Promoting awareness for the acoustic phenomenon: a survey of pedagogical practices and research projects developed at EA/CITAR

Promoting Awareness for the Acoustic Phenomenon: a Survey of Pedagogical Practices and Research Projects Developed at EA/CITAR

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Abstract

At EA/CITAR (School of Arts/Research Centre in Science and Technology of the Arts), sound has always assumed a fundamental role, both in academic research and curricular offer, featuring a Master Program in Sound Design and a Doctoral Program Specialization in Computer Music. This paper presents an overview of some recent artistic/research projects undertaken by students and researchers at this institution, which stimulate the user/listener awareness for the acoustic phenomenon. Furthermore, we describe three pedagogical practices, stemming from Soundscape and Film Sound studies, which aim at training students to avoid the devious influence of sight on the assessment of soundscapes.

Keywords: Acoustic Ecology, Audiogames, Soundscapes, Awareness, Pedagogy, Sound, Film Sound, Sound Design

1. Introduction

The acoustic phenomenon plays a fundamental role in the lives of most species. From fish to humans, insects to large-scale animals, sound (and its propagation) accounts for an important share of the communication processes occurring both at the interpersonal level and between individuals and the environment. However, in the saturated soundscapes of modern urban centers, the signal-to-noise-ratio has decreased to a point where meaningful sonic exchanges between the environment and citizens have become scarce, limited in distance or painfully loud. In order to change this situation is important to regain control and sense of identity over urban soundscapes, which, in our opinion, starts by creating awareness for the acoustic phenomenon among citizens.

The research projects described in this text all share the same underlying goal of inciting the listener to gain a deeper conscience about the auditory phenomena. For the sake of clearness, we have opted for grouping the projects under the following categories: 1) Audiogames, 2) Tools and 3) Soundscape Sensing Applications. A brief outline of each of the projects is presented next, followed by the description of the pedagogical practices.

2. Audiogames

An easy way to explain to a layman the concept of audiogame is to describe it as a videogame without image. Despite the over simplification and incorrect approach, the image of someone playing on a game device making sole use of auditory stimuli represents a faithful picture of what most audiogames look (and sound) like. For our present endeavor, audiogames are considered a privileged resource as they represent excellent examples of what (Pausch 2008) denominated by "head-fake": an indirect learning method "that teaches people things they don't realize they're learning until well into the process".

In this section we present two examples of audiogames, both designed and developed at UCP: Murky Shooting (Joao Cordeiro 2011; Joao Cordeiro, Baltazar, and Barbosa 2012) and Sound of Horror(Gonçalves 2014).

2.1. Murky Shooting

Murky Shooting is a first-person shooter game, a sub-genre of shooter games characterized by displaying a view from the player perspective. In the case of audiogames, that is accomplished by providing the user with an auditory perspective of the character they control in the game. It was initially developed a desktop version for OSX in Max/MSP version 5 and later a mobile version for iOS programmed in C++/openFrameworks. The audio output is to be listened with headphones in order to increase immersion and avoid contamination by external sounds. The initial version used HRTF[1] for sound specialization in order to have an improved matching between the auditory perception and the real experience. The objective of the game is to hit a target as many times as possible over a time limit. A noisy crow perched on a high voltage cable represents the target. Its position on the cable changes over time and is made accessible to the player through the crow's caw (sample sound), which changes its panoramic according to the crow's horizontal position on the cable. Different game levels are set by varying the amount of time the crow remains still in one place: decreasing the time increases the difficulty. On the entry level the crow remains still during five seconds before updating its position, decreasing one second per each level. Player has access to unlimited munitions, yet it has to recharge his/her weapon every eight shots. This control feature was included to dissuade players of indiscriminate shooting and is implemented differently in the desktop version and mobile version.

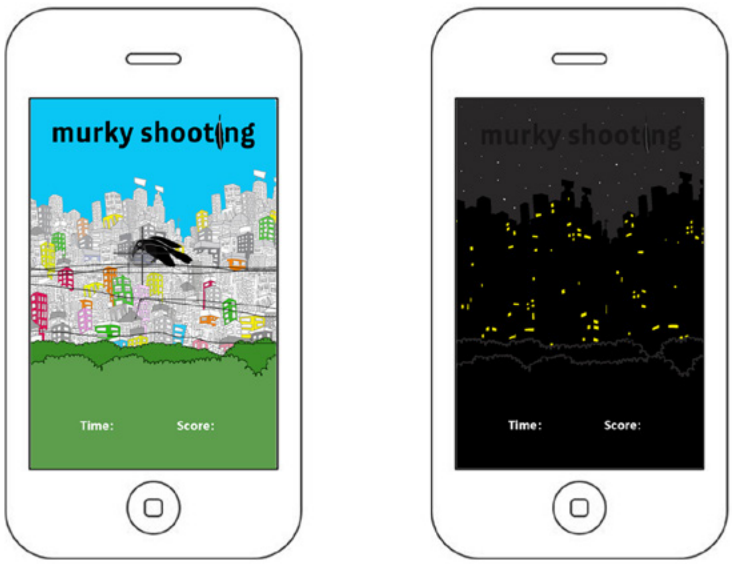

Figure 1. Murky Shooting GUI: daylight mode (on the left) and night mode (on the right).

1. HRTF – Head Related Transfer Functions.

In order to aid the player during the hunting task there are auxiliary sound guides that indicate the crosshairs position. These guides are blip-like sounds (synthesized sound) that change pitch and frequency of occurrence consistently with the distance to the target. Moving away from the crow's position lowers the pitch and decreases the number of blips. When the crosshairs are on sight with the crow, a burst of noise is triggered. Player has then the opportunity to hit the crow and increment his/her score. A background sound composed of a quiet city ambient was added to the game in order to set the context for the action. A celebration sound plays every time the player hits the crow and a rifle sound is heard on every shot.

The game has two distinct modes: 1) in "daylight mode" the player can see the crow and the crosshairs moving on the screen. This mode exists for practicing purposes, allowing the users to understand the match between sound and game action. 2) In "nigh mode" the player does not have any visual feedback.

Both versions of the game (mobile and desktop) were systematically tested. The most important conclusions were that the game could be learnt, users started to show a steady increase in the score after two gameplays. Nonetheless, for the sake of this paper, the results of qualitative analyses based on informal enquiries with the players disclosed rather interesting insights. In general the enquiries were surprised that such a visual game paradigm could be successfully played using basic and limited audio cues.

2.2. Sound of Horror

The Sound of Horror is an immersive and interactive installation, consisting of a single player first-person shooter survival horror audiogame. The user is placed in a confined space in the complete absence of light, in which he or she is subject to the attack of simulated monstrous creatures, manifested solely through sound, in 360 degrees.

The purpose of the game is the user's self-defense, for which he or she has access to a weapon, similar to a real shotgun that he can use to neutralize the attackers. In order to do so, the user has to successfully pinpoint every target in space.

There are several challenges placed upon the user: auditory acuity to locate the monsters, physical agility to point the gun at the creatures, swiftness to pull the trigger and control of the stress and anxiety before the increasing aggressiveness of the monster, which translates into the player's death if unsuccessful. The user is put under psychological pressure that increases throughout the game. The lack of accuracy or quickness will cause the attackers to get closer and closer to the point of virtually reaching the player physically before annihilating him. This impending panic contributes for the overall horror atmosphere, catalyzed by the darkness, while also acting as a stimulus to overcome the hurdles.

The primary interaction with the user is based on the sound of the game, the only feedback resulting from his or her actions. It is up to him or her to react to it by using the weapon. The player becomes aware of the unsuccessful shots through the creeping in of the monsters, which sound like they gradually get physically closer and become more violent. On the other hand, if the player hits the creatures, they will scream in agony. The game is structured into several levels, in which a new wave of monsters spawns, more agile and clever than before, forcing the player to adapt.

A 16.1 speaker system with discrete channels, setup in a circular setting with a diameter of 4.6 meters was used in the installation. For the real-time spatial synthesis of the dynamic sound sources, the Ambisonics technique was used (see (Gerzon 1985) for an insight on Ambisonics technology).The ©Nintendo Wii Remote, along with the ©Vicon Motion Capture system allowed for the tracking of the several actions for the weapon: point, shoot and reload. The programming of the game was accomplished using Max/MSP version 5.

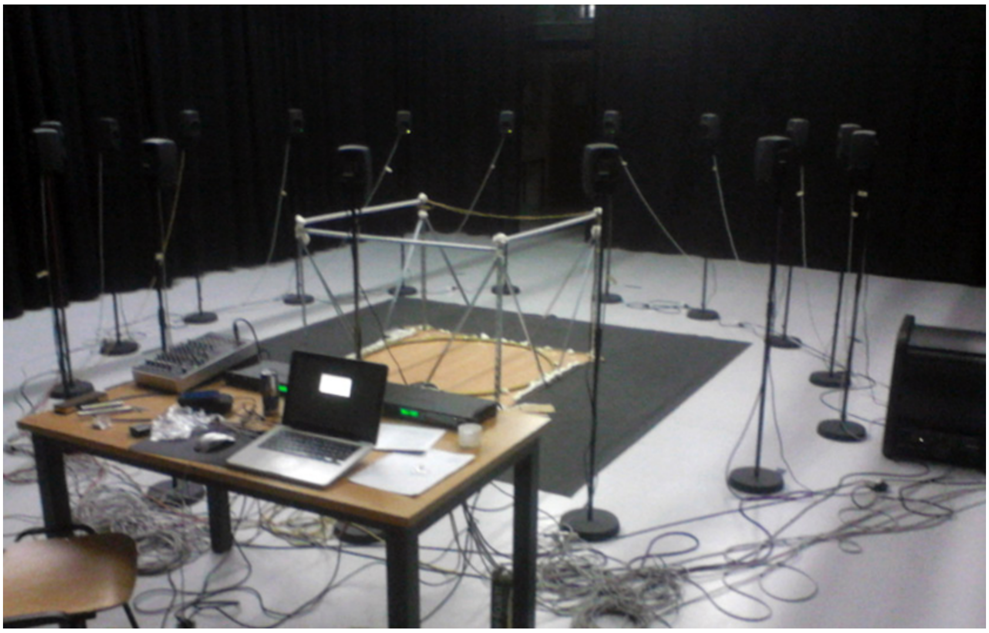

Figure 2. Sound of Horror game set.

The presentation of The Sound of Horror took place in the Motion Capture Laboratory, in the School of Arts of the Portuguese Catholic University in May 2013. The game was played by a total of 25 people. A slight change on the game's protocol was made, by introducing a very dim lighting, so that the public could observe the player's movements. The result was surprising. The immersion of the player, as it was conceptualized, leaked out and was shared with all of the audience. An interesting case was a child that felt this so strongly that became frightened and refused, at first, to play. General comments from users regarded the "intensity of the game", "accuracy of the weapon and positioning of the targets" and "feeling of improvement along the gameplay over different levels". No systematic gamability testing was accomplished.

3. Tools

The assessment of sound qualities is a common practice across different professional and scientific areas. Acousticians, Sound Engineers, Environmental Attorneys, Musical Instrument Builders are some of the groups of people that have to deal with measuring and analyzing sound. Typically, the sound assessment is made through a combination of objective and subjective analysis. In this section we present a framework created for soundscape assessment in laboratory, which is a combination of both objective and subjective analysis, expanded with an active participation of the test subject.

3.1. MMucS

MMucS - Massive Multichannel Speaker Setup (Joao Cordeiro, Barbosa, and Santos 2013), is a soundscape assessment tool that privileges aspects of Ecological Validity of auditory stimuli and Representative Design during listening tests. It is comprised of a room featuring a multichannel surround system of 16 discrete speakers (©Genelec 6010A plus a subwoofer), a costume made software for sound spatialization, video canvas and projector, a SPL meter, a midi controller and a set of audiovisual samples featuring HD video and 6 channels audio recordings. The room area is approximately 75m^2, with stonewalls, concrete floors and minor acoustic treatment (black flannel curtain converging the surrounding walls). The goal of this system is to accomplish listening tests in laboratory, assessing real or artificial soundscapes, in a way that the test subject's experience in the laboratory matches the experience in a real scenario. This is accomplished in different levels: first, the original soundscape is recorded with a microphone array technique optimized for recording sound *atmospheres*[2] and diffused through a matching multichannel speaker setup; second, there's a video canvas

2. IRT Cross (alsoknownbyatmoscross).

displaying real-scale video in front of the test subject, offering him or her the same visual perspective of the real scenario; third, the test subject is in contact with some furniture and objects from the real place.

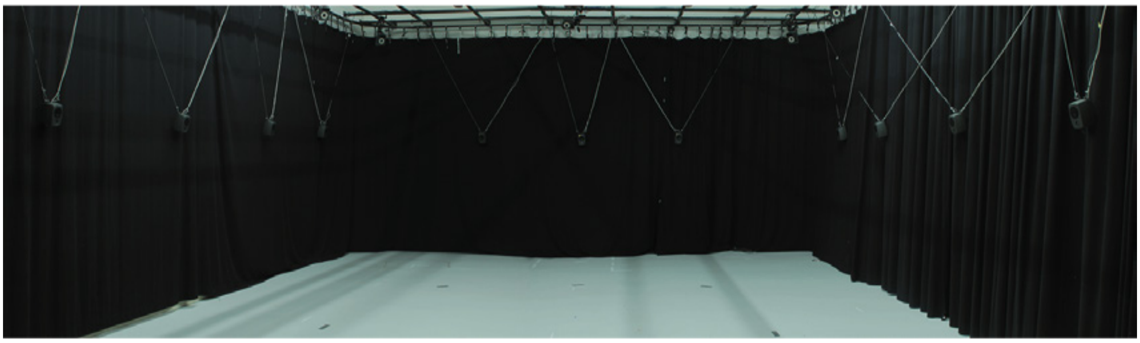

Figure 3. MMucS listening room featuring sixteen speakers(photography by Adrian Santos).

After setting up this test framework, we compared it against traditional techniques based on binaural recording and headphones listening. The results shown us that using a surround sound system that is headphone-free gives the test subjects a greater sense of reality even if some sound features are compromised (sound quality, fidelity).

Additionally, we have built a module for soundscape design, featuring four audio tracks, each one dedicated to a single category: dialogs, radio/tv, nature, cafeteria. Each track had four 6-channel surround samples, with a total of 16 samples and 256 possible combinations. The system allowed the user to select one sound for each track/category and modify its volume (a typical audio mixing process). No GUI was used; subjects interacted with the system using a tangible MIDI controller[3]. The sounds were reproduced using the surround system described before.

3. ©Behringer BCF2000.

Figure 4. MMucS being used during a listening tests (photography by Adrian Santos).

As mentioned before, the system was used and evaluated during a batch of systematic listening tests. The survey not only validated the assessment method as it told us that people agreed that the process of designing the soundscape was a efficient way of promoting awareness for environmental sound.

4. Soundscape Sensing Applications

In this section we describe two systems that have in common a sound-sensing mechanism as part of their core. This sensory characteristic is of high relevance in the interconnected world of sensor networks as it opens new windows of opportunity to understand our environment and routines. The two applications presented next are Hurly-Burly (Joao Cordeiro and Makelberge 2010; João Cordeiro, Barbosa, and Afonso 2013; Joao Cordeiro and Barbosa 2013a; Joao Cordeiro and Barbosa 2013b) - a sound-based social network application - and URB (Gomes and Tudela 2013), a system for automated analysis and storing of an urban soundscape.

4.1. Hurly-Burly

Hurly-Burly is a context-sensing mobile application for the iOS, comprised of three main blocks: soundscape-sensing, information visualization and relational database. It was developed as a research tool to be used in a broader research project about the Soundscape in the context of Mobile Online Social Networking, aiming at determining the extent of its applicability regarding the establishment and/or strengthening of new and existing social links.

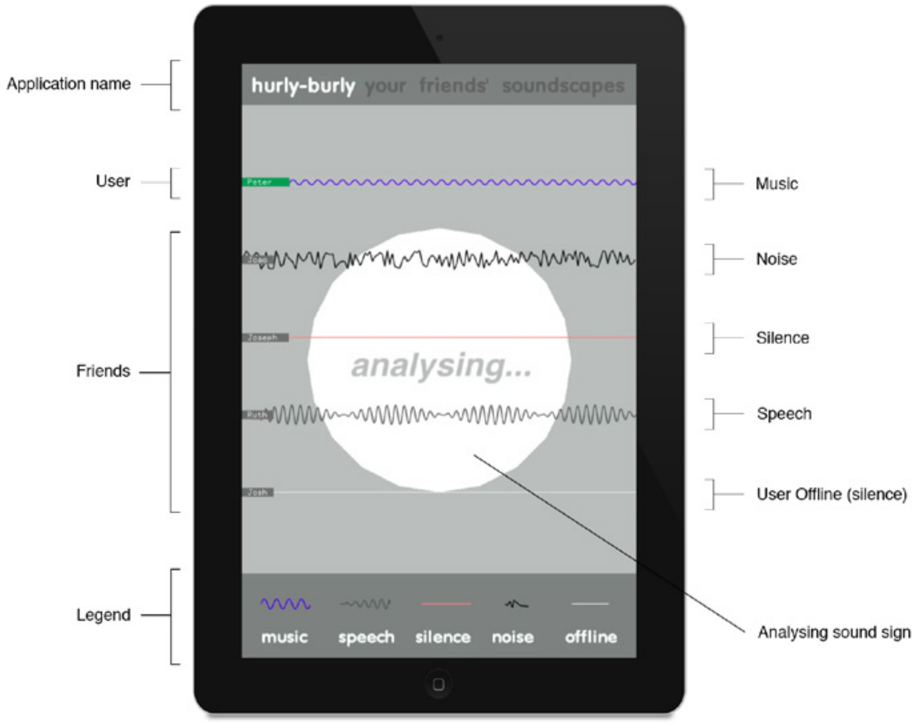

Figure 5. Hurly-Burly GUI for iPad (annotated).

Two main goals guided this prototypal research tool: collecting data regarding users' activity (both sonic and kinetic) and providing users with a real experience using a Sound-Based Social Network, in order to collect informed opinions about this unique type of Social Networking. The application – Hurly-Burly – senses the surrounding Soundscape and analyzes it using machine audition techniques, classifying it according to four categories: speech, music, environmental sounds and silence. A sample of users ran the application, gathering information about their acoustic environment and sharing it within their social network.

Results demonstrated that users, by visualizing long-term records of their acoustic environment, could identify the basic patterns of their quotidian activity and monitor their noise exposure, creating awareness for possible health problems. On the other side, exchanging this information with their peers allowed them to receive real-time non-intrusive information, regarded as useful for enhancing social interactions. Using sound as an unexpected element on online social networking, brought users attention to the acoustic phenomenon and made them think about their sound environment, both by analyzing long-term records and comparing their soundscapes with their peers. Taking this approach a step further, by implementing this features on commercial applications, would increase the users awareness for the sonic environment.

4.2. URB

URB[4] is a system for automated analysis and storing of an urban soundscape based on available and inexpensive hardware and open source software. It complements the traditional sound maps[5], allowing the direct access to the sound features at any arbitrary moment since the system boot, thus facilitating the study of the soundscape evolution and allowing for its direct comparison between specific timeframes. Moreover, this system simplifies the access to the aforementioned datasets for artistic purposes. It was developed to be used not only by environmentalists and urban planners but also by artists with creative intentions.

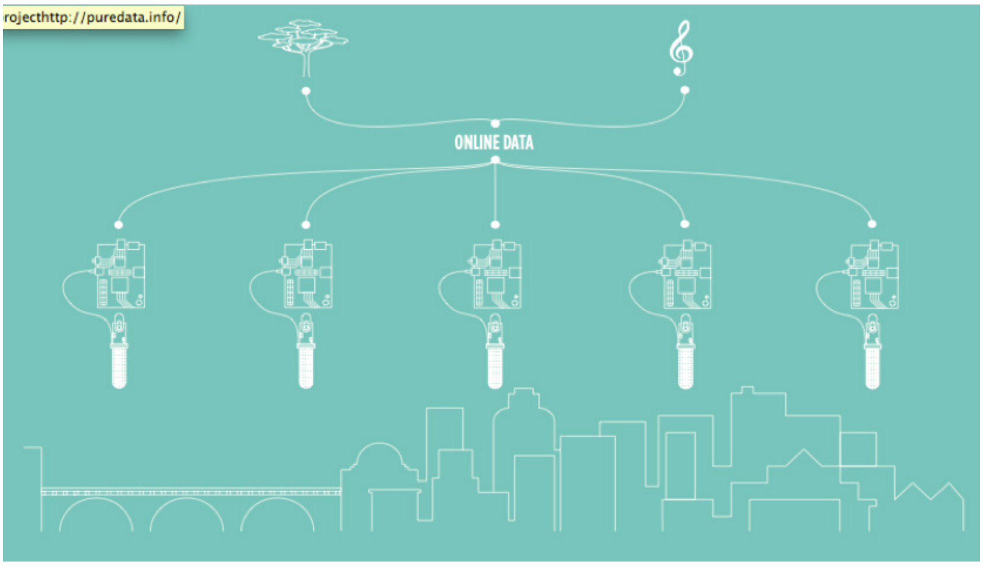

Figure 6. URB system (illustration by Diogo Tudela)

URB is part of an ongoing research project of exploratory nature, which emerged from the desire to find ways to use soundscapes as source material for significant artistic achievements. It aims to study the processes of capturing and storing the sound ambient and its

4. www.urb.pt
5. Sound maps are geographical maps that associate landmarks and soundscapes.

ecological decryption, specifically in its approach to artistic application. As such, in a first stage, seeks to understand how it is possible to capture and represent the most challenging variable of this massive sonic element that is constantly changing: its temporal axis. Grasping its nuances both on a scale of miniature time as in large time scales. In a second phase, attempts to understand the relevance of this information and its direct influence on the act of music and sonic creation. Therefore, our proposal is not only a continuation of the work already done, but also an artistic reinterpretation of sonic material that surrounds us and a study of how it influences us.

In a second stage a call was open to the musical and sound art community to work in the challenge of using URB[6] in the creative process. From that call emerged several works that the main element used was the data compiled by the system. URB proved to be efficient in accessing the audio descriptors data retrieved from sound ambient, in particular their temporal variations. It also provided composers enough raw materials in order to devise their works and achieve a higher awareness about sound environment. The artistic outcomes all pointed into diverse realizations about the aesthetic significance of using URB's raw data (described in detail in (Gomes et al. 2014). While some artists guaranteed musical elements such as melodies or formal coherences, others claimed that their instinct as composers induced them to adopt URB's metadata as a 'variation source', independent of the descriptors significance. In this case, even if the work is artistically interesting, there is not an evident correlation with the original source.

5. Sound Design Pedagogical Practices

In this section we describe three pedagogical practices we apply during the teaching of sound design courses, at different levels and stages of the academic path of our students. The aim of these exercises is to train the ear to perform judgment tasks detached from the devious influence of sight. Such skill is important to attain, particularly when designing sound for moving images, such as animations or feature films.

6. https://vimeo.com/79103493

5.1. Sound Sketching

Sound Sketching is an enhanced version of a soundwalk, were a group of four to five students walk through a given place having one of its elements blindfolded. Along the path, the blinded element listens to the soundscape and describes the different sounds he or she is listening, while other group element writes down this information, taking notes about the nature of the sounds, spatial features and temporal evolution (e.g. "car passing by on my left", "loud music in a cheap radio", "siren sound coming from behind"). At the same time, other members of the group record the soundscape (a few steps away from the other members to avoid capturing their voices) and take some pictures of the place. The second part of the exercise takes place at the sound editing room, where students try to reconstitute the soundwalk soundscape by searching and retrieving from a sound database, the sounds they have previously listed. The third part of the exercise is a critical listening comparison between the real soundscape and the one produced in the laboratory.

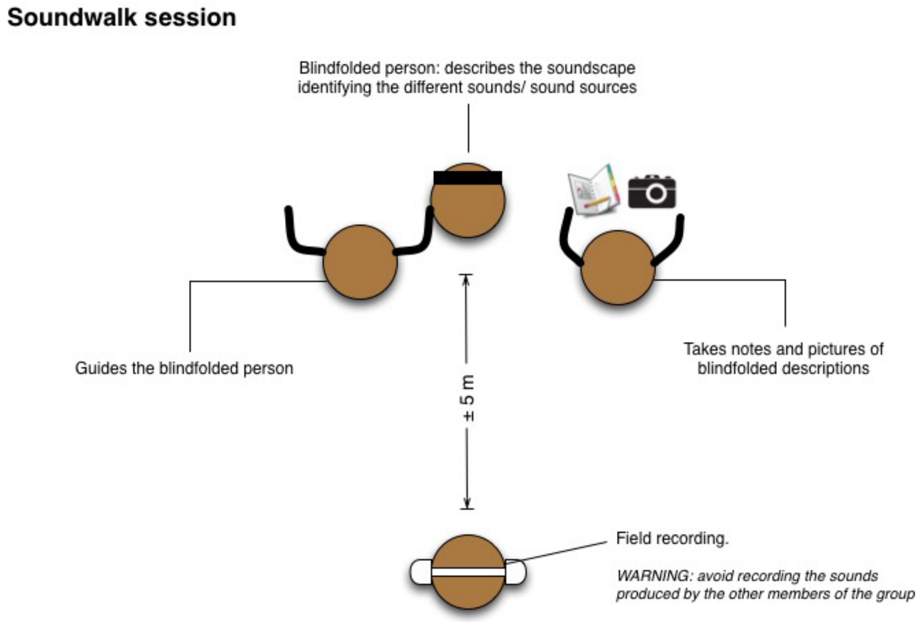

Figure 7. Sound Sketching exercise, recording layout.

Throughout the exercise several complementary learning outcomes are attained. During the first stage, students train critical listening on sound environments. Usually they will state that the blindfolded element will listen things that escaped their perception. Also at this stage, students learn how to do field-recordings. At the second stage, students realize that describing sounds in words is not a simple task. This is also the right time to teach them about basic sound categories (ambiances, voices, sound effects, natural vs. artificial, etc.) and the three listening modes: causal listening, reduced listening, and semantic listening. Additionally, they learn or improve their audio editing and mixing skills, using common digital audio workstations. At the last stage students realize that producing credible soundscapes in postproduction it is possible but requires mastering different skills. They acknowledge that the everyday sound environment is rather complex, and that non-trained ears usually overhear the plenitude of an intricate soundscape. Frequently, because they may have underachieved some of the steps, the resulting soundscape not always replicates well the original one.

5.2. Complex Soundscape Annotation

The complex soundscape annotation is an exercise based on a blind analysis of complex cinematic soundtracks. The students are asked to analyze the sound of a movie excerpt (2 to 4 minutes) deprived from image. The sound excerpt should be rather complex, containing several layers of sound from different categories and defying sources and variations. The images that go with the sound should be an obvious reproduction of what is being heard. The goal of the exercise is to reverse engineer the process of designing and composing a sound track for a given image. By listening to the sound first, students do not contaminate their interpretation with meanings imposed by the visual narrative. By itself, the sound is open to several interpretations and suggest different images on the minds of the listeners. During the analysis, students write down the list of sounds, how they evolve and what meaning do they carry. After that, the complete audiovisual excerpt is played and students have the opportunity to find the links between the meaning and emotional content present in each medium. Depending on the video excerpt, the results can be rather surprising since some soundtracks have a high level of abstraction, even if they are meant to complement a "real" action displayed on screen. Regarding the leaning outcomes, students practice their skills on acousmatic analysis and learn how to identify creative processes for sound design for moving images, both at ideation and implementation stages.

5.3. Soundscaping for Real Environments

Soundscaping for Real Environments is an exercise where students are asked to design in postproduction the soundscape for a real place represented on a silent video footage. It is important that they do not have a prior knowledge of the place, as it would affect their interpretation of the images. During the first stage they watch the footage, identifying actions, elements and events. Later they select which sounds to use (either recording them or searching on a database) and edit the soundtrack on a DAW. The final step is to compare with the real soundscape from the place. The learning outcome for this exercise regards the understanding of real soundscapes as a complex phenomenon, sometimes nothing obvious regarding the displayed images. Furthermore, students learn that the same place can "afford" different soundscapes and that, most of the times, it is a human responsibility to shape responsibly its sound environment.

6. Conclusion and Acknowledgments

In this paper we have present some of the projects and pedagogical practices developed at CITAR, which contribute for creating awareness for the acoustic environment. Nonetheless, this list is necessarily incomplete as a result of the profuse artistic and scientific production that every year takes place at this institution. Some examples not mentioned before include the organization of a seminar in 2012 on the topic "Sound Design For Electric Vehicles - A challenge and an opportunity?"[7] and the work from all other researchers that collaborate with CITAR on the field of sound.

In conclusion, we strongly believe that educating the ear and the hearing is the first step towards a better acoustic environment. The proposals presented here are a few examples of creative approaches developed and tested systematically that can contribute to accomplish such goal.

7. http://artes.ucp.pt/sound4ev/contest.php

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