COMPOSING WITH SOUNDSCAPES: AN APPROACH BASED ON RAW DATA REINTERPRETATION

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Keywords: Soundscapes, Data Reinterpretation, Networked Music, Composition

URB is a research project designed to collect and store raw data from soundscapes analysis. This paper presents a study about composing music using URB based on the analysis of work developed by several sound artists, focusing on the evaluation of their creative process and musical outcome. By comparing the processes and statements of each composer, the authors identified diverse systematic approaches to reinterpreting raw data provided by URB, raising questions about the musical outcomes vs original sound sources. Furthermore, some considerations are inferred about the artistic relevance of using URB to compose music.

1. INTRODUCTION

The auditory system tends to have a cultural and social disguised importance when compared to vision. This issue called *The dominance of eye culture* was developed and detailed by Berendt (Berendt 1992). Nevertheless, its importance is undeniable and it represents a vital action, not only in our survival (Middlebrooks and Green 1991) but also in our daily life. Hearing is permanent, unlike vision that can be blocked. To cope with the overwhelming sound information a person is submerged in, humans have different types of listening related with levels of awareness. Most of the time, a person listens without regards to details, what is called casual listening (Chion, Gorbman, and Murch 1994). This leads to an increase detachment from the nuances of soundscapes[1] that surround us, a problem to which Schafer refers in detail (M. Schafer 1977). This detachment represents a problem, for soundscapes have been an important element defining communities, influencing them and imprinting them an identity. The same way a distinctive landmark defines a given place, sound has the same power. These soundmarks can be from natural sources, as the sound of a waterfall, or artificial such as a bell or a factory siren. When recognised as such, one easily understands the influence that they represent towards a community and their social importance (Cordeiro, 2013). Any person transforms and affects his surroundings, in a relationship that is shared among the community. However, how does the ambient sound transform Man? Does the ambient sound influence the artist's work, as a product of their time and space? The usage of the soundscape concept is increasingly relevant not only for acoustic ecology but also in artistic contexts. Using this premise, this investigation focus on increasing the awareness of ambient sound to creators.

> *After all, the soundscape is not an alien force but a reflection of ourselves.(Barry Truax 2001)*

2. FRAMEWORK

2.1. SOUNDSCAPE COMPOSITION

The generalized access to powerful audio technology boosted the use of soundscapes as a resource for composers and sound artists (Westerkamp 1999), increas-

1 The Soundscape concept and movement was presented to the world in the 70's Murray Schafer considerations and researches. (M. Schafer 1977, 1998). Soundscape: Technically, any portion of the sonic environments regarded as a field for a study. (M. Schafer 1977)

ing the number of compositions using field-recordings. This possibility potentiated and democratized the trend Pierre Schaeffer had started, when he created *Musique Concrète*. However, according to Westerkamp *the essence of soundscape composition is the artistic, sonic transmission of meanings about place, time, environment and listening perception* (1999). There are two main approaches: 1) only using unprocessed sounds and the composition process focus on selecting, editing, mixing and organizing 2) using audio effects on recorded environmental sounds. Truax remarks that a given work to be considered a sound composition should have direct relations with the sound's original source, place, time, situation or context (Truax 1994). This is because *a piece cannot be called a soundscape composition if it uses environmental sound as material for abstract sound explorations only, without any reference to the sonic environment* (Westerkamp 1999).

2.2. ECO-COMPOSITION AND ECO-STRUCTURALISM

The term Eco-composition term was used for the first time in 2004 by the art critic Robert C. Morgan referring the Keller and Adriana Capasso installation *Vivir sin despué* (Keller and Capasso 2006). It is a more specific posture within soundscape composition. The term is used to describe the composer combining aspects of ecology with compositional processes. He does not work only with field recordings but takes into account the history, ethnography and geography of the sound that he is manipulating (Opie and Brown 2006). The eco-composition definition does not involve only the creation aspect, also requires a new way of listening. The audience is invited to take the context of the sounds into consideration (Field 2000; Keller 1999).

Eco-structuralism is derived from the eco-composition framework. It is a new approach to music composition designed to maintain the characteristics and context of a sound, even if not using the original recording data directly. In eco-structuralism, patterns are derived from analysis of natural environmental sound sources that reveal structures within the material. This structural data is used as the dominant material for creating the musical composition (Opie and Brown 2006).

In this kind of musical practice, structures must be derived from natural sound sources but not all the structures from a sound need to be used. Small sections of the structure may be extracted and used separately. The approach to the data extracted can be very similar to the "classical" composition by using tools such as elongation, compression, inversion, reversing, scaling and offsetting (Opie and Brown 2006).

2.3. URB

URB[2] 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,[3] allowing the direct access of its features at any arbitrary moment since the system boot, thus facilitating the study of the soundscape evolution and the differences between specific timeframes, and facilitating artistic approaches to such data. It was developed to be used, not only by environmentalists and urban planners, but also by artists with creative intentions.

URB consists in a system for capturing and analysing the soundscape it in real time. The data analysis results in 12 different elements or descriptors of the sound;[4] four listening points in the city of Porto that are capturing and storing permanently; a free access database with all the information resulting from the capture; free software to access the database.

The project also encourages spontaneous initiative for the multiplication of listening points[4] and promotes artistic creation from different areas, with the data in real-time and non real-time. It also makes efforts to present approaches to data processing systems for artistic purposes. (Gomes and Tudela 2013)

3. CASE STUDY

3.1. PROPOSAL

A call was open to the musical and sound art community to work in the challenge of using URB in the creative process. It could be an electronic piece, music for instruments or a sound installation. The only requirement was that somehow the data from the URB had to be used in the composition of the work. Several artist from different backgrounds and with different aesthetic purposes responded to the call.

2 *www.urb.pt.vu*

3 Sound maps are digital geographical maps that associate landmarks and soundscapes.

4 Described in detail in *Urb : Urban Sound Analysis and Storage Project*. (Gomes and Tudela 2013)

The main goal of this investigation, starting from the analysis of the pieces and of the feedbacks and opinions from the authors, is to assesses the relevance of this approach to the ambient sound as gigantic sensor to be used in artwork. If this approach is artistic relevant and if it will contribute to approximate the sound ambient and the creator. This investigation also tries to understand if the aesthetical characteristics of the original sound sources are captured within the structures will remain accessible in the final composition, and, from the comparison of the results, hopefully also to start to point a way to systematize the artistic approach from the comparison of the results between them.

3.2. PIECES DESCRIPTION AND ANALYSIS

... URB to B... [5]
Composer: Nuno Peixoto
For: 2 Percussionists (timpani, vibraphone, and multi-percussion set)

The composed work was commissioned by the Portuguese group *Talea et alaia*[6] to be premiered in a Brazilian tour on January 2014. This provided the perfect setting for the composer to create a piece entirely related and inspired by the characteristic Portuguese sounds. Envisioning this, Peixoto decided to accomplish it through a representation of Porto city. To do so, URB software became the essential tool that granted the necessary data for the elaboration of *... URB to B...*, allowing the transition of urban sound to the musical piece.

The entire musical material used on this piece derives from the extraction of data provided by URB software. This tool is used by the composer not only at a structural level, but also in pitched notes and rhythmic sequences. Through the arrangement of all these elements, Peixoto intends to capture the particularities of each listening point that will characterize and describe the different times of the day in Porto city.

Structure-wise, the composer uses solely data belonging to three listening points (of the four possible ones in URB Software): Casa da Música, Oliveira Monteiro/Rua da Boavista and Sá da Bandeira/Mercado do Bolhão. So we have the following structure:

5 Complete score: *www.jasg.net/URB/URB_to_B.pdf*

6 Formed by the percussionists Rui Sul Gomes and Nuno Aroso

- A – Casa da Música (b.1 – 22)
  Bridge I (b. 23 – 24)
- B – Oliveira Monteiro/Rua da Boavista (b. 25 – 100)
  Bridge II (b. 101 – 106)
  Development (b. 107 – 128)
- C – Oliveira Monteiro/Rua da Boavista (b. 129 – 150/end)

The Sá da Bandeira/Mercado do Bolhão listening point has a very brief part in the … *URB to B*… composition, in comparison with the remaining two. Its sole purpose it is to provide a vibraphone motif which is repeated several times, as can be seen in bar 38, 60, 84 and 127. The second assemblage of the city's characteristics is done through the obtainment of pitch levels (musical notes) and rhythmic sequences. For this purpose, the composer applies a strategic "*reading mode*" (Bernardes *et al*. 2012) over just two table indexes (same number of instrumentalists): *pitch and centroid*. The first one is designated for the timpanist (percussionist 1), due to the low frequency range of the *pitch*. Lastly, the second percussionist that plays several instruments such as the vibraphone, is directly related with the frequencies presented on the *centroid* index table. For the translation from numerical values to musical notation Peixoto developed a process termed *Reading Mode*.

Reading mode: The different values presented on the *pitch* and *centroid* tables were divided into two categories. Firstly, we have what we consider as "correct values", meaning all the frequencies provided by the chromatic scale, such as: 73.4Hz = D1, 440Hz = A3. We also consider as "correct values", frequencies that are 1Hz above and below the ones presented by the chromatic scale. This means that values such as 329.052Hz are equivalent to the E3 (329.6) note. Other examples of this process are: 83.2682 = E1 (82.4); 92.2924 = F#1(92.5); 104.436 = G# (103.8). (The values that result from this two sound features are within the scope F1 to B3. As such the fact of frequency being a logarithmic is not a problem because this process is only applied in a section of low frequencies. The high notes are achieved through octave transposition but always respecting the note.) Secondly, we have what we call "incorrect values", which are the ones that don't fit the "correct values" standards. For example: 90.4796Hz, 94,9886Hz, 95.5805Hz, etc. This category has the task of identifying the duration of a certain "correct value". Therefore, the more "incorrect values"

we find associated with a certain “correct value”, the longer will be the rhythmic duration of a musical note. For example:

219.621Hz = A2 (220Hz) attack time
214.381Hz = “incorrect value”
234.848Hz = “incorrect value”
235.523Hz = “incorrect value” note end

220.003Hz = A2 (220Hz) attack time
221.799Hz = “incorrect value”
242.159Hz = “incorrect value”
289.992Hz = “incorrect value” note end

292.947Hz = D3 (293.7Hz) attack time
304.007Hz = “incorrect value”
308.547Hz = “incorrect value”
326.367 Hz = “incorrect value” note end

Table 1 The following table depicts the rhythmic and melodic cell values (Fig 1).

Soundscape pitch from URB analysis	Reading Mode process to chromatic scale	Reading Mode process to rhythm
493.128 Hz	= B3 (493.9 Hz)	attack time
440.734 Hz	= A3 (440 Hz)	attack time
369.360 Hz	= F#3 (370 Hz)	attack time
414.962 Hz	= G#3 (415.3 Hz)	attack time
349.419 Hz	= F3 (349.2 Hz)	attack time
310.825 Hz	= D#3 (311.1 Hz)	attack time
417.578 Hz	“incorrect value”	
330.471 Hz	= E3 (329.6 Hz)	attack time
308.012 Hz	“incorrect value”	
298.537 Hz	“incorrect value”	
462.870 Hz	“incorrect value”	
235.322 Hz	“incorrect value”	
330.471 Hz	= E3 (329.6 Hz)	attack time
358.298 Hz	“incorrect value”	

If the value determined for each Unix Time unit represents a semiquaver, than the previous values represent the following rhythmic figuration: $_{qqq}$, with the respective pitch of A2, A2 and D3.The previous example was extracted from Casa da Música’s listening point, with the correspondent index time of 1376118294 (2013-08-10 07h04:54).

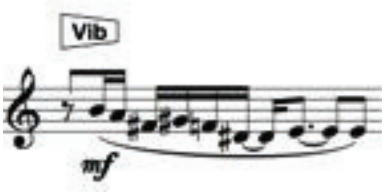


Fig. 1 Excerpt of …*URB to B*… musical composition (bar 84)

In the musical composition … *URB to B…*, the value assigned for each input */Unix Time* is of 250 ms. Therefore, the shortest rhythmic value provided by this *reading mode* will be the semiquaver.
After establishing this algorithm, it was necessary to develop a new URB version in order to interpret the currently *reading mode* and allow it to communicate with a MIDI sequencer, thus making it possible to convert the URB tables for automatic music notation.

Rascunho
Composer: Filipe Lopes
For: Live Electronic

According to Lopes, the mains issues that emerged upon the proposal was "why should one analyze a given soundscape as such?". Intuitively, it seems more expressive and interesting to use concrete sounds of the soundscapes rather than its analysis. Nevertheless, Lopes was curious about what could be revealed by such data and to find if he would be able to use it in a formalized composition.

The first experiments were focused on retrieving the online data, connect it to oscillators and hear the results. Later experiments evolved into controlling more general parameters such as wet/dry reverb, faster or slower pulses (e.g. using the number feed to control a metronome), extended or compressed harmonic fields (e.g. upon a chosen chord, use the number feed to expand, compress or transpose that chord). The initial experiments were done retrieving the values at slower rates, such as a value each second. Overall variations, however, ranged from 500 milliseconds to 5 seconds. In this case, Lopes was evaluating the feeds number by number, assessing the sonic discourse between successive values.

A different approach was to extract the number very fast, in order to get a gestalt idea of the feed, which he used to assess its potential as melodic lines or rhythmic contours. Lopes did such experiments retrieving values at fast speeds such as a value each 100 milliseconds or even faster.

By this time, Lopes was yet not convinced about the sonic results. It all sounded not natural. Melodies didn't have a melodic contour, rhythms didn't relate to each other and using URB to change any given parameter raised the problem of what sound to use. Globally, URB provided values that had no musical feeling between them, at least in Lopes preferred domain: formalized electronic music.

Lopes personal aim to use URB's data values had to match a valid necessity, in order to make sense of them and to make them different from a random generator. This was especially important since the descriptors were sound indicators with possible expressive sonic interest. Unlike sonification environments where often a composition is based on non-musical data (e.g. "*Omega – uma narrativa de sonorização e visualização*" (Lopes and Menezes 2012)), URB is based on extracting musical features from soundscape, which has been the topic of many compositions and, thus, has potential musical interest.

The work *Rascunho* was played live as opposed to a fixed electronic composition. It emerged by the division of URB's feeds between "high-variation" and "low-variation". For the piece, Lopes also decided to use concrete sounds of Porto, playing them with the software *POLISphone*.[7] The form used was the classical: A B A. Part A: Lopes used is older composition *Different Shapes*, *Same Rhythm* multiplied five times and used URB values to change its playing speed. Some of the values controlling playing speed were "high-variation" and others were "low-variation". This produced an organic drone but with a pitched feeling, as the composition itself is played in a piano. In addition, some values of URB were feeding a simple sine wave generator, masked with reverb. Towards the end of this section, it was introduced the concrete sounds of Porto and faded out all the other sounds. Part B: was comprised of very subtle concrete sounds such as night soundscapes or museum gardens and no URB usage. The use of concrete sounds of Porto seemed to fit the piece and the context proposed. The return to part A, was accomplished again with a fade-in, recycling most of the materials and URB's usage. The end was done by stopping sound-sources one by one until, in a slow fashion, reach silence.

Control and Unpredictability
Author: Gustavo Costa and Eduardo Magalhães
Sound Installation

The sound installation used audio recordings and URB data from the Carvalhido listening point. It explored the subjective interpretation of the listeners, especially when confronted with sounds that were embedded in their own particular geographical and social references. Since the parameters extracted from URB were highly objective, this piece relied precisely on the confrontation of objective and subjective data.

7 *https://vimeo.com/85330001*

Control and unpredictability consisted of:

- A loudspeaker inserted into the resonant body of a floor tom;
- A drum membrane with sand over it;
- Two loudspeakers playing processed field recordings from the Carvalhido area. (spectral filters and time stretch previously processed with the Kyma software)

Two URB parameters were used as input values for a Max MSP patch. These inputs acted as triggers for melodic and harmonic content. Input 1: Centroid values Input 2: Amplitude values

Centroid provided frequency values that were translated into pitch class sets (from 0 to 11), which were then transposed randomly to different octave registers to be played by a virtual instrument (a celesta). The values were then filtered to prevent the occurrence of some undesirable intervals. Only notes from a whole tone scale would be played and unisons, octaves and perfect fifths were blocked. Amplitude values provided a trigger for the processed field recordings after a defined threshold. Since the original values were triggering too many sound events, a re-scaling of that values was made in order to become musically adequate.

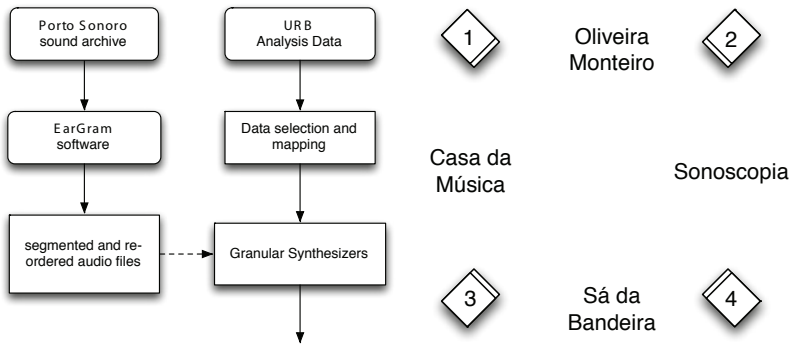
The sound of the virtual celesta was played by a loudspeaker inserted inside a floor tom. Over the membrane of the drum was some sand that was being excited when certain frequencies induced the vibration modes of the membrane. Since there was also a light inserted inside the floor tom, the sand created different visual patterns according to different vibration modes of the membrane.

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

Urban Sonic Impressions
Author: Rui Dias with the collaboration of Gilberto Bernardes.
Sound Installation

"Urban Sonic Impressions" is a sound installation inspired by the URB system, that creates moving sound textures using sounds from the *Porto Sonoro*[8] sound archive. Using the analysis data from the online stream coming from the four URB locations in Porto, the data is used to continuously select and alter the parameters of four granular synthesizers and processors (see Fig.2). Implemented in the Max/MSP/Jitter environment, the data is retrieved and mapped to four audio processor parameters to determine the resulting sound for each one. The audio processors consist basically on granulators and spectral FFT processors. Using the *EarGram* concatenative synthesis software by Gilberto Bernardes,[9] a selection of sound recordings from the *Porto Sonoro* online archive were analyzed and segmented according to the *brilliance* and *amplitude* descriptors. The segments were then reordered into a "scale" of sound grains forming a continuous sound file that starts with the segments with the lowest brilliance values and ends in the segments with the highest values. In order to obtain a greater sonic diversity, for each of the four different locations, a different set of sounds were chosen.

Fig. 2 Workflow diagram **Fig. 3** Source spatial position configuration



Because all of the four listening points are set on city streets, the real sounds that are analyzed are not necessarily very distinct. However, the locations have some relevant landmarks that were used as metaphors for the selection of the sound material. As such, while the selection of sounds for the "Sá da Bandeira" and "Oliveira Monteiro" streets were regular city sounds that include all sorts of vehicles, noises, voices, etc., the sound selection for the lis-

8 *http://www.portosonoro.pt/*

9 *https://sites.google.com/site/eargram/*

tening point in “Casa da Música” includes musical instruments, and the “Sonoscopia” location includes sounds from several percussive and metallic objects, seldomly used in the venue’s music concerts and sound installations.

After the segmentation and re-ordering process with EarGram, the resulting sound files are then loaded into the granulators, and the current URB *brilliance* analysis feature is mapped to the buffer read position.

Other audio processors are used to provide more richness and variation, namely FFT filters and resonators. The *amplitude* and *spread* features from URB control respectively the amplitude of the filter and resonator modules, while the pitch defines the base frequency for the resonators module.

The resulting sounds are then arbitrarily positioned in a four speaker square configuration around the space (Fig. 3). Each of the four sound locations is placed in a speaker pair corresponding to one side of the square.

Note: *Rascunho*, *Control and Unpredictability*, *Urban Sonic Impressions* were presented in the event “We, the citizens” at Future Places Festival 2014.[10]

4. CONCLUSION

URB proved to be efficient in the access to audio descriptors data retrieved from sound ambient, particularly to its time alterations. It also provided composers enough raw materials in order to devise their works in addition to an higher awareness about sound environment. The artistic outcomes analyzed point to diverse realization about the aesthetic significance of using URB’s raw data. While Peixoto, Costa and Dias guarantied musical elements such as melodies or formal coherences, Lopes claimed that his instinct as a composer induced him to adopt URB’s metadata as a ‘variation source’, independent of the descriptors significance. In the case of Lopes, even if the work is artistically interesting, there is not an evident correlation with the original source, thus, breaking with the Soundscape Composition and Eco-Structuralism principles.

Further research will be focused in determining how these and other artistic outcomes resulting from using the URB system, can converge to an understanding of the different soundscape composition based in raw data, as a coherent musical framework.

10 *Rascunho, Control and Unpredictability* and *Urban Sonic Impressions* video: *www.jasg.net/URBconcerts%26pieces.html*

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