations:

23rd May 2015 | Musica y Arte: Correspondencias Sonoras 2015 | Centro Galego de Arte Contemporânea

Web links:

www.gustavocosta.pt/works/encoderetrieve

4. Control and Unpredictability

CAU no. 1 credits:

Composition and performance: Gustavo Costa

Recording, mixing and mastering: Gustavo Costa

Photos: Alessandro Olla and Franco Casu

Executive production: Alessandro Olla / Signal

Public presentations:

16th November 2013 | Da Dove Sto Chiamando Festival | Pallazo di Citá, Sardinia, Italy.

Cau no. 2 credits:

Composition: Gustavo Costa

Technical Implementation: Gustavo Costa and Eduardo Magalhães

Photos: Miguel Tavares

Video: Miguel Tavares

Public presentations:

28th October 2013 | Future Places Festival | Sonoscopia, Porto, Portugal.

CAU no. 3 credits:

Composition and performance: Gustavo Costa

Acoustic laptops and sounding objects: Alberto Lopes and Henrique Fernandes

Photos: Sofia Afonso, João Bento and Gustavo Costa

Video: Sofia Afonso

Executive Production: Nuno Torres / Ricardo Jacinto / OSSO

Public presentations:

29th November 2013 | Echoes Festival | Estufa da Tapada das Necessidades, Lisbon, Portugal.

CAU no. 4 credits:

Composition and performance: Gustavo Costa

Percussion and string instruments: Jorge Queijo and Alberto Lopes

Photos: Gustavo Costa

Executive production: Rivoli Teatro Municipal

Production: Patrícia Caveiro / Sonoscopia

Public presentations:

21st March 2015 | Understage | Rivoli Teatro Municipal, Porto, Portugal.

CAU no. 5 credits:

Composition and performance: Gustavo Costa

Harp: Angélica Salvi,

Electronics: José Alberto Gomes and Miguel Carvalhais

Recording, Mastering and mixing: Gustavo Costa

Executive production: Xoán-Xil López and Angélica Salvi

Public presentations:

6th May 2016 | Festival Sons Creativos | Casa do Saber, Lugo, Spain

24th March 2017 | Festival Tripas | El Planeta de Los Wattios, Madrid, Spain

Web Links:

www.gustavocosta.pt/works/cau

www.sonoscopia.pt/works/cau

5. Phonambient

Credits:

Artistic direction: Gustavo Costa

Executive production and communication: Patrícia Caveiro

Archive and documentation: Patrícia Caveiro and Sara Gomes

Laboratorial trainers: Alberto Lopes, Eduardo Magalhães, Henrique Fernandes, Gustavo Costa, José Alberto Gomes, Filipe Lopes, Manuel dos Reis and Rui Dias.

Artistic team: Alberto Lopes, Carlos Guedes, Henrique Fernandes, Gustavo Costa, João Mascarenhas, José Alberto Gomes, Filipe Lopes and Rui Dias.

Local coordination: Braga: Rui Dias; Tondela: Eduardo Magalhães and José Tavares; Guarda: Alberto Lopes; Fundão: Filipe Lopes; Castelo Branco: Gustavo Costa and Carlos Semedo; Abu Dhabi: Carlos Guedes and João Menezes; Porto: Henrique Fernandes and José Alberto Gomes

Video: Miguel Tavares

Photos: Gustavo Costa, Henrique Fernandes, João Bento and Miguel Tavares

Web coordination: Rodrigo Cardoso

Web programming: Dream Code

Web and communication design: Micaela Amaral

Production: Sonoscopia

Institutional partners: CM Fundão, CM Guarda, CM Castelo Branco, Acert, Gnration, Casa da Música, ESART e New York University Abu Dhabi, Au Au Feio Mau

Laboratorial periods:

Braga: 6th, 7th and 8th October 2014

Fundão: 17th, 18th and 19th October 2014

Castelo Branco: 28th, 29th and 30th October 2014

Guarda: 31st October, 1st and 2nd November 2014

Tondela: 1st and 2nd November 2014

Ovar: 18th to 22nd July 2016

Public presentations:

13th December 2014 | ACERT, Tondela, Portugal

9th January 2015 | GNRation, Braga, Portugal

10th January 2015 | A Moagem, Fundão, Portugal

30th January 2015 | Centro Cultural de Castelo Branco, Castelo Branco, Portugal

31st January 2015 | NYUAD, Abu Dhabi, United Arab Emirates

31st January 2015 | Teatro Municipal da Guarda, Guarda, Portugal

10th - 15th February 2015 | Casa da Música, Porto, Portugal

23rd July 2016 | Festa Festival | Ovar, Portugal

13th to 16th July 2017 | Caminhos da Água Festival | Igreja da Misericórdia, Vila de Rei, Portugal

12th to 15th October 2017 | Caminhos da Pedra Festival | Igreja da Misericórdia, Sardoal, Portugal

Web Links:

www.phonambient.com

www.sonoscopia.pt/works/phonambient

6. Phonopticon

Credits:

Artistic direction: Gustavo Costa

Composition and performance: Gustavo Costa, Henrique Fernandes, José Alberto Gomes, Alberto Lopes, Alexandre Soares, Filipe Lopes, Rui Penha, Rui Dias and Ricardo Jacinto.

New Instrument Design: Alberto Lopes, Gustavo Costa, Henrique Fernandes and Ricardo Jacinto.

Recording: Gustavo Costa and Ricardo Jacinto

Mixing and Mastering: Gustavo Costa

Video: Miguel Tavares and Augusto Lado

Photos: Gustavo Costa, Miguel Tavares and Henrique Fernandes

Executive production: Sonoscopia

Production: Patrícia Caveiro

Public performances:

14th June 2016 | Liceo Mutante, Pontevedra, Spain

15th June 2016 | Larraskito Club, Bilbao, Spain

16th June 2016 | Zarautz @ Putzuzulu

17th June 2016 | L´Assaut de La Menuiserie, Saint Etienne, France

18th June 2016 | Worm, Rotterdam, Holland

19th June 2016 | Kulter Lab, Amesterdam, Holland

22th June 2016 | Q1, Bochum, Germany

24th June 2016| St. Gertrud Church, Koln, Germany

25th June 2016| St.Gertrud Church, Koln, Germany

28th June 2016 | Ausland, Berlin, Germany

30th June 2016 | Collectif IPN, Toulouse, France

01st July 2016 | IBA, Piera, Spain

02nd July 2016 | Festival Ensems, Centre del Carme, Valencia, Spain

04th September 2016 | Lisboa Soa Festival | Estufa da Tapada das Necessidades, Lisbon, Portugal

18th November 2016 | Extrapool, Nijmegen, Holland

19th November 2016 | Shinytoys Festival | Ringlokshuppen, Mulheim am der Ruhr, Germany

Web Links:

www.sonoscopia.pt/works/phonopticon

7. Peripatetic

Credits:

Composition and performance: Gustavo Costa, Henrique Fernandes, Rodrigo Cardoso, Alberto Lopes and João Ricardo.

Video: Augusto Lado

Photos: Gustavo Costa and Henrique Fernandes

Executive production: Gustavo Costa / Sonoscopia

Public performances:

5th June 2015 | Sonoscopia, Porto, Portugal

6th June 2015 | Txirbilinea, Bilbao, Spain

7th June 2015 | La Muloche, Chateaubriant, France

8th June 2015 | La Muloche, Chateaubriant, France

9th June 2015 | Macondo, Lille, France

10th June 2015 | Villa K, Den Haag, Holland

12th June 2015 | Ferme du Biereau, Louvain la Neuve, Belgium

14th June 2015 | Kulter a Lab, Amesterdam, Holland

15th June 2015 | Denkodrom, Essen, Germany

16th June 2015 | Makroscope, Mullheim am der Ruhr, Germany

19th June 2015 | Gallilaakirche Berlin, Germany

21st June 2015 | Ausland, Berlin, Germany

23th June 2015 | Tiefgarage, Koln, Germany

24th June 2015 | Le Chab, Brussels, Belgium

25th June 2015 | In de Ruimte, Ghent, Belgium

26th June 2015 | Rendez Vous Contemporain, Paris, France

Web Links:

www.sonoscopia.pt/works/ peripatetic

8. INsono

INsono credits:

Artistic direction and conception: Henrique Fernandes

Instrument design: Henrique Fernandes, Gustavo Costa, Tiago Ângelo and Rodrigo Malvar

Composition: Henrique Fernandes, Gustavo Costa, Tiago Ângelo and Rodrigo Malvar

Executive production: Madalena Wallenstein / Fábrica das Ideias Centro Cultural de Belém

Production: Patrícia Caveiro / Sonoscopia

INsono: O Ouvido Secreto das Plantas credits:

Artistic Direction, Conception and Instrument Design: Gustavo Costa and Henrique Fernandes

Composition: Gustavo Costa

Executive production: Raquel Castro / Lisboa Soa

Production: Patrícia Caveiro / Sonoscopia

Public Performances:

23rd and 24th October 2015 | Big Bang Festival | Centro Cultural de Belém, Lisbon, Portugal

20th and 21st May 2016 | Big Bang Festival | Onassis Cultural Center, Athens , Greece

7th – 26th February 2017 (33 performances) | Centro Cultural de Belém, Lisbon, Portugal

04th September 2016 | Lisboa Soa Festival | Estufa da Tapada das Necessidades, Lisbon, Portugal

Web Links:

www.sonoscopia.pt/works/insono

9. Phobos

Credits:

Conception and artistic direction: Gustavo Costa
New instrument design: Henrique Fernandes, Gustavo Costa and Alberto Lopes
Guest musicians: Thierry Madiot, Vincent Martial and Hanna Hartman
Programming and robotics: Tiago Ângelo and João Menezes
Composition: Carlos Guedes, Rui Dias, José Alberto Gomes and Gustavo Costa
Scenography: Igor Gandra (Teatro do Ferro)
Video: Miguel Tavares
Photos: Rui Pinheiro, Susana Neves and Gustavo Costa
Executive production: Patrícia Caveiro / Sonoscopia
Production: Patrícia Caveiro
Technical support: Digitópia
Logistic support: Teatro do Ferro

Residency periods with guest musicians:
16th – 20th January 2017 (with Thierry Madiot) | GNRation, Braga, Portugal
1st – 6th April 2017 (with Vincent Martial) | Centro Cultural Vila Flôr, Guimarães, Portugal
19th – 23rd June 2017 (with Hanna Hartman) | Centro Cultural da Gafanha da Nazaré, Gafanha da Nazaré, Portugal

Public performances:
20th January 2017 | GNRation, Braga, Portugal
6th April 2017 | Centro Cultural Vila Flôr, Guimarães, Portugal
3rd and 4th June 2017 | Serralves em Festa Festival | Museu de Serralves, Porto, Portugal
23rd June 2017 | Centro Cultural da Gafanha da Nazaré, Gafanha da Nazaré, Portugal
13th August 2017 | Bons Sons Festival | Cem Soldos, Portugal
18th October 2017 | FIMP | Mosteiro de São Bento da Vitória, Porto, Portugal

Web Links:
www.sonoscopia.pt/works/phobos

10. Tars

Credits:

Conception: Gustavo Costa, Alberto Lopes and Henrique Fernandes

Performance: Gustavo Costa, Alberto Lopes, Henrique Fernandes and Alexandre Soares

Video: Augusto Lado

Photos: Gustavo Costa

Production: Patrícia Caveiro / Sonoscopia

Public Performances:

12th September 2015 | Noite Branca | Casa Roldão, Braga, Portugal

11. Transarkiv

Credits:

Conception: Rui Dias, Tiago Ângelo and Gustavo Costa

Programming: Rui Dias and Tiago Ângelo

Web Links:

http://sonoscopia.pt/transarkiv