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Aural Architecture Practice

Creative Approaches for an Ecology of Affect

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PhD Music (Sonic Arts)

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The work presented in this thesis has been carried out by myself, except as otherwise specified.



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Abstract

While the acoustic environment and urban soundscapes shape our everyday life, architecture practice usually neglects the experience of acoustic space in its design process. My research addressed the challenge of integrating spatial acoustics and the experience of environmental sound in architecture practice. Drawing from acoustic ecology, creative approaches embody the aural experience of the environment into the design process of architecture. The research was guided by my explorations of a site-oriented aural architecture practice, to create unusual encounters and connections between human and non-human beings, for their relationship through the acoustic space. It experimented with the physical experience of vibrational forces in environmental sound, enhanced by acoustic resonance.

The research was carried out by the creation of four artworks, employed as practical case studies, to experiment with concepts such as: resonant soundscape, space as resonator (*Vibrational Fields*), space as a dynamic relation (*Radio Sonores*), soundscape for attunement (*Shores*) and space as energetic geometry (*Passage*). The artworks were used to develop sets of design methods to draw an aural architecture intervention. The first set guides the experience of site through context analysis, participation, soundwalking, field recording and sensory variation, for a transformation of the ambiance dynamic, to accentuate differences and multiple relationships. The second set offers different approaches in designing aural architecture through the recomposition of urban soundscape and architectural agency based in resonance, dynamic relation and energetic geometry, for an operation of translation. The third set concerns the acoustic spatialisation of vibrational forces, to open communication channels and symbiotic relationships, for an operation of attunement. My research explored the enhancement of an innate capacity of attunement (Morton 2014) to self and other beings (human, non-human). It resulted in the creation of a diversity of experiences of environmental sound, as a way to foster an ecology of affect.

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Chapter 1

Introduction

This chapter starts with a brief presentation of my personal background, following a contextual analysis to address the topic of my research. I will draw from the work of architects that have been concerned for the role that the auditory experience plays in the production of space (Bernhard Leitner and Juhani Pallasmaa). I will then present my research questions, explain the research methods that have guided the investigation and will outline my research's contribution to knowledge. I will also introduce a definition of key terms which I will be using throughout the research: *aural architecture*, *site-specificity*, *experience*, *design*, *ecology*. This chapter finishes with an outline of this thesis' structure.

1. Background

An aural architect, acting as both an artist and a social engineer, is ... someone who selects aural attributes of a space based on what is desirable in a particular cultural framework. (Blessner and Salter 2007, 6)

This practice-based PhD research has emerged from my own experimental practice as an aural architect and sound artist. My practice ¹ is site-oriented and merges field recording and soundscape composition into the design of aural architecture experiments. The term aural refers to the human experience of a sonic process, and aural architecture refers to the properties of space that can be experienced by listening, with a focus on the way that listeners experience space (Blessner and Salter 2007, 2-5). These terms will be further explained on

¹ See appendix 1 for an overview of my practice developed during my PhD research.

pages 23-24. Trained as an architect ² and an acoustician ³, my previous practice that has informed this PhD research includes collaborations with collectives of architects, artists and musicians, public space installations, scenographies, and performance projects, in which I have explored the relation between acoustic space and the experience of sound ⁴. From 2008 to 2010, during the research process for the co-edition of the publication *Site of Sound, of Architecture and the Ear, Volume 2* (LaBelle and Martinho 2011), I have realised the lack of architecture practices that experimented with acoustics, urban soundscape and the experience of sound in space.

In the theory of modern architecture we find very little about the relationship between sound, space and body, and this is reflected in architectural practice. While the acoustic features of the built environment shape our experience of the world, architecture practice usually neglects the auditory experience and acoustic space in its design process. Since the advent of the industrialisation in the 19th century, architecture and acoustical engineering got separated into different disciplines and specialisations. Until that time, architecture integrated the knowledge of acoustics. Architects knew how to integrate the relations between geometry, materials' density, spatial proportions, acoustic effects and the human experience of sound in the design process ⁵. But since the 19th century, architecture and acoustical engineering got separated into different disciplines. One of today's challenges is to integrate the knowledge of acoustics and the human experience of sound in architecture's design process. This is the gap in knowledge that my research addressed. With the exception of concert halls acoustic simulation and prediction, acoustics usually comes in after

² Graduated in 2000 by Faculdade de Arquitectura, Universidade do Porto, Portugal.

³ Master of Science and Technology in Architectural Acoustics, Université Pierre et Marie Curie, co-program with IRCAM and Ecole d'Architecture Paris La Seine, Paris, 2006.

⁴ See appendix 2 for an overview of my practice previous to this PhD research.

⁵ See Chapter 6, p. 183, for a description of some historical examples, from pre-history to the 18th century.

architectural design, as an acoustic correction, mainly concerning noise control and acoustic insulation techniques. Besides, the science of acoustics is constrained to investigate sensation and perception in a laboratory context. The lack of quality and diversity in acoustic space experiences in the everyday produced by a generic architecture is also a problematic issue, as it contributes to turn our sensorial interplay into a dormant state. A few architects have been concerned for the role that the auditory experience plays in the production of space since the 80s, such as Bernhard Leitner ⁶ and Juhani Pallasmaa ⁷.

Modern building technology as well as building economics have indeed shown an almost total disregard for the fact that human beings need rooms with good, 'live' acoustic qualities. (Leitner 1998, 293)

Architect and sound artist Bernhard Leitner has been arguing for a sensuous architecture, or the physical sensation of space, specially the acoustic perception. In his view, the world has become a saturated amount of poor quality experiences (Leitner 1998, 293). On a conversation ⁸ between architects Bernhard Leitner and Ulrich Conrad, they uncovered this problematic issue. A growing concern towards outside loud sounds and cacophony has been caused by modern buildings' architecture use of progressively thinner walls made of concrete and glass, with its reverberating echoes and their irritating effects. These problems are combatted through the use of modern sound-proofing materials. But it results as a contradictory solution to line concrete walls with intolerable acoustic properties, and then add insulating materials to make them

⁶ Bernhard Leitner is a precursor in sound and architecture practice and theory, with works such as *Le Cylindre Sonore*, Paris, 1987. He is also considered a pioneer of sound installation. See <http://www.bernhardleitner.at/en> - accessed November 23 2017

⁷ Juhani Pallasmaa is the author of several architectural theory books on the role that architecture plays in defining the human experience, such as *The Eyes of the Skin, Architecture and the Senses*, John Wiley: New York, 1996.

⁸ Leitner Bernhard and Ulrich Conrads, 1985, *Acoustic space: experiences and conjectures, a conversation between Bernhard Leitner and Ulrich Conrads*, p. 294-304, in Leitner, 1998.

soft, sound-absorbing and noise-proof (Leitner 1998, 299). Even with all the technological advances they argue that it is not getting any better, as the following solutions are typically associated with a comfortable way of living:

People are buried in rooms built out of concrete, and at the same time we are developing highly sophisticated stereo and quadro hifi technologies to allow some sounds to come alive in these spaces. (Leitner 1998, 293)

This is architecture's current generic solution to escape from the real world which has become acoustically saturated. Headphones' music and *muzak*⁹ effects played in elevators, restrooms, hallways etc. are not to be underestimated, as it is "an acoustical but entirely non-spatial conditioning of human beings" (Leitner 1998, 301). The sound quality of our everyday experiences has serious consequences for our well-being, as it directly affects our nervous system.

Heart, breathing and blood pressure which are largely beyond conscious control are affected. And psychomatic implications should also not be underestimated. In other words our entire physical and mental well-being is affected by the sound of a room. Because modern architecture has underestimated if not completely ignored these phenomena, it certainly has caused substantial damage. (Leitner 1998, 293)

Therefore Leitner calls for the need to engage people in acoustic sensibilisation, which involves not only the way a room sounds, its acoustic experience, but also "a knowledge of how sounds and noises can influence, dominate or destroy a particular space" (Leitner 1998, 301).

⁹ Muzak is a corporation of background music to stimulate consumption. It is also often used as a generic term to refer to all forms of background music, also known as "elevator music".

The modern tradition regards architecture and environments primarily as aestheticised objects designed for focused vision. However, it has become evident that we experience the world in a simultaneous and multi-sensory manner. (Pallasmaa 2017)

Architect Juhani Pallasmaa has been raising awareness on the concept of atmospheric perception and the importance of experiencing the world in a simultaneous and multi-sensory manner. He claims for a sensory architecture in opposition to the prevailing visual understanding of the art of building, which reduces our experience of the world into the sphere of vision (Pallasmaa 1996: 39-43). Pallasmaa points out that sound and unfocused, omni-directional experiences make us insiders and participants. And in this way we get to perceive atmospheres, ambiances and moods, through peripheral and diffuse perception (Pallasmaa 2017). He argues that “the acoustic percept usually remains as an unconscious background experience” (Pallasmaa 1996, 50). We do not often identify consciously the essential role acoustics plays in our everyday experiences. But indeed, the acoustic environment shapes our experience of the world. Pallasmaa therefore points toward the importance of architecture to create atmospheric experiences, and how acoustic qualities are an essential aspect of it (Pallasmaa 2017).

In this context, I have questioned the role of architectural design in the quality of our acoustic environment. As discussed previously, architecture practice usually neglects acoustic space in its design process. There is a need to re-integrate this knowledge in innovative ways. Therefore I became interested in exploring architectural design based on urban soundscape and acoustics as a way to transform the everyday experience.

We often disregard experience, even our own, perhaps because experience cannot be seen and measured, and frequently not even communicated properly. (Leitner 1998, 302)

I identified the need for alternative approaches to understand and explore the sensuous or affective experience of space, which acoustical engineering could not explain nor predict; and moreover, to transcend an anthropocentric view of experience towards an ecological understanding of space as not empty, as a field of relations, a dynamic system of vibrant matter (Bennett 2010), a symbiotic real (Morton 2016), as it will be unfolded throughout this thesis. Therefore I have engaged in this practice-based research on aural architecture, to explore modes of designing affective experiences of environmental sound. My aim was to create aural architecture experiments, in which environmental sound would become a channel of communication between humans and the non-human forces of a site.

2. Research question

In this context my research question was:

What kind of design methods could integrate the experience of urban soundscape and acoustic space, to create a site-oriented aural architecture, towards an ecology of affect?

In the conclusion of this thesis (Chapter 7), I will summarise the results of my investigation in relation to this question. I have explored this research question through the following research methods.

3. Research methods

In this thesis, there are methods that conducted my research process, which I have named **research methods**. Additionally, there are also **design methods** that I have developed throughout my practice. As it will be explained on p. 22, this set of design methods is my thesis contribution to knowledge. In this section, I will present my research methods.

My research is situated in the multidisciplinary field of aural architecture. This field mainly concerns the disciplines of architecture, acoustics and sound studies. During the research, I have looked to extend methods from the field of acoustic ecology, and from within explorations of sound art, field recording and soundscape design.

background to research

PhD research

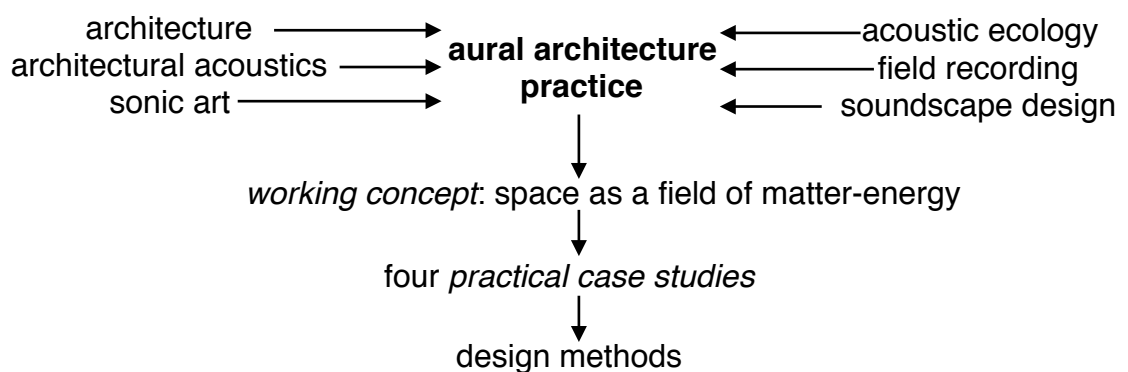


Fig. 1.01 - diagram of aural architecture practice

My research is practice-based. A major thread running through the thesis consists in the experimentation of *working concepts* through *practical case studies*, to develop design methods. As it will be seen in the chapters outline (p. 30), there are four chapters which correspond to four practical case studies, four modes of practicing aural architecture. I have started each chapter with an exploration of particular concepts to explore in my practice. Therefore each

chapter has a theoretical investigation of a *working concept*¹⁰ and its practical experimentation. A table is used next to clarify this articulation.

Chapter	Working concept	Practical case study	Design method
3	Field of resonance	<i>Vibrational Fields</i> (2011)	<ul style="list-style-type: none"> • Resonant soundscape • Space as resonator
4	Space as field	<i>Radio Sonores</i> (2012)	<ul style="list-style-type: none"> • Space as a dynamic relation
5	Space as field of attunement	<i>Shores</i> (2017)	<ul style="list-style-type: none"> • Soundscape for attunement
6	Ecology of vibrational affects	<i>Passage</i> (2017)	<ul style="list-style-type: none"> • Resonant soundscape • Space as resonator • Space as a dynamic relation • Soundscape for attunement • Space as energetic geometry

Fig. 1.02 - summary of working concepts, practical case studies and design methods

I have looked into developments of the genre and associated debates, theoretical positions and critical fields. Developments of the genre include the works of architects, acousticians, sound artists and composers. Concepts and works have been reviewed in a direct relation to each of my practical case studies, as a way to understand what has been done, what is missing, and what my research extends and contributes to.

From within my practical experimentation in each case study, concepts and design methods have emerged. And these were extended further in the following practical case study. Therefore the scope of my practice was the experimentation but also the process of unfolding theoretical concepts, for the

¹⁰ I have used the term *working concept* to address an idea of space that has evolved through my research process, in a direct relation with my practice. Each practical case study added new perspectives to it.

advancement of innovative design methods ¹¹. It resulted in the design of four practical case studies and the development of a set of design methods.

Practice specificity

On a broad view, my practice is site-oriented ¹² and converges field recording and soundscape composition into the design of aural architecture experiences. The main specificity of my approach is acting as an architect on sound matter, due to my background in architecture and acoustics. This means that my practical case studies were engaged as architectural projects, involving field work and studio activities. On the one hand, the focus was on the experience of the site specificities, by gathering impressions, following artistic intuition, analysing social, cultural or political contexts. And with an acoustic ecology approach, I have creatively explored environmental sound through field recording. On the other hand, the focus was on the use of scientific methods, such as acoustic accurate analysis (room modes calculation, spectrograms). This practice approach also articulated moments of working individually, and dynamics of collective work. Each of these processual movements corresponded to a specific phase of the practical case study. My background in architecture has also drawn my soundscape composition work into an exploration of spatial sound in multidimensions, switching back and forth from micro to macro scale. My process of composing sound was oriented towards the relational and the ensemble of operations, switching between micro to macroscopic scale, as in architecture. A micro-material approach was useful to look into the design of a specific aspect of the materials and its geometric organisation. And a macro-effect perspective allowed to study the movements,

¹¹ This methodology involved a complex and careful process of thought and experimentation. New degrees of comprehension of the same concept have emerged only after experimenting its articulation and cross fertilisation with different fields, going back and forth from practical work to theoretical enquiries. I am aware that there are moments that this might seem a repetition. I make this note to inform the reader that these apparent repetitions will subtly unfold and integrate new perspectives. At the end, it extends new degrees of comprehension.

¹² See pages 24 and 49 for my approach on site-oriented practice.

proportions and dynamics of groups of elements, and its acoustic effects. I became interested in environmental sound as dynamic sonic beings, and in acoustic phenomena as models in its internal processes. The resulting aural architecture installations aimed to connect the audience and site to an acoustic ecology awareness of the interconnectedness with the surroundings.

4. Contribution to knowledge

This thesis contribution to knowledge consists in an advancement in the field of aural architecture design and practical experimentation. A site-oriented aural architecture practice methodology has been developed and formalised as a set of design methods (see p. 47). These methods were elaborated in an open way to facilitate its further development. These design methods will be explained in detail on the next chapter.

Furthermore, my research contributed to integrate the knowledge of acoustics (the relations between geometry, materials' density, spatial proportions, acoustic effects) and the experience of environmental sound in the design process of architecture.

My practice also contributed to an ecology of affect, by creating a diversity of affective experiences of environmental sound, in which sound matter was accounted as a vibrational force.

5. Definition of key terms

In what follows, I will explain the key terms of my thesis. I will start by a clarification of the term *aural architecture* and how it relates to what I am investigating. I will then outline my approach to terms that are interrelated and recurrent throughout my research: *site-oriented*, *place*, *space*, *experience*, *ecology* and *design*.

5.1. Key term: aural architecture

Physical acoustics and aural architecture, while directly related, have profoundly different emphases. The former uses a scientific language to describe the way in which spatial acoustics changes attributes of sound waves, while the latter considers the experiences and behaviour of inhabitants in a space. One emphasises discrete measurement and modelling, while the other explores a complex interactive phenomenon. (Blessner and Salter 2007)

We may find different terms to define a practice of sound and architecture such as sonic architecture, acoustic architecture, and aural architecture. I have chosen to employ the term *aural architecture*, as aural parallels visual and as my practice addresses the affective experience of sound in space. According to acoustician Barry Blessner and environmental psychologist Ruth-Linda Salter, aural refers to the human experience of a sonic process, and aural architecture refers to the properties of space that can be experienced by listening, and focus on the way that listeners experience space (Blessner and Salter 2007, 2-5). Any environment, natural or built, generates an aural architecture. Every space has an aural architecture. It is the attributes of a space, such as surfaces, objects, materials and geometries, that will determine its specific acoustic aspects. And it is the human experience of that space that determinates its aural qualities ¹³. The acoustic cues orientate our navigation but provide also sensory stimulus which define the space's aural specificity and influence our associations and moods (such as feelings of cold or warm, public or intimate, freedom or insecurity). Aural architecture can be defined in social, navigational, aesthetic and musical aspects. This means that our auditory spatial awareness manifests

¹³ The aural qualities of a space are recognised by the human being since pre-history. Several European prehistoric chambers, especially in those that have megalithic art on the walls, have particular resonance qualities (Coimbra 2017, 128). See pages 182-183 for more on archaeoacoustics.

itself in at least four different ways: influences social behaviour; allows orientation and navigation through a space; affects our aesthetic sense of place; enhances our experience of music and voice. Moreover the aural experience can be described in terms of abilities: sensation as detectability; recognition as perceptibility; affect as desirability (Blessner and Salter 2007, 11-13). Throughout this thesis, I have explored modes of practicing and designing aural architecture. As it will be explained, there was a particular interest in understanding the aural experience of space as matter-energy and vibrational forces, to design affective experiences of environmental sound.

5.2. Key terms: site-oriented practice

The aural architecture practice that supports this research is site-oriented. This means that the practice is contextually orientated and relates to the conditions of specific spaces at specific moments. It involved research of the site prior to the design process and installation. The site-specificity was not approached as a fixed relation. Instead, site-specificity was engaged as a dynamic process of exchange between artworks and sites, with unpredictable events, ephemeral situations and transformation. I will unfold the difference between site, space and place in a broader context to clarify the meaning of my approach.

Philosopher Michel De Certeau made a clear distinction between the terms *space* and *place*. He explained that “a place is the order (of whatever kind) in accord with which elements are distributed in relationships of coexistence ... an instantaneous configuration of positions. It implies an indication of stability” (De Certeau 1980, 117). Contrary to place, De Certeau explained that a “space is composed of intersections of mobile elements” and in this sense, he claimed that “space is a practiced place” (De Certeau 1980, 117). Edward W. Soja argued that “the organisation, and meaning of space is a product of social translations, transformations, and experience” (Soja 2010, 80). For Soja, spatiality is a dynamic that affects our life experiences. He pointed out for “an essential connection between spatiality and being” (Soja 2010, 119).

There is an extensive literature regarding site-specific and site-oriented practices, which have been enquired by authors such as Miwon Kwon (2002), Nick Kaye (2000) or Brandon LaBelle (2006). According to Kwon, site specificity in art has dealt with the conflict between mobility and the place-identity bond, which led the genre to multiply itself in different forms of action in a possible search to find its own terrain. Kwon claims that it is the “*differential function* associated with places, which earlier forms of site-specific art tried to exploit”, that current site-oriented works seek to reimagine (Kwon 2002, 157). And as Nick Kaye has also explained, to move the site-specific work is to re-place it, to make it something else (Kaye 2000, 2). Kwon argues that this mobilisation of site-specific art and the nomadism of recent site-oriented practices are efforts to retrieve lost differences due to the deterritorialisation of the ever-expanding capitalist order, which tends towards homogeneity and elimination of existing differences (Kwon 2002, 157). To the space resulting from this homogenisation Henri Lefebvre called *abstract space*, the tool of domination (Lefebvre 1991, 370). Lefebvre remarked that “a new space cannot be born (produced) unless it accentuates differences” (Lefebvre 1991, 52). To this new kind of space he called *differential space*, and this would mean the “diversification of space”, with a need for “the restoration of the sensory-sensual” (Lefebvre 1991, 363). In this critical context and in my architectural practice, I have been aware of the deterritorialisation of place within the flux of globalised techno-capitalism and its spatiotemporal controls, and also concerned for how these controls homogenise affective sonic ecologies (Lacey 2014, appendix 1). As an architecture practitioner, I eventually got interested in the production of space beyond a structured, controlled or pre-formatted order of space. Therefore, I have been experimenting how architectural design can open up spaces for multiple appropriations by its users. My approach lies in accentuating site-specific differences and multiple relationships, for a diversity of sensory-sensual experiences to be produced. My site-oriented practice seeks to produce a kind of spatial experience that Michel Foucault has described as a heterotopia,

which is something that has the capacity of “juxtaposing in a single real place several spaces, several sites that are in themselves incompatible” (Foucault 1967). Foucault got interested in certain sites that had “the curious property of being in relation with all the other sites, but in such a way as to suspect, neutralize, or invert the set of relations that they happen to designate, mirror, or reflect”. He called them “heterotopias”, “counter-sites”, “different spaces”, “of other places”. And described it as “a sort of simultaneously mythic and real contestation of the space in which we live ... (it) could be called heterotopology” (Foucault 1967). This is the kind of spaces that my site-oriented practice seeks to create and that will also be discussed further in this thesis as *heterogeneous space* (see p. 102). Therefore, I could say that my aural architecture interventions create some kind of heterotopias that transform “places” into “different spaces” or “counter-sites”, by accentuating its differences. In the context of these reflections, I am interested in moving from an object to an environment and the very relational, spatial, and temporal nature of sound itself (LaBelle 2006, xii). Still, the focus of my practice is not merely perceptive, and not limited to “appropriate and create architecture for a renewed sense of listening” (LaBelle 2006, xiv). Instead, my interest is to create site-responsive aural architecture experiments that deal with “moving sound installation to public space”, and take into account an “enlarged environmental potential” (LaBelle 2006, xiv). Therefore my field work is related to field recording (see p. 52) and acoustic ecology (see p. 29), towards an ecology of affect (see p. 37).

As it will be seen, in all of the case studies presented in this thesis, a transformation occurs: places that had particular orders and functions are rearranged and opened up for appropriation, for other kinds of practices, relationships and sensory variations to arise. I got particularly interested in the experience of spaces as unusual encounters and connections between human beings, non-humans and things. Although places are planned and designed for specific practices, there is always an open possibility or potential which can

never be determined by the place's material order. Space is dynamic, relational, and variable. Spaces are temporally specific relations between specific subjects and their environment. Space is alive, full of vital materialities, vibrant matter (Bennett 2010), vibrational forces. In my approach, I have engaged space as a field (p. 101), as relational (p. 116), and energetic (p. 112). So in my practice, I have developed aural architecture design methods to connect unusual or imperceptible relationships between the elements of a specific site (human, non-human), to accentuate differences and produce a new space, with multiple identities and meanings. Architecture was engaged as a dynamic assemblage (p. 115) to open up potentials of a site and its contingencies. In my approach, these potentials lie in the encounters and relationships between human and non-human beings. My interventions address the potential of site-specific vibrational forces, enhanced by spatial acoustics, to accentuate differences and to open up experience and communication channels towards more ecological relationships between human and non-human beings. Therefore, with the projects developed for this thesis, my aim was to open up the experience, transformation and translation of vibrational forces of specific sites to move spatial practices beyond an anthropocentric perspective, and towards an ecology of symbiotic relations.

5.3. Key term: experience

This research addressed experience as a fundamental process in the development of the human being that is shaped by space and architecture. My interest lied in the experience of everyday spaces: how we experience everyday sounds in acoustic space, and how, as an aural architect, I could contribute with the design of forms of experience. My aural architecture explorations valued our own direct experience above all. My practice sought to value the process of experience as a way to unify life sensations: visual, acoustic, tactile, kinetic. My approach emphasised the experience of acoustic space and environmental sound, to create, communicate and understand the affective experience of

environmental sound. In this sense, I have sought to explore forms of experience of environmental sound, to incite sensory responses, and as a way to engage an ecological re-wiring of the senses interplay. My stance was that affective responses could be achieved through the experience of space as matter-energy, in which sound is accounted as a vibrational force for transformation and connection between humans and non-humans beings, as it will be explained on pages 33-34.

5.4. Key term: ecology

Trivially speaking, ecological awareness means realising that beings are interconnected in some way, but then we have to figure out what this interconnection actually means. At the moment, the phrase I'm using for the thing that ecological awareness names is "the symbiotic real". What do I mean by that? I mean that ecological relationships are best described in terms of symbiosis, and symbiosis is a very interesting thing because it's always a sort of fragile, contingent, uneasy relationship in which it's impossible to determine which entity is the top entity. ...

There's a sort of dynamic system there. (Morton 2016)

This research addressed ecology to explore a symbiotic real (Morton 2006), the potential relationships between human and non-human beings and their interconnection in space. The purpose of the case studies was to raise an ecological awareness through the experience of environmental sound and the dynamic systems (or symbiotic relations) acting in specific sites, usually neglected by humans. More specifically, the field of acoustic ecology has informed my ecological approach to aural architecture. I have found common ground with *The World Soundscape Project's* ¹⁴ approach in the use of environmental sounds as a pedagogical intent to foster soundscape awareness.

¹⁴ The *World Soundscape Project* is an educational and research group dedicated to acoustic ecology, established by Raymond Murray Schafer at Simon Fraser University during the late 1960s and early 1970. See appendix 3 for further details.

My practice involved field recording ¹⁵ and soundscape composition ¹⁶ as a way to enhance environmental listening awareness. I became interested in how soundscape composition could be engaged on an activist and political level, as a way to create a strong oppositional place of conscious listening (Westerkamp 2002), to create balanced aural architecture experiences in built environments. In other words, I became interested in exploring modes of creating affective experiences of environmental sound (p. 41). Therefore, I have extended relationships between ecology and affect, as it will be explained on page 36.

5.5. Key term: design

The approach to design was based in the idea of space as not empty, as a field of relations, of matter-energy (as it will be explained through this thesis). This research developed a set of aural architecture design methods based in acoustic resonance, dynamic relation and energetic geometry (explained on p. 56-57). As it will be unfolded throughout this thesis, aural architecture design is a mode of practice to be engaged in, to create relationships between humans and non-humans, more than to design and build a formal object. This will be discussed further on the section *Space as Field*, page 101.

A relevant aspect in my approach to design was that site-specific aural elements (such as background sounds or imperceptible sounds) were used as a material to design aural architecture. In some case studies, field recordings were used as sound matter. In other case studies the aural architecture design was focused on how the natural acoustics of the site could activate spatial potentials and interconnections.

¹⁵ My practice of field recording refers to audio recording of environmental sound, both natural or human-produced. I will explain my approach on page 52.

¹⁶ Soundscape composition is a practice of audio composition using field recordings. I will explain my approach to soundscape composition on page 56 and 57.

6. Chapters outline

In this section, I will describe the contents of the chapters of the thesis. The thesis is structured into seven chapters.

Chapter 1 is this introductory chapter. Chapter 2 will address an outline of this research's concepts and design methods. The conceptual framework will unfold an ontology on *the experience of space as matter-energy* (Jane Bennett), the design of *ambiance dynamics* which is central to my practice (Jean Paul Thibaud), a critical theory overview on the *ecology of affect* (Alfred North Whitehead, Brian Massumi, Marie-Louise Angerer), and the *design of affective experience of environmental sound* in relation with three *operations of the affective*, which are: *transformation, translation* and *attunement*.

Chapters 3, 4, 5 and 6 are structured similarly. Each of these chapters addresses *working concepts* and *practical case studies*, Therefore each chapter is divided into two parts:

- the first part of the chapter addresses the *working concept* of my theoretical enquiry;
- the second part of the chapter describes a *practical case study*, which concerns the practical experimentation of the *working concept* in a practical case study (see table 1.02, p. 20).

In this sense, Chapter 3 opens up my theoretical enquiry on the working concept of *space as a field of resonance*. I have started this exploration drawing from the domain of physical acoustics, and of space and body as musical instruments. I have looked into other practices such as Randy Yao and Scott Arford's performance project *Infrasound* (the experience of space and self as vibration), Edwin van der Heide (the audience inside the instrument), Mark Bain (space and body as connective tissue) and Iannis Xenakis (spatial sound and dynamic sonic beings). I have then extended the ideas of resonant soundscape and space as resonator into the practical experimentation of *Vibrational Fields* (2011). This practical case study explored a site-oriented soundscape

composition and spatialisation to resonate an existing building, and unfolded an auditory experience based in the idea of background listening (Barry Truax). Chapter 4 extends my theoretical investigation on the working concept of *space as field* towards a design based in *space as dynamic relation*. I have unfolded the concept of space as field from architectural theory and media studies (Stan Allen, Marshall McLuhan and Ted Carpenter, Michael Hensel and Achim Mengues). I have looked into practices of spatial agency, participation, relation and performance. I have then experimented with these ideas in the practical case study *Radio Sonores* (2012), an aural micro-architecture, mobile and modular, built collectively. It addressed a paradigmatic shift in the design: from an object of analysis to a field (Stan Allen), a milieu of relations and dynamic events. The practical case study engaged a dynamic of co-creation to build collectively an aural architecture.

Chapter 5 unfolds this thesis theoretical enquiry into the idea of attunement, as a phenomena based in sympathetic resonance that affects the quality of an experience. Attunement can be described in different ways by various disciplines. I have looked up for an understanding in the fields of physics, music, philosophy and psychology, and authors such as Timothy Morton, Martin Heidegger, Pauline Oliveros, Jane Bennett, Alfred North Whitehead, Brian Massumi, Daniel Stern, Kathleen Stewart, Juhani Pallasmaa. In turn, this discussion extended other ideas, such as sympathetic vibration, resonance, entrainment. I have then researched for links between attunement, ambiance and ecology, and enquired these ideas in relation to acoustic ecology and environmental sound awareness. I have looked into the work of composer Hildegard Westerkamp to explore soundscape composition as a tool for change and listening as conscious practice. Additionally I have looked into Barry Truax's research on listening-in-readiness and composition with environmental sound. These ideas were experimented in the practical case study *Shores* (2017), in the design of a soundscape for attunement, and its installation in an acoustic boat shell. As a result, other ideas were unfolded, such as experience as

embodied knowledge. From this practical case study emerged another auditory experience based in the idea of balance.

Chapter 6 wraps up my enquiry to link the working concept of space as a field of matter-energy towards an ecology of vibrational affects. I have explored the idea of translation of vibrant matter and the translation of the language of vibration into aural architecture. These ideas were experimented in the last practical case study of this thesis, *Passage* (2017), a soundscape installation in resonance with the acoustic space of a tunnel and the creation of an aural architecture based in a zome¹⁷ geometry. This practical case study converged the four aural architecture design methods produced by the previous case studies, into one single experiment, as a microcosmos with multiple experiences, an ecology of affect (concept explained on p. 36). *Passage* explored a further articulation of modes of activating the sensorial interplay through the inciting of responses and diversifying affects. Concepts have emerged from within this practical experiment such as: the affective experience of environmental sound, and the inner and outer dynamic of the auditory experience towards meditative states.

Chapter 7 is the conclusion of this thesis, drawing an overview over the research process, its learning points and contribution to knowledge. I have then extended further ideas on how this PhD research will continue to evolve in practice.

¹⁷ The term zome was coined in 1968 by thinker Nooruddeen Durkee, combining the words dome and zonohedron, a convex polyhedron with point symmetry.

Chapter 2

Overview of concepts and design methods

This chapter outlines the conceptual framework from which the *working concepts* of this research have emerged, and describes the *design methods* that have guided the *practical case studies*.

1. Conceptual framework

This section draws an overview of the following concepts: an ontology of *the experience of space as matter-energy* (Jane Bennett) ¹⁸, the notion of *ambiance dynamics*, which is central to my practice (Jean Paul Thibaud), and a critical theory on *ecology of affect* (Alfred North Whitehead, Brian Massumi, Marie-Louise Angerer). I will then extend my idea on *design of affective experiences of environmental sound*, in relation with three *operations of the affective*, which are: *transformation, translation and attunement*.

1.1. Experience of space as matter-energy

The figure of an intrinsically inanimate matter may be one of the impediments to the emergence of more ecological and more materially sustainable modes of production and consumption. My claims here are motivated by a self-interested or conative concern for *human* survival and happiness: I want to promote greener forms of human culture and more attentive encounters between people-materialities and thing-materialities. (Bennett 2010, ix)

¹⁸ Although I am aware of the link of my work with object oriented ontology, I preferred to address it as an ontology of space as matter-energy. To consider space as matter-energy has allowed me to expand an aural architecture practice based in energetic geometry, as it will be described on chapter 4.

In *Vibrant Matter, a political ecology of things* (2010), political theorist and philosopher Jane Bennett claims that an image of dead or thoroughly instrumentalised matter feeds human hubris and earth-destroying fantasies of conquest and consumption. She argues that this is done so by preventing people from detecting (seeing, hearing, smelling, tasting, feeling) a fuller range of the non-human powers circulating around and within human bodies (Bennett 2010, ix). Bennett calls up for the experience of space, objects and things as vivid, vibratory entities (Bennett 2010, 4). She describes this reality of non-human powers as vibrant matter, a vibrational force, an active *becoming*¹⁹ of vibrant bodies, “a creative not-quite-human force capable of producing the new” (Bennett 2010, 118). This idea has been explored as *material vitalism* by Gilles Deleuze and Félix Guattari in *A Thousand Plateaux* (1993). In the chapter *Of the Refrain* the authors explain how *milieux and rhythms* are born from chaos and that these forces of chaos, terrestrial forces, cosmic forces confront each other and converge in the territorial refrain (Deleuze and Guattari 1993, 312-313). These forces of chaos or matter-energy have also been addressed by other thinkers. For example, Michel Serres describes it as “a turbulent, immanent field in which various and variable materialities collide, congeal, morph, evolve, and disintegrate” (Serres 2000). Earlier philosophers, such as Lucretius, have also claimed that everything is made of the same matter, he called this *primorrua*; today this might be called atoms, quarks, particle streams or matter-energy (Bennett, 2011, ix). Bennett claims that everything is connected and irreducible to a simple substrate, resonating with an ecological sensibility. In this sense, Bennett calls up for humans “to tune into the strange logic of turbulence” (Bennett 2010, xi). Deleuze argues that material vitalism’s formula is “ontologically one, formally diverse” (Deleuze 1992, 67). I have found

¹⁹ *Becoming* is a term explored by philosophers Gilles Deleuze and Felix Guattari, and refers to a process of change within an assemblage. It serves to account for relationships between the “discrete” elements of the assemblage (in <http://www.rhizomes.net/issue5/poke/glossary.html> accessed March 24 2017). The term has been used in processual and generative design practices.

common ground with Bennett's approach on space as a field of *vibrant matter*, *matter-energy* and *non-human powers*, by Deleuze and Guattari's *material vitalism* and Serres' *turbulent, immanent field*. My practical case studies have explored this idea of vibrational vitalism of space to which I will be referring to as matter-energy. My aim was to create an aural architecture of encounters between organisms and things²⁰ for their detection and relationship through the auditory sphere. The purpose was to create an aural architecture of affective experiences of environmental sound, as a way to foster an ecology of affect.

Encounters generate affects. Encounters between organisms and things external to them, or groups of things, further generate affects that may engage the singular and the multiple. This results in changes in situation or conditions, productive of new bodies; different in their attributes and constitution. New bodies generate different affects, and so on. (Colman in Angerer 2017, 8)

My practice-based research addresses encounters that generate modes of experience of a space that is not empty, it is a vital materiality, a vibrational force, as a continuous process of transformation, in different rhythms and cycles. We, as human beings, are part of this vital materiality or vibrational force. With these ideas, my proposal was to design alternative forms of architecture that accentuate differences to generate encounters of vital or dynamic materialities and sensory experiences of spacetime, as part of it. My research aim was to experiment with environmental sound through a spatial approach, into the architectural design of ambiances, as encounters between humans, non-humans and things.

²⁰ I will use the term *thing* to address objects, phenomena or entities indistinctively.

1.2. Ecology of affect

In my practice, I have unfolded an approach to the experience of space as matter-energy in relation to affect, as a sensation of the here and now. In the process philosophy of mathematician Alfred North Whitehead we find such approach. He accounts for a rhythmic flow of timespace which he refers to as extensive continuum. He has explored affect related to the concepts of “blind feeling” (Whitehead 1978, 105), “prehension” or “occasion of experience” (Whitehead 1938, 150). For Whitehead, “actual entities”, “prehension”, and “nexus” are the basic facts of experience. Prehension is a simple physical feeling and a nexus is when actual entities feel one another (Goodman 2010, 92). According to Whitehead “the basis of experience is emotional” (Whitehead 1967, 176). He suggests that entities interact by feeling one another, even in the absence of knowledge and power. Things encounter one another aesthetically, and not just cognitively. Whitehead claims that we always feel more of a thing that we actually know of it (Shaviro 2010, 9). For Whitehead, one encounters the very being of a thing, its integrity, beyond the human understanding and grasp, in another level of apprehension, what he called a novelty, a new entity, an event. This level of apprehension before cognition builds up as an aesthetic experience of affect, the mode in which Whitehead calls “causal efficacy”, where experience is being. Whitehead used the terms “emotion”, “feeling” and “affect” inter-changeably to describe the same phenomenon. The way Whitehead used these terms has been argued by social theorist and philosopher Brian Massumi as being distinct. He has claimed for the difference between affect and emotion, describing affect as primary, non-conscious and intensive (Massumi 2002, 27). This is the mode of experience of affect that my aural architecture projects have explored. In this mode, “the inflow into ourselves of feelings from enveloping nature overwhelms us; in the dim consciousness of half-sleep, the presentations of sense fade away, and we are left with the vague feeling of influences from vague things around

us” (Whitehead 1978, 176). As Whitehead claims, all entities experience something like an “influx of feeling”, in the form of energy (Whitehead 1978, 177). For Whitehead, affect emerges in the intervals of the brain, a dimension of lost time, as “life... in the interstices of each living cell, and in the interstices of the brain” (Whitehead 1978, 105-106). In my view, this idea relates to Massumi's description on the electrical impulses of the brain as micro-shocks, what precedes the event. “In the instant of the affective hit, there is no content yet”, as it is the “onset of the activation” (Massumi 2008, 4). He calls it “small perception”, drawing from Gottfried Wilhelm Leibniz. Gilles Deleuze and Felix Guattari call this phenomenon “microperception”. They describe that when one attains a visual or sonorous microperception it reveals spaces and voids, like holes (Deleuze and Guattari 1993, 251). Massumi describes this phenomenon as “something that is felt without registering consciously. It registers only its effects” (Massumi 2008, 4). For Massumi microperception is bodily and is “a purely affective rebeginning of the world” (Massumi 2008, 5). It is this kind of affective experience of environmental sound that my practice aimed to create. For musician and theorist Steve Goodman, “affect is the vibration - the good or bad vibes - prior to organisation into organised feeling (prior to what phenomenology would call intentionality)”²¹. Goodman extends Whitehead's perspective into the physicality of vibrational force and the modulation of affective tonality. I also became interested in experimenting in my practice the physicality of vibrational force, but linked to the corporeality of environmental sound enhanced by space's acoustics. I found common points as well with sound artist Jordan Lacey's research on affective sonic ecologies, particularly on the importance given to “the role of sound(scape) installations in diversifying affects on human experience” (Lacey 2014, appendix 1). He has developed conceptual tools to discover spatiotemporal controls and understand how these controls homogenise affective sonic ecologies (Lacey 2014, appendix 1). As it

²¹ In <https://dj.dancecult.net/index.php/dancecult/article/view/310/301> - accessed October 16, 2017

will be seen, I have explored a diversification of affect, as ontologically one, formally diverse; meaning that from the physical experience of space as matter-energy, multiple modes of attunement have emerged. And this is how my practice contributes to an ecology of affect. I have found in Marie-Louise Angerer book *Ecology of Affect: Intensive Milieus and Contingent Encounters* (2017) some topics that I have addressed in my work too. Angerer revises relationships between environment, technology and humans based in sensation or affect. She explores the motions of connecting, disrupting and translating as new parameters of affect. In this sense, she describes three operations of the affective - connective, disruptive and translation - as “the temporally barred momentum of a relation, a blank, a gaping opening, into which and from which affect arises” (Angerer 2017, 11). I have drawn on her approach, moving forward and unfolding three operations of the affective in a direct relation to my practice. I will explain this approach on p. 41-44. My aural architecture practice intended to create an experience of spacetime as this gap opening - the design of an affective experience of environmental sound - towards an ecology of affect.

Next, I will unfold the notion of ambiance dynamics and its relation with my design practice of affective experiences of environmental sound.

1.3. Ambiance dynamics

With architecture we cannot radically separate the material world from the immaterial one, the spatial forms from the temporal dynamics. Instead of speaking in terms of the beauty of an architectural object, I prefer to focus on the capacity of a built environment to intensify everyday experience and be responsive to its inhabitants. (Thibaud in LaBelle and Martinho 2011, 53)

At CRESSON ²², a research centre at the Architecture School of Grenoble, dedicated to the study of ambiances and the design of innovative qualitative methodologies, architect Jean-Paul Thibaud investigated the notion of responsive environment to define different kinds of dynamics in ambiances and modes to account for its sensory variations. In his article *The three dynamics of urban ambiances* (LaBelle and Martinho 2011, 43-54) Jean-Paul Thibaud explores the notion of ambiance as a possibility to conceptualise how the built environment and social practice get mutually determined. Thibaud defines an ambiance as “a synergy between the senses that involves the emotional aspect of a situation. A quality of sound, light or fragrance is sensed in a single movement that confers unity on the sensory world” (Thibaud in LaBelle and Martinho 2011, 45). An ambiance involves not only the built environment of the place but also the lived experience of people. It is a time-space that can be qualified from a sensory point of view, relating to the sensing and feeling of a place. Therefore the way we relate to a place is based on the sensory experience it involves. And urban space provides numerous ambiances with particular properties and qualities, that engage passers-by physically, connecting them to the site. It shapes practices, which in turn affect it (Thibaud in LaBelle and Martinho 2011, 43). To take account on the sensory variations of a public space, Thibaud distinguishes three main dynamics involved in the creation of an ambiance. In his view, “an ambiance emerges from a triple process: acclimatisation, variation and alteration. These processes are always at work simultaneously in an ambiance but their respective power nevertheless varies from one atmosphere to another” (Thibaud in LaBelle and Martinho 2011, 53). Some ambiances change more than others, and are more flexible to variation and improvisation. This means that an ambiance may more or less have the capacity to integrate, exacerbate or neutralise social activities. By

²² CRESSON is a research centre founded in 1979 based in the School of Architecture of Grenoble, France. Initially dedicated to investigate sound environment and urban space, it extends its interests today to the study of ambiances and the design of innovative qualitative methodologies.

making this distinction, Thibaud aims to clarify three basic ecological processes that constitute an ambiance and that involve tuning, modulating and formatting. He argues that each process involves specific domains of thought and conceptual tools (Thibaud in LaBelle and Martinho 2011, 45). In this sense, in the first dynamic, a tuned ambiance “emerges as the place is brought into tune with the conduct it supports.” Therefore there is some close affinity between what is felt and what is produced, between the subject and the world. In his perspective, it is “an ecology of the lived world”. The second dynamic, a modulated ambiance, involves slight variations of the sensory context of the place. Therefore what is felt fluctuates over time and varies in line with activities. This ambiance engages “an ecology of situated perception”. In the third dynamic, a framed ambiance emerges through the conditioning of the place by the social practice itself. Therefore it gives shape to social situations and enfolds an “ecology of relations in public”. Another aspect that Thibaud mentions is that in the same place we may identify different ambiances. For example, a place saturated with stimuli and people walking fast may be perceived as tense, alarming, stressful; at a different time of the day or of the year, the same place may be sensed as relaxing, peaceful, restful (Thibaud in LaBelle and Martinho 2011, 44). I have found Thibaud’s work useful as a starting point to understand at which levels (physical, mental, social, ecological) phenomena may affect sensory variations of an ambiance. As it will be explained on the overview of the design methods (p. 47), I have extended this study into different methods to design aural architecture based in sensory variation. My stance was that this variation generated distinct ambiances and affected the auditory experience of a space.

1.4. Design of affective experiences of environmental sound

The question of affect emerges in the daily realm of routine, and survival; of our physical and existential existence. ...all systems are subject to affects as much as they are affective, and generative of positive and negative affects within and of a system. (Colman in Angerer 2017, 7)

As seen before, my research aim was to design and create aural experiences to incite affective responses of material vitalities and vibrational forces, that would engage an ecological re-wiring of the senses. Could this contribute to an ecology of affect? What kind of aural experiences would attune a person with self, others and/or the environment, to engage a transformation in her senses interplay and relationship with its surroundings? What kind of aural architecture design would transform our relationship with our surroundings, in such a mode as to act as a translator, a communication channel to vibrant matter?

Architecture is a system that engages affective operations, as it affects timespace conditions and constrains its experience. I have found similarities in my approach with the three operations of the affective described by Angerer, as the gaping opening into which and from which affect arises (Angerer 2017, 11). Drawing from Angerer's three operations of the affective (connective, disruptive, translation) (Angerer 2017, 11), and I have defined three operations of the affective, as parameters to design dynamic forms of aural architecture:

- transformation (disruption)
- translation, extended into the language of vibration
- attunement (connection)

I will now explain each of the operations in relation to my aural architecture practice.

Transformation

The ecological disruptions of the environment are only the visible part of a deeper and larger problem, concerning ways of living and being in society on this planet. The environmental ecology should be thought of as one piece with a social ecology and mental ecology, through an ecosophy of ethical-political nature. It is not to unify arbitrarily under an ideology of replacement of areas fundamentally heterogeneous, but to be underpinned by some other innovative practices for the restructuring of individual and collective subjectivities within new technical-scientific contexts and new geopolitical coordinates. (Guattari 1989, fourth cover)

The way in which our environment is built in western society is one of the causes of ecological disruptions, concerning ways of living and being. In this context, Felix Guattari presents an idea of ecology as an ecosophy²³ of ethical-political nature, and proposes the underpinning of society with “innovative practices for the restructuring of individual and collective subjectivities”. In this sense, I have engaged my aural architecture practice unfolding an affective micropolitics.

Micropolitics, affective politics, seeks the degrees of openness of any situation. ... Just modulating a situation in a way that amplifies a previously unfelt potential to the point of perceptibility is an alter-accomplishment. (Massumi 2008, 7)

Drawing from Brian Massumi, micropolitics emerged in my practice as a creative concept to explore the potential of transversal interventions in a micro-scale, events to activate matter-energy, which may underpin our society. For,

²³ Felix Guattari postulated the necessity of founding an “ecosophy” or ecological philosophy that would “link environmental ecology to social ecology and to mental ecology” (Guattari 1996, 264).

according to Massumi, “micropolitics is what makes the unimaginable practicable. It’s the potential that makes possible” (Massumi 2008, 20). As it was explained on p. 14, the way the environment is built in western society affects field conditions and constrains its experience. This has also been described as spatiotemporal controls that affect homogenous experiences in space (Lacey 2014, 95). My stance was that through alternative temporal relationships and spatial tensions, new constellations could open up experience, as an opening into which and from which affect arises. This can be understood as an affective operation of transformation. This operation of transformation relates to the design methods *experience of site* and *sensory variation* (explained on p. 50 and p. 53).

Translation

The second operation of the affective relates to the development of communication and translation methods of vibrant matter. I wanted to create an aural architecture experience as a medium of translation (or transduction) of matter-energy. Jane Bennett claims that "vitality is shared by all things" and that we are in need to develop communication and translation tools of this vibrant reality, between humans, non humans and things (Bennett 2010, 89) (see p. 34). I have explored my practice towards an amplified or enhanced experience of vibrant matter to engage the audience in an physical affective experience of vibrational forces, as a channel of communication with this reality. Through this operation of translation, I aimed for an aural architecture experience to open up *acoustic communication* (Truax 1984) ²⁴ with the surroundings in a symbiotic way, as part of the same micro-macro-ecosystem. As will be seen in my practice, I have engaged with acoustic communication through the soundscape composition, as a system of information exchange where sound *mediated* the

²⁴ What Truax called *acoustic communication* (Truax 1984) was a way to understand the complex system of meanings and relationships that sound creates in environmental contexts. He developed the acoustic communicational model as an interdisciplinary alternative methodology that included soundscape studies, acoustic communication and soundscape composition (Truax 1996: 58).

relation of the listener to the environment (Truax 1996: 59). This operation of translation was experimented with the method of aural architecture design (explained on p. 55).

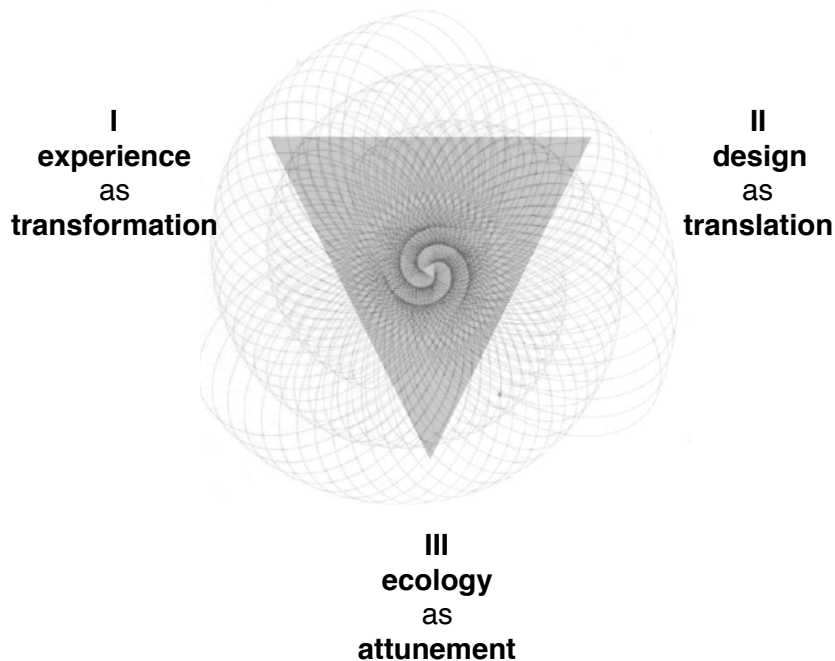
Attunement

This third operation of the affective corresponds to what Angerer has described as connective: “the first inscription of a movement as the opening of such an interval” (Angerer 2017, 60). It relates to what I have unfolded as an experience of attunement, on my enquiry on resonance and attunement (p. 124). As it will be seen, an inquiry on the phenomenon of attunement has been conducted drawing from various disciplines such as music, cognitive science, philosophy of science, physics and psychology. In my practical case studies, I have experimented with an innate capacity of attunement (Morton 2014, online reference) to self and other beings, towards an understanding of our environment as an unifying field, of a multiplicity of relationships through vibrational forces. I became interested to explore how, through an affective experience of aural architecture, our mind and body could be triggered in a pre-conscious level to get attuned into being, to here and now, to a symbiotic real (Morton 2006). This operation of attunement relates to the site-specific acoustic installation and spatialisation (explained on p. 58).

These operations of the affective have been experimented in this research’s practical case studies. In the conclusion of this thesis (p. 198), I will sum up the results.

Next, I will unfold the link between each set of methods to an operation of the affective. Then, a diagram will expand the dynamics of the design methods in relation with the operations of the affective.

Link between the design methods and the operations of the affective



I - The experience of site as an operation of transformation:

- dynamic of experience
- sensory variation
- ambiance dynamic

II - The design of aural architecture as an operation of translation

- resonant soundscape
- space as resonator
- space as dynamic relation
- soundscape for attunement
- space as energetic geometry

III - The resulting ecology as an operation of attunement

- diversity of affective experiences of the environmental sound
- contribution for an ecology of affect

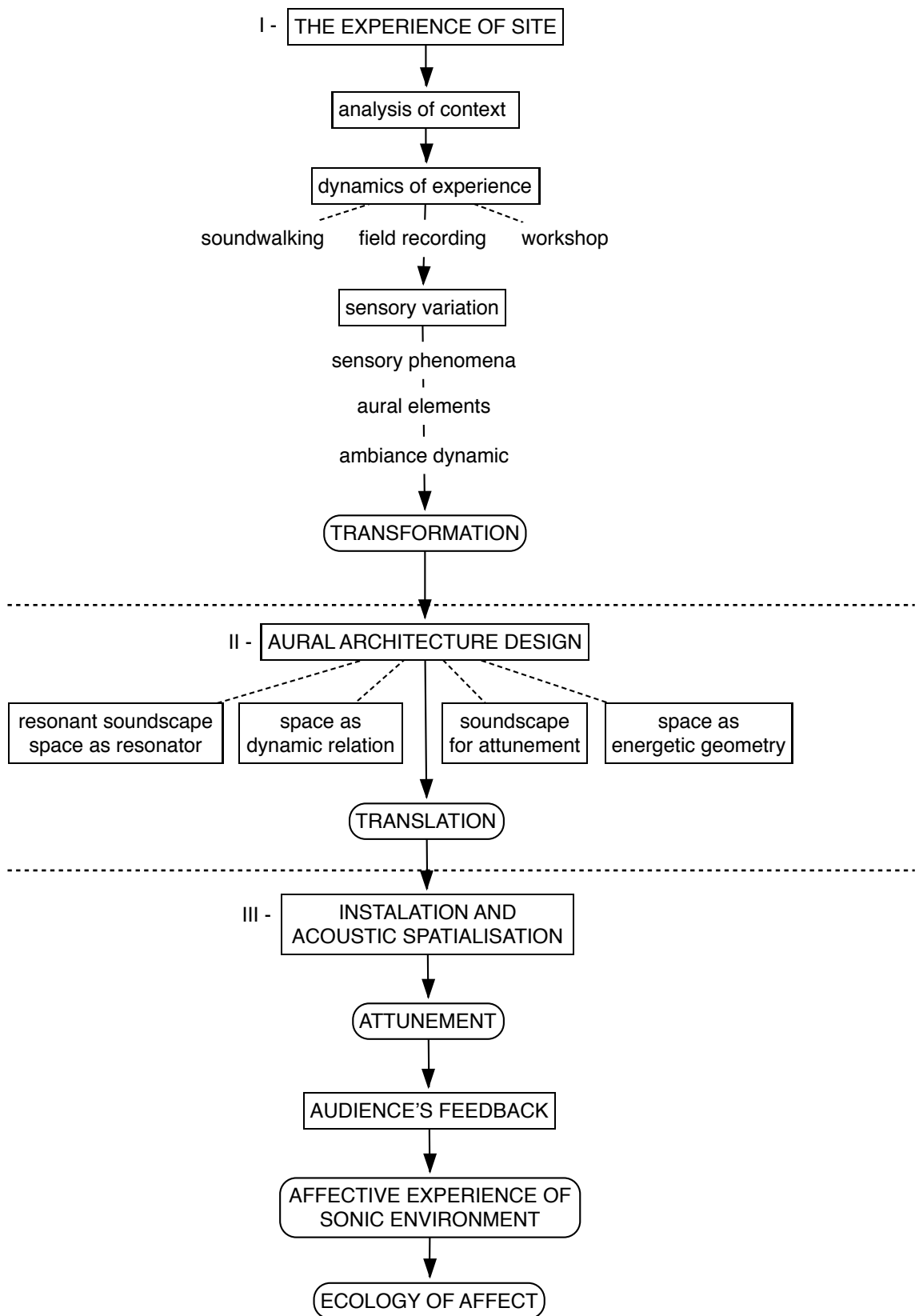


Fig. 2.01 - links between the design methods and the operations of the affective

2. Design methods

In this section I will draw an overview of the design methods involved in the practical case studies development.

Most of the gaps in the knowledge base which might inform environmental sound composition (...) can be traced to the models used by each discipline to determine its explanatory strategy. I have found that, although traditional bodies of knowledge are still useful in specific contexts, the only way to transcend the limitations inherent in each model is to construct a new interdisciplinary paradigm based on different concepts. (Truax 1996, 58)

According to composer Barry Truax, there are limitations inherent to models employed in separated disciplines, which might inform environmental sound composition. And the same happens for aural architecture design. I have realised that there are several gaps, such as a lack of tools to qualify the experience of aural space when compared to the amount of tools to quantify sound and space in terms of objective measurement (these are far more developed). In this sense, I have made an attempt to extend qualitative methods. My approach was to articulate multidisciplinary methods, drawing from the fields of architecture, acoustic ecology and philosophy.

These methods have been developed from theoretical concepts and/or from my practical experimentation. The methods unfold as follows:

1. The experience of site

- 1.1. Analysis of context
- 1.2. Dynamics of experience
 - 1.2.1. Soundwalking
 - 1.2.2. Field recording
 - 1.2.3. Workshop
- 1.3. Sensory variation
 - 1.3.1. Sensory phenomena
 - 1.3.2. Aural elements
 - 1.3.3. Ambiance dynamic

Operation of transformation

2. Aural architecture design

- 2.1. Resonant soundscape
- 2.2. Space as resonator
- 2.3. Space as dynamic relation
- 2.4. Soundscape for attunement
- 2.5. Space as energy geometry

Operation of translation

3. Acoustic spatialisation

Operation of attunement

4. Audience's experience and feedback

Result: affective experience of environmental sound

Next, follows a table to show the design methods application in each practical case study.

Method	<i>Vibrational Fields</i> (2011)	<i>Radio Sonores</i> (2012)	<i>Shores</i> (2017)	<i>Passage</i> (2017)
<i>1. Experience of site</i>				
1.1. analysis of context	x	x	x	x
1.2. dynamic of experience	x	x	x	x
1.2.1. soundwalking	x		x	x
1.2.2. field recording	x		x	x
1.2.3. workshop		x	x	
1.3. sensory variation	x	x	x	x
1.3.1. sensory phenomena	x		x	x
1.3.2. aural elements	x		x	x
1.3.3. ambiance dynamic	modulated	framed	tuned	modulated, tuned, framed
<i>2. Aural architecture design</i>				
2.1. resonant soundscape	x			x
2.2. space as resonator	x			x
2.3. space as dynamic relation		x		x
2.4. soundscape for attunement			x	x
2.5. space as energetic geometry				x
<i>3. Acoustic spatialisation</i>	x		x	x
<i>4. Result: audience's experience</i>	x		x	x

Fig. 2.02 - methods' application in each case study

Now, I will explain in what consists each of the design methods and its different steps.

1. Experience of site

As I have mentioned earlier, my practice is site-oriented and investigates responsive environments. This first step concerns the experience of the site for intervention as a creative process, and relates to an operation of transformation, to accentuate differences. It has been drawn from my experience as an architect and from an acoustic ecology and sound art practice. It concerns what is there at the site for intervention and what is my proposal for a transformation. This first set of design methods has arisen in each of my practical case studies, and evolved from one into another. Here follows a short description of each of the steps, that will unfold in the practical case studies.

1.1. Analysis of context

First, a contextual analysis of the site is carried out in a similar way as the preliminary process of an architectural intervention, in which I look to understand the physical, social, cultural, political and ecological contexts, and build up a body of knowledge based on that. It is based in my personal experience of place. It involves the following steps:

- experience the site at different times of the day, different days of the week;
- identify what is at stake;
- decide which actions are relevant;
- define the purpose of the intervention;
- choose where is the appropriate place for the intervention;
- move the intervention towards a specific sensory variation, for an affective transformation.

This contextual analysis can be achieved by a process of gathering impressions, through a sensorial drifting, by talking to people involved in the site context (inhabitants, communities, authorities, representatives of a group) or by consulting available information. An intervention always transforms a place (see p. 24 for Michel De Certeau distinction between place and space). So the questions are: in which terms, how and what for. An importance is given to a

sense of place. This concern is also recurrent in acoustic ecology and sound art practices. In the work of composer Hildegard Westerkamp, the experience of place is central to some of her pieces, such as *Fantasie for Horns II* (1979), in which horn sounds “are soundmarks that give a place its character and give us, often subliminally, a ‘sense of place’” (Westerkamp 1979 in Duhautpas and Solomos 2014 ²⁵). Sound artist Brandon LaBelle way of work is often “contextually orientated, and sensitive to being in a certain place at a certain time”. He feels particularly drawn by “how sound conditions our sense of place, and how it participates in relational exchanges, in our daily experiences” (LaBelle 2010, online reference). In my approach, I also focus on my personal experience of place, going to the site at different times of the day, different days of the week, to sense what are the site potentials, what underlying forces are gone unnoticed, what is there that is relevant to transmit. As mentioned earlier (p. 42), micropolitics emerged in my practice as a creative concept to explore the potential of transversal interventions in a micro-scale, events to activate matter-energy. This step is useful to understand what is there at stake and to move the practical case study’s intervention towards a specific purpose of sensory variation, for an affective transformation. It is also helpful to decide which actions are relevant and where is the appropriate place for the intervention and transformation.

1.2. Dynamic of experience

Second, enters the site experience dynamic process that will inform the aural architecture design process. This method was unfolded in different ways to experience the site, individually or collectively, and concerns:

²⁵ In <https://hal.archives-ouvertes.fr/hal-01202890> - accessed July 3, 2017.

1.2.1. Soundwalking

It concerns different ways to experience sound, walking through a site and listening. The technique of soundwalking ²⁶ has been extensively practiced worldwide. I draw from my own personal approach, but also from research carried out by composers Hildegard Westerkamp and Barry Truax, from the *World Soundscape Project* ²⁷. Westerkamp has defined soundwalking as “any excursion whose main purpose is listening to the environment. It is exposing our ears to every sound around us no matter where we are” (Westerkamp 1974, online reference).

1.2.2. Field recording

Field recording may involve different modes of capturing environmental sound. My approach to field recording involves different kinds of microphones in relation to each site: acoustic omnidirectional microphones (DPA 4060), contact microphones, electromagnetic microphones and hydrophones. In an interview talking about the equipment used for his work, Chris Watson, one of the world's leading recorders of wildlife and natural phenomena, mentions that he uses DPA's omnidirectional 4060s a lot. Besides the advantage of having tiny capsules, they sound natural. They're good for recording individual close-up sounds in mono, but he also uses them as a spaced pair on a coat hanger for stereo recordings (Watson 2016, online reference). The advantage of being tiny definitively allowed me access to narrow places. In some sites I became interested in capturing not only acoustic waves, the audible, but also everyday events that were not usually perceived. I looked to explore multiple dimensions and different materialities of space or milieus which we usually are not aware of. Therefore I also extended the spectrum of field recordings into infra sound and ultra sound; low and high frequencies beyond threshold ²⁸ (*Vibrational Fields*, p.

²⁶ Soundwalk is a practice of walking with a listening focus on the environment. The term was coined by members of the *World Soundscape Project* in the 70s.

²⁷ See appendix 3 for more details on the *World Soundscape Project*

²⁸ See appendix 4 (sound waves propagation and frequency perception)

74). With contact microphones I opened up the possibility to capture waves traveling inside different media, not only air, but also concrete, metal, glass, stone (practical case study *Vibrational Fields*, p. 77). Hydrophones allowed me to hear underwater (*Shores*, p. 155). I have used electromagnetic microphones in the practical case study *Vibrational Fields* (p. 77), to extend the enquiry into the building's infrastructure, capturing electricity impulses and glitches. The process of transduction²⁹ was of main importance to this exploration, to transpose imperceptible frequencies into a spectrum perceived as sound. My practice of field recording will be further commented in relation to each practical case study of my thesis.

1.2.3. Workshops

The aim of these workshops was to involve the public's participation in the practical case studies' creative process. In some contexts, there were opportunities to engage in a workshop with locals, which is always an advantage in order to activate pedagogical dynamics and social participation (*Vibrational Fields*, p. 107). This was also a way to incite ecological initiatives towards the environment (*Shores*, p. 145). There were no predefined methods. Each context defined the workshop dynamics.

1.3. Sensory variation

This method involved the following steps:

1.3.1. Sensory phenomena

Sensory phenomena is identified, which varies in general in terms of frequency, patterns, rhythm and tone; it can be sensed as movement, temperature, smell, light or sound.

²⁹ The term transduction refers to a form of transformation of electric energy to acoustic energy or vice-verse, such as a the process of a speaker or a radio in the first case or of a microphone in the second case (Fischetti 2003, 183).

1.3.2. Aural elements

This step consists in identifying particular aural elements of the existing ambiance, that affect and qualify the auditory experience, such as:

- fundamental tones
- key notes or soundmarks ³⁰
- specific acoustic spaces
- geometry
- material density
- spatial volume

These aural elements may be gathered through field recording and the modulation may be achieved through soundscape composition and acoustic spatialisation. The aural elements are selected for the quality of the acoustic cues, as it orientates navigation but provide also sensory stimulus which will define the space's aural specificity and influence associations, moods, practices, or the ambiance dynamics, as it will be now described.

1.3.3. Ambiance dynamic

The desired ambiance dynamic is defined. As seen on pages 38-40, according to architect Jean-Paul Thibaud, an intervention changes the ambiance dynamic and its aural experience. Thibaud describes different kinds of dynamics in ambiances (tuned, modulated, framed) and modes to account for its sensory variations. I have extended Thibaud's study into different methods to design aural architecture based in frequency fields variation to transform an ambiance dynamic - a subtle design of sound or space based in the selection of particular elements and the modulation of matter-energy. The act of modulating different frequency fields transforms an ambiance dynamic and explores a form of receptiveness that links up with specific corporeal states and brings the senses into synergy (Thibaud in LaBelle and Martinho 2011, 46). This is the aim of my

³⁰ Soundmark derives from the term landmark and refers to a sound unique to an area, that makes the acoustic life of a community unique (Schafer 1993, 10).

intervention. Building a new architectural space into the existing site may also be a way to transform an ambiance. The scope is that the intervention filters or amplifies the practical possibilities that a space affords (Thibaud in LaBelle and Martinho 2011, 48), and this may be achieved by introducing different rhythms and different relations between materials. Intervening in the relation between sound, acoustics and architecture results in an altered perception of spacetime and corporeal states. It transforms the ambiance, opening it up to different appropriations. As Thibaud explains, it often takes very little, almost nothing, to change an ambiance, and a minor detail is sometimes enough to qualify the whole of the sensory environment (Thibaud in LaBelle and Martinho 2011, 49). Each ambiance transformation generates a sensory variation and a different aural mode of experiencing urban environments. Therefore each intervention created different operations of affective transformation as it will be seen in the practical case studies. This method has been experimented in all the case studies.

Operation of transformation

A consideration is done on the operation of transformation (as seen on p. 42).

2. Aural architecture design

This second set of methods engages aural architecture design as an operation of translation, which I have explained on p. 43. I have converged soundscape composition, acoustics and geometry into the design of different kinds of aural architecture. I have come to the following modes of designing aural architecture.

2.1. Space as resonator

This mode of design addresses an intervention in an existing architectural space. It emerged from the practical case study *Vibrational Fields*, and concerns the phenomena of resonance and the idea of space and body as an

acoustic instrument, in which a resonator³¹ ensures that the vibration occurs at the right frequency (see p. 61). Here I have approached space as a resonator as a system that exhibits resonance or resonant behaviour to certain frequencies. Therefore it unfolds methods drawn from architectural acoustics, in the following steps:

2.1.1. Architectural acoustics study: acoustic space measurement

2.1.2. Reverberation time calculation (RT60)

2.1.3. Resonance frequencies calculation (room modes)

These will be explained in detail in Chapter 3, with the practical case study *Vibrational Fields*.

2.1. Resonant soundscape

This mode of design is inter-related with the previous. The soundscape design is based in space's resonance frequencies³² to magnify or enhance environmental sound, to enter into vibration with the audience's body and mind. It emerged from the practical case study *Vibrational Fields*, and is related with the phenomena of resonance and the idea of space and body as musical instruments (p. 64). It unfolds methods drawn from acoustic ecology and soundscape composition, in the following steps:

2.2.1. Composition with field recordings

2.2.2. Tuning with resonance frequencies

2.2.3. Layers

These will be explained in detail in Chapter 3, with the practical case study *Vibrational Fields*.

³¹ The term resonator was also used by Hemholtz in his 1862 book, "On the Sensations of Tone", to describe an apparatus able to pick out specific frequencies from a complex sound.

³² Resonance frequencies are explained on p. 62.

2.3. Space as dynamic relation

A new architectural space is designed based in a specific aural experience (such as relatively silent, attentive listening, inner and outer listening). It emerged from the practical case study *Radio Sonores*, and is related with the concepts of space as field, relational space and assemblage. It unfolds methods from architectural theory and experimental practices, in the following steps:

2.3.1. Space as dynamic relation

2.3.2. Energetic geometry and assemblage

2.3.3. Architectural acoustics study

These will be explained in detail in Chapter 4, with the practical case study *Radio Sonores*.

2.4. Soundscape for attunement

The soundscape design is based in the idea of attunement to environmental sound. It emerged from the practical case study *Shores*, and is explores relationships between attunement, ambiance and ecology. It experimented philosophical concepts and unfolded methods from acoustic ecology, in the following steps:

2.4.1. Composition with field recordings

2.4.2. Tuning with resonance frequencies

2.4.3. Layers

These will be explained in detail in Chapter 5, with the practical case study *Shores*.

2.5. Space as energetic geometry

Since the physical Universe is entirely energetic, all dimension must be energetic. Synergetics is energetic geometry since it identifies energy with number ... Synergetics provides geometrical conceptuality in respect to energy quanta. In Synergetics, the energy as mass is constant, and nonlimit frequency is variable. (Fuller 1975, 22)

This design method is a convergence of the previous four design methods. and an extension into the idea of space as energetic geometry. For Fuller, space has specific properties or constraints, it has underlying invisible forces and multidimensional fields and shapes. For him, the essential nature of matter-energy lied not in abstract form-making but in processes based in energetic geometry and in the characteristics of vibrating systems such as interconnection, relation, polarity and multidimensionality (see pages 168-171). This design method aimed to extend these ideas, and emerged from the practical case study *Passage* (p. 172). Its processual steps will be explained in detail in Chapter 6, with the practical case study *Passage*.

Operation of translation

A consideration is done on how the specific aural architecture design has created an operation of translation of an invisible design, attentive to the interplay between dynamic physical forces and spatial constrains (as explained on p. 43).

3. Acoustic spatialisation

This step refers to the site-specific acoustic installation which varies according to each place and practical case study's specificities. The spatialisation concerns the placement of audio equipment to perform the soundscape. Its placement depends on the place's acoustics. I have established a protocol for the process of acoustic spatialisation (to be used if appropriate), as follows:

- 1- Install the audio equipment.
- 2- Run tests to confirm the resonance frequencies of the space and the frequency range of the sub-woofer; adjust if necessary.
- 3- Spatialise the sound system; choose the best placement of the sound system exploring the relationships between resonance frequencies, geometry, materials' density and spatial volume.
- 4- Re-adjust soundscape composition if needed.

Operation of attunement

A consideration is made on how the acoustic spatialisation produced an operation of attunement (as explained on p. 44).

4. Audience's experience and feedback

The conclusion varies according to each practical case study outcomes. The audience's feedback was a valuable input to understand the affective results of the experiment. I chose to leave a notebook for comments instead of interviewing the audience. I have tried a few interviews and realised quickly that I was getting a mental feedback, with preconceived ideas, rather than a direct affective expression of the felt experience. As seen on p. 37, affect is primary, non-conscious and intensive (Massumi 2002, 27).

Affective experience of environmental sound

A reflexion is made on how the audience's feedback informed the kind of affective experience of environmental sound.

Chapter 3

Working concept	• Field of resonance
Enquiry	<ul style="list-style-type: none"> • Acoustic model of waves' propagation • Sympathetic vibration, resonance frequencies, standing waves • Space and body as musical instruments • Spatial sound
Practical case study	• <i>Vibrational Fields</i>
Design methods	<ul style="list-style-type: none"> • Resonant soundscape • Space as resonator
Affective experience	• The physicality of vibrational force in environmental sound, enhanced by space's acoustics
Emergent concepts	<ul style="list-style-type: none"> • Background listening • Dynamic sonic beings • Being vibration

In this chapter, I will introduce the working concept of field of resonance drawing from acoustics. and then situating it in relation to contemporary practice (such as Edwin van Der Heide, Mark Bain, Randy Yao and Scott Arford). I will open up an enquiry on space and body as acoustic instruments and on spatial sound, looking up into similar practices and associated debates. The point in which I differ from these examples, is my approach to acoustic ecology, with a site-oriented exploration of environmental sounds through field recording.

I will then present the experimentation of these ideas on my practical work *Vibrational Fields* (2011-2012), a site-specific soundscape composition and spatialisation to resonate an existing building. It has produced two design methods: the design of a resonant soundscape and of a space as resonator. It explored an affective experience of the physicality of the vibrational force of environmental sound, enhanced by space's acoustics. Concepts have emerged from within my practice experiment such as: background listening, dynamic sonic beings, being vibration.

Working concept:

The Field of Resonance

With this first experiment my aim was to research how an architectural space could become an acoustic instrument for the tuning of the body with its surroundings. I wanted to test ideas on how to acoustically activate the experience of sound as a field of resonance, and experiment with the ideas of a resonant soundscape and of space as resonator (the use of the term resonator was described on p. 55). The technique of resonance frequencies resonates with a mode of thinking about the relations between inanimate objects and forces such as sound. Here I have looked into similar approaches between an architectural space's acoustics and a musical instrument's acoustics. All musical instruments share the same functions: "a generator to get the vibration going, a resonator to ensure the vibration occurs at the right frequency and a radiator to communicate and make the vibration heard" (Johnston 1989, 41). I became particularly interested in the phenomena of resonance and how the vibrations of musical instruments happen. Therefore I elaborated on the essential characteristics and the causes of standing wave patterns, which are related to the vibrations of musical instruments. In this study lies the foundation for my exploration of space and body as musical instruments. I started this enquiry by developing further acoustic research on a sonic experience of sympathetic resonance between space and body, as an interconnected field of vibration.

Sympathetic vibration, resonance

The experience of sympathetic resonance between space and body, as an interconnected field of vibration, is directly related to the relationship between the geometry, materials' density, and spatial volume of the space of propagation, the type of sounds and frequencies that are performed, and its spatialisation. The main acoustic effects for this practical case study refer to sympathetic vibration and its physical manifestation as standing waves.

Sympathetic vibration or resonance may be defined as “an enhancement of the intensity of a sound that occurs when its frequency equals or is close to the natural frequency of vibration of an acoustic system or air-filled cavity” (Moore 2007, 403). Therefore a body resonates in response to frequencies that are close to its own, as further explained by the following definition of resonance: “as the frequency of the stimulus [sound] closely approaches that of the system [body], oscillation occurs, which reaches a maximum amplitude at the natural resonance frequency” (Fischetti 2003, 105). The natural or *resonance frequency*³³ of any system is determined by its size, surface, pressure and volume. Resonance frequencies and its multiples are avoided in architectural acoustics. Avoiding resonance disasters is also a major concern in every building, tower, and bridge construction practical case study³⁴. However, in the case of a musical instrument, these resonance frequencies are important for the quality and intensity of sound (such as vibrating strings or organ pipes). Therefore this is the aspect of resonance that I wanted to explore in this practical case study: how space and bodies may interact as musical instruments. This form of experience is directly related to the relationship between the geometry, materials’ density and spatial volume of the space of propagation, the type of sounds and frequencies that are performed, and its spatialisation. Drawing from acoustic literature, I have enquired on how sound travels through different mediums, its resulting acoustic effects, and how different frequencies produce different kinds of experiences in space, things and living beings. This exploration finds a theoretical reference in the acoustic model of waves’ propagation³⁵. In this model, a vibration is described as the movement of particles traveling through a medium, producing a wave. The

³³ It has been discuss that a common error found in literature is to refer the term *natural frequencies*, or *resonance frequencies* as *resonant frequencies*. Source: <https://leachlegacy.ece.gatech.edu/misc/resonance.html> (accessed May 12 2017)

³⁴ A commonly given example, is how the frequency of the wind can make the wire cables of a bridge vibrate like a giant harp causing the road to vibrate in sympathy through the principle of resonance, and even collapsing.

³⁵ See appendix 4 (waves’ propagation and frequency perception).

vibration of a source produces the propagation of particles of energy that travel along a wave. Sound waves propagate in any material, solid, liquid and gaseous. The propagation of a wave depends on the property of elasticity in the medium. The more elastic the medium, the faster the wave propagates (sound travels faster under water than in air, but it travels faster through metal than under water). The particles of matter in a medium act as enmeshed in a elastic web, a connective tissue.

Resonance frequencies and standing waves patterns

Musical instruments are set into vibration at their resonance frequency (also called natural or fundamental frequency). When one object vibrating at the same natural frequency of a second object forces the second object into vibrational motion, the phenomena of resonance occurs ³⁶. Resonance is the cause of sound production in acoustic instruments. And when an object is forced into resonance at one of its natural frequencies (also called harmonics), it vibrates in a manner such as a standing wave pattern is formed within the object. This wave pattern is characterised by points that appear to be standing still, referred to as nodal points. To understand these principles, a visualisation of these standing wave patterns is helpful, such as the Chladni sound figures. Physicist and musician Ernst Chladni, conducted a series of experiments to make visible the waves' modes of propagation and the phenomena of resonance. The experiment consisted of thin metal and glass plates in which he sprinkled powder on top and set them vibrating with a violin bow along one edge. The powder upon the plate vibrated until it settled onto positions of nodes. It moved away from where the vibration was greatest and collected along the nodal lines where the vibration was least. It resulted in beautiful vibration patterns. The conditions for resonance determined the shape of these figures: on the one hand the amplitude and the pitch of the sound, and on the

³⁶ Online reference: resonance and standing waves <<http://physicsclassroom.com>> (accessed 23rd January 2016)

other hand the shape and material of the plate itself. The sound produced by the bow was a natural frequency of the plate, and so the pattern formed was a standing wave pattern. His experiment was revolutionary at his time (1787) as it demonstrated that sound travelled in waves. Even today it is often used in physics classes to visualise the relation between vibration and an object's natural frequencies. This same phenomenon happens to any other object, musical instrument, body or space, as everything has a set of resonance frequencies at which it vibrates. Each resonance frequency is associated with a standing wave pattern. My hypothesis for the experiment *Vibrational Fields* was that the space of the installation could become an acoustic instrument if played with its resonance frequencies. Our body resonates in a similar way as a musical instrument when exposed to particular frequencies. To find out what the resonance frequencies are, of course it is easier to measure an architectural space than our body's cavities. In my understanding, as all bodies are different, cavities' dimensions vary, and therefore it is difficult to define natural frequencies to every existing body type. I have extended these ideas further in the practical case study *Passage*, drawing from neuroscientific studies (p. 183). But for now, this exploration addressed the architectural acoustics of a space. Therefore I remained mainly focused in exploring specific effects of architecture's resonance frequencies, reporting its bodily affects based in testimonies. This relationship of resonance with architecture as a musical instrument was explored in practice with the case studies *Vibrational Fields*, *Shores* and *Passage*.

Space and body as musical instruments

The idea of the practical case study *Vibrational Fields* was to research further how an architectural space becomes a musical instrument for the tuning of the body with its surroundings. Space and body were engaged as instruments through acoustic effects and resonance frequencies. Space and body were activated through a resonant soundscape. This technique has also been

explored by a few sound artists and musicians, such as the duo of sound artist and architect-acoustician Infrasound, or sound artists Edwin Van der Heide, Mark Bain, Ryoji Ikeda, Paul Bavister, Lukas Kühne. I had the chance to experience some of these works. There are some points that I share in their approach, valuable for this exploration, and other from each I differ. Next I will unfold these ideas.

Edwin van der Heide - the audience inside the instrument

In a reverberant space of four rings, each separated by a wall, with ring shaped corridors, here an unusual acoustic was already present. What artist and composer Edwin van der Heide did was to amplify its natural acoustic effects, particularly reverberation, using one microphone in one side of the wall and a speaker on the other side. It became possible to make the sound go round and round as if it were perpetual mobile (Heide in LaBelle and Martinho 2011, 284). Similarities are found here with Alvin Lucier's *I am sitting in a room*, which focuses on the resonance frequencies of the room. Heide considered these rings as circular strings where the audience would be inside an instrument. He altered the perception of the space by manipulating sound and frequencies with delay. He transformed "the acoustic properties of the space in real-time, turning it into a time-based transforming space; a dynamic form of architecture" (Heide in LaBelle and Martinho 2011, 288). I actually felt the space of the installation as if I was inside a large instrument. I, along with the other audience members, was acoustically playing that instrument, and experiencing it by being inside of it, exploring it. I share this idea of an audience inside the instrument, as a system determined by the acoustic properties of the space and the temporal alterations from sound and frequency shifts. Although in the case of my experiment, these have resulted more from natural acoustic effects than from the manipulation of sound with digital delay effects. Another aspect in which I differ is the source of sounds. Instead of real time audio produced by the audience movements, I have created a site-oriented composition using field

recordings. As will be seen, my aim was to engage an acoustic ecology awareness of the site dynamics, though the spatialisation of a multitude of sources captured from the surrounding environment.

Infrasound - the experience of space and self as vibration

Infrasound is a collaborative work between architect-acoustician Scott Arford and sound artist Randy Yau that resulted in a series of site-specific sonic performances and real time compositions. I share many common points with their approach regarding the form of experience of acoustic space. They explore the complex relationship between sound, space, perception, and the body. They claim that their ultimate aim has always been that of the physical experience of the tangible vibrancy. In their experiments “there is nothing else but sound, all that exists is vibration” (Infrasound in LaBelle and Martinho 2011, 196). Their manifesto clearly states how they compose the soundscape to build up the real time experience of vibration:

Hear with your body. This is not about music. This is not about performance or the performer. The goal is sound and the explicit translation of sound into physical force. The force is internal and external realisation. It is about provoking new modes of perceiving and experiencing one's own body – triggering variable and autonomous psycho-physiological response. It is about the total acoustic sense of space – observing sound to measure the capacity of architecture. It is about the phenomenon of resonance or sympathetic vibration – all things working in one continuum. (Infrasound in LaBelle and Martinho 2011, 196)

In their performance this is exactly what happened. They played with the resonance frequencies of the room, with pure sine wave generators. The sound and vibration unexpectedly took the audience into the void, where vibration activated and occupied bodies and space with variable sound pressure levels. I felt it became an experience of a real time-space continuum of events and

becoming, connecting everything, bodies, building and things. I have drawn from this practical case study particularly for its acoustic research and experimentation in activating body and space through sound; also from the kind of vibrational experience it addresses, as a tangible experience of void, of acoustic space as vibration, as a state of both physical and mental non-existence, ever-present. They are aware that the concept of void is an artefact of our perception, but still they claim that we can make it palpable and vibrate it into existence by activating particles and waves of sound, to pulse interludes and resonance between body, mind, space and time, “giving some tangible experience to some kind of unified field” (Infrasound in LaBelle and Martinho 2011, 197). What I have retained from this example is how sound as vibration and space's acoustics may become a strong vehicle for mind and body to enter into resonance with this unified field.

Mark Bain - Space and body as connective tissue

I also find some common ground with artist Mark Bain’s approach on the body’s experience of vibration, as vibration itself, through the interaction of acoustics, architecture and physical/mental reactions to infrasonics – sounds below the human hearing threshold. Bain explores the idea of a “connective tissue between structures and the audience (...) whose bodies contribute to the sum of vibrations”³⁷. He is involved in investigating the effects of inherent and induced sonic events on structures and the people that inhabit them.

In his performances, he uses the sound potential of the buildings' structure, sometimes with machinery to vibrate the materials, shaking the building and the ground for a sonic effect. He also uses the inaudible sounds normally present in the buildings in which he performs, amplifying it with seismographic and other specially designed equipment. In his performance at Tuned City 2008, Bain used analogue oscillators to map out the signature of an unfinished

³⁷ Online reference: http://www.tunedcity.net/?page_id=29&lang=en - accessed April 23 2013

building and to define a presence within, which is normally thought of as static. His final goal was to use infrasound generated by the building's architecture. The performance resulted in masses of infrasonic waves. The feeling of the infrasound pressure was more physical than hearable. I felt I was in the middle of an ocean of infrasound. It overwhelmed my senses and I became totally immersed in some kind of connective tissue. Space gain another materiality, dynamic but dense. I felt my organs vibrating, my blood pressure altered, my breathing and heart beat pulsing and responding sympathetically to the rhythm, and I thought it was almost unbearable to stay long. But still I stayed and enjoyed the experience of feeling my skin vibrating within the mass of acoustic waves. Here again, I have found common aspects, particularly with the approach on connecting architecture and the audience by the means of a physical experience of sound waves as infrasound and vibration.

Iannis Xenakis - Spatial sound and dynamic sonic beings

From another perspective, architect, musician and engineer Iannis Xenakis, also experimented with sound materiality through a spatial approach. I have found a particular common ground with Xenakis' exploration of space through sound matter through a multidisciplinary praxis between architecture and music. Although I must say that on the other hand I was also quite distant to his particular modern aesthetic in the sense of total composition. Besides, I was not just interested in the process of composition but also in the experience of the audience, as will be seen in the practical case studies. But being myself an architect and acoustician working with sound, Xenakis' approach to geometry as a generative, transformative and integrative process of spatial sound design and composition is a significant aspect that I share. His practice took him to discover that the composition problems are the same in architecture and music. In his research of a science of a general morphology, his thought and process are based in profound relationships between mathematics, geometry, physics, music, philosophy and architecture. His thought in music composition fed his

practice in architecture and his thought in architectural structure fed his musical practice. In this sense, he gave particular attention to macro scale and micro scale. Xenakis followed a composition process in a global form. He had the totality in mind, simultaneously thinking in details, elements and proportions. Through geometric drawing, the main tool in the process of composition in architecture, he developed his ideas in sonic space and time. Xenakis gave major importance to the generative, transformative and integrative process, as a construction strategy. In interview (Matossian 1977) Xenakis stated:

I found that problems in architecture were the same as in music. One thing I learned from architecture which is different from the way musicians work is to consider the overall shape of the composition, the way you see a building or town. Instead of starting from a detail, like a (musical) theme, and building up the whole thing with rules, you have the whole in mind and think about the details and elements and, of course, the proportions. That was a useful mode of thinking.” (Beilharz 2004)

I find some common points between my practice and Xenakis' approach of acting as an architect on sound matter. My process of modelling sound composition was also oriented towards the relational and the ensemble of operations, as in architecture. I have engaged design in a multiple scale approach, or multidimensionality, acting between groups of specific microsounds' frequencies and the macrophonic perception of these groups as sound masses. I became interested in Xenakis' idea of a transformable sound mass as musical sound and in his approach of playing with the compositional space's multidimensionality (Sedes in Solomos 2003, 231). Xenakis introduced phenomenological and geometric notions, enriched the musical thought and stepped away from all modes of thinking composition at his time (melodic or serial). He appealed to the internal logic of natural phenomena, its structure and perception; and freed the mind and thought of polyphonic classical schema and

the discussion on the detail. Xenakis scores (such as *Metastaseis*, *Le Diatope*, *Les Polytopes*) were graphic or geometric. Makis Solomos explains Xenakis' process of modelling sound was the opposite of that from serial composers. For Xenakis the material deployment of sound determines its own form (Solomos 2003, 156). There is a fusion between form and material. This is a process of modelling sound that I have explored in my process of composition of this experiment *Vibrational Fields* but also in my practical case studies *Shores* and *Passagem*. Xenakis gave major importance to the generative and transformative process, as a construction strategy, and to the ensemble of operations, as in architecture. Therefore, his practice was oriented towards process instead of result. This is also an important point in my approach. As Solomos points out, Xenakis looked to centre sound on its sonic plenitude (Solomos 2003, 150), in search of an integral presence (Solomos 2003, 151). He explored the intense presence of sound through acoustics and spatialisation (Solomos 2003, 163). He looked to create a sonic context for the experience of sound as to put someone in the middle of the sea, "to be in the sound that comes from everywhere", "surrounded by sounds" (Solomos 2003, 177). This is the kind of experience that I aimed to create with the soundscape installations *Vibrational Fields* and *Shores*. Xenakis transposed from architecture to music three ideas of parabola: the space parabola; the gases parabola; the numbers parabola. I find interest in his explorations of the parabola of space, in works such as *Les Polytopes* (in Montréal in 1967, in Cluny in 1972 and 1973), with the definition of elemental surfaces that generate the composition space (these works will be further explored on p. 167). In my composition process, I have drawn from his exploration of the parabola of gas, and the conception of sound masses, for the experience of sonic space as vibrational force. An example of this is Xenakis' early work *Metastaseis* (1955), which he conceived as the acoustical equivalent to the phenomenon of the crowd. He looked specifically for a compositional technique adequate to powerful personal memories. Xenakis drew upon his own graphic imagination and his training in geometry to

invert conventional procedures of composition. He began with a graphic notation describing the desired effect of *fields* or *clouds* of sound, and only later reduced these graphics to conventional music notation (Allen in Hensel, Hight, Menges 2009, 139). In his conception of *clouds* of sound, or *statistical* music, complex acoustical events cannot be broken down into their constituent elements (Allen in Hensel, Hight, Menges 2009, 120). Therefore Xenakis' fundamental concepts of composition were centred in a musical investigation of sound masses, in its regular and irregular variations. For Xenakis, phenomena are models in their internal processes and not in their final form or structure (Di Scipio in Solomos 2003, 192). Therefore he developed theoretical and formal means of conception of masses of sound, of clouds of punctual sounds. He explored concepts of pressure, density (new in the 50s), molecules' movement and the kinetic energy of gas clouds. Inspired by physicians Boltzmann and Maxwell on the propagation of gases (gases kinetic theory), Xenakis was a precursor of the model of granular synthesis. Xenakis' research contributed to the emergence of a granular thought, approached in a multiple way between the local and the global, between micro-sound and the macrophonic perception (Sedes in Solomos 2003, 234), which was further developed by several other music composers, such as Curtis Roads. In Xenakis' model of granular or corpuscular thought, sound is described as an integration of grains, of sonic quanta. Each grain has a frequency, a duration, an intensity. Xenakis explored particularly a methodology of modelling in a macroscopic scale. He explained the aim of this macroscopic methodology in the chapter on *Markovien stochastic music*³⁸ as follows:

For a macroscopic phenomena, it is the global massif effect that counts, and each time that one may observe the phenomena, first one should establish the relationship observer-phenomena. So, if we observe a galactic cluster, we must decide if it is the movement of the whole that

³⁸ In *Musiques formelles – revue musicale n°253-254*, 1963-1981, 67

interests us, if it is the movement of a single star, or if it is the molecular constitution of a very small region on a star. Inversely, to act as architects on sound matter, to build up complex sounds and the evolution of these beings, signifies that we must use analysis and macroscopic construction methodologies. Microsounds, the elemental grains, do not have importance at the scale that we place ourselves, only groups of grains and the characteristics of these groups make sense.

Xenakis explored the notion of intensity of grains and frames where sets of sound masses move, creating sonic beings. What I would like to point out is how Xenakis valued a new model given by sound analysis as a psycho-physic phenomena, where “sound is perceived in a global mode, in its gaseous environment, under the form of sound masses” (Sedes in Solomos 2003, 231). We may think here of his works *Syrmos*, *Analogique A et B*, *Achorripsis*, *Pithoprakta* and *Concret PH*. Here, he composed sets of sound masses that move to create “music as a sonic being”, where sound has a “processual form of *becoming* in relation to someone’s experience” (Sedes in Solomos 2003, 234). This is another common point that I find with Xenakis and that I have explored in my practice, where sounds result as psycho-physic phenomena.

The approaches discussed in the previous pages (Edwin Van Der Heide, Infrasound, Mark Bain, Iannis Xenakis) extend the inquire of the working concept *Field of Resonance* towards an interrelation between two approaches. On the one hand, I have explored the composition of a sound matter that can be described as sound masses and dynamic sonic beings. I got interested in its enveloping nature and psycho-physic phenomena. On the other hand, I have experimented with the spatialisation of this sound matter composition in architectural space through acoustic resonance, to enhance the vibrational force of sound, and to rise the experience of self as being vibration. As will be seen next, in *Vibrational Fields*, I have explored these two aspects. The point in

which I differ from the previous examples, is my approach to acoustic ecology, with an exploration of environmental sounds of the site through field recording. My stance was that it would eventually connect the audience and site to an acoustic ecology awareness of the interconnectedness with the surroundings. Therefore I have experimented a mode of building up the experience of being vibration based in the phenomena of sympathetic vibration (or resonance), with resonance frequencies, sound masses, standing waves and site-specific dynamic sonic beings. The design process engaged an exploration of a resonant soundscape and of space as resonator.

Practical case study:

Vibrational Fields

The soundscape *Vibrational Fields* was experimented and shared in different public spaces, in academic and cultural events:

- Media and the Senses*, conference, Goldsmiths, University of London (2011);
- Rhythm Materiality*, symposium, London Consortium (2011);
- Embodying Topology*, performance, Tate Modern, London (2011);
- Sound-Space-Signal*, performance, Guimarães European Capital of Culture, Portugal (2012).

These were engaged as opportunities to test the same purpose and methodology in different places and contexts, integrating in each case study the acoustic specificity of each place. This report refers to the research process of the first installation of the series, in the event *Media and the Senses*, at Goldsmiths, University of London, a 3 days event of talks and installations that took place at the Professor Stuart Hall building.

1. Experience of site

1.1. Analysis of context

My proposal was to intervene with the architecture of the Professor Stuart Hall building, to interfere with the usual experience of an everyday space, by modulating its acoustic perception. For these reasons I strategically selected the entrance hall of the building as the place for the installation and performance of the soundscape. This entrance functions as an intermediary space of passage between the exterior and the interior. It has two pairs of electric glass doors. The opening and closing rhythm varies during the day, being more constant in the early morning, lunch break and end of the afternoon. The louder sounds of this space are mainly mechanical: the electric system of

the doors and the ventilation system. Still, footsteps and voices are clearly heard.

The ambiance while standing inside this space was peculiar. It felt as being in some sort of decompression room in-between two different zones, as an expanded border between two territories. As doors opened and closed there was a sensory variation: the temperature of the space and the soundscape varied. From this place, through the glass doors and wide windows, I could clearly see what was happening outside and inside the building.



Fig. 3.01-3.06 - entrance of the Professor Stuart Hall building

I perceived this liminal space as an interstice (from the Latin *interstare*, to stand in between), which is usually defined as a small empty space between different elements. The interstice as a “void space within a substance (Lavoisier 1723; Baudrillard 1975) can refer to notions of permeability (De Certeau 1980), infiltration and passage (Bhabha 1994), interval (Barthes 1970; Virilio (1984), (...) transition, threshold and border (De Certeau 1980)” (Lévesque 2013). Besides its spatial character, the interstice also refers to “a temporal dimension as an interval of time” (Lévesque 2013). This aspect of the term “links the interstitial condition to the notions of transition, transformation, process and

event” (Lévesque 2013). I found this space very appropriate for the experiment of an acoustic amplification and to work with the idea of interval and transition through an event. Therefore I engaged this interstice as “an open and relative spatio-temporal condition, activated or created in-between bodies” and therefore as a “possibility for action between certain space limits” (Moles and Rhomer 1972; Koolhaas 1989) (Lévesque 2013). The acoustic amplification of the interstice would engage an operation of transformation (as described on p. 42).

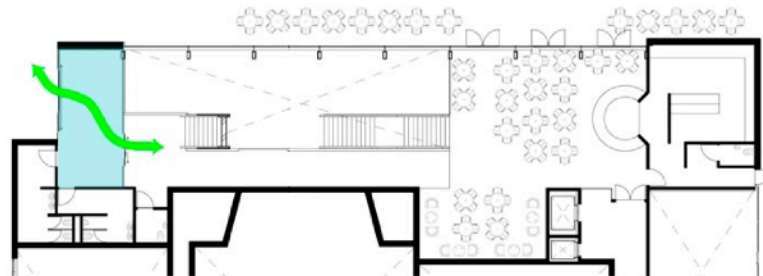


Fig. 3.07 - plan of the entrance level

1.2. Dynamic of experience: soundwalking and field recording

I have soundwalked inside the Professor Stuart Hall building and outside in its close surroundings at different times of the day. I gathered sounds of the cyclical rhythms produced by the movements of people in the building and by the infrastructure of the building itself. My aim was that these field recordings would extend the audience’s experience of the place of the installation, into an acoustic ecology awareness of that same space and its close surroundings. I have recorded 1 minute for each source, at different times of the day, to capture distinct dynamics and circadian rhythms of the building’s public spaces and outside close surroundings.

Sources

I gathered the motions of the place, of its sounds and vibrations. Temporalities, territories, borders and movements were guidelines to the field recording quest. The idea was to compile significant samples that would reveal the acoustic signature of the building and extend the perception of the place. Each source corresponded to one different type of public space or situation, according to its function, acoustics and soundscape:

Source 1 - outside, ambient (recording 3.08)

Source 2 - the entrance, fresh-hall (recordings 3.09)

Source 3 - the lobby, circulation corridor, choice of two paths, towards sources 4 or 5 (recording 3.10)

Source 4 - the cafe (recording 3.11)

Source 5 - circulation corridor and areas of rest (recording 3.11)

Source 6 - the void, from downstairs, acoustic tone of the building (recording 3.07)

Source 7 - electromagnetic and contact microphone recordings, at the entrance (recordings 3.14 to 3.24)

Please refer to the documentation to hear the raw files of these sources.



Fig. 3.08-3.13 - location of sources

Recording devices and techniques

I gathered a multitude of sounds and frequencies, using contact microphones, electromagnetic microphones and acoustic omnidirectional microphones (DPA 4060). Here I was interested in capturing not only acoustic waves, the audible, but also everyday events that were not usually perceived.

1.3. Sensory variation

Here the intervention was in an everyday space, which functioned as the entrance of the building. It transformed the place's usual function. While the usual everyday activities of the building continued, the entrance was hacked to become also a listening place. This sensory variation would transform a zone where people just passed by, into a place to stop and listen.

1.3.1. Sensory phenomena

I became interested in exploring multiple dimensions and different materialities of space in specific frequency fields which we usually are not aware of. With contact microphones I opened up the possibility to capture waves traveling inside concrete, metal and glass, which are the main materials of the building. Using electromagnetic microphones, I extended the enquiry into the building's infrastructure, capturing electricity impulses and glitches. Here the process of transduction³⁹ was of main importance to this exploration, to transpose these imperceptible frequencies into a spectrum perceived as sound. This activation of vibrational space to an audible spectrum, articulated an unusual acoustic relation with the site, interfering with its structured formatted order and therefore affecting its experience.

³⁹ The term transduction refers to a form of transformation of electric energy to acoustic energy or vice-verse, such as a the process of a speaker or a radio in the first case or of a microphone in the second case (Fischetti 2003, 183).

1.3.2. Aural elements

I found the following particular aural elements:

- fundamental tones: void, background drones;
- keynotes or soundmarks: footsteps, automatic sliding doors, doors shutting;
- specificity of acoustic space: a great amount of reflection from the glass windows and doors.

Emergent concept: background listening

Most of the time, we process acoustic information more at a background level without attention being focussed on it. This information provides the environmental context of our awareness, the ongoing and usually highly redundant 'ground' to our consciousness. (Truax 1996, 58)

According to Barry Truax, listening is multi-leveled because it can involve various degrees of attention. He claims that different levels of listening involve analytical attention being paid to short-term details in the foreground case, and holistic or gestalt pattern recognition in the background case. Interesting to notice that these two complementary strategies are often described as the left and right hemispheres of the brain (Truax 1996, 59). Truax describes background listening as "a sophisticated cognitive process, involving feature detection, the recognition of patterns and their comparison to known patterns and environmental *signatures*. Moreover, background listening can trigger conscious attention to be focussed on an incoming sound when there is sufficient need or motivation from the listener" (Truax 1996, 59). Background sound is normally considered insignificant, but in my spatial perspective, it modulates the whole ambiance. Therefore here in this experiment it was very significant. My point was that including field recordings of the background environmental sound in the soundscape composition would involve the public in

a form of background active listening. And this could extend the perception of a place and an awareness of environmental sounds.

I have also experimented further these variations of listening and how it contributes to a process of balancing hemispheres in *Shores'* soundscape composition (see p. 156).

1.3.3. Ambiance dynamic

The space for the installation converged the site's sounds and generated an acoustic of interference. The intervention would amplify the space's practical possibilities. Therefore I engaged with Thibaud's concept of modulated ambiance (p. 39), involving slight variations of the sensory context of the place. Here, what was felt, such as rhythms of human activity in the building (steps up and down the stairs, sliding doors, or doors shutting) fluctuated differently over time, with the recordings interfered and resonated with the actual activities going on in real time. This ambiance therefore has produced an ecology of situated perception (Thibaud in LaBelle and Martinho 2011, 45).

Transformation

My intention was to subvert the usage of this place and to generate a dynamic form of aural architecture, through the amplification of the sound dimension. The experience of the resonant soundscape would emerge within this in-between space. People would enter the building walking through the entrance as a sonic portal. Instead of a static entrance into the building, here space-time references would move and change in repetitive and flowing patterns. This place would work as the convergence point of multiple field recordings gathered in the site. Therefore the idea for the soundscape emerged as a convergence of multiple sources in one centre, to amplify the site's environmental sound into one focal point. My exploration of the site was based in a convergent movement, as a spiral or a vortex (fig. 3.14). In this sense, the space of the installation has embodied this movement as a vortex. This convergence of

sources, with its attractive forces at work, would produce a transformation of the affective experience as an acoustic interference.

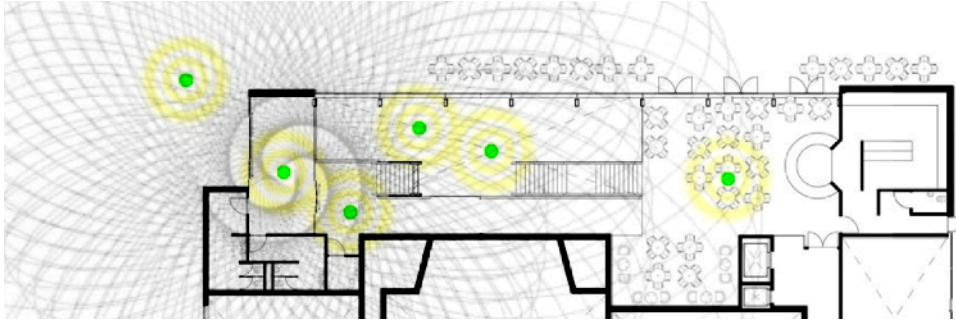


Fig. 3.14 - exploration and convergence of sources

2. Aural architecture design

2.1. Space as resonator

The concept of space as resonator explored the capability of a space to resonate with its physical structure and reveal a vibrational materiality in it. I built up the acoustic study based in the physical phenomena of sympathetic vibration or resonance, resonance frequencies, standing waves and reverberation, resulting from natural acoustic effects. These effects generated a particular acoustics with certain amplified frequencies, for an unifying experience between space and body as a musical instrument.

2.1.1. Architectural acoustics study

An architectural acoustics study was helpful to spatialise the soundscape and activate space as an acoustic instrument. This study consisted of three main steps. I started the enquiry by the acoustic space measurement, by the reverberation time calculation (RT60) and finally by calculating the room modes or resonance frequencies.

Acoustic space measurement

This study consisted in an objective measurement of the space, calculating areas of different material and the total volume. I will succinctly explain the methodology applied:

- 1- Get access to an architectural plan of the building.
- 2 - Measure the room with a meter, to complete missing dimensions (room's heights).
- 3 - Calculate the surface areas according to different materials' density.

I observed four main materials:

- carpet on the floor;
- painted concrete on the walls;
- plaster panels on the ceiling;
- glass windows and doors.

- 4 - Calculate the spatial volume (V).

The geometry was a a simple parallelepiped room, so it was easily calculated.

The room's dimensions are: X = 3,3 m; Y = 7,9 m; Z = 2,5 m (given by the architectural plan and confirmed in situ with physical measurement)

$$V = 3,3 \times 7,9 \times 2,5 = 65,1 \text{ m}^3$$

Different materials' density produced different acoustic effects, as will be explained next.

Reflection and absorption

Sound waves traveling in space at one point encounter different materiality and geometries in the room, and produce what is called acoustic effects. The main effects associated with waves are: reflection, refraction and absorption. Here I only considered reflection and absorption that are more relevant to sound propagation. The effect of reflection is how waves bounce off hard surfaces, producing reverberation or echo in a space. This affects the reverberation time of a room, and therefore defines a certain acoustic quality. Sound waves propagate for longer, so it generally augments the perceived loudness,

sometimes to the point of being aggressive for our ears. Concrete, glass and metal surfaces, which are very present in this space, reflect greatly sound waves, thus the perceived loudness is higher. Instead, the effect of absorption is the opposite. If the same room is filled with curtains and soft textiles hung, the energy is absorbed, decreasing the time it lasts; it is damped, so the perceived loudness of the sound will be lower (this is generally used as a solution for noisy environments, or to work on a precise reverberation time for a concert hall or an auditorium).

2.1.2. Reverberation time calculation (RT60)

The effect of reverberation main be explained as “a propagation effect in which a sound continues after the cessation of its emission. Reflections of the sound on surfaces in the surrounding space are added to the direct signal. The longer the reflections conserve their energy, the greater the reverberation time” (Augoyard and Torgue 2008, 111). Therefore I gave particular attention to this effect, as I could calculate and predict which specific frequency bandwidths would reflect and reverberate the most in this particular space. This notion is linked to the measurement of the time it takes for a sound to decrease by 60 dB. To determine the reverberation time (RT60) of the room I used the Sabine equation:

$$RT_{60} = \frac{0.161V}{A}$$

RT60 - reverberation time

V - spatial volume of the room

A - effective area of all absorbing surfaces

Physicist Wallace Sabine established this formula in 1898 (Watson and Downey 2012, 27). I calculated the surface areas for each significant material, as we have seen, and applied the correspondent absorption coefficient. “The effective absorbing area of a surface is the product of the real area with a quantity called the absorption coefficient. This is a number between 0 and 1. A perfect absorber

(like an open window) has a coefficient of 1; while a good reflector (like glazed tile) it is about 0.01” (Johnston 1989, 170). In any complete acoustic literature we may find the absorption coefficients measured for most of the materials (Watson and Downey 2012, 27; Johnston 1989, 171).

Room dimensions:	3,3 m x 7,9 m x 2,5 m
Spatial volume:	65.1 m ³
Effective absorbing area of the floor (carpet):	26 m ²
– of the ceiling (plaster panels):	26 m ²
– of the walls (painted concrete):	28.85 m ²
– of windows and doors (glass):	27.60 m ²
Total absorbing area:	108.45 m ²

Absorption coefficient (A) for each material, by frequency band	125	250	500	1000	2000	4000
Carpet:	0.04	0.04	0.15	0.29	0.52	0.59
Plaster panels:	0.04	0.12	0.52	0.95	0.93	0.58
Painted concrete:	0.02	0.019	0.023	0.022	0.026	0.026
Glass	0.18	0.06	0.04	0.03	0.02	0.02

I applied the absorption coefficient to each material surface area, and calculated the total effective area of all absorbent surfaces. Then I applied the Sabine equation. An easier way to have the same result is to use acoustic calculation softwares (such as AcMus). The results of the RT60 calculation was of:

Frequency bandwidth (Hz)	Time (s)
125 Hz	1.36 s
250 Hz	1.45 s
500 Hz	0.54 s

1000 Hz	0.30 s
2000 Hz	0.26 s
4000 Hz	0.31 s

With these values, I could predict that the acoustic space response in terms of reverberation was stronger in the bandwidths of 0-125 Hz, and 125-250 Hz. Therefore I decided to enhance frequencies within this spectrum. As will be seen, I have met these frequencies by adding layers of pure sine waves to the composition of field recordings.

Standing waves

As seen previously, a particular aspect that I wanted to explore was the experience of sympathetic resonance between space and body, as an interconnected field of vibration. The main acoustic effects for this practical case study referred to sympathetic vibration and its physical manifestation as standing waves (explained on pages 63-64). This form of experience is directly related to the relationship between the geometry, materials' density and spatial volume, the type of sounds and frequencies that are performed, and its spatialisation. The effect resulting from a standing wave or stationary wave gave me a way to understand exactly how vibration builds up into the phenomena of resonance. A standing wave is actually a vibrational pattern, and not a wave. It is the pattern resulting from the presence of two (or more) waves of the same frequency with different directions of travel within the same medium. The standing wave pattern allows the understanding on the relation between vibration, fundamental modes, and higher overtones that are called harmonics. As we have seen, every system (every space, form or structure) has a resonance frequency, to which it responds with greater amplitude, in sympathetic vibration or resonance, producing standing waves, or trapped energy. This is also called the fundamental mode of vibration (which I will refer to as resonance frequency). The resonance frequency depends on the

relationship between the system's size, surface, pressure and volume.

Therefore standing waves happen when the frequency of a sound is the same as the resonance frequency of vibration of a given system. This notion of standing waves is fundamental to understanding and applying the phenomena of resonance. When a sound in the particular resonance frequency of a room is emitted, the effect of a standing wave is produced and this is what causes a room to vibrate with greater amplitude, producing the phenomena of resonance. To calculate the space's resonance frequencies (also called room modes) that will produce standing waves, we need to know the dimensions of the room, and apply an equation. As we will see next, this method was applied in this experiment, *Vibrational Fields*. It will also be applied in the practical case study *Passage*.

2.1.3. Resonance frequencies calculation (room modes)

To calculate the space's resonance frequencies (also called room modes) that would produce standing waves, I needed to know the dimensions of the room. To calculate the first standing wave I applied the equation:

$$f_1 = c / 2L$$

f_1 is the fundamental mode or first resonance frequency

c is celerity ⁴⁰

L is the distance between two walls

Sound travels in air at a velocity of 343 m/s under standard conditions. As we have seen, the dimensions of the room are: $X = 3.3$ m ; $Y = 7.9$ m ; $Z = 2.5$ m.

⁴⁰ The celerity of a medium refers to the relation between how elastic its molecular structure is (tension/pressure) and the mass of the elements (density). Example: celerity of air = 343 m/s; celerity of water = 1400 m/s; celerity of glass = 5000 m/s. The higher the celerity of the medium, the faster the wave will travel. Celerity also augments with the temperature of the medium, as it augments pressure. If the temperature of the air is 0 °C, the celerity will be of 330 m/s, but if the temperature is 20 °C, then the celerity will be of 342 m/s. As a carrier of sound waves, air is not nearly as efficient as other materials such as glass, steel, or water. The molecules in these materials are under more pressure than air, so the internal force is greater and energy propagates faster at the slightest compression.

The space has a distance of 3.3 meters between two walls. Applying the equation:

$$f_1 = 343 / (2 \times 3.3) = 52 \text{ Hz}$$

If I play a sound with a frequency of 52 Hz in one side of the room, I get the effect of a standing wave. This sound wave goes back and forth between the two parallel walls and is “trapped”, reflecting between walls and augmenting its amplitude (or perceived loudness). In standing waves the nodes are points of no displacement caused by the destructive interference of the two waves (the initial wave and its reflection). The antinodes result from the constructive interference of the two waves and thus undergo maximum displacement from the rest position, and therefore boost in amplitude. When the reflections are repeated in the space, the specific frequency increases in resonance and vibrates the corresponding materials. I have looked into these resonance frequencies to integrate into the soundscape composition. A certain frequency will behave differently in different medium. When one knows its wavelength, the way it will behave can be predicted for interior spaces, with the study of the room’s geometry, materials’ density, the spatial volume. This is the main object of study of architectural acoustics. For each of the resonance frequencies there is the fundamental mode and its harmonics. This means that the room’s fundamental mode resonates with the space’s walls structure, but also its harmonics, with lesser intensity. In the resonance frequencies calculation there are axial frequencies, tangential frequencies and oblique frequencies. Axial frequencies hit on two facing surfaces, tangential frequencies hit on four surfaces and oblique frequencies include six surfaces crosswise. Here I worked mainly with axial frequencies. As the space’s volume is small, these are more relevant for this exploration.

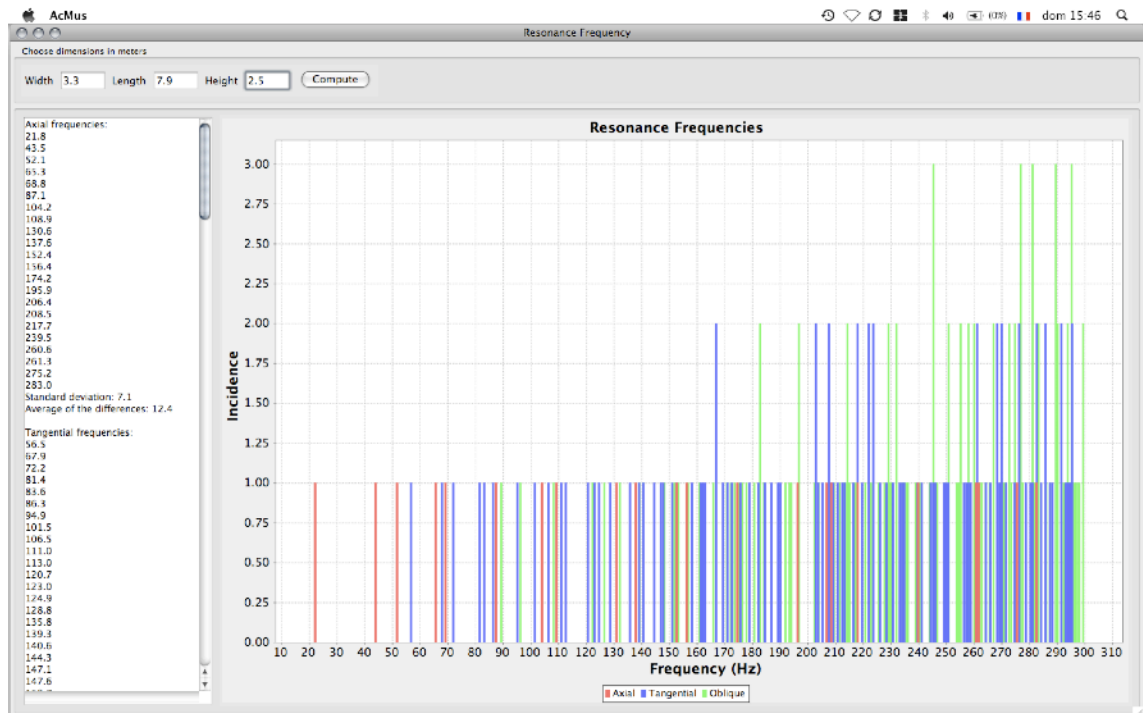


Fig. 3.15 - screenshot of room modes calculation using software *AcMus*

Axial resonance frequencies (calculated with the software *AcMus*):

- 21.8
- 43.5
- 52.1
- 65.3
- 68.8
- 87.1
- 104.2
- 108.9
- 130.6
- 137.6
- 152.4
- 156.4
- 174.2
- 195.9
- 206.4

208.5

217.7

239.5

260.6

261.3

275.2-

283.0

Standard deviation: 7.1

Average of the differences: 12.4

With this data, I selected the frequencies that could generate greater resonance in the room (we have seen that the reverberation was stronger in the bandwidths of 0-125 Hz, and 125-250 Hz), to integrate the soundscape composition, as it will be explained on p. 90. I also wanted to include very low frequencies in order to resonate with space and body in a physical level.

2.2. Resonant soundscape

To create a resonant soundscape, the composition process integrated the field recordings into a multi-layered set of recorded sounds of digital and analogue synthesisers in order to reach specific frequencies, rhythms and acoustic effects. The soundscape was then performed as a sound installation, spatialised in a site-specific relation to its acoustic space. The experience intended to attune resonating cyclic fields between body and space.

2.2.1. Composition with field recordings

The soundscape composition was developed through a process of active listening and from a spatial approach. As I have mentioned (p. 22), I acted as an architect on sound matter. I found my architectural background particularly helpful to work simultaneously in micro and macro-scale. I used analysis and macroscopic construction methodologies to model sonic beings. Therefore I engaged the soundscape composition as a whole spatial form, in a multiple

scale approach, or multidimensionality, simultaneously thinking in details, elements and proportions in a space-time continuum. Here there is a fusion between form and material, meaning that the deployment of material, in a multiple scale approach, determines its own form. The composition was multitemporal to build up a multidimensional perception of the space. Events did not take place in sequence but were instead interlocked in a continuous state of vibration and oscillation. I acted between groups of specific frequencies and the macrophonic perception of these groups as sound masses (see Xenakis p. 71). I composed a soundscape through specific bandwidths and layers of frequencies, so that the site of the performance became a vibrational timespace where one navigated, opening up different degrees of affect through different longitudinal waves. This could be a way of activating attunement ⁴¹.

2.2.2. Tuning with resonance frequencies

The environmental sounds' composition incorporated the selected resonance frequencies of the installation space. The soundscape was tuned into the space's vibration modes, through a multilayer of field recordings, resonance frequencies, pure sine waves and harmonics. Acoustic effects such as resonance and reverberation were explored in order to reach specific beats, cycles, rhythmic patterns and geometric interferences. Furthermore, psychoacoustic notions, such as binaural beats and masking effects, were integrated as a means to attain other levels of bioresonance and psychological response. My aim was to explore the relationship of bioresonance and attunement as a channel to amplify the experience of being in vibration, in a continuous field of interconnections between all things. Thus the idea was that the soundscape would offer a tangible experience of void, of acoustic space as vibration, as a state of both physical and mental non-existing, ever-present. Also, I have identified a pattern of transformation with the geometry of a spiral

⁴¹ To reach out an affective experience, of attunement, resonance is a key effect. A response in sympathetic vibration is understood here as a way of attunement. I will unfold an enquiry on the notion of attunement on p. 124.

or a vortex. In this sense, artistically and technically, I felt it was coherent to create the soundscape experience around the idea of the vortex, as a cluster of energy, or a radiant node of sounds. This would transpose the experience of the site's space and time into the inflow of feelings from enveloping nature, for the experience of being and *becoming* - the *now*. Therefore, this soundscape composition is an experiment of a process of spatialisation of entities of sound matter, as dynamic sonic beings. From within its spatial relation in acoustic space unpredictable sonic events have emerged, as it will be explored on p. 96. The soundscape composition explored this relation between beings, space and time as a direct experience linked through sound and vibration. As we have seen, I understand this phenomenon as an affective hit, the onset of an activation, an unconscious level of apprehension.

2.2.3. Layers

The soundscape is composed by four distinct layers:

Layer 1 - Resonance frequencies (40-43 Hz, 65-67 Hz, 156-162 Hz, 275-276 Hz) (recordings 3.02 to 3.06)

Layer 2 - Field recording of source 6 - the void (recording 3.07)

Layer 3 - Field recordings of sources 1, 2, 3, 4, 5 and 7 (recording 3.08 to 3.13)

Layer 4 - Field recording of source 8 - electromagnetic fields (recording 3.14 to 3.24)

These layers of sound were edited and mixed using audio software (Logic Pro).

Layer 1 - Resonance frequencies 40-43 Hz, 65-67 Hz, 156-162 Hz, 275-276 Hz

These layers of drones, pure resonance frequencies and binaural beats were created to engage a physical response and psychoacoustic dimension between bodies and space. A selection of the site's fundamental resonance frequencies and harmonics were recorded as pure tones through analogue and digital instruments (synthesisers and sine waves generators), and mixed in the composition with the field recordings. For each layer, the selected resonance frequencies were sets of two frequencies, which differed of 1 Hz, 2 Hz, 3 Hz

and 6 Hz. This is called binaural masking level difference and generates binaural beats. Binaural beats are “periodic fluctuations in peak amplitude which occur when two sinusoids with slightly different frequencies are superimposed” (Moore 2007, 400). The resulting frequency is a beat frequency $|f_1 - f_2| = f_3$ (beat frequency). When two frequencies are close, the binaural masking level difference results almost inaudible. This sound resulted as a drone, “a permanent bass note over which other elements are laid” (Augoyard and Torgue 2005, 40). It produced a psycho physical phenomena of resonance between the space itself and the whole body, as a musical instrument. I explored the notion of intensity of waves where sets of sound masses move, creating sonic beings. Here I have drawn from Xenakis’ model given by sound analysis as a psycho-physic phenomena, and where “sound is perceived in a global mode, in its gaseous environment, under the form of sound masses” (Sedes in Solomos 2003, 231). The sub-layer of 40-42 Hz penetrates and involves the whole body. R. Murray Schafer claims that low frequency sound is in “more intimate proximity to the listener” (Schafer 1994, 118). He describes this type of sound as a mode of listening related to immersion, rather than concentration, which is more related to high frequency. He defines low frequency as “wraparound sound; presence; sound wall; electroacoustic; immersion; ocean-womb” (Schafer 1994, 118). With the layer of 40-42 Hz I looked to attain these characteristics toward the integrity of inner space with outer space. The soundscape was performed using a sub-woofer to amplify these low frequencies, beats and vibrations of materials. Initially, I experimented to work with the resonance frequency of 22 Hz, but unfortunately the available PA equipment for performance did not reach that low. Nevertheless, the frequencies of 40-42 Hz were low enough to generate an ocean of low frequency sounds, sound masses and standing waves that would involve the senses of the audience, as being in the middle of the sea, surrounded by sounds that came from everywhere.

Layer 2 - Field recording of source 6 - the void

These sounds were recorded with omnidirectional acoustic microphones DPA 4060, at different times of the day. This layer corresponds to the mass of reverberating sounds of the building. It echoes the building's acoustic signature, a presence of void. In terms of the soundscape composition, this echoing sounds added a duration which "also allows the sound to reverberate in the listener's memory, providing time for long-term memories and associations to surface" (Truax 1996, 62). As we have seen, we normally consider background sound insignificant, but in fact it modulates the whole ambiance. Background listening can trigger conscious attention to be focussed on an incoming sound, "involving feature detection, the recognition of patterns and their comparison to known patterns and environmental 'signatures'" (Truax 1996, 59). Therefore the purpose of this layer was to involve the public in a form of background active listening, which could extend the perception of the place and an awareness of environmental sounds.

Layer 3 - Field recordings of sources 1, 2, 3, 4, 5 and 7

These sounds were recorded with omnidirectional acoustic microphones DPA 4060 and contact microphones. This layer was composed of several field recordings. It built up an altered spatio-temporal configuration of the place, of waves traveling through different media. It included sounds of birds, wind, tree leafs, distant cars, close and distant footsteps and voices, the entrance sliding doors, air conducts, the inside of walls and windows. In my perspective, this particular layer would help to extend the audience's experience of the surroundings into an acoustic ecology awareness of the variety of vibrational fields that actually exist in a place, and to what extent we contribute to it and are part of it.

Layer 4 - Field recording of source 8 - e.m.f.

These frequencies were recorded with electromagnetic microphones.

This layer integrated transduced frequencies, mainly electromagnetic waves captured from the electric circuit infrastructure, such as light and air conditioning. The resulting sounds ranged medium, high and very high frequencies. The process of transduction of usually unheard sounds into audible frequencies allows “the inner timbral character of the sound to emerge and be observed, as if under a microscope” (Truax 1996, 61). This process “changes both the morphology (Smalley 1986) and the associated imagery of the resultant sound” in a way that “the listener may experience a process of transformation or interpolation (Wishart 1993)” (Truax 1996, 62). In my perspective, listening and vibrating to the usually unperceived sounds of the structure and infrastructure could result in a feeling of integration to the building, as becoming part of its architecture. The listener’s body would enter in resonance with the materials and might experience a process of *becoming* with the acoustic space.

To hear the soundscape composition open the audio file 3.21. Please read first the note on the audio documentation on p. 225.

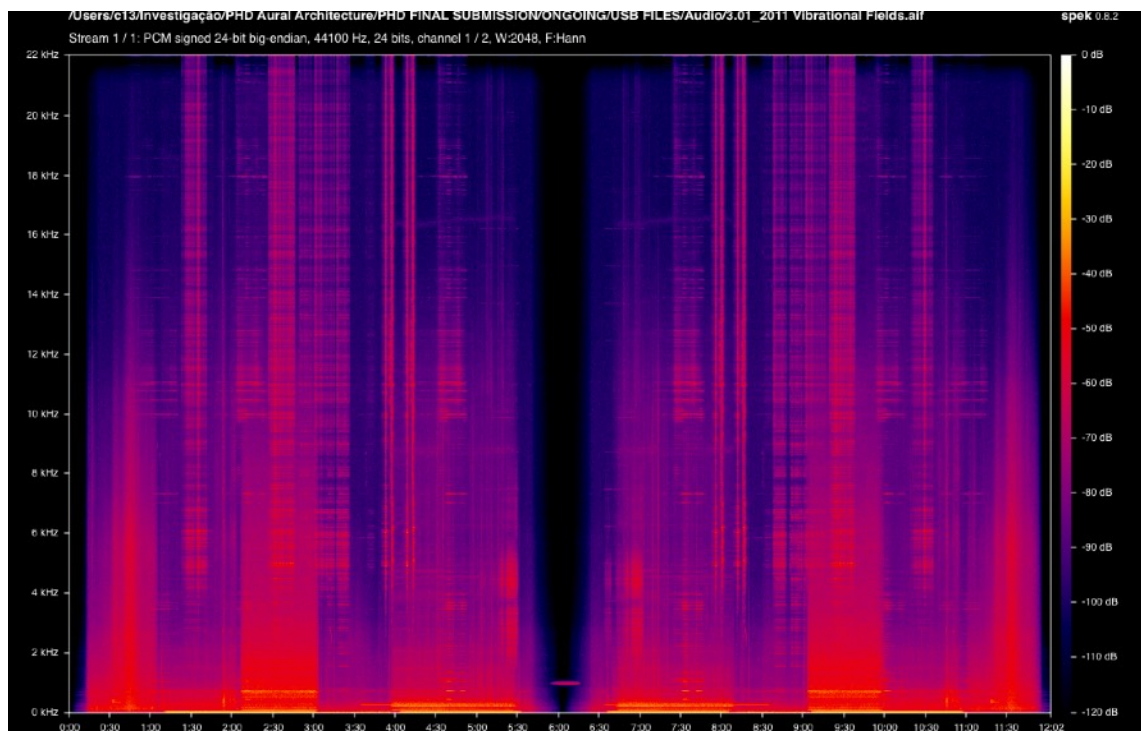


Fig. 3.16 - spectrogram of the soundscape composition using software *Spek*

3. Acoustic spatialisation

This installation consisted of a pair of stereo active speakers, one sub-woofer, and one mixing desk. The soundscape was played via a media player. The protocol for the process of acoustic spatialisation was as follows:

- 1- Install the audio equipment - stereo active speakers and one sub-woofer, spectrum range 40 Hz -20 Khz (in other events after this one I spatialised the soundscape using multiple speakers and quadraphonic sound).
- 2- Run tests to confirm the resonance frequencies of the space and the frequency range of the sub-woofer. Adjust if necessary. Resonance frequencies did set the architectural materials in vibration, except for the lowest frequency, because the sub-woofer did not respond to the 22 Hz frequency. The next lower resonance frequency was 43 Hz. This one vibrated the structure and was clearly heard and felt.
- 3- Spatialise the sound system. Choose the best placement of the sound system exploring the relationships between resonance frequencies, materials' properties, geometry and spatial volume. As this installation space is a long parallelepiped volume, one speaker was installed in each side of the longer dimension. The sub-woofer was installed in-between. In this sense, the audience path walking through the space would be binaurally immersed.
- 4- Re-adjust soundscape if needed. In this space, I had to readjust a layer of pure frequencies and substitute the frequency of 22 Hz for 43 Hz, as it was inaudible through the available sub woofer. Nevertheless, the acoustic effects were present and produced the expected result of standing waves and material resonance.

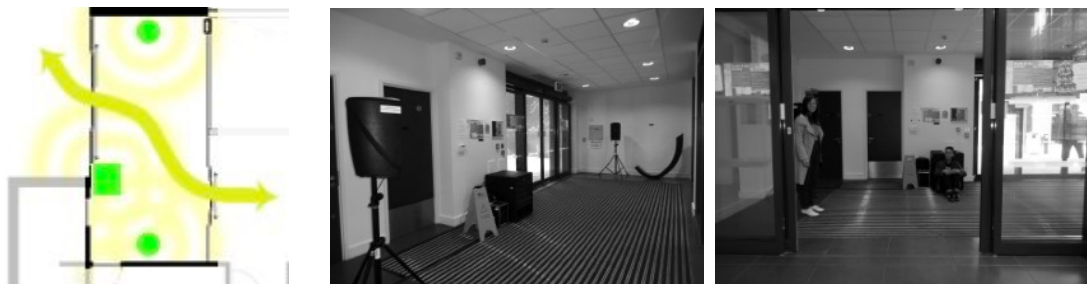


Fig. 3.17, 3.18, 3.19 - diagram and photographs of the acoustic spatialisation

Translation: stochastic score

An unexpected result of a stochastic phenomena took place, which I have identified as an operation of aural architecture's translation (as referred on p. 43). As described on page 72, I have found common ground with Xenakis' idea of a transformable sound mass as musical sound, where complex acoustical events cannot be broken down into their constituent elements (Allen in Hensel, Hight, Menges 2009, 120). Therefore I have approached sound matter in relationship with vibrational forces to capture. In this experimental process of exploring acoustic phenomena for an intense presence of sound, I composed sets of sound masses that moved with the natural acoustic effect of resonance. This created a soundscape environment as a sonic being, where sounds had a generative or processual form of *becoming*⁴² in relation to someone's experience. As a result, I observed an interesting phenomena of *becoming* happening - the experience of the soundscape changed with the movements of people. In fact, when the electric doors opened and closed, the space's volume changed; and when people would pass by or stand in the room, the material absorption was altered. Therefore these parameters affected the space's acoustics and the effect of resonance was distinct. In consequence, with different resonance effects, it transformed the vibration of standing waves and the oscillation of frequencies. This also generated new interferences between the composition's layers, with new sonic events - a dynamic ever-changing flow. Therefore the articulation between the different layers of sounds created unusual vibrant geographies and geometries and produced multiple physical experiences of the same space. In my understanding, this generative and transformative process was a form of exploration of the multidimensionality of vibrant matter. Therefore the notion of stochastic score of performance interestingly emerged from within this work process. In fact, it resulted as an open work, an open score, and the soundscape depended on the acoustic

⁴² As seen on p. 34, *becoming* is a term explored by Deleuze and Guattari, that is often used in processual and generative design practices.

effects produced by the movement of the public going through the performance space. The material deployment indeed determined its own form. It is important to note that the space's volume changed with the opening of the sliding doors, and the material density changed with the amount of people in the space (more or less absorption). Therefore the perception of acoustic effects were altered. But, as the distance between fixed walls is always the same, the impact of the effect of two standing waves remained present.

4. Audience's experience and feedback

As seen, the soundscape *Vibrational Fields* aimed to generate a connective tissue, an acoustic tangible experience of some kind of unified field. The purpose was to explore how the resulting psycho-acoustical effects would create an ecological experience of being vibration: humans and non-humans, all interconnected through vibration. This is what will be seen next with the public's feedback.

I left a notebook in the installation space over the sub-woofer to engage people to leave their feedback. The question was: "How do you feel with this experience? Please leave your feedback." According to the public's testimonies, this soundscape experience of being surrounded by masses of sound and vibration provoked feelings from enveloping nature. Here follows a transcription of some significant comments (see illustrations 3.20 to 3.30 of the artworks digital portfolio for the notebook copies):

It reminds me of a black hole for some reason.

Sounds like aircraft rumbles.

In the middle of the sea.

Moving through a space without time and references. The NOW.

I love the birdsong! Not so keen of the rest I'm afraid!

I love infrasound.

I feel like I'm in the engine room of a boat.

I feel like I'm walking into a different dimension.

Wombastic!

Bit uncomfortable.

Lift off!

(C. Martinho, *Passage* survey, May 5-6, 2011)

The comments revealed a response of affect, ranging from pleasure, fear, loss of references. People that loved bass sounds, people that felt scared. People that enjoyed the experience, people that found it unbearable. In some of them it overwhelmed or transcended senses beyond the hearable, towards other modes of feeling their body connected to space.

Attunement

The experience has engaged the audience in another feeling of time, space and their bodies in vibration. Interrupting the usual practice of that space, it turned a passage path into a place to stop and listen or feel, and provoked a different type of awareness of the surroundings. The resonant soundscape composition was a physical experience of the multidimensionality in vibrational forces and activated a mode of distribution of shared formations of the sensible. These sonic fields activated resonance through electrical impulses in the audience's body and mind. It has unfolded and modulated affect from the same constructive suspense. It triggered microperceptions, produced altered time and space perceptions and induced different states of awareness. This experience eventually provided some kind of a sensorial reset, and tuned peoples' biorhythms into an awareness of the now, and the forces at work at the site that were usually unnoticed. The aural architecture design resulted as a tangible connective tissue, which activated the experience of being vibration - humans, non-humans and things, all interconnected through vibration. And this is what the experience aimed, to engage attunement - all bodies were in some way

attuned but all were distributed differently, depending on the tendencies and capacities of each of them (natural, cultural).

Final thoughts

I considered this feedback enough for my enquiry. This experiment resulted as a kind of vibrational experience that unfolded and modulated affect as microperceptions from the same field of resonance. It validated my experiment of a resonant soundscape and of space as resonator. It confirmed that this mode of designing aural architecture could activate an experience of space as a vibrational force, from which multiple modes of attunement could emerge. The *Vibrational Fields* experience resulted in a new approach to design site-oriented spatial relations between inanimate objects and vibrational forces of sound, in order to produce a diversification of affect between humans, non-humans and things. Therefore this was a valid affective experience of the environmental sound and it contributed for an ecology of affect.

Chapter 4

Working concept	• Space as field
Enquiry	<ul style="list-style-type: none"> • Relational, energetic and performative architecture • Spatial agency
Practical case study	• <i>Radio Sonores</i>
Design methods	• Space as dynamic relation
Affective experience	• The experience of inner-outer listening and relatively silent, enhanced by the space's absorbent qualities
Emergent concepts	<ul style="list-style-type: none"> • Space as dynamic relation • Diagram as an energetic geometry • Modular design as a mode of assemblage • Mobile architecture

In Chapter 3, I have approached the working concept of field of resonance drawing from acoustics, experimenting it in the design of the resonant soundscape *Vibrational Fields*. In Chapter 4, I got interested in extending the working concept of space as field from architectural design theory. I will extend my enquiry in relational, energetic and performative architecture, looking up into practices of spatial agency. Then, I will present my practical experimentation in the case study *Radio Sonores* (2012), an aural micro-architecture, designed as a mobile structure, and built collectively with a group of architecture students. It was a gathering space to diffuse discussions and performances of sonic events, for a cultural event dedicated to the exploration of the topic *Sound-Space-Signal*. This experiment produced one design method: the design of an aural architecture based in space as a dynamic relation.

The space's absorbent qualities took (with the acoustic panels) allowed to explore an experience of the inner-outer listening dynamics and the relatively silent space. Key concepts have emerged from within my practice experiment such as: space as dynamic relation, diagram as energetic geometry, modular design as a mode of assemblage and mobile architecture.

Working concept:

Space as Field

The field is a material condition, not a metaphor.

(Allen in Hensel, Hight, Menges 2009, 130)

Decades ago, in their explorations on *Acoustic Space* (1960), media theorist Marshall McLuhan and anthropologist Ted Carpenter have criticised how space was conceived and its implications, which McLuhan extended further years later (1970). Already at that time, they claimed that in the everyday world, space is conceived in terms of that which separates visible objects, as *empty space* where there is nothing to see. The problem, they argued, is that we ignore much of the world beyond what is visually given in order to locate and identify objects in three dimensions. The objects compel our attention and orient our behaviour. And space is understood merely as that which is traversed in getting to or from the objects (Carpenter and McLuhan 1960, 65-67). McLuhan explained that for a Western person it is very difficult to take things except in a visual, connected, rational mode. And for that reason it has major consequences in all the scientific disciplines, as Modern physicists have troubles with the visual or acoustic problem. My view is that architecture also deals with this dichotomy. The prevalent and global architectural model is based in the rational Modern ethic of form follows function, where architecture is designed as a formatted generic object to place and to program an *empty space*. By the time of the McLuhan and Carpenter article, some visionary architects, such as Yonna Friedman, Archigram, Superstudio, Buckminster Fuller, Cedric Price, engaged in a critical practice of architecture for social and ecological change. Even though some architects have extended their ideas, prevailing systems have persisted in constraining architectural models to follow a global market logic of programs and formats. And despite decades of major technical advances in computer assisted design and material innovation, still the same approach remains,

constraining the experience of space to specific functions dictated by the rules of an economic system, most of the time ignoring social and ecological issues. We get different objects and shapes, fashions and trends, but we remain with the same underlying ethic.

Nevertheless, in the last decade, we have seen the emergence of a new generation of practitioners and theorists that argue for a paradigmatic shift from architecture as a formatted object in empty space, to architecture as a field of relationships, in all its dimensions (social, ecological, political, pedagogical).

The field describes a space of propagation, of effects. It contains no matter or material points, rather function, vectors and speeds. It describes local relations of difference within fields of celerity, transmission or careering points, in a word, what Mikowsky called the world. (Kwinter 2002, 60)

Architectural theorist Sanford Kwinter has been arguing that the notion of “field” expresses the complete immanence of forces and events while supplanting the concept of Cartesian or metric space (Kwinter 2002, 60). Architects and theorists, such as Stan Allen, Michael Hensel and Achim Menges, have also pointed out for a paradigmatic shift.

Field conditions are relational, and not figural, they are based on interval. (Allen in Hensel, Hight, Menges 2009, 120)

In an article entitled *The Heterogeneous Space of Morpho-Ecologies* (Hensel, Hight and Menges 2009, 195-215) Hensel and Menges argue for a shift away from an ethic that sees the objective of architecture as the production of form to one that operates through spatial relationships, through intervals. This relational architecture produces highly specific but differentiated effects and performances. They claim for heterogeneous space in architecture as an

energetic system with a set of internal relationships and external forces that inform it and to which it responds. In their view, this corresponds to a performative ethic which presents an innovation in the ecological understanding of architecture. Ecology, more than a green movement, is an energetic consciousness, and could be engaged as the relationship of any system to its environment and other systems (Hensel, Hight and Menges 2009, 195). I became interested in exploring further these working concepts - relational, energetic, performative - derived from a practical experimentation of space as field, towards a design method based in space as a dynamic relation, as will be seen next in the practical case study *Radio Sonores*.

Spatial agency

An online project entitled *Spatial Agency* presents a database of such other ways of doing architecture and designing space as field, moving away from architecture's traditional focus on the look of buildings. *Spatial Agency* proposes new ways of looking at how buildings and space can be produced with an expansive field of situations in which architects and non-architects can operate. Inspired by architect Cedric Price, this project started with the belief that a building is not necessarily the best solution to a spatial problem. Adopting philosopher Bruno Latour's terms, this project presents modes of practice where critical attention is shifted from architecture as a matter of fact to architecture as a matter of concern⁴³. This means that "as matters of fact, buildings can be subjected to rules and methods, and they can be treated as objects on their own terms. As matters of concern, they enter into socially embedded networks, in which the consequences of architecture are of much more significance than the objects of architecture."⁴⁴

⁴³ In *From Matters of Fact to Matters of Concern*, *Critical Inquiry*, 30, 2 (Winter 2004), pp. 225-48

⁴⁴ Online reference: <http://spatialagency.net/about/> - accessed September 23 2016

To sum up - relational, energetic, performative, agency - these are working concepts that I have extended into a mode of aural architecture design that focused on the consequences of the experience of space (sensorial, social, political, ecological), more than the formal production of an object of architecture; for an architecture that resulted as a field of dynamic relations, to open up space for affective experiences. As it will be seen next, the experiment of *Radio Sonores* was designed as a mode of assemblage based in a dynamic relation, instead of a fixed structure. A creative process extended the materiality of space as field and its dynamic forces, into an energetic geometry understanding.

Practical case study:
Radio Sonores



Fig. 4.1. *Radio Sonores* installation at ASA factory

Radio Sonores (2012) was built for the event *Sonores: Sound / Space / Signal*, an artists-in-residency project by Soopa collective. This happened during the art and architecture programme of the cultural event Guimarães 2012 European Capital of Culture, within the *Curator's Lab* cycle on audiences.

1. Experience of site

1.1. Analysis of context

A collective of artists and musicians (Soopa collective) conceived a radio art project to program a series of sonic events, music performances and talks, and explored the thematic *Sound / Space / Signal*. A radio studio would receive creators and thinkers for the period of three months (April, May and June 2012), and the sessions would be broadcasted live and recorded. Besides, there would be public happenings for local audiences. Their description of their idea of radio was resumed on the event's publication as follows:

Radio does not exist, it is diffusion, in the literal sense of the term. Today, radio seems to have lost its vocation to function as a 'promoter' - as a transmission link, an activity of mediation between objects and subjects. We find ourselves in a permanent space that does not begin or end, a vacuum that addresses everyone and no one. A space where time is continuously flowing. (Brejon 2012)

In this context, I was invited to create the headquarter space for *Radio Sonores*. My question was what kind of physical support could be offered so that it would remain a virtual diffusion within this space-time situation. The studio should be acoustically and visually isolated from the outside and simultaneously, it would be interesting to engage a relation to a physical audience for performances happening in this place from time to time. From my perspective, and inspired by radio works of acoustic ecologists, I thought that this radio art project could not only engage an opportunity to broadcast work, but could also offer a place, in this case both virtual and physical, where cultural exploration and political activism could meet (Westerkamp 2002).

1.2. Dynamic of experience: workshop of building together

Radio Sonores was commissioned as part of the workshop *Construir Junto*, conducted by Exyzt collective, with students from art and architecture local schools. This workshop built the whole space for these first three months of the *Curator's Lab* series. It included an auditorium, a kitchen, a common space to eat and to sleep, and the radio station. The space where the art and architecture program happened was a disused factory (fig. 4.02-4.03). The ASA factory used to be a renowned textile factory, in the outskirts of the city of Guimarães. It was now a typical abandoned industrial building, with suburban housing around it, where the factory former workers still lived. With the event *Guimarães European Capital of Culture 2012*, it was now object of rehabilitation through a cultural program that included its building renovation. The collective Exyzt facilitated a construction workshop so that students' participation would be at the core of the experience, to enable them to take an active part in the renovation of the factory and of the cultural face of their city. In their words, this pedagogical experience was crucial for the future role of students as active citizens in the shaping of their living environment. Moreover, one of the slogans chosen by the students to represent the project said that the most important thing to be built is understanding. Indeed, a new understanding of this place could be reached by building together, transcending differences and barriers. For Exyzt and for myself, this was the most important result that this type of collaboration could aspire to.

The workshop team and students who took part in the project are from various origins, abilities, ages, but the language of construction overcomes the differences to achieve common goals. It is an universal language with a simple technique: one assures that the beams are in the correct position, the other puts the screw in the right place and presses the drill. And it does not matter if one has never built something, because everyone can learn it with little effort and take part in the construction. (Exyzt 2012)

A dynamic of social participation spread out of the ASA factory, involving the city in the project. Students engaged in an exploration of the surroundings of the factory to collect experiences, impressions and expectations of the citizens, inviting them to participate. The gates of the factory opened up and citizens came in, looked around and gave their opinions. The construction went on day by day with opened doors welcoming the participation of anyone that came in. It offered a communitarian open space for people, with a kitchen, an auditorium and the radio. It was a relational space where cooking, eating, talking, listening was an invitation to all. For the Exyzt collective, more than a physical and architectural construction for ASA, the project *Construir Junto* (Building Together) sought to be essentially a social construction. Here, the context and the community were the true purpose of action. *Construir Junto* was like a bridge, like a way of binding the inner and outer experiences of ASA. Contributing to the returning of the factory to the city, reintegrating its new structure by the reunion of the artists and the inhabitants in its construction and in its meaning. This kind of practice inscribes itself in a context of participative architecture. Here we may think of collectives such as Atelier de Architecture Autogéré, Raumlabor, Hackitectura, muf architecture/art, in which citizens are part of the creative process of design ⁴⁵. In this same approach, *Radio Sonores* was engaged as a participative architecture, with a workshop of self-construction.

Do-it-yourself radio station

My interest to develop the radio project as a workshop was to engage a self-built collective process and a pedagogical dynamic. I invited a long-term collaborator, architect Mathieu Herbelin (we were part of the same collective, Mesarchitecture, in Paris) and together we facilitated the workshop with four architecture students, to create do-it-yourself (d.i.y.) techniques with specific

⁴⁵ For more details see Blundell-Jones, Petrescu and Till (eds.), *Architecture and Participation*, 2005.

acoustic solutions. We also counted on the valuable help of Jean-Marc Chevalet, expert in wood construction.

The planning of this practical case study was as follows:

- 1- conception - November to December 2011
- 2- construction workshop - February to March 2012
- 3- events - April to May 2012

As the central idea was to create an aural architecture which could be adapted to different uses, it called up for the exploration of the concepts of field and relational architecture (as seen). The approach to space as field would engage a relational network, both human and non-human, as the field condition “implies the acceptance of the real in all its messiness and unpredictability. It implicates architects in a material improvisation conducted on site in real time. Field conditions treat constrains as opportunity. Working with and not against the site, something new is produced by registering the complexity given” (Allen in Hensel, Hight, Menges 2009, 119). As a d.i.y. workshop, it engaged a participative and collective process of self-construction. Students practiced how to do more with less, by building acoustic panels with their own hands and very few materials. They have learned simplified and smart construction techniques, to work with site constrains and its complexity. In my view, this workshop was a way of learning architectural acoustics by practicing and experimenting simple acoustic solutions. Architecture students do not usually have access to this kind of d.i.y. practice at school. In this sense, this alternative practice of aural architecture as a workshop engaged an educational approach for a practical understanding of acoustics by making. Furthermore, it experimented the ideas of social ecology.

1.3. Sensory variation

Affirming the public's capacity to modify the sensory amenities of a place goes hand-in-hand with recognition of the modular and circumstantial character of the built environment.

(Thibaud in LaBelle and Martinho 2011, 48)

Sound-Space-Signal event was going to take place in the central space of the factory where the main entrance stands. The space was built out of concrete, metal and glass, so acoustically it was a reverberating and very noisy environment.



Fig. 4.02, 4.03, 4.04 - ASA factory

Note: as this practical case study did not involve field recording, the step of *aural elements* did not apply.

1.3.1. Sensory phenomena

Our approach was to create a dissociation in the sonic environment, through a contraction on acoustic space, into a relatively silent mode of experience, for a focused attention on the creation of sound and music. But it should also be possible to open this space for interactions with public, from time to time. Our proposal was then to create a modular, adaptive and mobile installation that allowed multiple uses in relation to different sonic events. Sensory variation could be produced according to its users needs. This possibility enabled *Radio Sonores'* users to engage the necessary attention to switch from inner to outer

listening, from an interior and personal creative process, to an exterior and co-creative dynamic.

1.3.2. Ambiance dynamic

The space for *Radio Sonores* could be assembled as an enclosed environment, to generate an insulated acoustic sphere for the radio sessions (streamed live). And from time to time it could open up to the outside, for public interaction. Therefore it engaged with Thibaud's concept of framed ambiance (p. 40), where a specific social practice sets the conditions that define a place. Here, the radio sessions gave shape to social situations that built new spatial relations, defining the ambiance of the acoustic sphere. It enfolded an "ecology of relations in public", as the ambiance results from the public relations happening in the place (Thibaud in LaBelle and Martinho 2011, 45). This aspect extends the concept of relational space, as a social practice that defines an ambiance. As the social situations in this space were dedicated to sound and music practice, it also engaged relational space as a network between humans, non-humans and things, connected through sound matter.

2. Aural architecture design

Radio Sonores addresses a design paradigmatic shift: from an "object of analysis" to a field, a milieu of relations and dynamic events. In *Radio Sonores I* have engaged the working concepts of space as field, and experimented the ideas of relational, energetic and performative architecture. Building a micro-architecture dedicated to sound events allowed me to extend an understanding on the materiality of sound from the previous practical case study, *Vibrational Fields*, into the design of relational space as an assemblage, based in energetic geometry, as will be explored next.

2.1. Space as a dynamic relation

The idea of designing space as a dynamic relation unfolds from the previous enquiry on a paradigmatic shift in architecture, from space as formal object, to space as a field of relations. In the practical case study *Vibrational Fields*, I have approached the concept of field drawing from acoustics, which I have experimented in soundscape design and spatialisation. In this practical case study, *Radio Sonores*, I became interested in extending the concept of field from architectural theory, drawing from architect Stan Allen's idea that "the field is a material condition, not a metaphor", and to experiment it in the design of aural architecture (Allen in Hensel, Hight, Menges 2009, 130). My aim was to explore a design process that extends the materiality of space as a field of vibrational forces, into an energetic geometry understanding, based in relation, intervals and geometric patterns. For this, I have explored a bit further how field conditions have the capacity to make abstract forces visible. Besides demonstrating well phenomena of resonance, the well-known example Ernst Chladni's experiment with a plate of iron registering the patterns of a magnetic field, reveals that the fillings are not the field. They are the graphic record of the invisible forces of the field itself, the intervals, also called vibrational patterns. These can be engaged as diagram of forces, energetic geometry patterns. I have looked to integrate this idea of diagram of forces in the design of *Radio Sonores*. As seen on page 102, Stan Allen describes field conditions as relational, not figural, and based in interval. Therefore field conditions are defined by the intricate local connections, the intervals and the capacity to make imperceptible forces tangible. In his article *From Object to Field* Stan Allen resumes this idea in a simple way: "form matters, but not so much the forms of things as the forms between things" (Allen in Hensel, Hight, Menges 2009, 120). Therefore I became interested in directing my practice of aural architecture towards space as a dynamic relation, or the form between things. I got into an exploration of the generative process of this invisible field of forces, as a creative process of design. I wanted to understand the generation of form

between things in its relation to geometry; how the form between things was given by the kind of relationships to engage.

Relational space

Field configurations are inherently expandable; the possibility of incremental growth is anticipated in the mathematical relations of the parts. (Allen in Hensel, Hight, Menges 2009, 124)

Field conditions are defined by the intricate local connections. Stan Allen resumes this idea in a simple way: “form matters, but not so much the forms of things as the forms between things” (Allen in Hensel, Hight, Menges 2009, 120). I have assumed the formal configuration and design as a relation between things, as that which defines the qualities and specificity of the experience of space. Allen claims for a theory of the field as a model to revitalise the practice of architecture and to significantly alter the Modernist relationship between form, programme and space (Allen in Hensel, Hight, Menges 2009, 119). In these terms, he calls for alternative practices to perform space in architecture. In *Radio Sonores* I have explored these ideas to result as an experience of fields of relationships, instead of producing an object in a field, like most contemporary architectural production does. Therefore more than a formal configuration, I have engaged in field conditions to design an aural architecture as an assemblage that admits change, accident and improvisation. It resulted as an architecture that did not invest in durability, stability and certainty, but an architecture that left space for the uncertainty of the real (Allen in Hensel, Hight, Menges 2009, 142). *Radio Sonores* derived from experimentation of a self-built architecture, in contact with the real in all its messiness and unpredictability. This process produced a shift of emphasis from abstract formal description of an architectural drawing process in a studio, to a close attention to operations of making relational space (Allen in Hensel, Hight, Menges 2009, 129).

2.2. Energetic geometry

Geometry is the invisible scaffold that once controls the distribution of parts, but disappears in the final building.

(Allen in Hensel, Hight, Menges 2009, 122)

My following question was quite practical: what kind of geometry allowed an architectural design of space as a dynamic relation, that left space for the uncertainty of the real and the appropriation by its users? I wanted to step away from the conventional Euclidian geometry. As it is based in axioms and theorems it results in a reduced system of metric measurement of a visible thing. We know that physical space is not Euclidian. This was confirmed when the theory of general relativity was introduced by Albert Einstein in 1915. Non-Euclidian geometries have emerged ever since, when the need for a metric system was relaxed or the parallel postulate was replaced by hyperbolic and elliptic geometry. I.e. Iannis Xenakis, as we will see on page 167, developed his work based on a hyperbolic geometry which he translated in music compositions and spatialisation. As seen on page 57, Buckminster Fuller has introduced the term synergetics as energetic geometry. For Fuller, since the physical Universe is entirely energetic, all dimension should be energetic. Fuller claims that synergetics is energetic geometry since it identifies energy with number, and provides geometrical conceptuality in respect to energy quanta (Fuller 1975, 22). My aim was then to use energetic geometry to design space as a dynamic relation, to modulate sensory variations in aural architecture. Therefore I approached geometry based in forces, vectors, intervals, frequencies' patterns, instead of a fixed structure, which is the usual approach in the production of abstract space (p. 25). As seen, my aim was to create to a *differential space*, or the diversification of space. Moreover, I wanted to explore a geometry in relation with material efficiency, as a dynamic relation between things that would allow variable intervals and tensions, according to the spatial

practices and performances. In this sense, *Radio Sonores* proposed an alternative mode of building space that embodied the materiality of relations, and articulated simple systems, forces and agents in its design process, for the performative quality of vibration (beyond formal). From the experiment *Vibrational Fields* I knew how to transform and modulate an energetic system (a resonant soundscape and a space as resonator) based in energy and forces, and therefore in frequencies, intensities, amplitudes, duration, rhythm. Here I got interested in how to build this energetic system into an assemblage with physical materials.

Diagram as energetic geometry

The radio station was the meta-space that condensed the whole program as a radio art project and provided a permanent broadcast, streaming and archive of an influx of events. In this sense, it acted as an epicentre of activities. Therefore the space was generated around the principle of a circle, as the figure of an immersive acoustic space. The circle was engaged as “an emblem of universal geometries, with potential metaphysical or cosmological overtones” (Allen in Hensel, Hight, Menges 2009, 130). Therefore the initial diagram was very simple, based in a concentric circle, as an epicentre, to expand into an energetic geometry (see figures 4.05-4.07, p.116).

These diagrams generated an energetic geometry, from which emerged the spatial form of the acoustic space for the radio, which should be adaptable and evolutive. This means that the same architectural installation could be assembled in distinct acoustic configurations, for distinct aural experiences. It resulted in an acoustic dissociation between the inside silent space of the radio station and the outside reverberant space of the factory. From *Radio Sonores* experiment emerged the concept of a diagram as an energetic geometry, which was further developed in the practical case study *Passage* (p. 189).

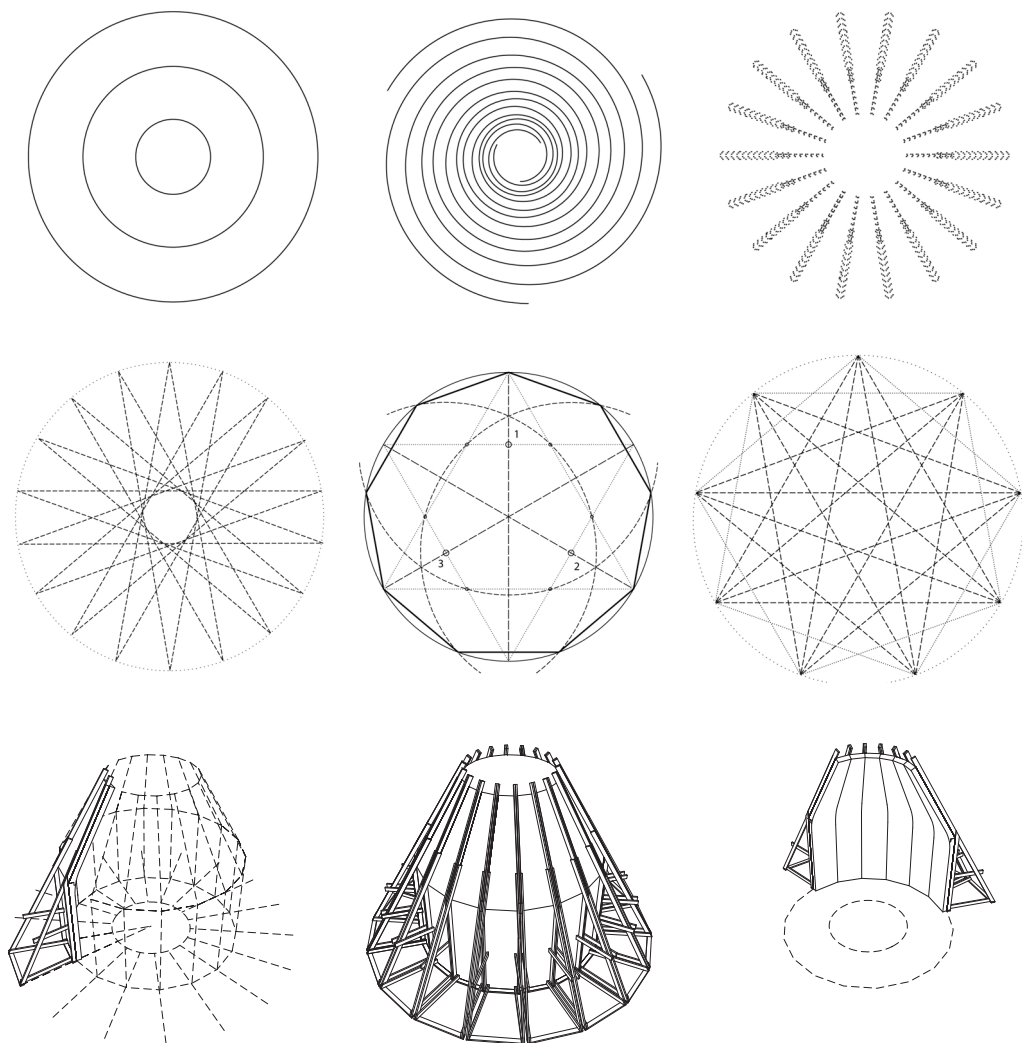


Fig. 4.05, 4.06, 4.07 - diagrams of energetic geometry

Assemblage

In the aural architecture design of *Radio Sonores I* I have expanded geometric diagrams, into an energetic understanding of form as an assemblage, drawing from Deleuze and Guattari.

In all things, there are lines of articulation or segmentarity, strata and territories; but also lines of flight, movements of deterritorialization and destratification. Comparative rates of flow on these lines produce

phenomena of relative slowness and viscosity, or, on the contrary, of acceleration and rupture. All this, lines and measurable speeds constitutes an *assemblage* ⁴⁶

I have used the term assemblage instead of structure, as an assemblage opens up endless possibilities to gather a multiplicity of things. Therefore the initial diagrams become energetic geometry, engaged as lines of articulation, as vibrational forces that produce phenomena, intervals and dynamic relations. Here again, a link is drawn to the previously discussed ideas of space as a field, as a connective tissue between humans, non-humans and things.

This mobile radio station needed a simple solution for relational space: a circular assemblage of light-weight modules, easily transportable and assembled. But with the possibility of transformation: from an enclosed space to an open space according to its users needs and responsive to the site where it was to be installed. Therefore the geometric diagram became a relational base for the design and assemblage of an aural architecture, with adaptable acoustics.

2.3. Architectural acoustics study

Adaptable acoustics means opening and enlarging spaces or making them narrower and quieter. It also means, for example, composing phase-like spaces which can expand and contract in rhythmic waves ... To be able to change the acoustics to conform with specific requirements means to be able to alter the sensorial qualities of space. Independent acoustics opens up new dimensions of architectural design. This sounds somewhat utopian today. However, experimentation and creative innovation will help to define the meaning of this design approach and

⁴⁶ Deleuze and Guattari, in <http://www.rhizomes.net/issue5/poke/glossary.html>

lead to architectural expressions rooted in the potential for human enrichment offered by modern technology. (Leitner 1998, 303)

Radio Sonores was designed and built with such adaptable acoustics. Extending the diagrams as an energetic geometry, and assuming the radio station infrastructure as a round table connected to an antenna, the space surrounding its users was conceived as an insulated and absorbent acoustic capsule. This capsule was assembled as a circle with eighteen identical modules for a closed and isolated situation.

From time to time there were performances with public interaction. In this case, the circle opened up, its modules sprawl in different configurations (i.e. half-circle), and its inside revealed itself the time of a transmission. Then the circle would reconfigured itself, the capsule would reshape itself in its integrality, generating the decontextualised and protected necessary conditions for a focused attention on the creation of sound and music.

Next, I will describe each of the properties - geometry, materials' density and spatial volume - that has defined the quality of the acoustic space.

Geometry

The geometry of the capsule was based in eighteen identical modules and covered with a ceiling. The assemblage of nine elements would create an half-moon geometry and the shape of an acoustic shell. This assemblage allowed open performances, for interactions with public, and at the same time the performers would have the acoustic conditions to hear themselves.

The assemblage of 18 modules (the total amount) would close the geometry of the circle, creating a closed environment, a volume with an adequate size for a

radio station. Therefore the same architecture installation could be assembled in distinct acoustic configurations, for distinct aural experiences.



Fig. 4.08, 4.09 - assemblage in circle and in half-circle

Besides, it was also transportable to other places. We started by the design and experimentation of one single element, a module, a prototype, that would be repeated. It was designed according to the overall geometry and proportions. The module was vertical until the head's height and then inclined to the interior.

Materials' density

The materials available for the construction workshop were the same for every work: wood beams, screws and insulation cork panels. Here the material deployment determined the architecture form. We designed and built movable wooden partitions, making the acoustic manipulation temporary and variable.



Fig. 4.10, 4.11, 4.12 - movable wood panels

For a more efficient acoustic absorption performance, we added an extra absorber material. The inside of the walls and ceilings were fully covered by acoustic panels with excellent absorption capabilities and an effective amount of diffusion (fig. 4.13, 4.14, 4.15). It resulted in a relatively quiet environment, suitable for a recording and broadcast studio, or a performance space.

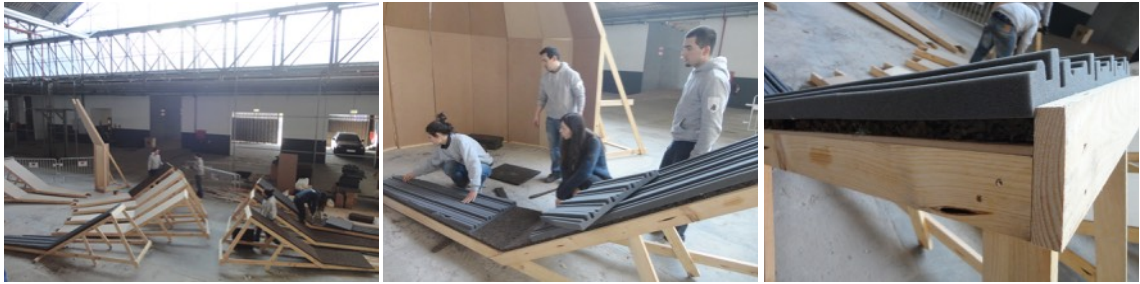


Fig. 4.13, 4.14, 4.15 - movable wood panels

Spatial volume

The acoustic space is also determinate by the way we sit: the height of the seats in relation to the height of the room, the way the seats are grouped. (Leitner 1998, 302)

Once the radio station was built, we designed and built a round table with seats distributed around the circle, according to the space's proportions. On the one hand, the dimensions and proportions were large enough to allow several people to interact in the space and to circulate behind the seats, if needed. On the other hand, the room's height was designed to have an acoustic volume large enough above heads, for a comfortable sense of intimate space (not too tight, but not too high either).



Fig. 4.16, 4.17, 4.18 - interior space

Spatial agency

A space is left for the tactical improvisations of future users. A 'loose fit' is proposed between activity and enclosing envelope. (Allen in Hensel, Hight, Menges 2009, 142)

Radio Sonores engaged a spatial agency that operates through relationships, into socially embedded networks. This approach allowed an experience of space as an evolutive event. This means that it opened up the re-appropriation of space, according to each place and its users. Therefore its architecture dealt with the consequences of its form, rather than the way it looked. Therefore *Radio Sonores* emerged as an autonomous spatial device, mobile, performative, evolutive and adaptable to different uses. It was installed in two different places. First, it was placed behind the main auditorium, in a closed position, acoustically and visually isolated from the surroundings (figure 4.19). Then, it was positioned between the auditorium and the kitchen, half opened, to allow acoustic permeability and public interaction (fig. 4.20-4.21).



Fig. 4.19, 4.20, 4.21 - spatial agency

2.4. Final thoughts

This alternative practice of aural architecture as a workshop engaged a educational design method for a practical understanding of acoustics. Therefore, it was a successful experiment of a participative mode of building architecture, contributing for a social ecology. Also, it raised awareness among architecture students of the important role aural architecture plays in shaping our environment. Another relevant contribution was the emergence of a mode of

aural architecture design that focused on the consequences of the experience of space (sensorial, social, political, ecological), more than the formal production of an object of architecture, like most contemporary architectural practice does. This aural architecture design was based in space as dynamic relation, of fields of relationships. The design was based in diagrams of assemblage as an energetic geometry. These diagrams opened up space for material improvisation and for affective experiences. *Radio Sonores* resulted as an experience of relationships between humans, non-humans and things. These ideas will also be further experimented in practical case study *Passage*. But the experiment also had its short-comings. The initial idea was that this radio station would continue to be used by the Soopa collective (the group of artists and musicians which has commissioned the project), to develop other radio activities in different places. Unfortunately this radio capsule was destroyed after the event by the Guimarães Capital of Culture production. It was a very short life for such an evolutive and adaptable aural architecture. Nevertheless, there was a strong learning point. This practical case study was the start of a series of experiments in designing aural architecture based in space as relation, and diagrams of assemblage as energetic geometry. This practical case study inspired me to repeat the experiment but in a different context, with different materials and geometries, as I will explain in the conclusion of this thesis.

Acknowledgments

Conception: Cláudia Martinho and Mathieu Herbelin

Construction: Cláudia Martinho, Mathieu Herbelin, Jean-Marc Chevalet with Exyzt collective and the workshop *Construir Junto* (Build Together), with students from the Architecture School of Guimarães.

Chapter 5

Working concept	• Space as field of attunement
Enquiry	• Sympathetic resonance, entrainment and affect • Attunement, ambiance and ecology
Practical case study	• <i>Shores</i>
Design methods	• Soundscape for attunement
Affective experience	• Experience of environmental sound in extension with the site, in tune with the environment in a symbiotic way • Auditory experience of balance between inner and outer worlds
Emergent concepts	• Experience as embodied knowledge • Ecological intimacy from oral communities

In Chapter 4, I have extended the working concept of space as field drawing from architectural design theory. In the case study *Radio Sonores*, I have experimented this concept with the design of an aural architecture based in space as a dynamic relation. Here, in Chapter 5, I became interested in exploring the working concept of space as a field of attunement. I have extended my enquiry on the idea of attunement as a phenomenon based in sympathetic resonance, entrainment and affect, looking up for an understanding in the fields of physics, music, philosophy and psychology. I have then linked attunement, ambiance and ecology, drawing from acoustic ecology. These ideas were experimented in the practical case study *Shores* (2017), a soundscape installation in a boat, converted into an acoustic shell to transmit a collective sonic memory of fishermen. This practical case study produced one design method: a soundscape for attunement to being and the surrounding vibrational forces. It explored an affective experience of environmental sound, in extension with the site; a sense of place and being in tune with the environment in a symbiotic way; and an auditory experience of balance. Concepts have emerged from within this practice such as: experience as embodied knowledge (Westerkamp 2002), ecological intimacy (Morton 2014) from oral communities.

Working concept:

Space as a field of attunement

When we study attunement, we study something that has always been there: ecological intimacy, which is to say, intimacy between humans and nonhumans. (Morton 2014)

The phenomenon of attunement has been defined in various disciplines such as music, philosophy, physics and psychology. I have looked into these fields for definitions which pertain directly to my research, to understand how to raise an experience of attunement through listening to sound. In what follows, I have unfolded a discussion and articulated different perspectives to come to an understanding that I could explore in my practice. Therefore, I have approached attunement from two different points, looking for links:

- as an acoustic research, with scientific facts that deal with frequencies and objects;
- as a creative process, in an interpersonal and social level.

To reach out an affective experience, of attunement, resonance is a key effect. If I consider bioresonance as the phenomena of entering in sympathetic resonance, then attunement is the relation of bioresonance. For, as Timothy Morton defines, “attunement is a living, dynamic relation with another being” (Morton 2014, online reference). But attunement is also “the place where causality happens. Consider what happens when an opera singer's voice attunes to a wine glass. If done with the greatest accuracy, the wine glass explodes” (Morton 2014, online reference). Therefore one may say in general terms that the notion of attunement is directly related to the phenomena of bioresonance and the effect of sympathetic resonance or vibration. In physics and acoustic research, sympathetic resonance is a harmonic phenomenon where a vibratory body responds to external vibrations to which it has a harmonic likeness. This means that a certain vibration reaches out and sets off

a similar vibration in another body. The physical phenomenon of the resonance effect “refers to the vibration, in air or through solids, of a solid element. The production of resonance requires (...) a concordance between the exciting frequency and the object put in vibration.” Under specific conditions resonance produces an infinite gain in amplitude, as a “swing set in motion by rhythmic impulses that have the same frequency” (Augoyard and Torgue 2008, 99). An important notion for this research is that every system (every space, body, form or structure) has a natural frequency (also known as characteristic frequency or resonance frequency), to which it responds with greater amplitude, in sympathetic vibration or resonance. This is also called the fundamental mode of vibration. The natural frequency depends on the relationship between the system or body’s size, surface, pressure and volume. I understand this response in sympathetic vibration as a way of attunement.

The vibrations produced by musicians playing can create a similar empathic resonance effect in the space, between the musicians themselves and with the audience. This resonance effect is similar to the phenomena of sympathetic vibration, and can also be understood through the phenomenon of entrainment. In psychoacoustics, the term entrainment is used to describe rhythmic pulsating fields synchronising in sympathetic or arrhythmic resonance (Kossak 2007, 37). Entrainment is discussed in scientific literature in reference to resonance fields rhythmically synchronising together such as brain waves, circadian rhythms, lunar and solar cycles, breathing, circulation, and rhythms found in the nervous system (Jenny 1967; Hall 1983; Thant, Kenyon, Schauer, & McIntosh 1999). We may say that this phenomena depends on factors such as rhythm, intensity, tone, duration. While the term attunement is not directly used in music literature, the same phenomena is generally referred to as “sympathetic entrainment”, “rhythmic entrainment”, or with more common expressions such as “locking in” or “being in the groove” (Kossak 2007, 38). Therefore it has been argued that the experience of attunement is achieved through improvisation that uses sound and rhythm (Kossak 2007, 23). Philosopher and sociologist Alfred Schütz

describes the phenomena of attunement as a participative and relational process through which musicians tune in each other. In his view, this act of sharing a mutual tuning-in relationship relates to the lived experience of the flow of “inner time” and its duration (Schütz 1951).

Another term used to describe this phenomenon is the idea of “empathic attunement”, which was found in the music education literature (Seddon 2005). In this sense, it has been described that musicians often achieve an emotional and interpersonal interaction, such as empathy and bonding. Qualitative research looking at jazz musicians’ experience while improvising describe the phenomena of attunement in words such as: embodied, ecstatic, moments of transcendence (Jeddeloh 2003), truly alive and awake, fully embodied yet beyond the body, achievement of a higher consciousness, a greater unseen force (Burrows 2004). All these terms are used to describe “an experience of sympathetic resonance where the rhythmic pulse shifts to a driving force and some other kind of energy is experienced” (Kossak 2007, 39).

Composer Pauline Oliveros has developed a work of improvisation and *Deep Listening*⁴⁷, in which she has called up for experiences of conscious empathy, resonance, entrainment, that all together can be understood as a process of attunement. She has said that when we are empathic, distance, as we know it, ceases to exist because we are both in the same resonance field (Kossak 2007, 27). I remember a *Deep Listening* workshop lead by Pauline Olivero’s herself in which I had the chance to participate in 2011 (ISMAE, Porto). We were in a room, sitting in a circle, and the session consisted of several exercises of relaxation, conscious listening and improvisation. We started by listening to the

⁴⁷ Pauline Oliveros herself described Deep Listening as “listening in every possible way to everything possible to hear no matter what one is doing”. Basically Deep Listening, as developed by Oliveros, explores the difference between the involuntary nature of hearing and the voluntary, selective nature - exclusive and inclusive - of listening. The practice includes bodywork, sonic meditations, interactive performance, listening to the sounds of daily life, nature, one’s own thoughts, imagination and dreams, and listening to listening itself. It cultivates a heightened awareness of the sonic environment, both external and internal, and promotes experimentation, improvisation, collaboration, playfulness and other creative skills vital to personal and community growth. Online reference: <http://www.deeplisting.org/site/content/about> - accessed March 12 2016

outside sounds, then inside, the room resonance, then each of the participants playing a sound, with our voice or found objects. And finally all together we improvised. This gradual process of listening, tuning to the space's resonance, then tuning in to the other, was helpful to achieve a state in which I could feel more deeply and freely my self, and finally got attuned to the group. This process raised enough confidence and bonding between all participants in order to enjoy playing together and embody a sense of unity. I have found in this experience of empathy and entrainment a way of attunement.

Moving on towards philosophical literature, we find Martin Heidegger drawn to the twofold sense of *Stimmung* as mood and as attunement, in the sense of a relation, as the tuning of a musical interval (Phillips 2015). As Frances Dyson explains in her book *Sounding New Media: Immersion and Embodiment in the Arts and Culture* (2009), "Heidegger would seem to be offering a phenomenology that leads us towards sound and listening". And she continues, "for Heidegger, vibration, as attunement (*Stimmung*), provides a metaphysical interval, a space where certain rhetorical manoeuvres can take place, and a portal through which individuals can access the spiritual center of their 'own most' being ... Heidegger's philosophy is grounded in the metaphor of silence – not the inner silence of the Cartesian subject, but the silence of *Dasein* (being-in-the-world, literally being-there) in its authentic understanding of Being" (Dyson 2009, 11). As we have seen, the experience of *being vibration* was explored in the practical case study *Vibrational Fields*. Here in the practical case study *Shores*, I wanted to extend this idea into an experience of attunement in the sense of opening up to transcendence into the now; as a channel of communication with a site-specific vibrant reality and its vibrational forces; a channel to amplify the experience of being; an experience of being-in-the-world, of being in vibration, in this continuous field of interconnections between all things. As seen before, this is what Angerer has referred to as "the temporally barred momentum of a relation, a blank, a gaping opening, into which and from which affect arises" (Angerer 2017, 11).

When we study attunement, we study something that has always been there: ecological intimacy, which is to say, intimacy between humans and nonhumans. (Morton 2014)

We may say then that every being relates in search for attunement with other being. For attunement is also described “as the capacity to sense, amplify, and attend to difference” (Ash and Gallacher 2015, 73). I have engaged my practice as an ecological affair to explore an amplification of this innate capacity of attunement to self and other beings (human, non-humans, things). Therefore as we will see on the practical case study *Shores* (but also in *Passage*) I have explored attunement as a living, dynamic relation with another being. This is also what Jane Bennett explored in *Vibrant Matter, a political ecology of things* (2010). As seen before (p. 33-35), she describes reality as vibrant matter, a vibrational force, an active becoming of vibrant bodies, “a creative not-quite-human force capable of producing the new” (Bennett 2010, 118). She claims that “vitality is shared by all things” and that we are in need to develop communication and translation tools of this vibrant reality, between humans, non humans and things (Bennett 2010, 89). In this sense, as we will see, my proposal for practical case study *Shores* was to offer an amplified experience of this vibrant matter, to engage the audience in an active listening to it, as a channel of communication with this reality. This could be a way of attunement between humans, non humans and things. In other words, my interest was to explore the relation between beings, space and time as an experience linked through sound and vibration, and I understand this way of linking as attunement. For this reason, “an attunement is an active relation, not a form of contemplation, and can thus act upon that which is attuned” (Phillips 2015). This is also a point in which Timothy Morton argues and extends further:

Since a thing can't be known directly or totally, one can only attune to it, with greater or lesser degrees of intimacy. Nor is this attunement a 'merely' aesthetic approach to a basically blank extensional substance. Since appearance can't be peeled decisively from the reality of a thing,

attunement is a living, dynamic relation with another being. (Morton 2014)

In this sense, my approach to attunement is not a merely aesthetic approach of contemplation. Instead, in the practical case studies *Vibrational Fields*, *Shores*, *Passage*, I have enquired this idea of attunement as an active relation, a level of apprehension before cognition. The purpose was to explore the experience of being vibration. Actually prior to empiric experience, this what Alfred North Whitehead calls “causal efficacy”, where *experience is being*. As we have seen on page 37, Whitehead has described this mode of experience as an inflow into ourselves of feelings from enveloping nature that overwhelms us (Whitehead 1929/1978, 176). This is an affective experience that I wanted to experiment with the soundscape for attunement of *Shores*. I wanted to test if in this mode, presentations of sense would fade away, and the audience would experience a vague feeling of influences from vague things around them. My hypothesis was that in this mode of experience, other sensorial interplays would take place. I wanted to test if these new conditions for experiencing would favor renewed relationships of attunement between the audience, the site (activated by the installation) and the surrounding vibrational forces, evoked through the soundscape.

Attunement

This brought me to enquire further on the question of affect in the experience, and its relation with attunement. Affective attunement, refers to a concept drawn from theorist Daniel Stern (2004). Stern defines *affect attunement* as relational attachment in psychology. He uses this notion to describe the tuning in process between a mother and her child, in the rhythmic interaction of sharing inner feelings, through sounds, facial expressions and affect. Stern also relates this tuning in process to artistic endeavours where “the participation in rituals, artistic performances, spectacles and communal activities, like dancing or singing together, all can result in a transient real or imagined intersubjective

contact” (Stern 2004, 109, in Kossak 2007, 24). The affective attunement experience happens then with synchronistic rhythmic experiences. Massumi claims that the idea of affective attunement is a much more supple way of approaching affective politics, because it finds difference in unison, in the complexity of collective situations. Therefore this is the kind of relation of attunement that I have sought to explore. As we have seen with *Infrasound* (p. 66) and in my practical case study *Vibrational Fields* (p. 74), this is what happened. The experience of *Vibrational Fields* aimed to generate a connective tissue, a tangible experience of some kind of unified field. The practical case study *Shores*, as we will see next, extended this mode of experience, to enquire if these conditions would enable the emergence of affective attunement.

Atmospheric attunement

In search for links between ambiance, ecology and attunement, I have looked into another perspective from urban studies literature, with Kathleen Stewart’s paper on *Atmospheric Attunements* (2011, 445-453). She calls for attention to the charged atmospheres of everyday life ⁴⁸. She describes atmospheres generated by circulating forces that come to reside in experiences. These forces “spawn worlds, animate forms of attachment and detachment, and become the live background of living in and living through things”. She suggests that “atmospheric attunements are palpable and sensory yet imaginary and uncontained, material yet abstract. They have rhythms, valences, moods, sensations, tempos, and life spans” and may raise senses in a state of alertness, distraction or denial. These reflexions draw a link to the description of multi-sensory experiences (Leitner 1998), atmospheric perception (Pallasmaa 2017) and dynamics of urban ambiances (Thibaud 2011). Stewart questions how people that inhabit these ambiances or atmospheres become attuned to the sense of something coming into existence. This idea suggests that

⁴⁸ Here I considered the term atmosphere similar to the term ambiance. I am aware though that some authors differentiate the terms.

attunement may engage a sense of emergence, or becoming part of some sort of unified field, in such a way that one may sense life and movement. This is an idea that Pallasmaa as described as the result of the senses interplay and has referred to it as the sixth sense: “Modernity, obsessed with clarity and form, has regarded atmospheres as sentimental and entertaining properties. However, it is becoming increasingly clear that our emotive atmospheric perception is a consequence of evolution and could well be named our sixth and the most important sense” (Pallasmaa 2017, online reference).

Attunement to a symbiotic real

Trivially speaking, ecological awareness means realising that beings are interconnected in some way, but then we have to figure out what this interconnection actually means. At the moment, the phrase I’m using for the thing that ecological awareness names is “the symbiotic real”. What do I mean by that? I mean that ecological relationships are best described in terms of symbiosis, and symbiosis is a very interesting thing because it’s always a sort of fragile, contingent, uneasy relationship in which it’s impossible to determine which entity is the top entity. Symbiosis can fail in various different ways: if there’s too much stomach bacteria in my stomach, I might have some problems. If there’s too little, I might have some problems. There’s a sort of dynamic system there. (Morton 2016)

In the practical case study *Shores*, I have experienced a very similar phenomena while recording fishermen on a boat. As it will be described next, Azorean native hunters are in such a mode of attunement with their environment that they have developed a symbiotic way of experiencing place. The interesting fact I have learnt, is that while the fishermen experience a deep ecological intimacy with their environment, it results as an embodied knowledge of the ocean’s language. In the experience of *Shores*, I have understood that

we have much to learn from oral communities about ecological intimacy, symbiotic ways of experiencing place and embodied knowledge.

I have enquired these ideas of attunement and ecological intimacy further in relation to acoustic ecology. As we have seen in this thesis introduction, I find some common ground with the *World Soundscape Project*, particularly with research by composers Hildegard Westerkamp and Barry Truax, such as conscious listening (Westerkamp) and acoustic communication methods (Truax), as will be explored next.

Environmental sound awareness

How can soundscape composition enhance environmental listening awareness? What is its role in inspiring ideas about balanced soundscapes and acoustic ecology? How can the soundscape composer raise listening awareness in an already overloaded sound world with yet another sound piece? What is the ecological stance that we take through our compositions both as listener and composer? (Westerkamp 2002, online reference)

Hildegard Westerkamp was one of the key speakers at the Invisible Places Symposium ⁴⁹ in Azores, where the practical case study *Shores* was developed. I had the chance to soundwalk with her guiding a group a couple of times. These moments were definitively a source of inspiration for my work on *Shores*. Westerkamp has been actively engaged with our soundscapes and contributing for an awareness of environmental listening. In her article *Linking Soundscape Composition and Acoustic Ecology* (2002), she describes acoustic ecology as the study of the inter-relationship between sound, nature, and society. She claims that this arena is the basis from which this work and the term

⁴⁹ See <http://invisibleplaces.org/> - accessed May 13 2017

soundscape composition emerged in the first place in the mid-seventies. Westerkamp argues that if soundscape composition is always rooted in themes of the sound environment, then it should be the soundscape composer's responsibility to act like an acoustic ecologist. She takes this one step further, questioning if a soundscape composition can initiate ecological change, as energy for change can be created in the link between composer and audience. And furthermore, in the link between soundscape composition and acoustic ecology meaning is also created. Therefore the ecological balance of our planet is a major issue that soundscape can make audible. And for this, she says, the soundscape composers have the skill and the expertise. They just need to learn to hear it and to speak back. The soundscape composer's attention to ecological issues should then start with listening as a conscious practice in daily life, continue during the acquisition of sound materials, the work in the studio, right through to the presentation of the final piece (Westerkamp 2002). As will be explored next with the practical case study *Shores*, listening is central to my process of composition, as sound guides the shaping of it, not the other way around. One is both composing and being composed through sound (Truax 1996, 60). One may also contribute to re-integrate the listener with the environment (Truax 1996, 63). I also found essential to conduct *Shores'* soundscape presentation with conscious attention towards an ecologically balanced acoustic environment.

Soundscape composition as a tool for change

In the face of wide-spread commercial media and leased music corporations, who strategically try to use the *schizophonic*⁵⁰ medium to transport potential customers into a state of aural unawareness and unconscious behaviour and ultimately into the act of spending money. In

⁵⁰ For Murray Schafer a 'schizophonic' listening experience is characterised by the fact that the sound source always originates in another place than where it is heard and often produces a mood or atmosphere that is out of context of the listener's physical location (Westerkamp 1999).

the face of such forces the soundscape composition can and should perhaps create a strong oppositional place of conscious listening. Rather than lulling us into false comfort, it can make use of the *schizophonic* medium to awaken our curiosity and to create a desire for deeper knowledge and information about our own as well as other places and cultures. It is a forum for us as composers to 'speak back' to problematic 'voices' in the soundscape, to deepen our relationship to positive forces in our surroundings or to comment on many other aspects of a society. Rather than disorienting us, such work potentially creates a clearer sense of place and belonging for both composer and listener, since the essence of soundscape composition is the artistic, sonic transmission of meanings about place, time, environment and listening perception. (Westerkamp 1999, online reference)

Westerkamp claims that our actual acoustic environment, an overloaded sound world which in itself can be dense, noisy and *schizophonic*, may be perceived as 'natural' and 'normal' by many. But the fact is that it can also have a disorienting effect, create a sense of unreality, and "the listener's 'sense of place' may become confused and uprooted" (Westerkamp 1999, online reference). In this context, Westerkamp claims for a soundscape composition as a strong oppositional place of conscious listening on a more activist and political level. She argues for the engagement of soundscape composition as a tool for a change in the way we perceive and connect to the world around us, as it presents an ecologically meaningful language. It is a powerful means to comment problematic issues of the environment and society, or deepen our relationship to our surroundings (Westerkamp 2002, online reference).

Composing with environmental sound

For Truax (as seen on p. 43), the term *acoustic communication* (Truax 1984) refers to a way of understanding the complex system of meanings and

relationships that sound creates in environmental contexts. He developed the acoustic communicational model as an interdisciplinary alternative methodology that included soundscape studies, acoustic communication and soundscape composition (Truax 1996: 58). Here, I became interested to engaged the soundscape composition as a system of information exchange to generate an *acoustic community* (Truax 1984) where sound *mediated* the relation of the listener to the environment (Truax 1996: 59). Truax claims that when composing with environmental sound, one learns that these sounds are rich in acoustic complexity, and rich in multiple levels of meaning, both personal and cultural (Truax 1996, 59). This process is very different from composing sound abstractly. It amplifies relationships of the world of lived experience, bringing them into the compositional process (Truax 1996, 60). The fact that environmental sounds are situated within the world of lived experience, turns a soundscape composition relevant for an acoustic ecology awareness. As listeners get connected to a web of social relationships, they get involved in the composition and complete their network of meanings (Truax 1996, 55). Truax claimed that the quality of environmental sounds are “more complex in their spectral and temporal shape than most other musical material; synthesised sound in particular (...) has none of the corporeality of environmental sound” (Truax 1996, 51-52). In the same line of approach, musicologist John Shepherd argued that “as the essence of individual sonic events, timbre speaks to the nexus of experience that ultimately constitutes us all as individuals. The texture, the grain, the tactile quality of sound brings the world into us and reminds us of the social relatedness of humanity” (Shepherd 1987). Barry Truax has also established important principles of the soundscape composition, and to which my work has referred to:

- (a) listener recognisability of the source material is maintained, even if it subsequently undergoes transformation;
- (b) the listener's knowledge of the environmental and psychological

context of the soundscape material is invoked and encouraged to complete the network of meanings ascribed to the music;

(c) the composer's knowledge of the environmental and psychological context of the soundscape material is allowed to influence the shape of the composition at every level, and ultimately the composition is inseparable from some or all of those aspects of reality;

(d) the work enhances our understanding of the world, and its influence carries over into everyday perceptual habits. (Truax 1996, 63)

As will be seen next with the practical case study *Shores*, and drawing from this enquiry, I have experimented the design of a soundscape for attunement with the environment and the creation of a place for conscious listening. It explored an innate capacity of attunement (Morton 2014, online reference) to self and other beings, towards an understanding of our environment as an unifying field, of a multiplicity of relationships through vibrational forces. My goal was the re-integration of the listener with the environment in a balanced ecological relationship. I composed with environmental sound enhanced by acoustics, exploring its corporeality and physicality, to amplify the world of living experience, the transmission of meaning and sense of place.

Practical case study:

Shores



Fig. 5.01 - Shores installation at Ponta Delgada harbour

The practical case study *Shores* was created while in residency at the *Invisible Places Symposium* ⁵¹, a biannual event. The aim of this conference was to bring together scholars, artists and theoreticians on soundscape art and acoustic ecology to further new perspectives in interdisciplinary research and practice. A central topic discussed was about the fundamental role of our sound heritage for the holistic evaluation of landscapes in the evolution of all species. This year it took place in São Miguel, Azores.

⁵¹ See <http://invisibleplaces.org/> - accessed May 13 2017

1. Experience of site

1.1. Analysis of context

Collective memory of São Miguel, Azores

I had never been in Azores before, although this was a travel I dreamt of, but not as a tourist. The *Invisible Places'* call for residencies was the perfect opportunity to get to know this unique place. Being Portuguese myself, when I thought of Azores I have always imagined boat sailing, fishermen and deep ocean. Of course there is much more than that, but still, it is an important part of Azores' cultural heritage which is disappearing. Arriving to São Miguel I confirmed that artisanal fishing has been drastically declining. One of the main reasons is that as the fishing activity is inevitably industrialised, small scale fishing companies are disappearing, and so are certain fish species, most of artisanal fishermen and wood boats' builders. Consequently a significant part of the island's sustainability is out of balance. Next to that, I realised that each year, tourism is augmenting exponentially in São Miguel, for its unique attractive ecosystem. And so is the number of airplanes landing and taking off. Adventure tourism tours are contributing to the infrastructure evolution with motorways. Therefore the acoustic ecology of São Miguel is becoming heavily contaminated by jet airplane motors and tourism buses. Obviously, these changes in such a small territory (736 km²) have a strong ecological impact. Sea exploration to watch dolphins and whales is also an issue. Locals complain that multinational companies have monopolised the Azores market as they have the capital to invest in high tech boats, captivating tourists. Of course, one may say that this is inevitable, this is the world's global progress. Still, there are ways to balance and work towards local sustainability. I am aware I may be here a bit "ashamedly" nostalgic. But I realised that for the fisherman and their families, it is hard to live everyday on the hope to find subsistence. In this context, as

fishing activities are diminishing, fishermen are left workless and poor, excluded from this emerging sea tourism. The link between traditional sea activities and new sea tourism markets should be a major political, social and cultural concern. But according to locals, there is no education investment in the fishing communities towards new inclusive sea activities. Therefore traditional fishermen are left out of the touristic scenario and small communities by the sea are disappearing, as it has happened over and over in different places around the world. And unfortunately, their ancestral sea knowledge is being quickly forgotten. My question therefore was how could I contribute to valorise this collective memory and cultural heritage, and moreover to promote their aural identity? My idea was that my soundscape work should create and transmit meaning, connect places, renew a collective memory of São Miguel. I wanted to do a sonic intervention in urban space to create embodied and multiple understandings of the island's reality. This sense of place, or essence, could be many different things, according to the one that experiences it. Therefore the idea was not to transmit one meaning, one memory, one understanding, one sense of place. On the contrary, I wanted to create an affective experience to open up different ways of listening to São Miguel's life's diversity, urban and natural, its sea culture and its ecological richness as a small island in the middle of the ocean. This could raise listening awareness and even incite an active engagement with the surrounding soundscapes. In this context, I wanted to avoid a touristic or superficial approach. Being Portuguese was already an advantage. Still, this place's specificity was foreign to me. At first I could not understand some words because of the strong accent of this island. Here it was very clear how the sounds of an oral language, its rhythms, tones and inflexions, are attuned to the contour and scale of the local landscape (Abram 1996). Curiously though, I felt some kind of immediate resonance I could not explain. Perhaps it was because I lived half of my life near the sea. Therefore I was in residency the longest I could, almost four weeks, to reach a deep experience. Generally, when I get to a place that I do not know, my approach is

to follow my intuition and let my work emerge from within everyday life's experiences, at the rhythm of the place.

We may find similarities with an ethnographic approach in the way that it focuses “on fieldwork primarily through sensuous experience and the creation of an outward response to that experience from the inside”, as John Levack Drever points out (Drever 2002). And ethnography may offer practices of soundscape composition ways to move forward in a relevant and social way, with a more critical and reflexive mode of operation (Drever 2002).

I wanted to take time to embody the territory, to live and feel its essence, so that the soundscape would reveal itself. And in the same way, it also takes a long time to build up confidence with local communities. Luckily the symposium organiser, Raquel Castro, has engaged a local producer, Diana Diegues, who made my task a lot more easy. By introducing me to Liberato Fernandes, the former president of fishing cooperative Porto de Abrigo, the doors of the fishing reality got opened to me. He has done an impressive amount of political and social work to help the fishermen communities in reclaiming their rights and improving their work conditions. And curiously, he was very enthusiastic with the whole practical case study, as he believed that these cultural and artistic interventions were means to reveal the fishing world to people that are normally not aware of it. This local expert informed my work with a reality that I was not aware of. He helped me in building up an accurate knowledge of the fishing reality but also, and more importantly, he facilitated a direct and confident relationship to the fishermen. He was the bridge between myself as an artist-researcher and the local communities of fishermen and their families. Liberato Fernandes was the key person that made this practical case study possible.



Fig. 5.02, 5.03, 5.04 - Photographs at Porto de Abrigo cooperative

1.2. Dynamic of experience

The creative dynamic involved a process of soundwalking, field recording and a workshop.

Sense of place

My immediate feeling was that the sea, the wind and the island shores' sharp topography were major elements that determinate São Miguel's sense of place and its people's identity. The forces at work were very powerful and raw. For the soundscape composition, my aim and central idea was to get on a fishing "hunt" and record it; and to go to the harbours of fishing communities and record everyday sounds. I also wanted to develop my work in a dynamic of co-creation, in a collaborative and participative process with local communities. I thought of interviewing fishermen's families, to let their voices be heard about their actual situation and concerns. And besides, I also wanted to engage students in a workshop of sound mapping, soundwalking and field recording around the island's shores. My practical case study had several layers to take into consideration. It articulated a social, cultural, educational and ecological intervention; and an artistic, architectural and acoustic creation.

Rabo de Peixe

On my third day in the island, Liberato Fernandes personally took me to Rabo de Peixe, which is the biggest, poorest and most united fishing community of São Miguel. I became aware of this side of the island reality, which is ignored by most of the people in the main city of Ponta Delgada. Surprisingly, the fishermen were very enthusiastic as well with my practical case study, even though they are not the usual public for this kind of artistic intervention. I was generously offered three old boats that I could use and convert into an acoustic shell. Additionally I also got several possibilities to join fishing companies. I decided to go on board with the companion of master Paulo Sousa, a traditional fishing boat with 13 fishermen. A curious fact is that women are normally not allowed to go on board. But luckily, they opened an exception for me.



Fig. 5.05, 5.06, 5.07 - Rabo de Peixe – views of harbour and village

1.2.1 Field recording: sea sources

The fish “hunt”

A couple of days later, my first fieldwork was to get on a boat with these fishermen and go on a fish “hunt” (I use the word “hunt” as I really felt like I was on a native hunt). I had never been on a fishing boat before, therefore I had absolutely no idea how this was going to be. I knew that it would last for about seven hours. We left at 7 am and got back at 2 pm. Normally they would have left at 6 pm and return at 6 am, to fish mackerel during the night. But it was a time of major crisis, there haven’t been any mackerel for three weeks already. For this reason, they had to hunt the little sardines, which is done by daylight near the shores, with the traditional technique of purse seine fishery. It is still a challenge for me to describe in detail this overwhelming experience.

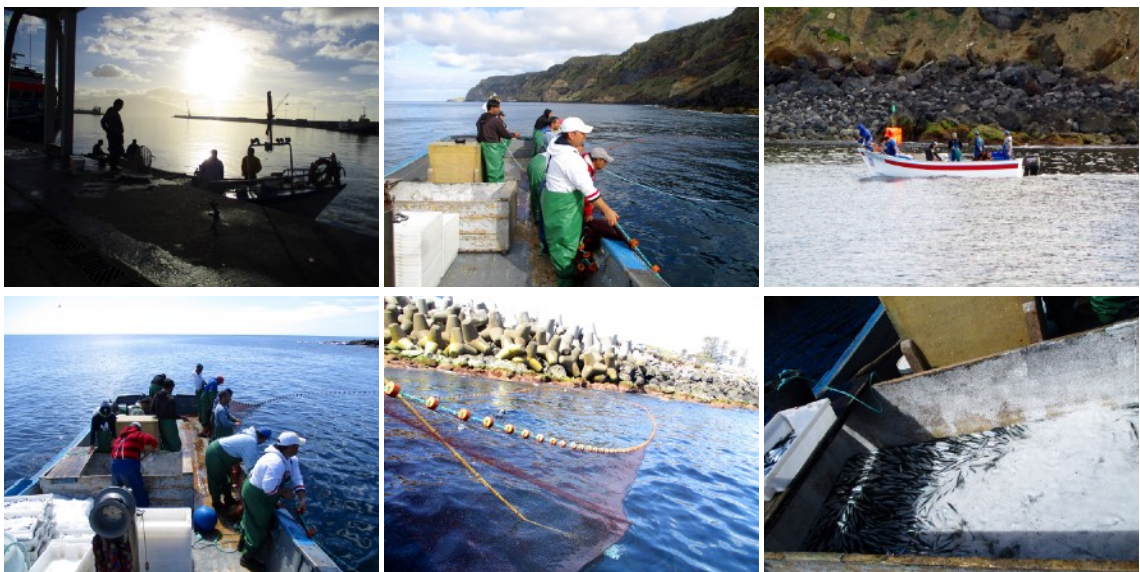


Fig. 5.08 to 5.13 - the fish hunt

I have retained though a deep feeling of how the experience changed my whole way of understanding the human relationship with the sea and its ecosystem. I felt that the movement and balance of the boat over the sea waves immediately liberated my senses, as some sort of sensorial reset. And this was a new soundscape and acoustic reality that I had never listened to before: the fishermen's strong powerful voices, echoing as the sea waves against the cliffs, the changing hunting movements of the fishing net, at the quick rhythm of the schools of sardines, with a constant background drone of the motor, with modulating frequencies changing with the speed of the boat. And still we could also clearly hear sounds from the shores coming once in a while with the wind blows, such as church bells, cars, motorcycles, airplanes, waves crashing against the volcanic stones. For me, this was a whole new relation to the territory and to myself. I felt part of the team, in the same dynamic. Somehow I felt this close relationship between the Azorean human being and the ocean being, as one. I was experiencing this ecosystem reality through the fishermen's oral culture, as native sea hunters, micro-macrocosmos everyday practitioners. The familiarity with the ocean environment and the instinctive knowledge of the habits of his prey provides the hunter with "an expanded set of senses, an awareness of events happening beyond his field of vision" (Abram 2015). It has been argued that this sort of interplay between sense perceptions creates a dynamic process, as "being, alive - the ritual drama - particularly in primitive societies where the association of elements in such patterns is especially strong" (Carpenter and McLuhan 1953, 70). As seen, this senses synergy engages a peripheral or atmospheric perception, and is a valuable way of experiencing the environment, of sensing a place (Pallasmaa 1996; Leitner 1998; Thibaud 2011). I understand this state as a mode of attunement, which has been described on p. 126 as an act of tuning-in relationship which relates to the lived experience of the flow of "inner-time" and its duration (Schütz 1951). In this sense, fishermen engaged a tuning-in relationship with the fish school and the sea being, through their sharp senses and their artisanal instruments. It

looked incredibly hard to fish the way they do, it is a real hunt. At the same time, it feels like they naturally know the sea forces and how to anticipate their prey's movements. As their ancestors, they surround manually, patiently and precisely the exact species of fish they are hunting for. A very important point is that this is a sustainable and ecological way of fishing. They are not just throwing the net and grabbing whatever comes in, as most of the industrial fishing companies do with trawl nets. Therefore I realised that one of the most valuable things we can learn from oral communities and Azorean native hunters is ecological intimacy, for its symbiotic way of experiencing place, of being in tune with their environment, and in this case, an embodied knowledge of the ocean's language. This way of attunement has always been there: an ecological intimacy (Morton 2014, online reference), between humans, fish and the ocean. Therefore this is the collective memory and sense of place that I wanted to share through my work. After this amazing experience in which I learnt much, I felt an even greater respect for these people.

Oral culture

If we listen, first, to the sounds of an oral language - to the rhythms, tones, and inflections that play through the speech of an oral culture - we will likely find that these elements are attuned, in multiple and subtle ways, to the contour and scale of the local landscape, to the depth of its valleys or the open stretch of its distances, to the visual rhythms of the local topography. But the human speaking is necessarily tuned, as well, to the various non-human calls and soundings that animate the local terrain. Such attunement is simply imperative for any culture still dependent upon foraging for its subsistence. Minute alterations in the weather, changes in the migratory patterns of prey animals, a subtle shift in the focus of a predator—sensitivity to such subtleties is inevitably

reflected not just in the content but in the very shapes and patterns of human discourse.⁵²

While in the boat, I also interviewed fishermen, to provide a contextual testimony of their current situation. I have composed a selection of testimonies into a soundtrack. It was presented as a separated piece to complement the soundscape composition, which the audience could listen to attentively with headphones (audio file 5.41).

1.2.2 Field recording: shores sources

Back to the ground, it was time for a sound-mapping, soundwalking and field recording with students. I could have selected the sources myself, but it seemed to me important to engage participation of the inhabitants in spotting out their island's ecological diversity. This was a way to raise awareness and concern on the acoustic environment. Therefore I enquired the architecture students I was going to work with and different locals I met around. My question was what sounds and places with particular acoustics near the shores they liked. Many people told me about quiet, restful places in the interior of the island. They turned their back to the sea because they found it aggressive, associated with struggle, disgrace and death. But there were some that mentioned the ocean with passion as an amazing living being, and its shores as strong, powerful places that made them feel alive. I realised the ocean is a love-hate relationship for São Miguel's people, as it tends to happen in most of the islands. Some commentaries significantly outline this relationship:

I don't particularly like the sea, but I miss it when I'm elsewhere.

I love the ocean, it's such a huge, enormous, living being.

⁵² Abram 1996, in <https://www.acousticecology.org/writings/animaltongues.html> accessed May 14 2017

The sea rules it all, you have no idea how it is like to live on a island.

Much respect.

In this place I feel myself, I feel alive.

I cannot live elsewhere. I wanted and tried, but I could not.

(C. Martinho, *Shores* survey, March 21-31 , 2017)

This enquiry confirmed my feeling that the ocean is a major element that determinates São Miguel's sense of place and its people identity. Its shores are very rich ecosystems, with amazing acoustics due to its shorelines' topography and surrounding landscape. Many people mentioned the same places, therefore I started to draw a sound map with a few spots to experience.



Fig. 5.14 - Map with sources location

Emergent concept: conscious listening

Conscious listening and conscious awareness of our role as soundmakers is an inseparable part of acoustic ecology, as it deepens our understanding of relationships between living beings and the soundscape. (Westerkamp 2002, online reference)

Conscious listening is important both to composer and listeners as a way to make sense of the sound environment. A practice of continuous attention to the sounds of daily life deepens soundscape composers' relationship to the acoustic environment. Westerkamp calls attention to the fact that this also

deepens an ability to communicate through soundscape composition as an acoustic ecologist. Katherine Norman describes the same idea:

Listening is as much a 'material' for the composer as the sounds themselves. (Norman 1996, 2)

Barry Truax proposes an understanding of listening within a system of information exchange that he called 'acoustic community' where sound mediates the relation of the listener to the environment (Truax 1984). To emphasise this idea, Truax mentions how Westerkamp has characterised the relationship as a balance between input and output, impression and expression, listening and soundmaking (Westerkamp 1988; Truax 1996). Truax draws attention to how the act of recording changes the way we listen, as it changes our mode of selective hearing to a broader all surrounding perspective. When we record environmental sound attentively, "listening becomes active, unlike the conventional approach of 'getting it on tape' where the recordist is merely the conduit' for transferring the signal to a storage medium" (Truax 1996, 61). Therefore the use of a microphone may intensify the recordist's listening process and bring alerted awareness to the soundscape. I have tried to explore these ideas in a workshop of soundwalking and field recording, as will be seen next.

1.2.3. Workshop and soundwalk: listening as a conscious practice

In *Shores*, I proposed a workshop as an educational approach to develop conscious listening and acoustic sensibilisation (see p.16). It was engaged as a way to generate a sonic connection with the surroundings, and as an incentive to care and explore further the acoustic environment.

In this sense, the goal of was to share experiences of environmental listening, favouring cross-generation relations, acoustic memory and the promotion of an aural culture identity. Also, I was interested in recording places with particular

natural acoustics (specially through binaural recordings), as a symbiotic process of integration between place and self.

The idea for the workshop was to soundwalk, background-atmospheric listening, and recording coastal places with particular natural acoustics. To captivate students, I did a presentation at the local architecture school. Students got all very excited with the topic of architectural acoustics, they all wanted to know more. But as typical as it is in architecture schools, they were contained in a theoretical way, extremely busy with tight schedules.

Therefore I only managed to get a couple of them to come along for a journey in Maia. We basically explored different modes of listening with the ear and with binaural microphones. “The ear and the microphone are the starting points for the soundscape composer. They are two quite different tools with which we gather our sound materials and our listening experiences”, as it transmits different information about the soundscape and often changes recording/listening practice (Westerkamp 2002).

In this place, besides fishing, there were people crab hunting, and scuba-diving. In ancient times, women used to wash their clothes in a beautiful volcanic stone construction of water tanks and small cascades, through which a river flows down to the sea. Curiously it also created some sort of amphitheatre where the sea waves resonated with great force, playing with the water falls’ sounds (fig. 5.19, 5.21, 5.22).

We found very distinct patterns and rhythms in relation to the activities of the people we met, and to the coast line topography. I also felt that our senses were clearly washed up with this experience. The students seemed satisfied and wanted to join me in the soundscape installation process as well.

After the workshop, I continued fieldwork on my own, and went on recording other places: Rabo de Peixe, Lagoa, Ponta da Ferraria, Nordeste, Ponta do Arnel, Ponta da Madrugada, Ponta Delgada.



Fig. 5.15 to 5.26 - Places recorded

1.3. Sensory variation: a soundscape on a boat

In this context, my question was how the soundscape installation could create attunement between audience and composition. My idea was to convert an old boat into an acoustic shell to transmit a sonic memory of the fishing community and ecosystems of São Miguel's shores. This boat would act as a sonic intervention in an urban public space of the main city of Ponta Delgada, in order to reach a bigger audience.

1.3.1. Sensory phenomena

I was offered an old boat that had been abandoned in Ponta Delgada's harbour for several years. I decided to leave the old boat to recycle there in the harbour, instead of moving it to a central place in the city. It seemed to me relevant to attract people to the harbour, to get to know the reality of this part of the city, its ambiance, and its powerful sensory phenomena. In this way, the urban intervention would act as an extension of the forces at work already there. This means that it would extend the acoustic ecology of that place, in a relation of continuity to its context. Therefore the acoustic ambiance of the harbour would enhance the whole soundscape experience. While the usual everyday activities of the harbour continued, an old abandoned boat was appropriated to become a listening place. A small variation in the position of the boat was enough to transform the whole ambiance. With this sensory variation on a place where fishermen just passed by, here they would eventually stop to listen.

1.3.2. Aural elements

In each of the places that I have recorded, I have found several aural elements. There were a few that come out of the soundscape composition more significantly:

- fundamental tones: the sound of sea, background drone of the motor of the boat, waves' crashing, water falls.
- key notes or soundmarks: fishermen voices, church bells, harbour sirens, endemic birds (*cagarros* and *prioulos*), seagulls, captured sardines, motorcycles, airplanes, volcanic stones being thrown on the crab hunting.
- specificity of acoustic spaces: up the cliffs, down the cliffs by the sea, harbours' round bays, volcanic stones topography, wind, fog, low clouds, underwater sounds.

1.3.3. Ambiance dynamic

The idea was to incline the old boat and convert it into an acoustic shell. The boat shape as an acoustic shell would generate an intimate aural space but would still remain visually open to the surrounding environment. Therefore when seated, the whole body would be immersed in the soundscape, facing the water, receiving a fresh sea breeze with a smell of fish. People would be in tune with the surrounding environment, but at the same time would be transported to the middle of the sea. The intervention would amplify the space's practical possibilities. I find that Jean-Paul Thibaud's description of tuned and modulated ambiances fits well my intervention. For him, a tuned ambiance emerges as the place is brought into tune with the conduct it supports and therefore engages "an ecology of the lived world" (Thibaud 2011, 45). And a modulated ambiance involves slight variations of the sensory context of the place. Therefore what is left fluctuates over time and varies in line with activities. It engages "an ecology of situated perception" (*ibid*). In this sense, by tuning and modulating the harbour place's ambiance, I experimented with a form of receptiveness that linked up with specific corporeal states to bring the senses into synergy, and involved the emotional aspect of the situation (*ibid*).

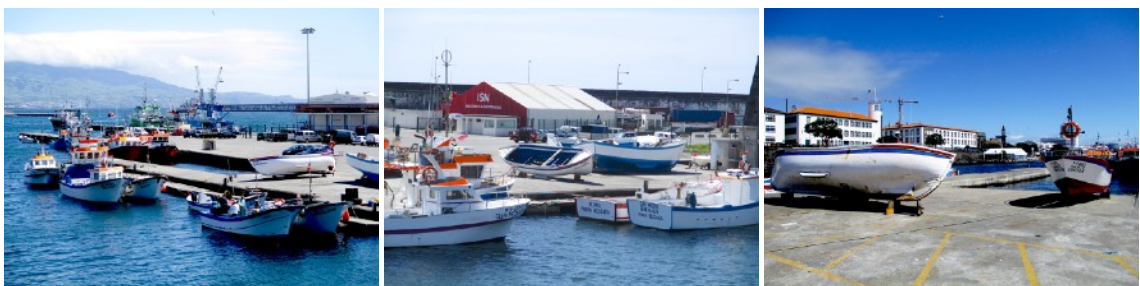


Fig. 5.27, 5.28, 5.29 - The harbour ambiance

2. Aural architecture design

The urban intervention would act as an extension. The soundscape installation would extend the acoustic ecology of that place, in a relation of continuity to its context, as it will be described next.

2.1. Soundscape for attunement

The soundscape design was based in the idea of attunement to environmental sound which is related to the working concept of environmental sound awareness (as described on p. 132).

2.1.1. Composition with field recordings

The emergence of a piece is not unlike getting to know a soundscape itself, its rhythms and shapes, its atmosphere.

(Westerkamp 2002, online reference)

After two weeks of fieldwork, soundwalking and recording, my ears started to adapt to the harsh climate changes and strong winds. I finally got the feeling that I embodied the island and the island embraced me. Still my overall feeling was that this place raised a sense of how small and vulnerable we are. A deep listening experience arose from a powerful soundscape of ocean waves, human voices attuned to their territory, peculiar chanting of native bird species (such as *cagarros* and *prioulos*), extremely loud airplanes, church bells, cow bells, noisy motorcycles and milking motors; resounding through the wind, fog, low clouds, rain and the reverberating acoustics of volcanic stones, volcanoes' craters, cliffs and harbours. I have explored São Miguel's soundscapes in two ways. On the one hand, I have enquired how sonic landmarks and dominant frequencies created a sense of orientation and place. On the other hand, as an extension, I have explored how certain spaces were dominated by specific sonic effects, generated by particular acoustic qualities of certain places (LaBelle 2010;

Auinger and Offenhuber 2013). As seen before, I have resumed these aural elements on page 150.

The recordist/composer's knowledge of a place extends beyond the recorded soundscape to the smells, the air, the temperature, the time of day, the atmosphere, the feel of a place, the season, the social situation and significantly, the changes that occur when a microphone enters a space. This extended knowledge is bound to influence the piece in some way, as well as intensify the relationship between composer and place, between composer and composition.

(Westerkamp 2002, online reference)

In a similar way as in *Vibrational Fields*, I have engaged in a process of field recording and soundscape composition as a method to extend knowledge of place. What was intuitively engaged in *Vibrational Fields*, here in *Shores* it has become a clear intention. The experience of recording contributed to a deeper understanding of the surrounding environment. My approach lied in accentuating site-specific differences and multiple relationships. Therefore my approach to *Shores*' soundscape composition was to illuminate the environmental context, to enhance the auditory experience, to highlight the world around us and our relationship to it, and to create unusual encounters and connections between human beings, non-humans and things. My intention was also to create a place of balance between inner and outer worlds (Westerkamp 1999, online reference). I was inspired to explore the idea of a soundscape narrative or document, created with unprocessed sounds. The sounds were recorded, edited and mixed with that same approach.

A fundamental truth about soundscape compositions is that they emerge, they can only be pre-planned to a limited extent.

(Westerkamp 2002, online reference)

The emergence process is an important aspect in my approach to the soundscape for attunement's composition methodology. In *Shores*, the materials spoke with their own language and the soundscape essence and its deeper meanings emerged. Westerkamp refers to materials not only as recorded sounds, but also to the composer's musical training, listening experience, along with her or his cultural, social, political and spiritual perspective. She explains that the essence of soundscape composition is located precisely in the meeting of these "materials" that the composer brings into the compositional process (Westerkamp 2002, online reference). In other words, she describes the soundscape essence as the artistic, sonic transmission of meanings about place, time, environment and listening perception. My soundscape composition emerged as alive matter and dynamic sonic beings. The aesthetics of the raw field recordings was already very intense that I decided to only subtly highlight the essence of this place's life with its own energy and forces at work. To enhance its essence, I have selected recordings that have captured natural acoustic effects, due to topography or architectural qualities. I approached the soundscape as a narrative or document, created with the unprocessed sounds. The sounds fade one into another, according to similar rhythms. Rhythms, tension, relaxation, climax or time-scale are given by the recorded places topography. There is a clear relation between the sounds characteristics and acoustic space. There are moments of relaxation with the sounds of water flowing and chanting; then moments of tension with waves crashing against the cliffs. A climax is attained when finally after a long wait the sardines are captured. The sounds of captured sardines moving around was a totally new sound to my hears.

2.1.2. Tuning with resonance frequencies

Then, I composed the field recordings with layers of specific frequencies, to reach acoustic and psychoacoustic effects in its spatialisation; fading one into another, with no digital effects processing.

2.1.3. Layers

The soundscape composition had a total duration of 27 minutes and seven distinct layers:

- layer 1 - field recordings of Rabo de Peixe ambiance
- layer 2 - field recordings of fishermen, surrounding and capturing sardines
- layer 3 - field recordings underwater at Ponta Delgada harbour
- layer 4 - field recordings of boat arriving to Lagoa harbour
- layer 5 - field recordings at Praia da Maia
- layer 6 - field recordings at Nordeste forest shores, native bird specie *prioulos*
- layer 7 - field recordings at Ponta da Ferrara cliff, native bird specie *cagarros*

These layers were edited and mixed using Audacity and Logic Pro.

To hear the soundscape composition open the audio file 5.40. Please see first the note on the audio documentation on p. 225.

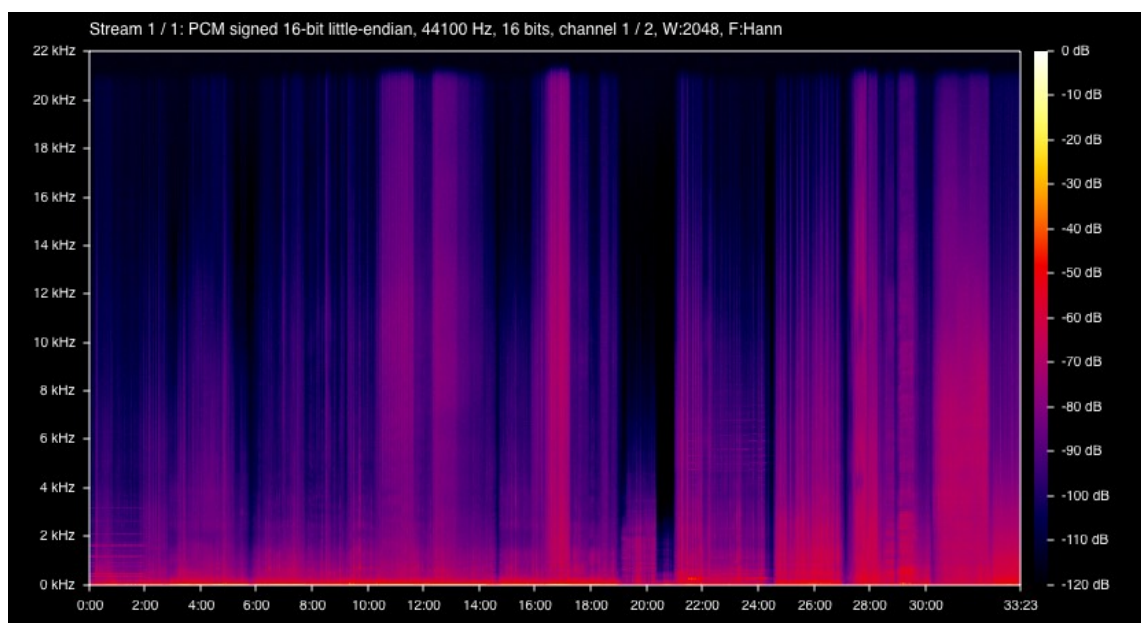


Fig. 5.30 - spectrogram of the soundscape composition using software *Spek*

Emergent concept: listening-in-readiness and balancing

I call this situation 'listening-in-readiness' because it involves both background and foreground listening strategies. It requires a favourable acoustic environment for information to be available (a good signal-to-noise ratio in technical terms), and an active cognitive processing of patterns and their comparison to known ones. (Truax 1996, 59)

Barry Truax claims that different levels of listening involve analytical attention being paid to short-term details in the foreground case, and holistic or gestalt pattern recognition in the background case. The interesting fact is that these two complementary strategies are often described as the left and right hemispheres of the brain (Truax 1996, 59). Generally, music is known to involve either or both such strategies depending on the listening context and the listener's training or competence (Bever & Chiarello 1974; Wagner & Hannon 1981; Truax 1996, 59). Therefore, I became interested to explore in *Shores*, how a soundscape composition and its presentation as an aural architecture could create a situation that involves listening-in-readiness and therefore contribute to a process of balancing hemispheres. The experience of listening to the soundscape composition as an extension of the site's ambiance would produce different kinds of auditory awareness, switching from foreground to background listening strategies. In this sense it probably might have contributed for the hemispheres balance. This result was reported in the audience feedback.

3. Acoustic spatialisation

3.1. Installation: the boat conversion

I cleaned the old boat full of holes that was left abandoned and filled with trash. It was brought to life. Recycling an old boat was also a way to valorise

traditional wooden boats' heritage, which is disappearing. Even fishermen that passed by it, ignoring it everyday since four years, started to look at it, stepping inside of it and talking about possible uses to recover "such an old and rare beautiful boat"; "perhaps we could put a sail in and take tourists for a sailing tour", they commented. I was glad already that my intervention was generating discussion among fishermen. For the purpose of my intervention, the shape of the boat wood structure was perfect to generate a resonant aural architecture, with no need for modification.

3.2. Spatialisation: the boat inclination

The boat was intentionally inclined with the help of fishermen, so that by stepping in, the audience would feel slightly unstable, and would have to reach for a different state of equilibrium, in a similar way as when we get on a boat floating above water. I remembered that I experienced this when I got in the fishermen's boat. It was this search for balance that produced a strong change. I felt that it somehow switched my senses interplay and produced some sort of sensorial reset. The sense of balance or equilibrioception results of several sensory systems working together. The vestibular system (ears) work with the visual system (eyes) and the skeletal system to maintain a sense of balance and orientation. The vestibular apparatus is the region of the inner ear where three semicircular canals converge; with the cochlea, it forms the labyrinth, which is a membranous region with vestibular fluids (endolymph). The sense of balance is determined by the level of the vestibular fluids. Therefore, my soundscape installation produced a sensorial variation, not only through hearing, but also with a change in the audience's body's balance. I believe that by stepping inside an inclined boat, and seating in an unstable balance position while hearing strong background and foregrounds sounds, the audience's vestibular liquid levels might have changed. And so did the whole sense of balance. This change was reported in the audience's feedback (p. 159).

3.3. Spatialisation: amplification

The soundscape amplification was quite simple. We built in two speakers inside the boat, in opposite sides. A sub-woofer was placed outside, behind the boat, to transmit vibration into the wood material and set the boat in resonance. Here it came out very clear that wood is a material with a strong 'live' quality (Leitner 1998, 299). It responded and resonated. The wood boat became an acoustic shell and turned into a communication channel. Therefore this aural architecture's vibrational materiality effectively acted as a translator. The sound transmission was felt through the whole body senses. Space's resonance magnified environmental sound and entered into sympathetic vibration with the audience's body and mind. The soundscape resonated with the boat's physical structure and the audience, into an aural travel experience, as in the middle of the sea - surrounded by sounds.



Fig. 5.31 to 5.39 - Installation and public presentation

4. Audience's experience and feedback

In this experiment, I also left a notebook to report on the public's feedback, as in *Vibrational Fields*. But given the specialised audience present at the *Invisible Places* symposium, I also conducted a few interviews, as this would provide valuable input for my research. These are presented transcribed below and as audio recordings. Here follows some significant comments transcribed.

I loved the feeling of the mixture of the outside sounds with the soundscape composition. There were resonance frequencies happening. I felt quite immersive, a physical experience of sound.

– Jen Reimer, artist in residency at *Invisible Places* symposium
(See digital artworks documentation - audio file 5.43)

I'm feeling slightly dizzy from this experience. I wonder if it was because of the angle of the boat and the vibrations... When I got back to the ground, I actually felt like I have been at sea.

I also felt I was part of a working energy, constantly surrounded by this motor sound, which was interesting, because I think we often forget about that presence. I wonder if the fishermen and the people would also forget about that sound. It is a barrier between us and the water experience. It comes out really clearly here.

I'm still feeling emotional. I wasn't when I was on the boat, but I'm feeling it now.

– Hildegard Westerkamp, composer and sound ecologist
(See digital artworks documentation - audio file 5.42)

I liked how the work is done with the fishermen, you can feel there is a respect for their work, for what they do. Not like someone that comes from outside, takes things, uses them and goes away. On the opposite, it feels like you were working together and doing something with the community. It seems you tried to learn from them, and for a continuity with it.

The choice of the boat made all the sense, not just an obvious thing, but for the place where it was placed, the angle, the relation with the water, how it resonated, how you could go on the back and hear how wood resonates sound. I liked the particularity how the boat wood structure resonated the sound of the sea so well, this took me on a travel.

– Sam Auinger, sound artist and sonic thinker

I listened by getting in the boat and outside the boat by putting my ear to the wood. Quite different experiences of course. It's really nice to hear the water bubbling through the wood. a close idea of what it would be like, to be at sea.

– Peter Cusack, field recordist and musician

(See digital artworks documentation - 5.44)

I felt a bit sick, you feel movement, as if the other boats around are moving.

It was like being on a real boat over water, some sounds are really taking you inside the water space.

I liked the angle of the boat, it turned into a big sound system. And I liked the interaction with other people.

You're just there with the fishermen, in the sea.

I felt I was living your experience at sea. I was inside the vibration, it feels like it is really happening for real.

Peaceful, then violently sick, then peaceful again.

I liked the boat angle, I laid down looking at the sky and felt like I was sailing.

We need to have this kind of experiences permanent in public space, its really important to share this longer, to be part of everyday life.

(C. Martinho, *Shores* survey, April 9, 2017)

Attunement

According to the testimonies transcribed, it seemed that this aural architecture resulted as an experience of immersion, balance, deep listening, resonance and attunement. The set up opened up different degrees of affect and a diverse range of experiences of attunement: with them selves, with others, the fishermen, vibration, the boat, the sea, the harbour's place or the island. My goal was also the re-integration of the listener with the environment in a re-balanced ecological relationship. Therefore I have composed with environmental sound to explore the potential of its corporeality and physicality to amplify the world of living experience. My intervention addressed the potential of site-specific vibrational forces, enhanced by spatial acoustics, to accentuate differences and to open up experience and communication channels towards more ecological relationships between human and non-human beings. The acoustic boat connected unusual or imperceptible relationships between the elements of the shores (human and non-human), to accentuate differences and produce a *differential space* (Lefebvre 1991), with multiple identities and meanings, all interconnected in a vibrational spacetime continuum, in some sort of symbiotic real. This acoustic boat shell aimed to generate a tangible experience of some kind of unified field, through a subtle amplification of material vibration with resonance frequencies. As seen, resonance triggers the emergence of attunement, or the feeling of being vibration, as a living dynamic

relation with another being, through a participative process (Stern 2004; Massumi 2008; Morton 2014). Therefore I created an experience of attunement as a channel of communication or method for translation (p. 43). In this soundscape for attunement, the ocean being took over the affective, and took the audience in its waves. It engaged the audience into an active listening and in an immersive experience. And it was reported as overwhelming by its vibrational forces, as entering a gaping moment of spacetime suspension and re-balance. This was the kind of result that this case study aimed at.

Continuity

After this experience, my feeling is that it would have been interesting to instal the acoustic boat in an everyday public space, to invite people into an unexpected soundscape travel. This would allow to reach an ecological soundscape awareness into a wider and less specialised audience. The initial idea was that the installation could be appropriated by the community, and even installed in different places. Unfortunately this was not possible for budget reasons. But Liberato Fernandes (from fishing cooperative Porto de Abrigo) showed interest to give continuity to this project. Therefore I hope I can go back to São Miguel, to do a workshop with Rabo de Peixe's community. Resulting from this collaboration, I would like to co-create a permanent acoustic boat soundscape installation with a local traditional boat constructor, for Rabo de Peixe public space, and for its community's appropriation with their own cultural and artistic activities.

Acknowledgments

The fishing community of Rabo de Peixe, master Paulo Sousa and his companion of the boat Lisboa, shipowner of the boat Sónia Cristina, Liberato Fernandes and the Cooperative Porto de Abrigo, Lotaçor SA, Portos dos Açores SA, students from the department of Architecture of Azores University, and the Municipality of Ponta Delgada.

Chapter 6

Working concept	• Ecology of vibrational affects
Enquiry	• The language of vibration • Synergetics (or energetic geometry)
Practical case study	• <i>Passage</i>
Design methods	• Resonant soundscape • Space as resonator • Space as relation • Soundscape for attunement
Affective experience	• Modes of ecological re-wiring of the senses through the inciting of affective responses • Diversification of affects
Emergent concepts	• The affective experience of environmental sound • The inner and outer dynamic of the auditory experience towards meditative states

In Chapter 5, I have extended the working concept of space as a field of attunement, and in my practical work *Shores* I have explored the design of a soundscape for attunement. Here, in Chapter 6, I will explore the working concept of an ecology of vibrational affects. I conducted an enquiry on the language of vibration and synergetics (or energetic geometry). These ideas were experimented in the practical case study *Passage* (2017), a soundscape installation in resonance with the acoustic space of a tunnel and the creation of an aural architecture based in a zome geometry. This case study converged the four aural architecture design methods produced by the previous case studies, into one single experiment, as a microcosmos with multiple experiences, an ecology of affects. *Passage* experimented further articulations of modes of ecological re-wiring of the senses through the inciting of affective responses, and the diversification of affect. Concepts have emerged from within this practice experiment such as: the affective experience of environmental sound, and the inner and outer dynamic of the auditory experience towards meditative states.

Working concept:

Ecology of Vibrational Affects

As seen in my thesis' introduction (p. 22), my practice has sought to contribute to an ecology of affect, by creating an experience of aural architecture that produces a diversification of affect, as ontologically one, formally diverse. This approach means that from the physical experience of space as a vibrational force, multiple modes of attunement have emerged. This has also been described earlier on page 25 as a site-orientated intervention that accentuates differences and creates a diversification of space, for the production of new or "differential space" (Lefebvre 1991, 52) and "the restoration of the sensory-sensual" (Lefebvre 1991, 363). In practical terms, it regarded the creation of an experience of spacetime as a gap opening - a gaping moment into which and from which affect arises (Angerer 2017, 11). This became my main intention for my thesis' final practical case study, *Passage*.

As seen on p. 38, I have defined three operations of the affective, as follows:

- transformation
- translation
- attunement.

The operation of transformation was engaged in each of my previous practical case studies as the aural modulation of a situation in a way that amplifies a previous unfelt potential as affect. I have understood the result of such experiences of aural architecture as attunement, in which body and mind are triggered in a pre-conscious level to get attuned into being, to the here and now, to imperceptible forces at work in a site. The operation of translation has emerged in the previous practical case study, *Shores*. Therefore in this next practical case study, *Passage*, I wanted to focus on the operation of translation, by extending the exploration of the language of vibration. As seen before (p. 33-35), Jane Bennett claimed that "vitality is shared by all things" and that we are in need to develop communication and translation tools of this vibrant

reality, between humans, non humans and things (Bennett 2010, 89). In this sense, the practical case study *Passage* engaged the creation of an aural architecture as a medium of acoustic communication and translation (or transduction) of vibrant matter. In this sense, the practical case study *Passage* explored further an amplified or enhanced experience of vibrant matter to engage the audience in an physical affective experience of it, as a channel of communication with this reality. Through this operation of translation, I aimed for an aural architecture experience to open acoustic communication with the surroundings in a symbiotic way, as part of the same micro-macro-ecosystem. I would eventually allow further explorations of a symbiotic real (Morton 2006), and the potential dynamic relationships between human and non-human beings and their interconnection in space.

To sum up, as it will be now seen, the practical case study *Passage* converged the four aural architecture design methods produced by the previous practical case studies, into one single experiment, as a microcosmos with multiple experiences, and multidimensional modes of sensing material vitality. It explore how can aural architecture design engage an ecology of affect, as a communication channel and medium of translation.

The language of vibration

Wherever we look in nature, animate or inanimate, we see widespread evidence of periodic systems. These systems show a continuously repeated change from one set of conditions to another, opposite set. This repetition of polar phases occurs alike in systematised and patterned elements and in processes and series of events. (Jenny 2001, 17)

Vibration creates form (geometry, material density, spatial volume). The nature of forms as vibrating structures or periodic systems was vastly investigated in

meticulous experiments carried by physician and natural scientist Hans Jenny, to which he called Cymatics⁵³, a study of wave phenomena to visualise examples of patterns' formations. He studied how vibrations generate and influence patterns, shapes and moving processes. This work, along with other earlier experiments, such as the Chladni figures, the Lissajous figures or harmonograph studies, allowed the visualisation of vibration and frequency patterns, clearly revealing visually that form is a vibrating structure. These patterns "are the expression of a 'dialogue', a dialogue between the vibration of the tone and the 'answering' matter, between the motion energy contained in the vibration, and the matter which is either resonating in co-movement or paused inertia, 'unwilling' to participate" (Lauterwasser 2006, 42-46).

What insights into vibration and periodicity have been gain in the vast range extending from the cosmic system (rotations, pulsations, turbulences, circulations, plasma oscillation, periodicity of many kind in both constituent elements and the whole) down to the world of atomic or even nuclear physics (shell model of nucleus; nucleon structure; organisation of meson clouds). The idea of periodicity is all embracing. (Jenny 2001, 18)

According to Jenny, the idea of periodicity of vibration is all embracing, and the same periodic principle underlies in the macrocosmic and microcosmic scale⁵⁴. Jenny also claimed that one needs "to learn to 'hear' the *process* that blossoms in flowers, to 'hear' embryology in its manifestations and to apprehend the inwardness of the process" (Jenny 2001, 276). This is what I have sought to experiment in this final practical case study: to apprehend, translate and communicate the inwardness of the vibrational process, through the experience of environmental sound, enhanced by acoustics.

⁵³ Cymatics is a term originated from the Greek "*to kyma*, the wave; *ta kymatika*, matters pertaining to waves, wave matters" (Jenny 2001, 20).

⁵⁴ See appendix 5 for further details on vibrating systems.

My intention for the next experiment of this thesis, *Passage*, was to extend further research on the language of vibration and translate its understanding into aural architecture design modes. In the works *Polytopes* of Iannis Xenakis and *Synergetics* by Buckminster Fuller I have found a similar intention (with distinct formalisations), as it will be explored next.

Polytopes

As seen on p. 64, architect, musician and engineer Iannis Xenakis also approached the integrative behaviour of systems based in forces, frequencies and geometry, applying his architectural thinking into his musical compositions. Some of his work was created based in a hyperbolic geometry which he translated in music compositions such as *Metastaseis* (1955), in architectural design such as the Philips Pavilion (1958), or in his multimedia performances such as *Les Polytopes* (in Montréal in 1967, in Cluny in 1972 and 1973) (Xenakis 1975, 11). In these works, there are evident similarities between the hyperbolic geometry and the musical glissandi scores (Xenakis 1975, 12). The *Polytopes* are works in space of an art of time (Xenakis 1975, 19). This geometric approach allowed him to create “actions of light and sound” (Xenakis 1975, 134), events in multiple spacetime, therefore the title *Polytopes*⁵⁵. In his sketches of the *Polytope de Montréal* we find notes of sound-space phenomena such as “tentacles, labyrinths, spiral movements, random steps, stochastic rivers, black holes formation, crystals projection, water falls, anemone” (Xenakis 1975, 19, 65-69). This dynamic geometry of phenomena was based in intervals: in a sonic variation in terms of amplitude, duration, intensity, tone, and in a spatial variation in terms of points, lines, curved surfaces, clouds (Xenakis 1975, 33). He paid major attention to the sensible, as the eye and the ear were his main tools to design these geometric relations, and to produce sensory variations (Xenakis 1975, 33). As seen before (p. 144), his geometric approach

⁵⁵ In Greek: *poly* - multiple, *topes* - place (Xenakis 1975, 10)

in architecture and music was stepped away from the conventional Euclidian geometry (which is a reduced system of metric measurement of a visible thing). Instead, Xenakis' geometry was topological, hyperbolic, and sensible. It was a generative, transformative and integrative process of spatial sound design and composition, based in forces, vectors, intervals and frequencies' patterns. A particular aspect that I share, regards his purpose in translating phenomena of patterns' formation from micro to macro scale, embodying its geometry in his musical and spatial architecture.

This operation of translation relates to Alfred North Whitehead's claims on vibrational patterns:

On the organic theory of nature there are two sorts of vibrations which radically differ from each other. There is vibratory locomotion, and there is vibratory organic deformation; and the conditions from the two types of changes are of a different character. In other words, there is vibratory locomotion of given pattern as a whole, and there is vibratory change of patterns. (Whitehead 1997, 131)

On my next practical case study, *Passage*, I have drawn from this approach on macro-micro scale design practice. This means that my purpose was also to design an aural architecture based in the dynamic geometry of vibratory phenomena, as a translation of micro events (environmental sounds) to a macro experience (dynamic sonic beings, spatial acoustic effects) through our whole body's senses. Although I must say that the aesthetic formalisation of my work is quite distinct from that of Xenakis.

Synergetics

In the knowledge of the comprehension of nature patterns and evolutive consciousness, one may find ways to build a sustainable life between beings and the environment... I am confident that humanity's survival depends on all of our willingness to comprehend feelingly the way nature works. (Fuller in Edmondson 1986, 5)

Visionary architect, engineer, geometrician Buckminster Fuller developed for more than five decades pioneering solutions in innovative design that did “more with less”, and was responsive to the way nature works (Fuller 2008, 7). In 1985 (after Fuller's death), a new carbon molecule (C₆₀) was discovered with a similar structure to that of a geodesic dome. It is a form of carbon with molecules of 60 atoms arranged in a polyhedron resembling a geodesic sphere. Therefore this molecule was named “buckminsterfullerene”, now commonly known in the scientific community as “buckyball”⁵⁶. This fact confirmed that Buckminster Fuller's geometric creations definitively comprehended nature patterns. With his two volumes of work entitled: “Synergetics: Explorations in the Geometry of Thinking” (1975), Fuller contributed with major advancements in the building of space based in energetic geometry and molecular structures. His research was based in powerful thought tools: topology, geodesics, synergetics and general systems theory (Fuller 2008, 83). For Fuller, the essential nature of matter-energy lied not in abstract form-making but in processes based in energetic geometry and in the characteristics of vibrating systems such as interconnection, relation, polarity and multidimensionality. He investigated the principle of vibration, observing nature's processes and forms. Buckminster Fuller uncovered frequencies and rhythmicity of structural motifs, and translated it into geometric patterns of formation, as architecture.

⁵⁶ In <http://www.chm.bris.ac.uk/motm/buckyball/c60a.htm> (accessed august 2017)

Since the physical Universe is entirely energetic, all dimension must be energetic. Synergetics is energetic geometry since it identifies energy with number ... Synergetics provides geometrical conceptuality in respect to energy quanta. In Synergetics, the energy as mass is constant, and nonlimit frequency is variable. (Fuller 1975, 22)

With his mathematical-geometric investigations and practical experimentations, he actively sustained his argument that “all dimension must be energetic” (Fuller 1975, 22). Fuller claimed for the concept of synergy as essential in architectural design and in our societies construction in general, for it explains the eternally regenerative integrity of the universe: the integrated behaviour of whole systems (unpredicted by the behaviour of their parts taken separately, which is the usual scientific perspective), which is fundamental for the understanding on the way nature works. This relates to what has been seen with Iannis Xenakis’ micro-macro scale practice (p.164). Moreover, it is fundamental to develop sustainable ways of living, based in energy efficient structures.

The fundamental hypothesis behind synergetics - and the work of many other pioneers exploring the science of form - is that nature's structuring occurs according to the requirements of minimum energy, itself a function of the inter-play between physical forces and spatial constraints. (Edmondson 1986, 9)

Synergetics principles are embodied in nature. Buckminster Fuller claimed that this system described the coordination of physical and metaphysical phenomena alike, both energy and thought ⁵⁷. Synergetics is a triangular and tetrahedral system ⁵⁸, using 60 degree coordination instead of 90 degree

⁵⁷ In <http://www.pauladaunt.com/books/afullerex%20Folder/60.htm> - accessed October 23, 2017

⁵⁸ In tetrahedral molecular geometry, a central atom is located at the centre with four substituents that are located at the corners of a tetrahedron.

coordination, which does not exist in nature, and is not energy efficient (Fuller 1975, 23). He introduced the tetrahedral model to substitute the cube, to simplify the understanding of the physical universe, and to open up innovative practical applications. Fuller has explained the importance of the role of physical forces (gravity, magnetism, electrical and chemical attractions), and how space was not empty. For Fuller, space has specific properties or constraints, it has underlying invisible forces and multidimensional fields and shapes. In his introduction to "Space Structures", scientist and crystallographer Arthur Lee Loeb explained that "space is not a passive vacuum, but has properties that impose powerful constraints on any structure that inhabits it. These constraints are independent of specific interactive forces, hence geometrical in nature" (Loeb 1976, xvii; in Edmondson 1986, 10). In this sense, Buckminster Fuller investigated thoroughly nature's coordinate system, to uncover the operative principles in the universe. However, his main purpose was to call our attention to an invisible design revolution taking place, and to inspire our active participation in guiding this progression in preferred ways (Edmondson 1986, 268). In this sense, I was inspired by Buckminster Fuller's thought and practice, to contribute to a translation of an invisible design based in synergetics, into affective experiences of environmental sound. In the next practical case study, *Passage*, I have explored synergetics, or energetic geometry, into the design and self-construction of a zome structure, with specific acoustic qualities (geometry, material's density and spatial volume). My aim was to integrate synergetics into the aural architecture design method of space as dynamic relation (experimented in the practical case study *Radio Sonores*). As it will be seen, I have engaged in a design of form based in nature's structural requirements of minimum energy, attentive to the interplay between site-specific physical forces and spatial constrains.

Practical case study:

Passage



Fig. 6.01 - *Passage* installation at *Estufa Fria*, Lisboa

In this final practice, my aim was to converge the aural architecture design methods produced by my previous practical case studies into one single experiment. I also wanted to extend further research on the operation of the affective as translation (p. 43). I had the opportunity to do so with the practical case study *Passage* (2017). This project was commissioned for the event *Lisboa Soa*, an annual event on sound art, urbanism and auditory culture in Lisbon, Portugal. This edition happened at *Estufa Fria*, a green house with hundreds of species of plants in the middle of the city of Lisbon.

1. Experience of site

1.1. Analysis of context

In a microcosm with hundreds of species of plants in the middle of a city, what do you listen to? This was my question when I got to *Estufa Fria*. The last time I have been there was 17 years ago. I soon realised that this was so for most of the visitors of the event *Lisboa Soa*. The aim of *Lisboa Soa* was precisely that: to take citizens on a sonic journey to re-discover their cities' green spaces, and value them. This was a particular green space. It was a human-made ecosystem of thousands of plants' species, running water, water falls, stones, steps, caves and tunnels. This artificial landscape seemed like an exotic romantic island. Simultaneously, sonic layers of urban drones and airplanes would mix with birds, insects, water running and the gardeners working. Some interesting acoustic effects happened there when walking around, as the place had several specific spatial features: several levels with different heights, some openings on the sides, stone covered walls and a permeable roof (fig. 6.03, 6.04). There were also some caves and tunnels which produced particular acoustic effects. I have chosen to intervene with a spatialisation of a passage way, a small tunnel (fig. 6.01), and to extend its experience with the construction of an aural architecture based in synergetic principles (p. 168-171).



Fig. 6.02, 6.03, 6.04 - *Estufa Fria*, Lisboa

1.2. Dynamic of experience: soundwalking and field recording

In my first visit, I practiced soundwalk around the place from morning until evening. I recorded some parts of the soundwalk and specific places. I identified the place for my aural architecture installation. I listened carefully to these recordings to get a closer idea of the material that I wanted to gather. I was looking for vibrant matter, as potential forces susceptible of producing overwhelming affective experiences. And this place was full of it.

Sources

On my second visit I identified the sources I wanted to record, and I spent one full day doing so. I have recorded ambient sounds at different times of the day. It changed drastically at specific times - in the morning, lunchtime and end of the afternoon - the rush hours. It became very noisy and saturated with sounds of cars and buses. Another strong sound was the constant passage of airplanes, every 5-10 minutes. In the intervals of these noisy events, drones of city sounds could be heard, such as the low frequencies of trains passing in the subway underneath. I used binaural microphones to record all the sounds. My purpose was to amplify what was there already, and that one could listen to if getting closer to some sources, or go inside particular acoustic spaces.



Fig. 6.05 to 6.10 - sources

1.3. Sensory variation

Here the sensory variation was engaged as a translation of languages, as a transduction into a hearable spectrum. My purpose for this sensory variation was to draw the public's attention to the forces at work in the greenhouse, usually unnoticed. My intention for the aural architecture installation was to explore ways to listen to this ecology through acoustic phenomena.

My initial idea was to create a walking path with two different interrelated experiences, and engage the public in two different kinds of sensory variation:

1- a soundscape to amplify the vibratory forces that propagated there, and modulate specific frequencies, in resonance with the space of the tunnel.

2 - a zome as a quiet moment for attunement. It would be built in a strategic place, where the path coming out of the tunnel divided in two paths. The zome would embrace the path coming out of the tunnel and transform it into another experience.

This sensory variation connects to the operation of transformation, as described on p. 42.

1.3.1. Sensory phenomena

I was attracted to how water was everywhere, early in the morning: water falls, water drops, water channels, chanting all over the place. The water presence was a powerful vibratory force that modulated the whole ambiance. But in the end of the morning, the water channels were closed, and its song would slowly fade away. Therefore I have chosen to enhance the water presence in the greenhouse, and amplify it in the acoustic space of the tunnel, which was a cold, dark, humid passage. The tunnel would turn into a water channel, a passageway between different time-spaces, a communication channel to the whole network of the thousands of species of plants living there. As an extension, the zome would offer a cosy, dry, warm shelter, to turn the experience to the interior of self.

Here I identified some sound marks, and specific sonic effects, as will be explored next.

1.3.2. Aural elements

I have gathered the following sound marks and key notes:

- water flowing, falling or dropping in different places;
- watering sprinklers, recorded early in the morning, before the doors opening;
- airplane heard inside of the tunnel;
- birds signals;
- human voices mixed with urban sounds;
- drones of insects (cicadas), recorded in a warm summer day.

Additionally I recorded the following acoustic effects:

- close up to water drops falling along the tunnel stone walls;
- close up to water running in the gravel ground of the tunnel;
- inside the tunnel, at different heights and positions in length, closer or farther from the wall;
- outside the tunnel, at the entrance;
- inside a smaller tunnel-canal of water;

I have chosen these sources (Fig. 6.05 - 6.10) for the affect they created on me, as I will explain next.

1.3.3. Ambiance dynamic

My aim was that the ambiance dynamic would engage an active and immersive listening, in a mode of attunement with our ourselves, the place and the surroundings. This experience mobilised Thibaud's three ambiance dynamics: tuned, modulated and framed ambiance. The tunnel passage would involve the audience in a modulated ambiance (as explained on p. 40). The audience would have their mind and body literary washed up and connected to the molecules of water. After the passage, the zome would involve the public in the experience of a relatively quiet space, turned into the inside. This would create

a framed ambiance dynamic (as explained on p. 40). Inspired by the surrounding geometry of plants, I explored the geometry of the flower of life (p. 189), into the construction of a zome⁵⁹. The zome geometry would resonate with the patterns of the plants. Therefore this would engage a tuned ambiance (as explained on p. 40). I will describe this in detail on p. 189.

Emergent concept: the language of water as vibration

I engaged with water as the main element for my intervention. The sounds of water sounded like talking to me. Listening to its different dynamics (falling, flowing, dropping), at the encounter of different materials, resonating in different acoustic spaces - I felt like I was tuning into the language of water. Through an amplified sonic experience of this vibrational materiality I embodied the feeling of being water.

About 70 percent of the human body is made up of water and, coincidentally, more than 70 percent of Earth is covered in water. Water creates an environment that sustains and nurtures plants, animals and humans.⁶⁰

The auditory experience of water was resonating deeply in me. I was experiencing what Thibaud has described as a form of receptiveness that linked up with specific corporeal states and brought the senses into synergy (Thibaud in LaBelle and Martinho 2011: 46). This was a kind of transformation that engaged an affective experience of vibration. I felt as I was entering into the molecular language of vibration. My purpose was that the enhancement of the experience of water, through a physical acoustic experience, would activate a vibrational materiality of water in the audience's bodies. Eventually this acoustic

⁵⁹ The term zome was coined in 1968 by thinker Nooruddeen Durkee, combining the words dome and zonohedron).

⁶⁰ In <https://www.nasa.gov/vision/earth/everydaylife/jamestown-water-fs.html> - accessed November 3 2017.

amplification of masses of sounds of water flowing would draw the audience into an immersive experience, as part of the greenhouse's plants ecosystem, in which water flows and infiltrates everything. My aim was that this experience could contribute to an embodied understanding of the environment as an unified field of relationships, all interconnected through vibration.

2. Aural architecture design

As I have mentioned already, I wanted to converge the four aural architecture design methods produced by the previous practical case studies, into one single experiment. And this single experiment of *Passage* turned into a microcosmos with multiple experiences, and multidimensional modes of sensing material vitality.

Operation of translation

Passage engaged the creation of an aural architecture as a medium of acoustic communication and translation (or transduction) of vibrant matter. Through this operation of translation, I aimed for an aural architecture experience to open up acoustic communication with the surroundings in a symbiotic way, as part of the same micro-macro-ecosystem. In this sense, *Passage* explored further an amplified or enhanced experience of vibrant matter to engage the audience in an physical affective experience of it, as a channel of communication with this reality. This intervention addressed the potential of site-specific vibrational forces, enhanced by spatial acoustics, to accentuate differences and to open up communication channels towards more ecological relationships between human and non-human beings. With this operation of translation I have also sought to apprehend the inwardness of the process of formation of vibrational materiality (Jenny 2001, 276). This has been explained as the translation of phenomena of patterns' formation from micro to macro scale into geometry, musical and spatial architecture (Xenakis, p. 167). This has also been described by energetic geometry, or synergetics and translated into architecture (Buckminster Fuller, p. 168). My aim was to engage in a process of translation of phenomena into

geometry, and embody this geometry in aural architecture design. As will be now seen, this aural architecture design was based in the dynamic geometry of vibratory phenomena, as a translation of micro events to a macro experience through our our body's senses. Sound became a channel to communicate with the non-human forces of that site. With this operation of translation, my aim was to enable an experience of attunement to invisible forces, towards an acoustic communication between humans, non-humans and things. In this sense, I have explored different modes of ecological re-wiring of the senses through the inciting of affective responses, and to contribute to a diversification of affect, as will be presented next.

As I have described, the installation *Passage* created a walking path with two different but interrelated experiences (fig. 6.11 and 6.12). Therefore, in the aural architecture design of *Passage*, two different actions took place:

- 2.1. The tunnel - an intervention in an existing architectural space
- 2.2. The zome - the creation of a new architectural space

Both designs were based in acoustics, dynamic relation and geometry. Instead of repeating the same design methods as before, my aim was to extend and integrate simplified principles of energetic geometry into the design methods.

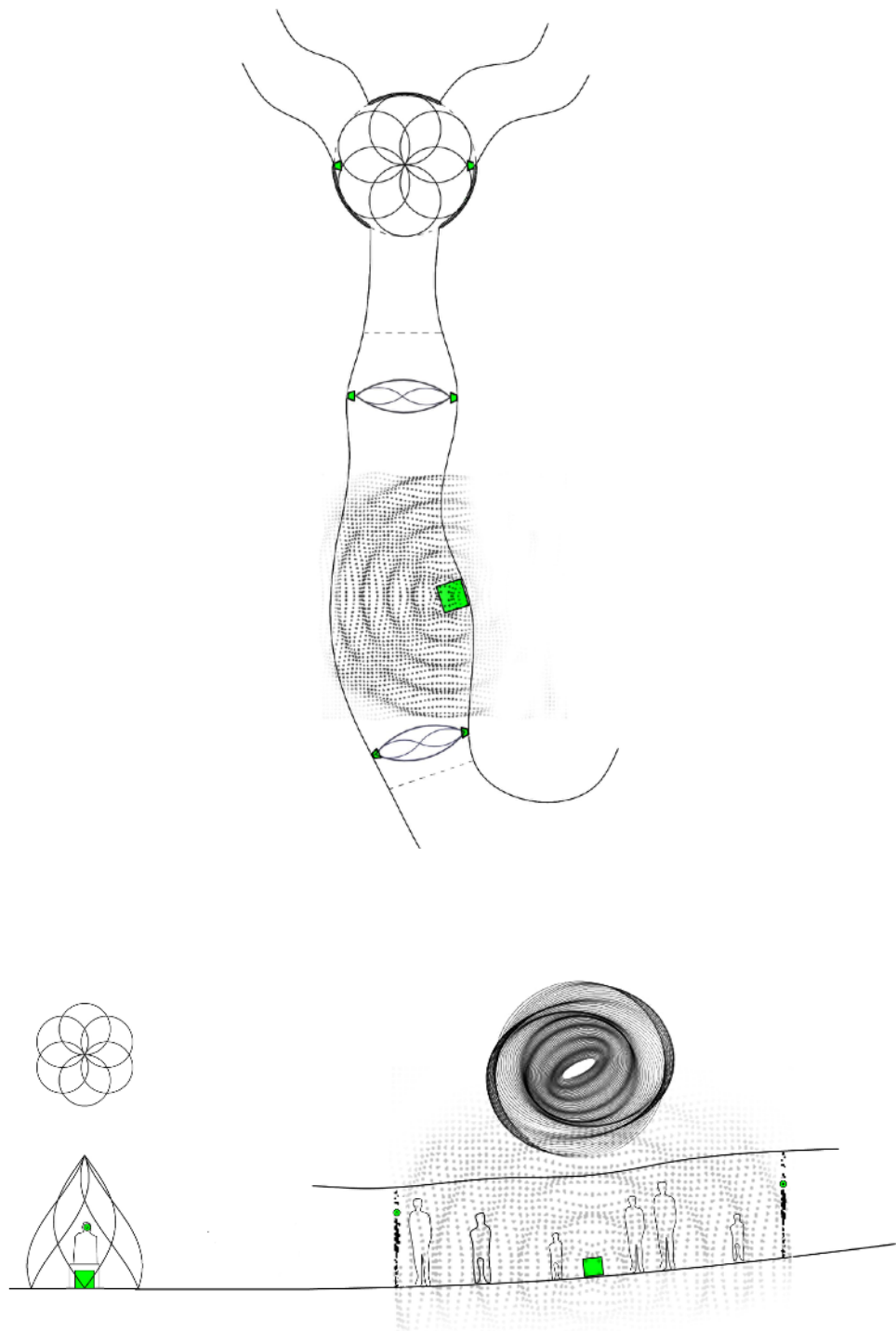


Fig. 6.11, 6.12 - plan and section of the zome and the tunnel

2.1. The tunnel

In this stone tunnel, I was inspired by ancient places such as Chavin de Hantuar, or Tihuanaco, in South America, where amazing acoustic infrastructures of water channels are found. It is possible that when water was passing in, a deep roaring sound was produced, probably associated with an entity of rain or thunder, or as an acoustic matrix, where oracular pronouncements could be deciphered (Devereux 2001, 143). For the experience of the tunnel, I thought of a similar effect. With the intention of amplifying a deep roaring sound, I imagined an immersive passage, an amplified void, as an in-between zone of low frequency sound, with portals of standing waves (fig. 6.11, 6.12). Again, this resonates with the recurrent idea throughout my thesis of the experience of a gaping opening, into which and from which affect arises (Angerer 2017, 11). Therefore I became interested in exploring this idea drawing from archaeoacoustics and related neuroscientific studies (see p. 182).

2.1.1. Space as resonator (tunnel)

As we have seen, the idea of space as resonator was explored before in the practical case study *Vibrational Fields*. These are the aspects that I have drawn from *Vibrational Fields*:

- a new acoustics was integrated into an existing space, with resonance frequencies activated by the soundscape;
- acoustic spatialisation into the space's resonance frequencies;
- resonance between space and body as musical instruments.

Here, the difference was that this tunnel was not an enclosed space. For this reason, an accurate acoustic space measurement could not be conducted, neither a reverberation time calculation. Anyway, these studies were not needed to conduct my experiment. My aim was to reach out for particular resonance frequencies, to create standing waves, which was quite simple to find out based in the distance between two parallel walls, as will be calculated next.

2.1.2. Resonance frequencies calculation (room modes)

To reach out the acoustic effect of a standing wave pattern, I needed to calculate the primary resonance frequencies between two parallel walls. For a distance of 1,60m, I calculated a resonance frequency of 108 Hz, and introduced also its harmonics ⁶¹.

1	28.58 Hz	A0#	1-0-0	ax
2	57.17 Hz	A1#	2-0-0	ax
3	85.75 Hz	F2	0-0-1	ax
4	85.75 Hz	F2	3-0-0	ax
7	108.54 Hz	A2	0-1-0	ax
9	114.33 Hz	A2#	4-0-0	ax
15	142.92 Hz	D3	5-0-0	ax
21	171.5 Hz	F3	0-0-2	ax
22	171.5 Hz	F3	6-0-0	ax
30	200.08 Hz	G3	7-0-0	ax
36	217.09 Hz	A3	0-2-0	ax
44	228.67 Hz	A3#	8-0-0	ax
57	257.25 Hz	C4	0-0-3	ax
58	257.25 Hz	C4	9-0-0	ax
79	285.83 Hz	D4	10-0-0	ax
97	314.42 Hz	D4#	11-0-0	ax
101	325.63 Hz	E4	0-3-0	ax
120	343 Hz	F4	0-0-4	ax
121	343 Hz	F4	12-0-0	ax
156	371.58 Hz	F4#	13-0-0	ax
185	400.17 Hz	G4	14-0-0	ax

Fig. 6.13 - resonance frequencies

Interesting to point out archaeoacoustics reports on some of the acoustical effects in prehistoric chambers in connection with recent research in neuroscience (Coimbra 2016, 126). It has been argued that since prehistory, space with particular acoustic resonance qualities were used to achieve body-mind experiences. Archaeoacoustics investigations inside pre-historic chambers such as Newgrange or Loughcrew identified acoustic resonances between 95 Hz and 120 Hz (Jahn *et al.* 1995, in Coimbra 2016, 126). In neurophysiologic

⁶¹ The resonance frequencies calculation was explained on p. 86 of this thesis.

studies, thirty adults were monitored with electroencephalography while exposed to frequencies between 90 and 120 Hz. Between 108 and 112 Hz the brain activity was significantly lower. This corresponds to “a shift to pre-frontal activity that may be related to emotional processing” (Cook *et al.* 2008, 96, in Coimbra 2016, 126). In studies assessing brain activity (by functional magnetic resonance imaging), conducted in experienced practitioners of meditation while meditating, there is an increased activity in the prefrontal cortex (Xu *et al.* 2014, 5, in Coimbra 2016, 126). These authors argue that this activity is related to the relaxed focus of attention, which allows spontaneous thoughts, images, sensations, memories and emotions.

By coincidence, the resonance frequency of the tunnel was of 108 Hz. This allowed me to experiment this phenomena with standing waves. I wanted to open a gaping moment in spacetime, tuned to this resonance frequency, to create an affective experience of presence in the now, a sense of self as part of a field of energy, a driving force.

Archaeoacoustics and mind-body experiences

The aural qualities of a space are recognised by the human being since pre-history. Several European prehistoric chambers, especially in those that have megalithic art on their walls, have particular resonance qualities, with a resonance frequency around 110 Hz (Coimbra 2017, 128). It seems then unlikely that acoustic effects would have gone unnoticed in prehistory (Cook and Watson 2006, 107). I have always been interested in sound behaviour in ancient places, to understand how and why our ancestors used spaces with very particular resonance qualities. This is also the object of study of archaeoacoustics. As it has just been described, recent findings in archaeoacoustics and neuroscience have shown that the experience of these places with particular resonance frequencies, produces a relaxed attention and facilitates mind-body experiences. While the primordials of aural architecture might have resulted from unplanned acoustic accidents, it certainly resulted as

the origin of inspiration for intentional aural architecture constructions, from which has emerged knowledge and cognitive frameworks on the relationship between sound, frequencies, vibrational patterns, geometry, acoustic effects, affect and consciousness.

I have presented this practical case study *Passage* at the Archaeoacoustics conference III (2017) ⁶². I have pointed out the value of the geometric knowledge of ancient civilisations' architecture that has been "forgotten". The ancient civilisations used natural spaces' acoustics and built architecture based on an embodied knowledge of vibration, energetic geometry, light and sound as creative design. Until the advent of the industrialisation in the 19th century, architectural design devised very particular acoustic qualities to the experience of space, with a deep knowledge on its consequences. This is very explicit in known examples of European churches such as *St. Paul's Cathedral* and the *Whispering Gallery* (1697), in Islamic mosques such as the *Ālī Qāpū Palace and Music Hall*, Isfahan, Iran (17th century), in pyramids' chambers, such as in *Saqqara, Egypt*, or in pyramids stairs such as *Palenque, Mexico and Tikal*, Guatemala (see Devereux 2001; Blesser and Salter 2007).

While recognising the value of such knowledge, my practice was not aiming to reproduce an imitation of pre-industrialised acoustic space. Today we need to explore new forms, adapted to our culture. I became interested though to explore the same purpose common to so many ancient civilisations: mind-body experiences of attunement through the experience of sound in space.

Therefore, my interests and common points with ancient aural architecture were:

- The use of natural phenomena and elemental sounds (particularly water);
- Architectural space as an acoustic resonator (by the appropriation of existing places with particular resonance qualities or building new ones);

⁶² See <http://www.otsf.org/2017-conference.html> and <http://www.archaeoacoustics.org/> - accessed November 13, 2017

- The enhancement of mind-body experience (which I have named experience of attunement);
- Research on relationships between sound, affect and human consciousness.

2.1.3. Resonant soundscape (tunnel)

A resonant soundscape was experimented previously in the practical case study *Vibrational Fields*. These are the aspects that I have drawn from *Vibrational Fields*:

- to activate resonance frequencies of the whole setup as an unified field through sound;
- the physicality of vibrational force of environmental sound, enhanced by space's acoustics;
- multidimensionality, spatial sound and dynamic sonic beings.

Here the focus was on the embodiment of acoustic phenomena, the corporeality of environmental sound and the physical affective experience of water resonance as a dynamic sonic being, to step into the language of water.

Emergent concept: corporeality of environmental sound

In terms of soundscape considerations, the magnification seems to relate less to the 'brute force' amplification of the public address system than it does to the corporeality that is characteristic of acoustic sound (Truax 1996: 62)

I have explored a form of experience based in the corporeal aspect of environmental sound and acoustic embodiment. Therefore I have designed an immersive experience of the physical environment, as an interconnected field of vibrational forces. My stance was that this form of experience could engage the experience of space and time as an unified field of resonance. Acoustic embodiment here means that through the space's resonance, the magnification

of environmental sounds produced a sense of physicality and entered into sympathetic vibration with the audience's body and mind. I have searched for an enhanced water experience, into micro molecular movements of drops, and macro embodiment of the physical flow of its driving forces. Low frequency sounds were already present in the tunnel, therefore the soundscape would amplify its experience and embodiment. *Passage* addressed how the enhancement of the natural acoustic phenomena of a soundscape could reconfigure the relationship between body-mind-space-time as embodied molecular vibration.

2.1.4. Composition with field recordings

My purpose for this soundscape composition was to sublimate the presence of the vibratory force of water in its different dynamics, that modulated distinct layers of frequencies, pitch, rhythms, intensities. I have also decided to amplify the presence of infrasound, to enact intensity at the physical level. I have added specific frequencies to draw mind-body experiences to levels of relaxation and meditation, as it was described on p. 183. These are the main aspects that have emerged from my composition:

- dynamic sonic beings - the water being
- multiple scale approach:
 - macro acoustic space, spatial sound - the movement of water sound masses, washing up;
 - micro close-up to the molecular movements of water and subtle frequencies modulation and pitch of water singing.
- multidimension of different acoustic spaces' spatial volumes and reverberation, different tunnels, narrow, long, wide.

As in *Vibrational Fields*, here the tunnel would undergo a process of acoustic transformation, engaged as an overwhelming force, an immediacy, like an immersion that takes experience into a field of interconnection between self and the surrounding vibrational forces.

2.1.5. Layers

The soundscape composition had a total duration of 6 minutes and 6 distinct layers:

Layer 1 - ambiance outside the tunnel - minutes 00 to 01:38

Layer 2 - inside the tunnel, water drops, infrasound - minutes 01:30 to 02:58

Layer 3 - inside the tunnel, water dropping fast - minutes 02:50 to 03:21

Layer 4 - narrow tunnel with water flowing - minutes 04:05 to 05:23

Layer 5 - resonance frequencies, binaural beats (108-110Hz; 216-217 Hz; 432-434 Hz)

Layer 5 - resonance frequencies, binaural beats (27-28Hz; 54-57 Hz; 85-86 Hz)

To hear the soundscape composition open the audio file 6.37. Please see first the note on the audio documentation on p. 225.

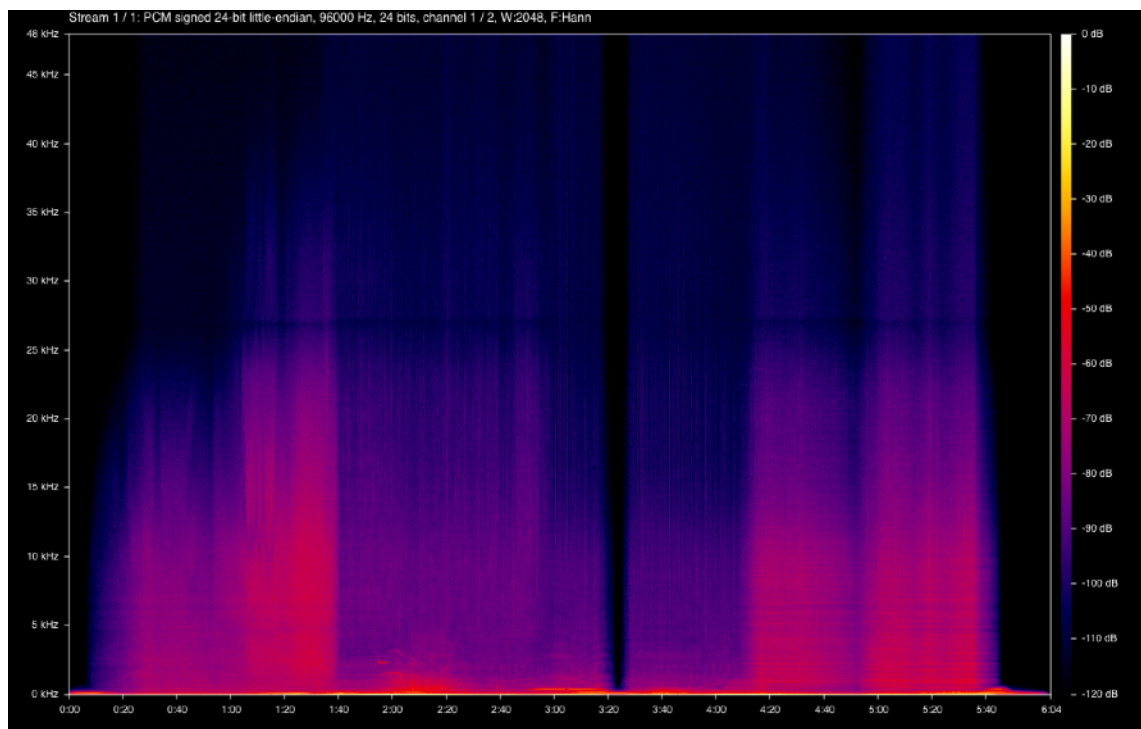


Fig. 6.14 - spectrogram of the soundscape composition using software *Spek*

After going through this passage, the audience would go inside the zone, an ostensibly silent space, covered with portuguese cork.

2.2. The zome

The zome⁶³ was self-constructed and incorporated specific acoustic qualities, due to its geometry, material's density and spatial volume, as will be explained further next. My aim was to integrate synergetics into the aural architecture design method of space as a dynamic relation, experimented in practical case study *Radio Sonores*. Therefore in the aural architecture design of this zome, there were aspects which I have drawn from *Radio Sonores*, and that were further extended.

2.2.1. Space as a dynamic relation (zome)

These are the aspects that I have drawn from *Radio Sonores*:

- relational, energetic, performative, modular, self-built architecture;
- specific acoustic qualities.

Here in *Passage*, the focus was in extending design of space based in a dynamic relation towards ecology, sustainability and synergetics. These are the ideas that I have expanded further:

- extend architectural acoustics studies further into energetic geometry and synergetics;
- explore frequencies and rhythmicity of geometric patterns of formation, and translate it into aural architecture design;
- design space according to requirements of minimum energy; as a function of the inter-play between physical forces and spatial constraints (Edmondson 1986, 9);
- design space based in energy efficient structures, as a contribution for sustainable modes of building and ways of living.

⁶³ The term zome was coined in 1968 by thinker Nooruddeen Durkee, combining the words dome and zonohedron.

As we will now see, I have engaged in a design of form based in ecological structural requirements of minimum energy, attentive to the interplay between physical forces and spatial constraints.

2.2.2. Energetic geometry - synergetics

I have extended an architectural acoustics study one step further into energetic geometry. Therefore I have engaged in an experimentation of geometry in relation with natural materials efficiency and a sustainable mode of building. Zomes are geometric volumes composed of lozenges arranged in a double spiral. The geometry of this zome was based in a frequency of six, which is a diagram of equilibrium and balance of forces (a triangle up and a triangle down, same distance between the points) (fig. 6.15). This is also the diagram at the base of the geometry of the flower of life, which is known since ancient cultures as a geometry that includes all existing geometric patterns (fig. 6.16). Therefore the zome design was based in this geometry. The spatial variation started from the base. The reference was the dimension of the space for its installation. This geometry expanded then vertically as a double spiral or helix, one spiral curving clock-wise, the other spiral curving anti-clock wise (fig. 6.17).

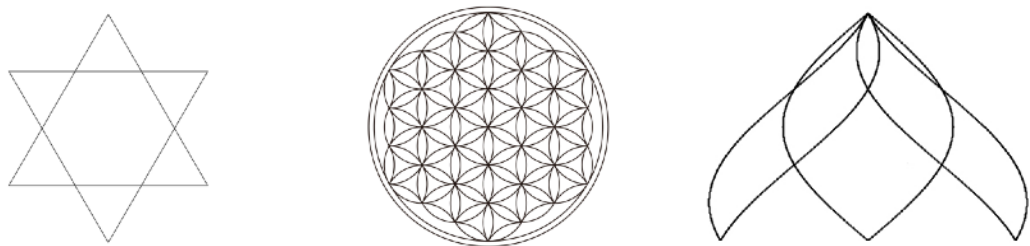


Fig. 6.15, 6.16, 6.17 - hexagram, flower of life and zome geometry

Materials' performance

Here, I focused on the performative quality of the building material. I had to use bendable wood, in order to easily assemble the zome. The building process involved cutting the materials myself. I was living by the mountain of Gerês, therefore it was easy for me to cut the materials, and assemble it there (fig. 6.18)

to 6.20). I did this one month before the event so that the wood would dry up and maintain the bending position.



Fig. 6.18, 6.19, 6.20 - zome assemblage

A few days before the event, I disassembled it, transported it to Lisbon, and reassembled it there in *Estufa Fria* (fig. 6.21 to 6.23). I decided to use only natural materials (bendable wood, jute wire, cork), to integrate the architecture as part of the site. I have used roles of bendable cork to cover some parts of the zome. This would create a protective environment, absorbent but at the same time allowing permeability (fig. 6.24 to 6.26).

Spatial volume

I did not use any metric system to determine this spatial volume. It was all based in relation and performance. The spatial volume was determined by the diameter at the base and the available dimension of the used bendable wood (approximately 3 meters high each branch). The diameter at the base was chosen according to a strategic place, where the path coming out of the tunnel divides in two paths. The zome embraced the path coming out of the tunnel to transform it into another experience (fig. 6.27, 6.28, 6.29). The resulting spatial volume and energetic geometry engaged some sort of dynamic stillness. I wanted to create an inner intimate experience, connected to the outside environment but at the same time protected and isolated. My aim was to open up a dialogue between inside and outside. Therefore I have engaged an acoustic communication as a dialogue, an inner-outer listening towards a meditative state.



Fig. 6.21 to 6.29 - zome assemblage

2.2.4. Soundscape for attunement

These are the aspects that I have drawn from *Shores*:

- emergence process of composition;
- subtly highlight the essence of place;
- experience of attunement to environmental sound, awareness.

The main idea here was for an experience of attunement to the zome geometry, the double spiral, and the acoustic intimate sense of place. I had thought of leaving it as a relatively silent space. But then I decided to create an experience based in binaural field recordings. The purpose of this soundscape for attunement was to only subtly illuminate aurally the zome experience. What could be heard inside such an intimate environment that would enhance the zome experience?

2.2.5. Composition with field recordings and layers

The soundscape composition (audio file 6.38) had a total duration of 3.30 minutes and three distinct layers:

- layer 1 - field recordings of watering sprinklers
- layer 2 - field recordings of cicadas
- layer 3 - field recordings of water drops

Layer 1 - watering sprinklers (min 00 to min 01:43)

I had the chance to find out that the green house activated watering sprinkles in the early morning and closed them when the doors opened to public. Therefore I have arranged a way to get in early and record these sounds. I recorded it below a plant with large leaves. For that reason we can hear heavy water drops falling once in a while over the top of our head. Hearing this inside the zone was quite agreeable, the feeling of protection was highlighted.

Layer 2 - cicadas (min 01:39 to min 02:44)

I was lucky to record during the summer the sound of stridulation⁶⁴ of cicadas in the green house. Acoustic signalling is a widespread form of communication that occurs in vertebrates, arthropods and even in plants. Acoustic communication in cicadas is well-known for their timbal sound-producing mechanism in males. Male cicadas emit different types of acoustic signals in different behavioural contexts in order to gain benefits such as attracting specific females and deterring predators⁶⁵. Listening to this sound tuned me to a relaxed rhythm, possibly related to summer time. I also felt that this sound would propagate well in cork walls.

⁶⁴ Stridulation is the act of producing sound by rubbing together certain body parts.

⁶⁵ In <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4340015/> - accessed October 9, 2017.

Layer 3 - water drops (min 02:44 to min 03:29)

This layer resonated to what the audience had experienced in the tunnel, but with a lower intensity, higher pitch and clarity. It would connect the audience to their relation to water as a song, singed close to the ears.

To hear the soundscape composition open the audio file 6.38. Please see first the note on the audio documentation on p. 225.

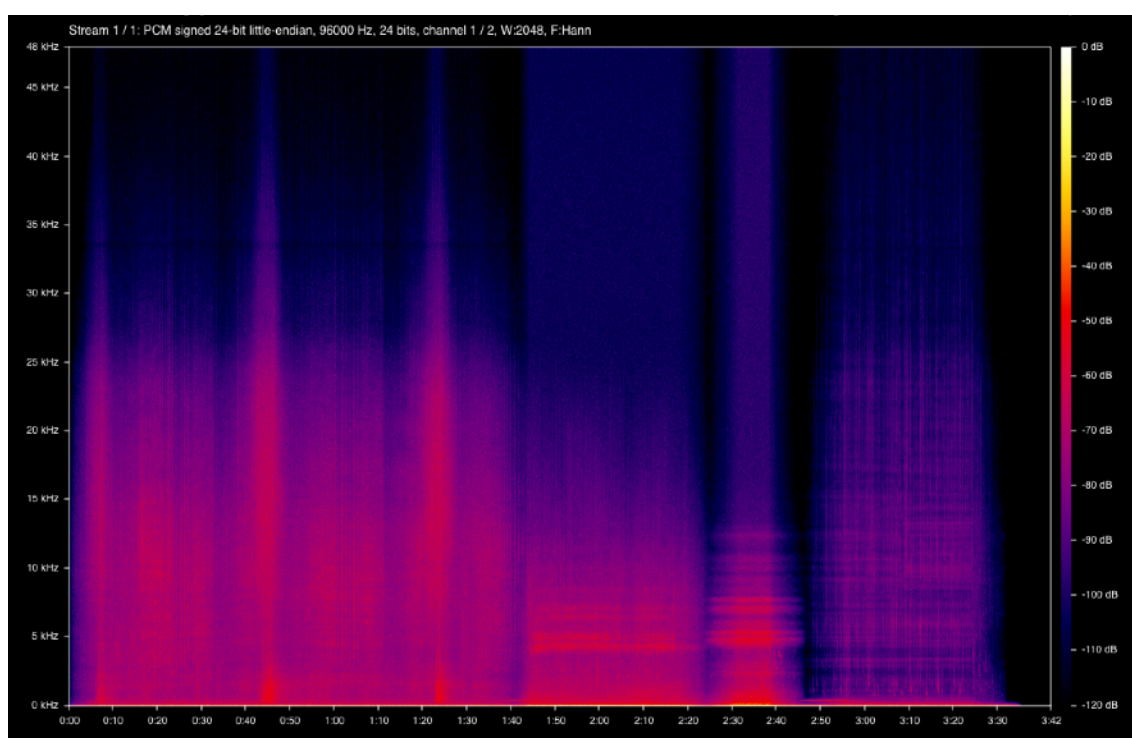


Fig. 6.30 - spectrogram of the soundscape composition using software *Spek*

3. Installation and acoustic spatialisation

3.1. The tunnel installation and acoustic spatialisation

The tunnel installation process was a bit complex regarding the available PA and the tunnels's stone walls. Initially I had request four 3-way car audio speakers and one sub-woofer, so that the speakers would be integrated to the wall, and would not be visible. Unfortunately, the production did not have this

audio equipment. For this reason, I had to install two pairs of stereo heavy active speakers with two stands, one sub-woofer, and one mixing desk. The soundscape was played via a media player. The protocol for the process of acoustic spatialisation was the same as the previous practical case studies, as follows:

- 1- Install the audio equipment - stereo active speakers and one sub-woofer, frequency spectra range of 40 Hz -20 Khz
- 2- Run tests to confirm the resonance frequencies of the space and the frequency range of the sub-woofer; there was no need for adjustment.
- 3- Spatialise the sound system – choose the best placement of the sound system exploring the relationships between frequencies resonance, materials' properties and spatial geometry. The idea was that the audience would be binaurally immersed. Therefore the speakers were placed at the ears' height, two at the way in and two at the way out. The sub-woofer was placed in-between.



Fig. 6.31, 6.32, 6.33 - tunnel spatialisation

3.2. The zome installation and acoustic spatialisation

The zome installation was simple. I have used two small car audio speakers, and installed them on the cork walls, one in each side of the ears (hight of an average person position when seated in the bench), for a binaural experience.



Fig. 6.34, 6.35, 6.36 - resonance frequencies

4. Audience's experience and feedback

The event received a great amount of audience. As in my previous experiments, I have conducted a survey by leaving a notebook with the question: how do you feel with this experience? Here follows a transcription of some of the comments.

4.1. The tunnel - audience's feedback

Impressive! I felt like a plant for the first time! Seeing with vegetable ears. No time. A dimension with a lower frequency.

I feel like I'm falling into a hole. I like the strong sensation in the sounds, it seems like I feel it inside myself. I closed my eyes and it becomes much more powerful!

With my body inside the wall, but with my ears out.

I'm in a menthol cave, with water drops going up and going down (signed: Tiago, 9 years old).

Inspired. The entrance was not very inviting, but the way out opens a new world.

A passage is normally an in-between space, but here it becomes a place in it-self, like a reality bubble.

I remembered I breed!

It reminded me how sensual the sound of water is... I wonder how would sound the fire, the earth, the wind...?

Flying in the water

Refreshed

Relaxed

Peaceful

Water transports me in harmony and balance

The sounds travel through the stones like if they are communicating between themselves

(C. Martinho, *Passage* survey, September 15-17, 2017)

4.2. The zome - audience's feedback

Sliding in life

I don't want to go out

Floating

In another world

In my world

In balance

Free

Very calm

Quiet

Relaxed

Is this what bees hear? I like this shape. It smells good like the earth

(Joana, 7 years old)

Suspended

Tuned with the vibrations of this space

I feel the transmission of nature on an human shape, like if it was a real person.

Centred

(C. Martinho, *Passage* survey, September 15-17, 2017)

Affective experience of environmental sound

Drawing from the comments, I may say that all bodies were attuned, and there was a diversification in the affective experiences. It was an experience of non-verbal communication between being and place. On the one hand, it created an affective experience of environmental sound as a presence in the now, a sense of self as part of a field of energy of the site, a driving force. Sound and acoustics enhanced communication with vibrational forces at work in the site, that are usually unnoticed by humans. On the other hand, the aural architecture of the zome acted as a point of centring in the balance of self with the surroundings.

Final thoughts

My aim for this practical case study was achieved, as it was a contribution to a translation of an invisible design based in the contingencies of the site but also in synergetics, into a diversity of affective experiences of environmental sound. As will be explored next in Chapter 7, which is the conclusion of this thesis, there are several ideas that have emerged from within this practical case study that will be further developed into future experiments.

Chapter 7

Conclusion

In this section, I will start by summarising my research proposal, questions and methods used to answer the questions. I will describe the design methods developed, its learning points and how it contributed to knowledge. I will finish by describing further developments such as the continuity of one of the practical case studies and the creation of a new aural architecture experiment, that will extend this thesis' research further.

1. Research proposal, questions and methods

While the acoustic environment and urban soundscapes shape our everyday experiences, most of architecture practice usually neglects the consequences of acoustic space in its design process. In this context, my research proposal addressed the challenge in integrating the knowledge of acoustics and the human experience of sound in architecture practice.

Therefore I have engaged in this PhD research with the following research question:

What kind of design methods could integrate the experience of urban soundscape and acoustic space, to create a site-oriented aural architecture, towards an ecology of affect?

I have answered this question through my practical experimentation and by an exploration of theoretical concepts.

To answer my research question, on the one hand I have drawn methods from acoustic ecology and acoustics. On the other hand, I have engaged a shift in the conception of space as visual orientated or “empty”, as it is usually approached from most of architectural practices. To embody the auditory experience of urban soundscape and acoustic space in its design process, architectural design needs to move beyond the modern mode of design based in focused vision and formal objects. Therefore I have engaged a mode of design based in space as a field of relations, and in multi sensory, omnidirectional and unfocused experiences. This has resulted in a series of approaches to design aural architecture. I will explain its outcomes on p. 203.

I also became interested in an exploration of the auditory experience of urban soundscape as an affective experience of environmental sound. Therefore I have explored theories of affect, and got interested by an ecology of encounters of organisms and things (Angerer, Bennett), in relation to specific sites. I also got interested in exploring the experience of space as matter-energy, in how aural architecture could amplify a previous unfelt potential as affect - as primary, non-conscious and intensive (Massumi 2002, 27). I wanted to understand how the physical experience of vibrational forces in environmental sound, enhanced by acoustics, would relate to affect. Drawing from Marie-Louise Angerer’s three operations of the affective (Angerer 2017, 11), I have developed three operations of the affective in relation to my practice as a way to link this theory of affect to an ontology of vibrant matter. These operations are: transformation, translation and attunement.

Following my enquiry, I have approached the idea of *space as field of matter-energy* (Bennett 2010) as a *working concept*, cross-fertilising it with ideas from the disciplines of physical acoustics (field of resonance, pages 61-64), sound art (body and space as musical instruments, pages 64-67), music (spatial sound, dynamic sonic beings, pages 67-72), architecture (space as field pages

101-104; space as a dynamic relation, pages 111-114; space as energetic geometry, pages 167-171 and 188-190), philosophy (microperceptions, p. 39, p. 98; space as a field of attunement, pages 124-131), acoustic ecology (attunement, ambiance and ecology, pages 131-135).

Additionally I have experimented this *working concept* exploration in four of my practical experiments, engaged as case studies for this thesis. It was from these four practical case studies that I have developed four different approaches to design aural architecture, towards the kind of affective experiences described above. So, the design methods have emerged from my own practice. These four creative approaches resulted as four sets of design methods, in relation with the operations of the affective. The first set of methods guided the experience of the site for intervention, through analysis of context, participation, soundwalking, field recording, in order to decide a specific purpose for the sensory variation that the particular context required, for an operation of transformation of the ambiance dynamic. The second set of methods offered different approaches in designing aural architecture through the recomposition of urban soundscape and architectural agency based in resonance, dynamic relation and energetic geometry, for an operation of translation; the third set concerned the acoustic installation and spatialisation, for an operation of attunement; the fourth set explored the affective experience of environmental sound based in the audience's feedback.

To develop such methods, I have drawn from architectural practices that approach the design of space as relational, energetic, performative, sustainable, that is responsive to its inhabitants, such as *dynamics of urban ambiances* (Jean-Paul Thibaud), *spatial sound* (Iannis Xenakis), *synergetics* or *energetic geometry* (Buckminster Fuller). Additionally, I have drawn from acoustic ecology methods that approach the soundscape experience as a way to foster a sonic connection with the acoustic environment, and to balance inner

and outer worlds, such as *acoustic communication methods* (Barry Truax) and *conscious listening* (Hildegard Westerkamp).

Next, follows a summary to clarify the unfolding of each operation of the affective as a set of design methods, and in relation with the fields and methods that have informed its development.

Operation of the Affective	Design method	drawn from methods /fields
I. Transformation	1. Experience of site 1.1. Analysis of context 1.2. Dynamic of experience 1.2.1. soundwalking 1.2.2. field recording 1.2.3. workshop 1.3. Sensory variation 1.3.1. sensory phenomena 1.3.2. aural elements 1.3.3. ambiance dynamic	<ul style="list-style-type: none"> • Architecture as spatial agency • Participation • Acoustic ecology • Sensorial architecture
II. Translation	2. Aural architecture design 2.1. Resonant soundscape 2.2. Space as resonator 2.3. Space as dynamic relation 2.4. Soundscape for attunement 2.5. Space as energetic geometry	<ul style="list-style-type: none"> • Site-specific sound art • Acoustics • Acoustic ecology • Soundscape composition • Relational architecture • Synergetic architecture
III. Attunement	3. Acoustic spatialisation 3.1 Installation in acoustic space	<ul style="list-style-type: none"> • Acoustics
IV. Affective experience of environmental sound	4. Audience's experience and feedback	<ul style="list-style-type: none"> • Survey based in anonymous commentaries • Interviews to specialised audience

Next, I will explain the learning points of this thesis.

2. Learning points

I will start by explaining my aural architecture practice outcomes in relation to each practical case study, the emergent methods and concepts addressed. I will then describe more general learning points of the research process.

Outcomes of the practical case study *Vibrational Fields*

Working concept	• Field of resonance
Enquiry	<ul style="list-style-type: none"> • Acoustic model of waves' propagation • Sympathetic vibration, resonance frequencies, standing waves • Space and body as musical instruments • Spatial sound
Practical case study	• <i>Vibrational Fields</i>
Design methods	<ul style="list-style-type: none"> • Resonant soundscape • Space as resonator
Affective experience	• The physicality of vibrational force in environmental sound, enhanced by space's acoustics
Emergent concepts	<ul style="list-style-type: none"> • Background listening • Dynamic sonic beings • Being vibration

With the practical case study *Vibrational Fields* (Chapter 3), I have learned to design with the physicality of vibrational force in environmental sound, enhanced by space's acoustics and resonance. The result was an aural architecture that activated the experience of space as a vibrational force of dynamic sonic beings, unfolding and modulating affect from the same field of resonance.

The resulted aural architecture design method was: resonant soundscape and space as resonator (explained on p. 55). Here the soundscape design was based in space's resonance frequencies to magnify or enhance environmental sound, to enter into vibration with the audience's body and mind. This method related with the phenomena of resonance. It also unfolded methods drawn from

acoustics, acoustic ecology and soundscape composition. The design of space as resonator was inter-related with the resonant soundscape, and addressed an intervention in an existing architectural space. It concerned the idea of space and body as a musical instrument. It unfolded methods drawn from architectural acoustics, such as acoustic space measurement, reverberation time calculation, and resonance frequencies calculation (room modes). These methods might be useful for other practitioners who wish to enhance their sound works through the acoustics of architectural space and play with resonance frequencies to activate a physical and affective experience of being vibration.

Outcomes of the practical case study *Radio Sonores*

Working concept	• Space as field
Enquiry	<ul style="list-style-type: none"> • Relational and performative architecture • Spatial agency
Practical case study	• <i>Radio Sonores</i>
Design methods	• Space as a dynamic relation
Affective experience	• The experience of inner-outer listening and relatively silent, enhanced by the space's absorbent qualities
Emergent concepts	<ul style="list-style-type: none"> • Space as a dynamic relation • Diagram as an energetic geometry • Modular design as a mode of assemblage • Mobile architecture

With the practical case study *Radio Sonores* (Chapter 4), I have learned to design space as an interval or a relation, focused on the consequences of the experience of space (sensorial, social, political, ecological), more than the formal production of an object of architecture. The result was an aural architecture as a field of relations, evolutive, adaptable and that opened up appropriations of space for affective experiences.

The resulted aural architecture design method was: space as a dynamic relation. Here, a new architectural space was designed based in a specific aural

experience (relatively silent, attentive listening, inner and outer listening). It is related with the concepts of relational space and assemblage. It can be useful for practitioners who wish to build up a modular aural architecture based in energetic geometry, to create a specific acoustic environment for a studio or performance space, based in geometry, materials' density, spatial volume and proportions.

Outcomes of the practical case study *Shores*

Working concept	• Space as field of attunement
Enquiry	• Sympathetic resonance, entrainment and affect • Attunement, ambiance and ecology
Practical case study	• <i>Shores</i>
Design methods	• Soundscape for attunement
Affective experience	• Experience of environmental sound in extension with the site, in tune with the environment in a symbiotic way • Auditory experience of balance between inner and outer worlds
Emergent concepts	• Experience as embodied knowledge • Ecological intimacy from oral communities

With the practical case study *Shores* (Chapter 5), I have learned to design space as a field of attunement, based in the experience of environmental sound in extension with site, of a symbiotic way of being in tune with place and self, as embodied knowledge. The result was an aural architecture of balance between inner and outer worlds. I have also learned ecological intimacy from oral communities.

The resulted aural architecture design method was: soundscape for attunement. The soundscape design was based in the idea of attunement to environmental sound. It explored relationships between field recording, urban soundscape recomposition, ambiance extension. This method might be useful for other practitioners who wish to create an aural architecture to highlight the sense of a

certain place. It can be helpful to enhance an urban soundscape experience through a sensory variation based in tuning and modulating an existing ambiance.

Outcomes of the practical case study *Passage*

Working concept	• Ecology of vibrational affects
Enquiry	• Ecology of affect • The language of vibration and vibrational affect
Practical case study	• <i>Passage</i>
Design methods	• Resonant soundscape • Space as resonator • Space as a dynamic relation • Soundscape for attunement • Space as energetic geometry
Affective experience	• Modes of ecological re-wiring of the senses through the inciting of affective responses • Diversification of affects
Emergent concepts	• The affective experience of environmental sound • The inner and outer dynamic of the auditory experience towards meditative states

With the practical case study *Passage* (Chapter 6), I have learned to design an ecology of vibrational affects, based in the language of vibration, translated from water as matter-energy. I have explored modes of ecological re-wiring of the senses and the inciting of affective responses. The results were two aural architecture experiments that engaged a diversification of affect and the inner and outer dynamic of the auditory experience towards meditative states. Drawing from the comments, I may say that all bodies were attuned, and there was a diversification in the affective experiences.

The resulted aural architecture design method was: space as energetic geometry. This mode of design is a convergence of the previous four modes of design. Therefore it extends the studies of resonant soundscape, space as

resonator, space as a dynamic relation and soundscape for attunement, and integrates it into one single experiment. It emerged as a microcosmos with multiple experiences, as an ecology of affects. This design method of *space as energetic geometry* has created an experience of attunement as an experience of non-verbal communication between being and place, through the element of water dynamics. On the one hand the tunnel created an affective experience of environmental sound as a presence in the now, a sense of self as part of a field of energy, a driving force. On the other hand the aural architecture of the zone acted as a point of centring in the balance of self. This method might be useful for other practitioners who wish to enhance their sound works through the acoustics of architectural space, play with resonance frequencies for mind-body experiences, and open communication channels with the vibrational forces of sites. It may also inspire the self-building of an energetic geometry aural architecture.

As for general learning points, related to this thesis' research process, there were challenging aspects, such as the articulation of my multidisciplinary practice with a multidisciplinary theory, and theorising about my own practice. Nevertheless these were valuable learning points as well. My research was a very long process, due to many contingencies of life. At one point, it was a challenge to understand in which way I could articulate my multidisciplinary practice with a multidisciplinary theory, as a thesis. It became quite complex. It was not an easy task to articulate concepts and methods from a wide range of disciplines, with different languages (artistic, scientific, philosophical). My idea was to translate concepts to practice and systematise it as sets of design methods, so that these would become useful for my practice, and accessible for other practitioners and researchers as well. This was one of the main reasons also why I did this thesis. In my opinion, there is a very wide array of interesting research being conducted in academia that could inform and contribute to advancements in the field of aural architecture. But most of it stays within

academia, or a specialised public, or it does not reach a practical application. Perhaps that is not the purpose of theoretical authors. But I believe it should be the task of practitioners to bring forth and disseminate these ideas into an aural architecture practice, to experiment in everyday life, and to contribute to more sustainable ways of living and being. Our built environment needs innovative design in architecture with an acoustic ecology approach. The sound quality of our everyday experiences has serious consequences in our well-being, as it directly affects our nervous system (Leitner 1998, 293), so our architecture's design approach to the built environment should also focus on the consequences of the aural experience.

Also at times, I found it was a challenge to stop my practical dynamics and to sit down to theorise about my own practice. It required a certain time passed the experience. I was only able to develop the last two practical case studies a few months before submitting this thesis, due to unforeseen circumstances. For this reason, I had a very short time to integrate the experiments and finish the thesis. Therefore, sometimes it was not an easy task to articulate my practice-based research, which involved such a variety of methods and multidisciplinary concepts, and produced a clear and concise thesis. Nevertheless, it was a valuable learning process. Through this practice-based research process, I have learned how to develop an aural architecture practice methodology, as an architect and acoustician working with sound. Today, I know how to approach research methods to design aural architecture, I see more clearly its relation with other disciplines and its potential for further developments.

Other important points that contributed to the development of the design methods that I have developed, were the collective dynamics and the audience's feedback. The workshops were a positive way to exchange ideas and to engage art and architecture students and communities in acoustic ecology, to foster a soundscape awareness. I have learnt a lot with these

collective dynamics. I.e. in the case study *Shores*, I have learnt ecological intimacy and embodied knowledge of site from the oral communities of fishermen. The architecture students have learnt to be more aware to the acoustic experience of site and the importance that aural architecture plays in the environment. These are also valuable points of contribution. I believe that workshops are a very important way to advance in aural architecture. And in the future, I will look for opportunities to engage my practice further in collective dynamics.

The audience's feedback was a valuable way to confirm my artistic explorations and contributed for the advancement and development of the aural architecture design methods. I.e. in the case study *Shores*, the idea of balance emerged from the commentaries. I became interested to explore further this approach of balancing the auditory experience in the following project, *Passage*, with an exploration of inner and outer listening dynamics into centred aural architecture.

Therefore, my research towards this thesis was sometimes a slow, stagnant process, and other times extremely active and creative. But aren't all creative processes that way? My advice for other PhD students is that a PhD research does not have to be a lonely process. I am very thankful for all the exchanges during the workshops, the artistic residencies and the presentations. The feedback and critics made my PhD research process much more interesting, constructive and fruitful.

3. Contribution to knowledge

This thesis aimed to contribute with advancements in the field of aural architecture design and practical experimentation. A site-oriented aural architecture practice methodology, formalised as a set of design methods, was my main contribution to knowledge. These design methods were elaborated in a way to facilitate its further development and other practitioners' use.

Next follows a summary of why and how other practitioners might be interested in using the design methods. The design methods may be useful for architects, soundscape designers/composers and spatial practitioners that look for methods to:

- Create site-responsive aural architecture experiments that deal with moving sound installation to public space, and take into account an enlarged environmental potential;
- Design site-oriented aural architecture based in sensory variation and ambiance dynamics, as a way to enhance the soundscape experience;
- Connect unusual or imperceptible relationships between the elements of a specific site (human, non-human), to accentuate differences and multiple dimensions, for the emergence of a diversity of sensory experiences;
- Address the potential of site-specific vibrational forces, enhanced by spatial acoustics, to open communication channels towards more ecological relationships between human and non-human beings;
- Open up the experience, transformation, translation and attunement to vibrational forces of sites, to move spatial practices beyond an anthropocentric perspective, and towards an ecology of affect and symbiotic relations;
- Experience environmental sound as dynamic sonic beings, enhanced by natural acoustic effects and resonance, for unusual encounters and connections between human beings, non-humans and things, and towards a symbiotic way of attunement.

Furthermore, my research contributed to re-integrate the knowledge of acoustics (the relations between geometry, materials' density, spatial proportions, acoustic effects) and the human experience of environmental sound in the design process of architecture.

My practical case studies also contributed to an ecology of affect, by experimenting a diversity of affective experiences of environmental sound.

4. Future projects

As for future projects, I would like to give a continuity to aural architecture workshops: teaching and learning through practicing, to extend design methods, and as a way to contribute further to an ecology of affect.

I will develop further the *Shores* project. Not only in São Miguel but also in other coastal places. I would like to do so working with fishermen communities and their children, to engage them in listening and recording their families' fishery activities, to encourage conscious listening across generations and a sonic connection with the acoustic environment. Resulting from this work, I would like to co-create a permanent acoustic boat soundscape installation with a local traditional boat constructor and young adults, for Rabo de Peixe public space, and for its community's appropriation with their own cultural and artistic activities. This will allow to reach an ecological soundscape awareness into a wider and less specialised audience. I would like to see how this project would evolve in time, and how the community would appropriate the space.

Another project that I will develop is a *Temporary Autonomous Zome* or TAZ, referring to the book *Temporary Autonomous Zone* (Hakim Bey, 1991). The book describes urban tactics to elude formal structures of control. This aural architecture experiment will create a temporary space that might elude homogenisation of the built environment and transform it into affective experiences of environmental sound, by offering a diversity of urban soundscape experiences. This project will extend the zome geometry of the assemblage of *Passage* into an assemblage of acoustic panels, with specific features. TAZ will be a mobile and modular aural architecture, based in the zome geometry. It can be installed in any public place, outside or inside. It will involve a participative process of collective self-construction (d.i.y.); and a participative process of soundwalking, field recording and soundscape composition. This project will allow me to advance in my aural architecture design methods into an experiment with modular acoustic panels, assembled in

different configurations, based in energetic geometry. There will be different kinds of acoustic panels (reflective, absorbent, diffuser), with specific materials. Some panels can be played as percussion musical instruments. Other panels integrate small amplified speakers in the inside wall, to hear soundscape compositions created during the workshops. The interior acoustics of the zone will be optimised for that. And some other panels will integrate mini-jacks entrances to hear with headphones in the outside wall, to hear field recordings that highlight particular sounds of the surrounding close environment.

This project will also research further participative methods to experience the site, that may incite participants to continue the co-creative soundscape dynamics and the appropriation of space. I hope I can also run workshops to engage children in playful dynamics with the acoustics panels.

The *TAZ* will open up several possibilities due to its modular assemblage, so that it can be installed temporarily in any everyday public space. The *TAZ* can travel to another place, to reach out different audience and different contexts. This will be a way to extend my PhD research further, to advance other kinds of aural architecture design methods, to incite an active engagement in the co-creation of our soundscapes, and to contribute to a diversity of affective experiences of environmental sound, for an ecology of affect. Hopefully this work will also be of inspiration to other practitioners and researchers.

Thank you for reading.

Appendices

Appendix 1

Practice developed during the PhD research

Selected installations, performances and presentations

2017, *Passage*, installation. Lisboa Soa, Lisbon, Portugal. <http://lisboasoa.com/>

2017, *Shores*, installation. Invisible Places symposium, São Miguel, Azores, Portugal. <http://invisibleplaces.org/>

2017, *Archaeoacoustics III International Conference*, presentation, Tomar, Portugal. <http://www.otsf.org/2017-conference.html> and <http://www.archaeoacoustics.org/>

2017, *Architecture, Geometry and Education*, presentation, Pedagogia 3000, Bolivia. <http://www.pedagoogia3000.info/index.php/es/agosto-bolivia>

2017, *Invisible places: Sound Urbanism and Sense of Place*, presentation, São Miguel, Açores. <http://invisibleplaces.org/>

2016, *Sound Education Experience: Women In Sound, Women On Sound*, presentation. Goldsmiths, University of London, UK. <https://www.gold.ac.uk/calendar/?id=9966>

2012, *Radio Sonores*, installation. Guimarães Capital of Culture, Portugal. <http://spacefrequencies.org/2012/12/13/sonores/>

2012, *Applied Universal Geometry*, presentation, Isla del Sol, Bolivia. <http://spacefrequencies.org/2012/12/12/applied-universal-geometry/>

2011, *Site of Sound: of Architecture and the Ear, Vol. 2*, publication, co-edition with Brandon LaBelle, Errant Bodies Press. <http://spacefrequencies.org/2011/12/21/site-of-sound/>

2011, *Topology: Embodying Transformation*, performance. Tate Modern, London, UK. <http://spacefrequencies.org/2011/12/12/topology-embodying-transformation/>

- 2011, *Rhythm and Event Symposium*, performance. The London Graduate School, London, UK. <http://spacefrequencies.org/2011/10/29/rhythm-and-event/>
- 2011, *Drone Ensemble*, site-specific performance, Matéria Prima, Porto, Portugal. <http://spacefrequencies.org/2011/07/30/drone-ensemble/>
- 2011, *Vibrational Fields*, installation, Goldsmiths, University of London, UK. <http://spacefrequencies.org/2011/05/26/vibrational-fields/>
- 2010, *lost-in-space workshop*, presentation. University College of London, UK. <http://spacefrequencies.org/2010/12/02/lost-in-space/>

Appendix 2

Previous practice that has informed the PhD research

Selected installations, performances and presentations

- 2010, *Body Sound*, scenography of sound artworks from Centre Pompidou Media Art Collection, Zebrastraat, Liedts-Meesen Foundation, Ghent, Belgium. <http://spacefrequencies.org/2010/03/25/body-sound/>
- 2010, *Constellations*, scenography, Les Anciens Abattoirs, Nice, France. <http://spacefrequencies.org/2010/10/02/constellations/>
- 2010, *VLF~UHF*, performances, Paris, France.
- 2009, *Architectones seminar on sound, art and architecture*, co-mediation and presentation. La Saline Arc-et-Sénans, France. <http://spacefrequencies.org/2008/07/09/architectones/>
- 2009, *Evento*, co-curatorial, public art biennial, Bordeaux. <http://spacefrequencies.org/2009/10/09/evento/>
- 2008, *Tuned City – between sound and space speculation*, presentation, Berlin, Germany. <http://www.tunedcity.de/>
- 2008, *Architectones seminar on sound, art and architecture*, presentation, La Saline Arc-et-Sénans, France. <http://spacefrequencies.org/2008/07/09/architectones/>

2008, *Fiction Vs Reality*, installation and scenography of works from the Centre Pompidou New Media Collection. CAMJAP, Gulbenkian Foundation, Lisbon, Portugal. <http://spacefrequencies.org/2008/01/25/fiction-vs-reality/>

2006-2011, *Infra*, irregular series of events and recordings, Paris, France. <http://spacefrequencies.org/2006/05/11/infra/>

2000-01/2006-11, *Bureau des Mésarchitecture/ Didier Faustino*, collaboration. Paris, France. www.mesarchitecture.com/

Other architecture collaborations include *Acconci Studio* (2003-04), *Storefront for Art and Architecture* (2003-04), *nArchitects* (2004).

Workshops on *sound and space installations* at art schools, such as: Le Sonic Sound Art and Design program, Le Quai Art School of Mulhouse; Master in Art and Design for Public Space, Fine Arts School, University of Porto; Ecole Supérieure des Beaux Arts, Art School of Le Mans.

Appendix 3

The World Soundscape Project (WSP)

The *World Soundscape Project (WSP)* was established as an educational and research group by Raymond Murray Schafer at Simon Fraser University during the late 1960s and early 1970s. Its main instigators are composers Raymond Murray Schafer, Hildegard Westerkamp and Barry Truax. Murray Schafer created the term *soundscape* and opened up the field of acoustic ecology with his work *The Soundscape, Our Sonic Environment and the Tuning of the World* (1977). Barry Truax describes that the principal work of *the WSP* was to document and archive soundscapes, to describe and analyse them, and to promote increased public awareness of environmental sound through listening and critical thinking. Eventually a parallel stream of compositional activity also emerged that created what he has called *soundscape composition* (Truax 1984) (Truax 1996, 54). But, according to him, the aim of *The World Soundscape Project* was not to exploit the environment as a source of musical material, but

rather to explore the knowledge base of musical design, in order to redesign the soundscape, and to reawaken people's perceptual appreciation of its importance. The field of acoustic ecology eventually expanded worldwide, and *The World Forum for Acoustic Ecology (WFAE)* carries on investigation with numerous contributors.

Appendix 4

Sound waves propagation

In the acoustic model of waves' propagation, a vibration is described as the movement of particles traveling through a medium, producing a wave. The vibration of a source produces the propagation of particles of energy that travel along a wave. Sound waves propagate in any material, solid, liquid and gas. Several factors affect the way an acoustic wave travels. The propagation of waves depends on the property of elasticity in the medium. The more elastic the medium, the faster the wave propagates (sound travels faster under water than in air, but it travels faster through metal than under water). The particles of matter in a medium act as enmeshed in a elastic web, a connective tissue. The speed of the wave decreases as the mass of the elements augments (density augments inertia) and the speed of the wave increases as the internal forces of the medium increase (tension/pressure produces greater force) (Johnston 1989, 145). As acoustic waves propagate in any medium (except vacuum), the traveling energy penetrates and involves everything. The degree of absorption and propagation of energy through matter will depend on the relationship between the frequency and the properties of the medium. This means that waves propagate differently according to the space's architectural acoustics: of its material density, volume and geometry, which result in acoustic effects.

Frequency perception

Modern physics has defined different categories to classify ranges of frequencies or bandwidths, according to its wavelength, but also of its origin, its

source, natural or artificial (human made). Different modes of propagation characterise different kinds of waves. Sound is categorised as an acoustic wave. Frequency varies according to its wavelength: the lower the frequency, the wider is its wavelength; and the higher the frequency, the shorter its wavelength. Waves' motion is different according to its nature and frequency of vibration. I.e., an acoustic wave of very low frequency, such as an earthquake, has a very wide wavelength and expands spherically from its epicentre in all directions. But a laser beam (or any other light, x-rays or radio waves) produces an electromagnetic wave, formed by an electric field and magnetic field, and its wavelength is short and directive in one precise point. According to its wavelength, the vibration may or not be perceptible. In terms of frequency, humans perceive the bandwidth between 430–790 THz as visible light, and in average between 20 Hz and 20000 KHz it is perceived as sound (these values as a general consensus but it varies according to each individual). This perception of sound refers to the sensation of a frequency, commonly referred to as the pitch of a sound, or tone – the higher the frequency, the higher the pitch, as in musical notes. We also sense frequencies as temperature, as a trembling sensation, with our skin, nerves and organs. When it comes for human perception of frequencies, psychoacoustics has widely study its effects.

Appendix 5

Vibrating systems

Hans Jenny used sound waves in his experiments to vibrate different matters, creating vast recognisable pattern formations. He investigated vibrating systems to characterise the underlying phenomena of vibration and periodicity in nature. Jenny claimed that he was not dealing with the vibratory phenomena in the narrow sense, but rather with the effects of vibrations. Vibration's periodic phenomena affects our planet's nature – the vegetable, animal and mineral kingdom. The vegetable and animal kingdom is a endless formation of tissues on a macroscopic, microscopic and electron microscopic scale, of cells

formation or degeneration, and processes of cell division and gene formation. And “it is in the vibratory field that all bioelectrical, chemical, mechanical, energetic, thermal, structural, kinetic and dynamic processes take their course” (Jenny 2001, 20). According to Jenny, wherever we look we can describe morphology and physiology in terms of periodicities and rhythmicities. Throughout the animal and vegetable kingdom nature creates in rhythms, cycles, frequencies, reduplications, serial phenomena, sequences, etc. These are the characteristics by which natural structures are built. This characterisation is about the general process; each step and change “must be seen in the context of metamorphoses, development stages and functional cycles (Jenny 2001, 271). To illustrate this we can just think of simple examples such as the skin of animals, the bones and muscles' structure, the formation of flowers, etc., all arranged in serial patterns based in periodicity or vibration. Whether we take this for granted or not, to characterise nature's mode of construction it is important to recognise and understand the vibration principle in this mode of periodicity which is ubiquitous in nature's creations (Jenny 2001, 270). This take us to the fundamental fact that nature's structures are created in terms of periodic/vibrational morphology and physiology and are therefore based in the universal laws of vibration. Jenny resumed a few characteristics shared by vibrating systems (Jenny 2001, 269-277):

- Polarity – everything is cyclical, and expresses as a waveform;
- Relational – every part relates to a whole; relation is based on vibration;
- Interconnection – everything is composed of interconnected fields of vibration (theory of the field);
- Multidimensional – everything belongs simultaneously to different dimensions, and its materiality is perceived differently according to the observer's perceptive spectrum.

What is evident even by observation is that their nature, dynamics and kinetics, structure and texture reveal its periodicity. Meaning that periodicity or vibration affects material density, geometric patterns and spatial volume. And the same

principle underlies the mineral kingdom. The periodic formation or vibrational structure is also quite visible in the lattice structures of matter in the crystalline state.

But it is not only the structural elements which show a repetitive periodic character; functions also proceed rhythmically, in regular cycles and serial processes. This is exemplified by the pulsations of the heart, the respirations, the oscillations in contracted skeletal muscle, the autonomic rhythmicity of the intestinal musculature, and the serial action currents of the nervous pathways, etc. (Jenny 2001, 271)

Human physiology and morphology naturally follow the same principles that we have seen in Nature's vibrating systems. The human body consists of interlocking and interdependent vibrational systems of various frequencies and densities within an environment of fluids. We may mention a few physiological examples such as systems of respiration and circulation controlled by natural periods or rhythms, the active muscle system which is in a state of constant vibration. Events that do not take place in sequence, are also in a continual state of vibration. In the nervous system impulses occur serially and therefore are described as frequencies. The brainwaves are described in categories through frequencies, and each frequency bandwidth triggers different states of awareness, concentration, and relaxation.

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Guide to the artworks' digital documentation

Please open the USB drive included in this thesis.

The artworks digital documentation refers to this thesis' four practical case studies and is structured under two folders:

1. Primary materials: audio-visual files

Audio files of the case studies' soundscape compositions.

Raw audio files of field recordings, when relevant.

Illustrations of the case studies' design process.

2. Secondary documentary audio-visual files

Audio files of the survey's interviews.

Audio-visual documentation of the installations.

Note on the audio documentation

As the soundscape experiments operated with resonance frequencies (meaning that sound waves of particular size were in relation to each place's specific spatial volume, geometry and materials) it is not reproducible through audio documentation because the acoustic effects are gone. These psycho-physical effects could only be heard and felt in each specific space of the installation. Nevertheless, you may hear the audio file of the soundscape composition that was spatialise in each place, in the artworks digital documentation.

Equipment

Recorders: Fostex FR2-LE; Edirol R-09HL; MacBook Pro

Microphones: 2x DPA 4060 Lavalier microphone with omnidirectional polar pattern; 2x contact microphone handmade diy; 2x electromagnetic microphone handmade diy; 1x hydrophone Aquarian H2a-XLR.

Contents of the artworks' digital documentation

1. Primary materials: audio-visual files

File name	Practical case study
3.01 to 3.20	<i>Vibrational Fields</i> (drawings, photographs and spectrogram)
3.21	<i>Vibrational Fields</i> (soundscape composition)
3.22 to 3.44	<i>Vibrational Fields</i> (raw files)
4.01 to 4.21	<i>Radio Sonores</i> (drawings and photographs)
5.01 to 5.39	<i>Shores</i> (photographs and spectrogram)
5.40	<i>Shores</i> (soundscape composition)
5.41	<i>Shores</i> (fishermen interviews)
6.01 to 6.36	<i>Passage</i> (drawings, photographs and spectrogram)
6.37	<i>Passage</i> (soundscape composition - tunnel)
6.38	<i>Passage</i> (soundscape composition - zome)

2. Secondary documentary audio-visual files

File name	Practical case study
3.21 to 3.31	<i>Vibrational Fields</i> (copies of the survey comments)
3.45	<i>Vibrational Fields</i> (video documentation)
5.42 to 5.44	<i>Shores</i> (survey audio interviews)
5.45 to 5.46	<i>Shores</i> (video documentation)
6.39 to 6.43	<i>Passage</i> (video documentation)