# Cyber enhancing the Urban Soundscape

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**Abstract** – *Sound is one of the most direct pathways to a person's mood and emotions. Tuning the urban soundscape by enhancing the experience of existing elements or by introducing new sounds therefore allows to create more pleasant and restoring public spaces or to nudge the crowd towards a more social behaviour. For this, sounds produced by loudspeakers or mechanical systems have been used but apart from some sonic exhibitions, the installations do not allow for user interaction. This paper discusses how ICT could be introduced in soundscape design. It is based on recent findings on perception of the urban sonic environment and interpretation of the soundscape by the users of the space. Evolution in machine listening allows to adapt installations to the current state of the soundscape and open new opportunities. It is concluded that the ICT may promote urban sound planning, an often forgotten aspect of designing the urban environment.*

**Keywords—urban sound planning; soundscape; mental restoration; ict; machine listening**



## I. INTRODUCTION

In western society, urban sound has been treated as a nuisance since several centuries. The introduction of mechanical transport, industry and amplified music in the urban sonic environment have strengthened this vision. Moreover as early scientific insight in hearing grew and analytical measurement equipment became affordable, policy has focused mainly on negative sounds and their levels. Urban sound management has been identified with urban noise control based on calculated noise maps [1] or level measurements.

However, towards the end of the 20$^{th}$ century, the understanding started to grow that the noise control based approach may not be well suited, in particular for urban public spaces. In this context the work of Vancouver based scientists such as Murray Schafer have often been cited [2]. With a COST project that started in 2008 the urban soundscape concept was further explored and promoted within Europe. Very useful insight in how to analyse, interpret, and design the urban soundscapes were gained [3].

In this paper the opportunities created by including cyber aspects in the design of the urban soundscape, including its perception and appraisal are discussed. In Section II this is done from the perspective of general soundscape design, in Section III from the perspective of restorative public spaces, and in Section IV from the perspective of influencing mood and social behaviour.

## II. URBAN SOUNDSCAPE DESIGN

### A. A classical design process

The process of designing the soundscape of an urban public space is not different from designing other aspects of such a public space (Figure 1). The designer builds a vision of the soundscape of the place taking into account the possible use of the space and the expectations of the potential users. Expectations can be quite different for different users. For example a tranquil urban space may have a different meaning for different users [4]. Some may associate urban space tranquility to social activity; others may expect nature and a small group may even be thinking mainly about silence when mentioning tranquility.

The sounds that a person identifies in a sonic environment obtain meaning in a given cultural context. These sounds-with-meaning contribute to giving identity to a place. Surprisingly, a relatively small number of sounds selected automatically based on their saliency – that is how much the sounds stand out of the urban background sound – suffice to allow people to identify their own living environment [5].

The designer's vision regarding the appropriate soundscape for an urban space can be categorised in three main classes [6]:

- Backgrounded soundscape. This vision assumes that soundscape does not contribute significantly to the experience of the space. Hence the purpose of the design is to assure that users do not notice the sounds and that they are affected in the least possible way by the sound environment. This rather unrealistic design unfortunately is a rather common vision.
- Supportive soundscape. The soundscape supports the experience of the public space but the experience is not primarily focused on sound. In other words, the soundscape has to be congruent with the vision of the space that is mainly determined by other factors.
- Focused soundscape. In this last situation, the sonic environment itself is the purpose of being in a place. Obviously, open air theatres, street performance spaces, etc. fall under this category. In this case not only the sound itself but also the acoustics of the environment become relevant. Reverberation, clarity, warmth, and signal to noise ratio have to be considered.

Based on the designer's vision a composition emerges. In this context, the word composition is used for the collection of sounds that are offered to the user and their relative strengths and noticeability.

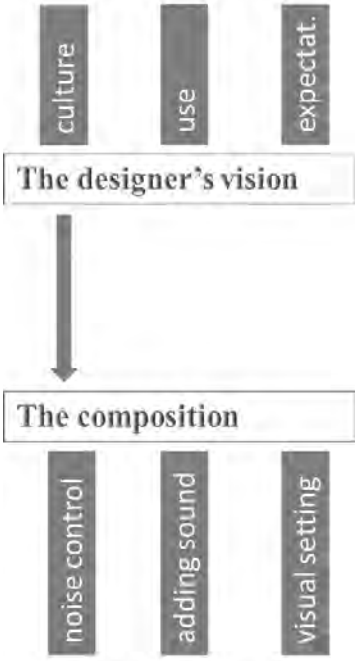


Fig. 1. The urban soundscape design process. The designer's vision inspired by knowledge on cultural aspects, the use of the space, and expectations of potential users leads to a composition. Implementing this composition requires sound control but also adding desired sounds and exploring the interaction with the visual setting.



### B. Guiding attention

In composing the soundscape – particularly when its design is not in the focused category mentioned above – there is a slight difference to composing music or any other artistic expression since people visiting the acoustic space are generally not focusing on the sound environment. Thus auditory attention and noticing of sounds become important. The sonic environment experienced from within one's own dwelling is a typical example of a backgrounded soundscape and it was shown that in this situation accounting for notice-events allowed to explain some of the epidemiologic observations [7]. In the urban public space attention focusing seems equally important [8].

Thus implementing the soundscape composition should be grounded in a good understanding of what sounds users of the space are likely to notice and on the idea to guide the attention to the sounds that the designer wants them to notice. Using classical noise control, unwanted sounds can be removed from the sonic environment, and if their noticeability is high, that is indeed the only option. However, adding wanted sounds or even masking unwanted sounds by wanted ones, both energetically and perceptually/informational, is an equally appealing option ([9], [10]). As attention processes are multisensory, vision and audition will interact. Thus obscuring an unwanted sound source may in some cases result in a change in appraisal of the sonic environment.

### C. The potential role of ICT in enhancing the experience

Electronic means have been used to add sounds that are usually positively appraised to a public area. This additional sound can be subtle and aim at masking or at least changing the character of unwanted sound, usually traffic sound (e.g. Mariatorget in Stockholm). It may also involve adding sound marks such as benches equipped with loudspeakers reproducing bird sound or the sound of a beach as was demonstrated in Nauener Platz in Berlin [11].

In future, ICT is likely to play a more prominent role in this process. Machine listening techniques and an internet of sound observatories [12] combined could lead to more active monitoring of the soundscape in urban public spaces. Although providing live information of soundscape quality in different public spaces in a city already has some value in itself, the real benefit occurs when a feedback mechanism influencing the sources of wanted and unwanted sounds is implemented. Such feedback could consist of playing different sounds through loudspeakers but it could also influence traffic speed, activate low emission zones, change preferred take off routes, etc.

## III. RESTORATIVE SPACES

### A. Classical restoration theory applied to soundscape



Classical restoration theory [13] explains the restorative potential of nature amongst others by the fact that natural environments make attention wander freely between different sensory observations. This allows the mind to relax from focused attention. The feeling of being away, fascination, peace and social cohesion increase the potential of a public space for being restorative [14].

The sonic environment can contribute considerably to all of these aspects. Sounds (natural or even human) can occasionally draw the attention of the user of the public space. Fascination or positive appraisal of unexpected yet inoffensive sounds can be created by adding sound marks or focal points to the soundscape design. These sounds can be observed as one moves around a corner into another area of the public space or they can simply emerge at a certain point in time.

Nature and by extension natural soundscapes were shown to have a strong restorative potential. Hence a possible way to understand the key features of a restorative soundscape is to analyse in detail this natural soundscape. In earlier work [15] we observed that such sonic environments behave like a complex system which leads to a 1/f spectral distribution of amplitude fluctuations (where f is the frequency of amplitude fluctuations). This spectral distribution is observed over time intervals of the order of 15 minutes. By creating artificial sounds with this temporal fluctuation one can easily observe that this condition is necessary but not sufficient.

### B. The potential role of ICT in outdoor restoration

Is there an opportunity for ICT to enhance the restorative role of nature and the natural soundscape?

Non-focused attention is seldom associated with Internet, gaming or the use of computers in general. However, one could envisage an internet-based system that occasionally attracts the attention of visitors to specific parts of the public space experience. Sound is well-suited for this purpose as it is the natural way for the human perceptual system to switch to another object or another location.

Promoting classical use of wireless devices in public spaces seems contradictory to creating a feeling of being away since it would on the contrary allow people to continue their usual everyday activity. However, one could think of carefully designing internet-based services that are embedded in the public space and that enhance the feeling of being away. Connecting to the soundscape of the great outdoors, Iguassu falls, the Amazon, the Artic, the Balinese jungle from within designated areas of a public space may connect people to nature elsewhere.

Noticing different elements of the sonic environment depends on the degree of attention that the visitor pays to environmental sound but also on its degree of knowledge [16]. It has indeed been shown that knowing a sound makes noticing it more likely. Thus informing users of a park about the sounds of nature that are audible might indeed increase their fascination for those elements of wildlife and other natural elements that they would otherwise ignore.



## IV. MOOD AND SOCIAL BEHAVIOUR

### A. The soundscape affects behaviour

In an innovative experiment in Brighton body language was used to assess how people react to their sonic environment [15]. It was shown that appropriate sound could make people more friendly and willing to help and to reduce violence in clubbing areas. Prior literature indeed pointed at changes in social behaviour depending on noise levels in working environments and therefore these results were not completely unexpected. Yet they open a whole range of new opportunities to stimulate social cohesion, reduce violence, and increase perceived safety of public spaces in cities.

### B. The cyber factor

The Brighton experiment, no matter how successful, had a couple of restrictions. Firstly the experiment in the clubbing district made the choice of mood changing sound rather trivial: music. In other areas, it might be more difficult to find appropriate sounds. Secondly, and more importantly, a well-known DJ was hired to modify the outdoor urban soundscape to influence the crowd. This involved continuous feedback. At a larger scale alternatives are needed. Internet and machine listening may help. Machine listening could grasp the

soundscape of the moment and with the aid of appropriate indicators also get an estimate on how the crowd responds. Collaborative awareness and co-creation platforms may further be used to involve the public at large in creating a soothing or exciting soundscape matching the needs of a public space at a particular time of the day or the season.

Finally local interaction with sound devices and interfaces should be envisaged, thus connecting the physical space and cyberspace more directly. Soundscapes that can be modified only by acting on the spot, leaving soundmarks only when you are there, and travelling back in time to the date of an outdoor concert, are just a few examples of possible implementations. Involving the users of the space in this way may enhance the experience of the urban soundscape in a way that we are unable to foresee today.

## V. CONCLUSIONS

Several opportunities for modifying or enhancing the perception of the sonic environment and hence change the appraisal of urban soundscapes, in particular in the public space, have been discussed. Today, most applications are relatively low tech and do not make extensive use of ICT or the Internet. Yet it may be expected that an internet of sound observatories combined with different types of actuators and interfaces could either affect the elements of our sonic environment or at least change the way they are perceived by the average user of the public space. It remains a challenge for urban designers and those who teach them, to discover how to include these opportunities or to create the feeding ground for letting them emerge in a co-creative way.



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