Composições Interdependentes Aplicadas a Ecossistemas Sonoros: Integrar o Ouvinte na Paisagem Sonora em Transformação

MARCELO FERREIRA DE SOUSA
SCOTT L. MILLER
EDUARDO MIGUEL CAMPOS MAGALHÃES

Faculdade de Engenharia da Universidade do Porto
St. Cloud State University

Sounds are harbingers of cultural and acoustic information, couriers of the general atmosphere of our places and the relationships that binds us. Sounds trigger memories and feelings from our surroundings, our cultures and our communities (AUTOR, 2019), the aural landscape links the sensorial tissue of cities to our human experience.

At the beginning of the second half of the twentieth century and spearheaded by Canadian composer and acoustic ecologist Murray Schafer (1993), a group of researchers called the *World Soundscape Project*[1] built upon the foundations of *soundscape*[2] studies. Since then many researchers have been debating the changing panorama of our sonic spaces and their correlations to human activities. As agents of the sonic ecosystem, humankind has in its arsenal the power of shaping the tone of our soundscapes.

Our attitude towards our sounding spaces and a noise-oriented design of urban and suburban centers reveals a troubling aspect: the lack of our sonic consciousness unveils the disconnection towards our environments (Oliveros, 2005). It is therefore with an acoustic ecology mindset and proper methodology in developing interactive soundscapes that we can allow for the preservation of our spaces (Truax, 2008).

The looming issue amid the transformation of Porto's soundscape is consequently a matter of cultural nuances and socio-political issues. Throughout the last couple of decades, efforts have been made to revitalize the city's social fabric. A series of renovations in public facilities and residential buildings have swept the city as a whole, from the booming metropolitan center towards the suburban outskirts.

[1] https://www.sfu.ca/~truax/wsp.html – Accessed at the 6th of January 2020.
[2] An atmosphere or environment created by or with sound.

The influx of mass tourism coupled together with lax housing regulations have sparked the growth of an aggressive real-estate market, leading to rapid propagation of the local accommodation industry.

The renovations specifically targeted traditional neighborhoods and avenues in the first waves of development, as some of the key strategies towards seducing the massive influx of tourists built upon the capitalization of Porto's values: it's characteristic lifestyle, it's social customs and the outspoken personalities of *portuenses*[3]. However, the overflow of people and the scarcity of livable spaces meant that some communities began to lose their grasp of the city.

The city's soundscape found itself as an evolving texture, while a renewed sense of cosmopolitanism flourished under the umbrella of entrepreneurship, middle to lower-class people found themselves forced to move further away from their communities and lifelong homes on the promises of reallocation (Carvalho, 2018).

As the physical topography of the city shifted, so has its cultural and sensorial backbone. Certain dialects accents and expressions become less and less frequent to hear and are verging on the possibility of fading away into low-tier commercial applications, functionally extinct (Autor, 2019).

It was necessary to look upon the city as a whole, as the source of the artistic matter for encouraging debate and preserving its social and cultural landmarks.

Through the creation of an artistic medium, in the form of an interactive sound installation, where listeners are confronted by the sounds of their environments, we could induce self-reflection and foster people's consciousness about their habitat. By integrating participants in transforming sonic ecosystems, we created a space where people could clearly perceive their role as composers of Porto's soundscape.

By composing interactive soundscapes and by reconnecting listeners with their physical spaces we can enhance the preservation of their communities (Truax, 2008). The flow of energy in a sonic ecosystem is analogous to the relationships between its agents. The sonic outcome depends on the relationship between the internal and external elements, as well as the surroundings (Musick, 2016).

These interdependent relationships arise among the foundations of ecosystems. Systems revolve around communication amidst its peers – there's a sense of inter-reliability – for even a singular message uttered inside an empty room ripples across the airwaves, bouncing back and forth the walls. No sound is ever only a product of chance, for sounds go beyond simple storytelling.

On the assurance that sound has this capability to untangle social roots, cultural barriers and provide meeting points between different communities from the social spectrum, we proposed to build upon the artistic efforts that have been materializing across the nationwide panorama during the last couple of decades.

A prototype audio installation named *Aural Wandering* was devised, developed as an interactive sound installation where participants navigate through a generative sound ecosystem, existing a relationship of interdependence between

[3] People from Porto.

internal sound elements and participants, acting as composers of the surrounding sound space, shaping the experience.

The remainder of the paper is structured as follows: section 2 presents considerations about soundscape studies in Portugal as mediums for cultural preservation and some notes on embracing an ecological approach to creating sonic art. Section 3 documents the devised methodology and the proceedings of the field recording sessions. Section 4 details the technological development of *Aural Wandering,* and section 5 presents the validation of our research. To conclude, section 6 highlights the main contributions and conclusions and deliberates possibilities for future work.

Sound as a medium for social engagement and cultural preservation

In recent years, a chain of field recordings spread across the panorama of Portuguese sound art. Different groups of investigation sprouted throughout the Portuguese territory creating archives of sound memories such as *Sons do Arco Ribeirinho Sul*[4] (Antero, 2012) and *Arquivo Digital Binaural Nodar*[5] (Costa, 2014). These audio archives established cartographies of sounds as mediums for the preservation and ecological awareness of the heritage of spaces, which were practically non-existent in Portugal at the time (Rios, 2014).

In Porto, *Phonambient*[6] arose as a collective effort between sound artists to document the contemporary soundscape and harness its sounds through varied artistic endeavors. This collective of researchers came to fruition through the coordination of sound artist Gustavo Costa and the cultural association *Sonoscopia*[7].

Phonambient distinguishes itself by studying the inherent musicality among the citizens' accents, the way they convey and transmit messages among themselves, whether by using expressions intrinsically rooted in their social and community aspects or by their relationship with their spaces. As a platform and as a group, *Phonambient* was apart of a bigger undertaking of the previous research group *Porto Sonoro*[8], which was also apart of the larger event *Manobras no Porto*[9] which took place throughout 2011 and ending in 2012.

Manobras no Porto aimed at studying the relationship between the city's creative and cultural agents amid its historic city centre in order to revitalize the bond among inhabitants and visitors in city-wide artistic cooperation. A variety of cultural approaches and experiences was employed in producing artwork that promoted social engagement and a conscious relationship with soundscapes that restores harmony within the city's most crucial aspect and resource – its people (Landry, 2012).

[4] www.cidadesom.pt/places/category/sars/ – Accessed on the 7th of January 2020
[5] www.archive.binauralmedia.org/ – Accessed on the 7th of January 2020
[6] www.phonambient.com – Accessed on the 6th of January 2020
[7] www.sonoscopia.pt – Accessed on the 7th of January 2020
[8] www.portosonoro.pt – Accessed on the 6th of January 2020
[9] www.futureplaces.up.pt/manobras/livro_manobras.pdf – Accessed on the 7th of January 2020

Soundscapes are a part of and a causality of the compositions between its agents, who are its audiences and performers (Schafer, 1993). In order to foster a greater consciousness by the public, a soundscape composer should listen.

Listening is a paramount task when composing soundscapes. It's through a compositional approach towards our soundscapes that we comprehend the forces at play, and how we understand how to create a sense of balance between *motifs*, and which elements we preserve and encourage in the ensemble and which elements we discourage in order to improve its orchestration (Schafer, 1993)

Immersing participants in information-rich soundscapes such as ecosystemic[10] music systems encourages the interpretation of the historical, ethnographic and geographic aspects of sounds by its listeners and imprints the ecological necessity by which we achieve social engagement in an artistic undertaking (Opie and Brown, 2006; Truax, 2008).

Ecosystemic music systems (re)create entire ecosystems by understanding their place as part of complex network, where energy is part of a sonic interplay and the flow of energy stems from the dynamics of interdependent relationships (Remmert, 1980). An ecosystem is therefore continuously structured on top of elements that move across their environments according to their inherent set of rules (Nees, 2000).

Applying an ecosystemic perspective towards interactive music systems emphasizes the structure of the whole body of sound as a solid unit where the composed ambience is a sum of its parts: a consequence of its "sound-transmitting and sound-modifying elements" (López, 1998, p.1).

Porto's *soundscape* is intrinsically weaved by the communities, the human and non-human actions and experiences that emerge from this shared sense of reality. The nature of sound is not as an *object* (Schaeffer, 1966), but an audible manifestation of these interactions (Solomos, 2014).

The act of wandering: nurturing a closer symbiosis between sound-making agents

The need for implementing compositional approaches to create a sense of harmony between citizens and their aural dimension is structured around the perception that humanity can structurally impact soundscapes (Schafer, 1993). By comprehending and designing the topographic plane by which our soundscapes resonate, we create a framework by which we reinforce the kind of sounds (and messages) we want to preserve, encourage and produce to retain our sense of being and to connect to our surroundings, and our cultures.

As such, *Aural Wandering* can be divided into three practical stages: 1) the field recording sessions in the historical city centre, 2) conceptualizing and developing the sonic ecosystem, and 3) the practical evaluation of the aural cartography.

We adapted the practice-led research methodology into the *wandering approach* in order to comprehend the soundscape of Porto. This was an exploratory method that allowed to clearly delineate a *praxis* in its sequential stages of investigation.

[10] Of or pertaining to an ecosystem.

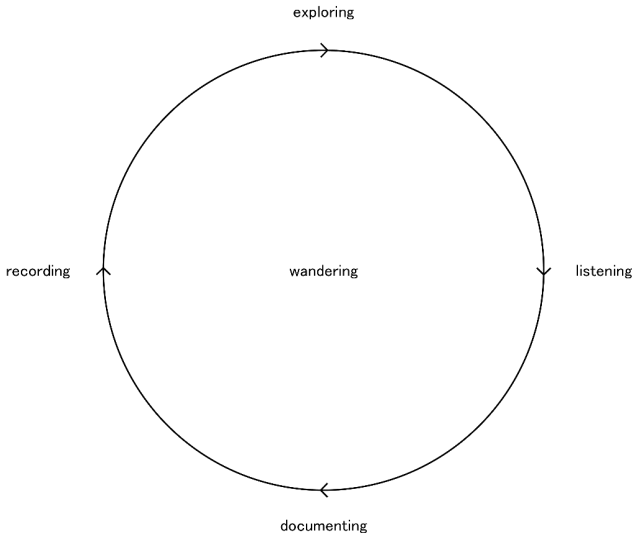

Fig. 1 - The wandering approach.

The cyclic nature of this methodology aimed at exploring, listening, documenting, and recording the soundscape progressively, leading me to identify the most sonically interesting areas and plan the recordings iteratively.

A great variety of sounds were gathered during the time spent wandering about the historical centre. Different recording techniques were used throughout the sessions, from stereophonic techniques, such as AB or XY, for capturing perceptible movements in the angular field to surround techniques, such as A-format recordings with an ambisonics kit. The use of A-format recordings proved fruitful, as it provided for a greater depth in capturing the field of sounds in its wider spectrum, a considerable asset for recreating the city's sonic ecosystem in the development stage that followed.

Applying an explorative approach to this primary stage of investigation demonstrated the resourcefulness of practice-based methodologies, for the time spent wandering through the city granted us with a deeper understanding of the nature of the sounds and their roots.

The Historical Centre of Porto (HCP) emerged as a crucial part in comprehending the relationships between the cultural elements but also the transforming agency that converged in shaping the physical landscape of the city and its *soundscape*. We gradually narrowed our approaches by looking at meeting points among the communities that connect the HCP, places where the old and new coincide and stitch the diverse cultural fabric.

We identified the traditional areas of Sé and Fontaínhas as a vibrant sonic juncture and assigned them as the basis of our sonic recreation, as per their historical importance and for being located precisely at the epicenter of the HCP. While both zones served as long-established residential areas with similar communities

inhabiting them, they diverge at the cornerstone of their commercial activities and population density, granting different possibilities of sounds.

Sé is the nerve center of the cultural transformation happening throughout Porto, while Fontaínhas resists as a sparsely populated counterpart, preserving, in a broader sense, most of the communities that were more common around Sé, but also presenting a dichotomy between its quiet, abandoned slopes, the fauna and flora that persist, and the reverberating machinery of incessant construction work.

It's also at the meeting point between Sé and Fontaínhas, in the stairways of Guindais, that we encountered the most elaborate sonic nuances. From families that always made their life on those steps and the huge flocks of tourists climbing up the alleyways, Guindais unravels its nature precisely as a testament of the old and the new living side by side.

While the stairways of Guindais linked the traditional neighborhoods, we looked upon the Dom Luis I Bridge as another interesting connection between the twin cities of Porto and Gaia.

Although the two cities are bound together by their nature and their proximity, new sonic roots have sprouted. The local accents, phrases, expressions, and the general musicality of speech itself, have fragmented, leading to tonal variations.

As the recording sessions progressed, we realized that not only were we piecing together narratives but creating a middle ground for people to express their own. The act of wandering became the entangling medium by which we could link together all of these stories.

As the field recording sessions were approaching their end, sound cataloguing commenced, consisting of dividing, editing and documenting sounds according to their acoustic sources, following Krause's (2008) methodology.

Krause dissects soundscapes as relating to three different types, following their acoustic sources and their roles in shaping our sonic magnitude: 1) the anthrophony – human-produced sounds, 2) the biophony – sounds produced by the natural fauna, 3) the geophony – organic sounds from non-biological sources, "the effects of wind, water, weather, and geophysical forces." (2008, p.75).

As sound cataloguing concluded we moved onto developing the aural cartography of *Aural Wandering,* aiming at intertwining our sense of being and our sense of living within the soundscape of Porto.

Aural Wandering: fostering self-reflection by designing interaction

Aural Wandering is an audio installation prototype that invites participants to navigate the aural landscape of the Historical Centre of Porto. The experience takes place in a dark environment where participants explore generative aural cartographies, transforming iteratively the compositional nature of the soundscapes by exploring different layers of the sonic space.

It presents itself as a dynamic *soundmap*, a practical application of the devised Microscope/Kaleidoscope (M/K) paradigm of interaction that allows participants to dissect pieces of the ecosystem by exploring the sonic density on different levels

(Autor, 2019). On smaller – microscopic – levels or wider planes: the kaleidoscope counterpart. M/K looks upon the fabric of sounds as a complex weaving of sonorities. By establishing a capability of perceived sonic zoom on specific aspects of sounds, we progressively break or mend apart each of its atoms in evolving sonic ecosystems. Listeners create their patterns of interaction by shaping their surroundings and adapting their sense of listening to the deep resonances of the environment.

As the conductors of sonic energy flowing within our ecosystems, our sense of listening is a consequence and a reflection of our auditory disconnection towards our soundscapes. With *Aural Wandering* we devised a sensitive space where listeners are immersed in a deep synergy between the sensorial forces at play to endorse and continuously experience profound listening, shifting "the focus of our attention and understanding from representation to being." (López, 1998, p.2).

Traversing the cartography transforms the outcoming soundscape by imbuing it with generative sonic agents that compose it. By lingering in certain spaces or aspects of the aural cartography we shape its sonic environment, sound spreads around and within listening bodies, as well as across and within the surrounding ambiance. As it takes place, it also takes on the semantic connotations of (recreated) places, exploring emotional triggers within the memory of sounds, as an event in and of the environment (Solomos, 2014).

Developing the technological prototype

The prototype of Aural Wandering – the aural cartography of Porto – was entirely developed in Max[11] using digital signal processing, sound synthesis, and spatial transformations.

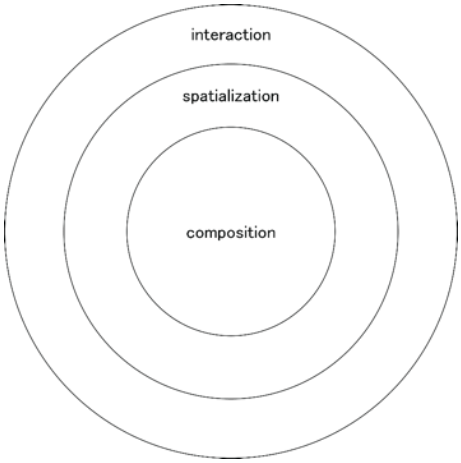

Fig. 2 - A circular diagram representing the stream of processes, transformations, and their interdependence.

[11] https://cycling74.com/ – Accessed on the 14th of January 2020.

Three inter-reliant layers form the sonic ecosystem, namely 1) composition – generative sound algorithms 2) spatialization – for rendering and transforming sound fields, and 3) interaction – handling all the communication between users, through the tactile interface, and the system (via OSC).

The aforementioned M/K interaction was practically applied for developing the aural cartography by interpolating data graphically in a cartesian diagram through the nodes object in Max. By allocating sounds to nodes we assign each of them spheres of incidence/influence in a bi-dimensional plane.

Participants control a knob that wanders through the plane according to the imputed X and Y values on the cartography, this controls the playback volume of the encountered sound by combining its interpolated weight, from 0. to 1., into a list. This value depends on the overall distance from the epicenter of the node (Fig. 3). Multiplying both signals creates the perception of distance and simulates an environmental depth of field through amplitude modulation.

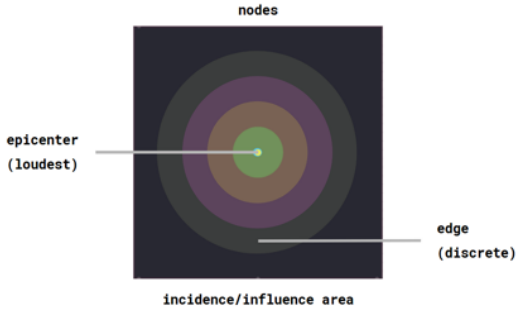

Fig. 3 - An overview of sound nodes and amplitude modulation.

The aural cartography of Porto was designed with 30 nodes, numbering 43 different samples allocated to their recreated spaces of origin. The previously recorded zones of Sé, Fontaínhas and Dom Luis I Bridge were assigned zones on a bi-dimensional plane and spatialized according to their inherent physical characteristics and movements (Fig. 4).

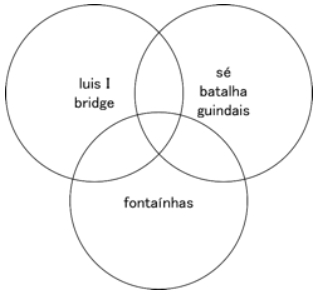

Fig. 4: The bi-dimensional plane divided into three zones and their general spheres of influence (Dom Luis I Bridge – top-left sphere; Guindais – top-right sphere; Fontaínhas – bottom sphere).

The soundscape of *Aural Wandering* can be dissected according to the agency of its constituent spheres of sound in producing different layers of interaction. The texture of the sonic environment is established by providing a dense sense of stability and place, arranging the sonic ambiance or mood by interplaying foreground sounds with pivotal agents that enrich the cultural fabric of sounds by conveying meanings about space.

Zones are populated with different degrees of sonic energy, mimicking their real-world counterparts. Some zones are packed with an increased concentration of sonic agents in tight spheres of incidence, while other zones make use of their reverberating characteristics in causing ripples across the continuum.

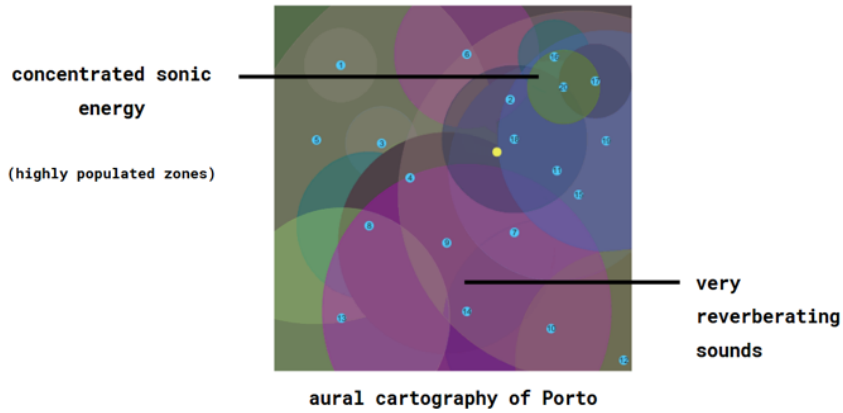

Fig. 5: The aural cartography of Porto and its varied degrees of sonic agency.

Aural Wandering relies on different sound design methods for inducing interaction through listening. Inspired by the complex reality of human interactions and organic communications between non-human agents, the algorithmic approaches range from generative, cyclic, intermittent or sporadic events and linear or nonlinear agents for creating a sense of being in a conscious space.

The capability of permutation within our means of interaction with the soundscape encourages the disembodied sense of wandering about a sonic space which imprints a higher awareness of our belonging within the environment and sonic density. This complex atmosphere of sounds creates a sense of adaptive listening, as participants progressively adapt their approach to the perceived characteristics of sound.

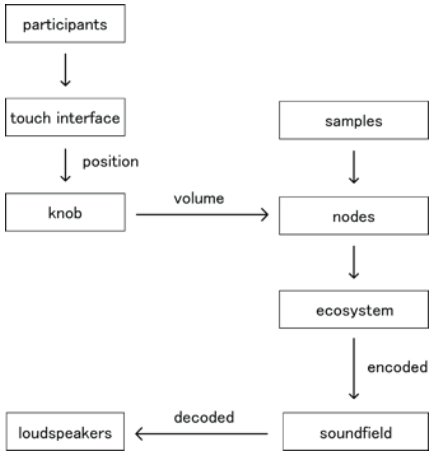

Figure 6: The system's architecture and modulation by the user, and all the processes at play.

Evaluation

Setting up the practical experimentation

The practical evaluation of the *Aural Wandering* consisted of five-minute experimentations between 11 participants and the ecosystem, taking place at the university campus of FEUP[12]. A qualitative-oriented analysis was set in place by testing the prototype of the audio installation with a varied group of participants for feedback. Data evaluation aimed to comprehend patterns of interaction between the participant/composers and the sonic ecosystem, identifying the sound sources of the composed soundscapes and their correlation with the memories of the sounds.

The room was dark, barely lit by hints of sunlight. Participants sat upon a movable chair and were given the touch interface (Figure 7). A blindfolded interaction was implemented, giving a brief explanation of the experience. We presented the interface and provided tips on how to interact with the overall experience. We reminded participants of its duration and started the practical experiment.

The technical setup of the prototype audio installation was as follows: 1) a circular arrangement of 8 horizontal speakers, 2) one chair, 3) one mobile touch interface running an OSC based application, and 4) one personal computer running the aural cartography.

[12] www.fe.up.pt – Accessed on the 14th of January 2020.

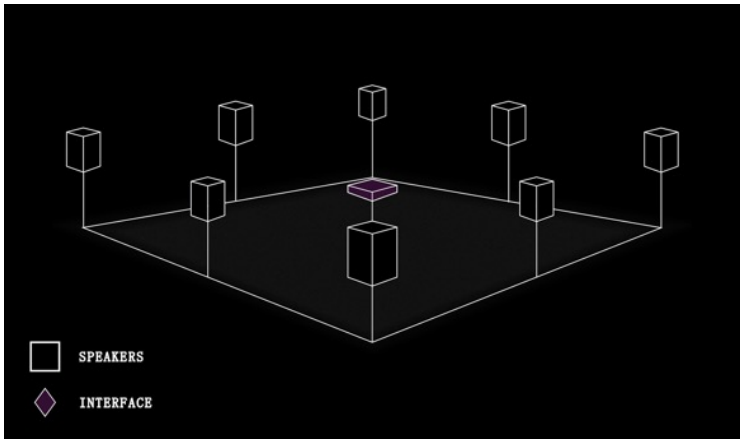

Fig. 7: A sketch of the prototype of the audio installation. The soundfield is established by 8 spatial speakers, in a 2 order of ambisonics. Participants interact through a touch interface that was positioned in the middle, the sweet-spot of the soundfield.

Validation

A conversation followed the conclusion of the practical interaction, where we thanked the participants and asked them about their feelings about the experience and solicited comments and observations about the perceived aspects of the experiment, the system, and the interaction.

Positive feedback was gathered as people made some interesting remarks about the installation and their experience with it. Participants were excited about shaping/composing the experience and learning about the origin of sounds and their own integral part in bringing them into the array. They frequently answered the overall aim of the research, expressing a concern for revealing the sounds of spaces, communities, their people, and their own memories and experiences with similar sounds in everyday life. They noted their own impact and the impact of other internal agents in shaping the soundscape, pondering the necessity to preserve some elements and to have different kinds (a variety) of sonorities.

Participants remarked the value of having a plurality of spaces with different characteristics of sound. They noted how discrete sounds of people instill the ability to breathe, and to become one with the environment, praising the "freshness and openness of these surroundings" (AUTOR, 2019, p. 87). They relied on building mental pictures and paths during the experience, explaining that this digital interpretation of spaces impacted them positively and guided them through their journeys across their memories of Porto and the recreated historical centre.

Not only were participants perceiving cultural information, but they were also part of making it, being the mediators – the composers of the aural environment.

Conclusions and future work

In this paper, we presented *Aural Wandering*, an aural cartography of the sounds of the Historical Centre of Porto in the form of an interactive audio installation. Our goal was to create a space that induced self-reflection, fostered social engagement for the cultural preservation of soundscapes and nurtured a closer harmony between the sonorities of Porto and the people that produce, shape, and live through them every day.

When participants were approached with the evolving theme of their soundscapes by having the means to transform them, carve them and construct new sonorities, they perceived the new social state entrenching itself in the fabric of Porto, validating Jacques Attali's stance on the prophetic nature of music (1977).

Aural Wandering is an initial step towards creating a delicate sensorial experience that invites citizens into a collaborative experience, interested in raising social debate about communities and their place in culture-making. It is vital that this research deeply stem from the outcomes of everyday interactions, for the act of wandering shapes our understanding of our physical spaces, allowing us to treasure our memories through sound, and to connect and understand on a deeper level the livelihood of this city.

Future work

In light of pursuing new layers of interaction and articulating the artistic medium with the social message and to bring people together in conscious play, we are pondering new dynamics, such as motion control and sonic input to move away from palpable technology to an enriched, sensorial sense of being within the soundscapes, creating immersive spaces where we move away "from interactive composing to composing inter-actions" (Di Scipio, 2003, p.270).

We are also considering scaling down the experience for mobile users, implementing *Aural Wandering* into an online audiowalk mobile application using GPS, that balances outcoming sounds from the aural cartography coming through speakers or headphones with the incoming soundscape, mixing the sounding ecosystems in an ambient of portable performance.

References

Antero, L. (2012). *Sons do Arco Ribeirinho Sul*. Accessed on the 7th of January of 2020, from Cidade Som: https://cidadesom.pt/sons-do-arco-ribeirinho-sul/

Attali, J. (1977). *Noise: The Political Economy of Music.* Paris: Presses Universitaires de France.

Carvalho, P. (9th September 2018). Câmara do Porto quer retirar todos os moradores do Bairro do Aleixo em seis meses. *Público*. From https://www.publico.pt/2018/09/09/local/noticia/camara-do-porto-quer-retirar-todos-os-moradores-do-bairro-do-aleixo-em-seis-meses-1843394

Costa, L. &. (2014). Accessed on the 7th of January of 2020, from Arquivo Digital da Binaural/Nodar: https://www.archive.binauralmedia.org/

Di Scipio, A. (2003). Sound is the Interface: from Interactive to Ecosystemic Signal Processing. *Organised Sound*, pp. 69-77.

Krause, B. (2008). Anatomy of the Soundscape: Evolving Perspectives. *Journal of the Audio Engineering Society*, pp. 73-80.

Landry, C. (2012). *The Sensory Landscape of Cities.* Gloucestershire, United Kingdom: Comedia.
López, F. (1998). *Environmental Sound Matter.* From http://www.franciscolopez.net/pdf/env.pdf
Musick, M. (2016). *Practice-Led Research/Research-Led Practice Identifying the Theory and Technique of Sonic Space Ecosystems.* NYU. New York: Steinhardt School of Culture, Education, and Human Development.
Nees, G. &. (2000). Growth, Structural Coupling and Competition in Kinetic Art. *Leonardo*, pp. 41-47.
Oliveros, P. (2005). *Deep Listening: A composer's sound practice.* New York: IUniverse.
Opie, T. &. (2006). An Introduction to Eco-Structuralism. *Proceedings International Computer Music Conference*, pp. 9-12.
Remmert, H. (1980). *Ecology.* Berlin, Germany: Springer Berlin Heidelberg.
Rios, P. (10 de January de 2014). Os caçadores de sons que nos dão a ouvir Portugal. *Público*. Accesed on the 7th of January of 2020, from www.publico.pt/2014/01/10/culturaipsilon/noticia/os-cacadores-de-sons-que-nos-dao-a-ouvir-portugal-329451#gs.ptBq755Z
Schaeffer, P. (1966). *Traitédes des objets musicaux: Essai interdisciplines.* Paris: Éd. du Seuil.
Schafer, R. M. (1993). *The soundscape: The tuning of the world.* Rochester: Destiny Books.
Solomos, M. (2014). Agostino Di Scipio: Audible Ecosystems. *Contemporary Music Review*, pp. 2-3. doi:10.1080/07494467.2014.906673
Truax, B. (2008). Soundscape Composition as Global Music: Electroacoustic music as soundscape. *Organised Sound*, 103-109. doi:10.1017/S1355771808000149