SOUND TOPOLOGIES, FROM *IN SITU* OBSERVATIONS TO A NEW QUALITATIVE SOUND MAP REPRESENTATION

PACS 43.50.+y Noise: its effects and control ; 43.58.+z Acoustical measurements and instrumentation ;

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ABSTRACT

The sound topologies, as spatial sound distributions, have been observed in an inquiry in housing about acoustic comfort. A specific instrumentation was developed for their measurement. They have been tested in CAPS-IST laboratory and have contributed to the development of a new method for the qualitative representation of the sound space.
Starting from the obtained results the notion of sound topology is defined and discussed. The acoustical situations observed in the inhabitant inquiry will be shown under the scope of the sound topology concept. The design competence limits for architects and town planners is discussed.

INTRODUCTION

A large inquiry about sound confort has been conducted in a PHD reasurch [1]. The aim was to demonstrate that the inhabitants are activs in the sound confort production within their built spaces. Confort was not only considerated as an acoustic quality of the buildings but also as the manner that inhabitants oraganize a sound space inside of it because of their dynamic of living, perceptions and sounding actions. It appears that the ordinary perception of sounds focuses on the sense of what is heard. Sounds are perceived as meaningful objects in the sound space. It is neither about signal nor its measurements. This alows one to consider that the ordinary sound perception is a contact with a sound object. It can not only be considered as the reception of the signal emited by a source. But the main difficulty that arises in that work was to spatially describe the sounding objects as closer as they are spatialy perceived and not as their signal could be measured. Finally it became more important to describe sound shapes according to whether there is sound contact or not. The limit where this contact happen, allows one to call this shape a sound topology.

OBSERVED SOUND TOPOLOGIES

While basing on the inhabitants descriptions of their own sound situations, one tried a spatial translation (Figure.1): the sound topology is represented by a square (S is the source) and the subject area of listenning ia represented by rounds (1,2 and 3). Intersection between square and rounds describe the different contacts between the sound topology and the listenner. Centrifugal and centripetal arrows show respectively the repultion and the attraction of the subject by the sound topology.

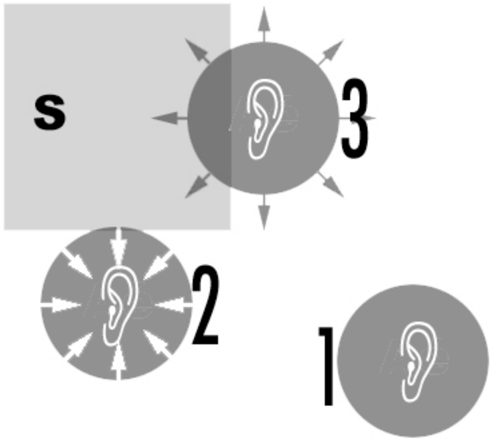

Figure 1 – Diagrammatic representation of sound topology and its contacts

This diagram allows one to make some complex sound situations of comfort easily understandable to the glance.
The following representation (Figure.2) describes a conflict situation in a building, between neighbors living in two similar apartments. The solution was found by permutation of the living room, which was the source of noise, and the room in the first floor.

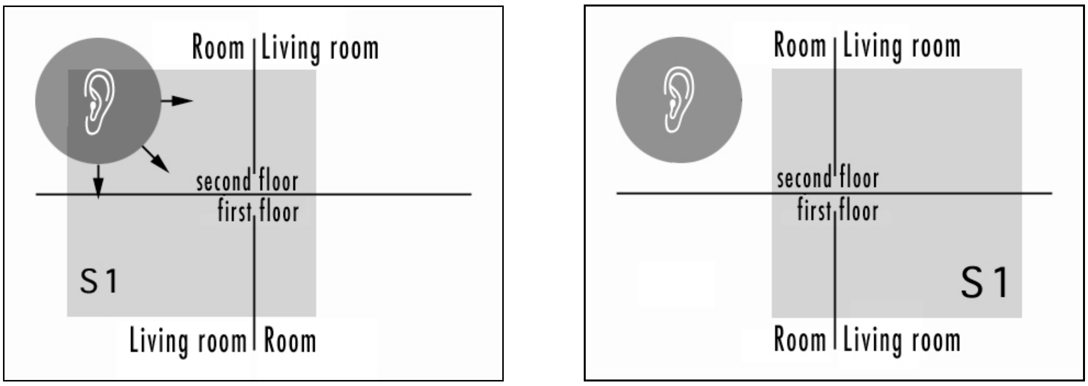

Figure 2 – Permutation Room(Silent)/Living-Room(noisy)

The sound topology is not always limited by the isolating built spaces but sometimes just by an absorbing materiel as the carpet in the following situation (Figure.3).

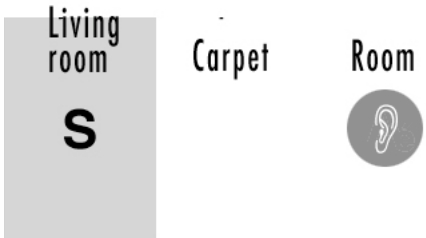

Figure 3 – Noise reducing carpet

In some situations, the inhabitants prefer to switch on all the radios of the apartment, one in each room, in the same radio station, so that they can have a continuous listening and a free motion in their house. This device of cloned-sources avoids the situation of one louder and annoying speaker.

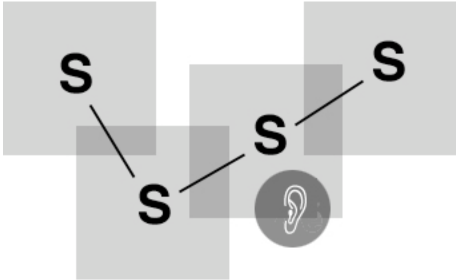

Figure 4 – Source relay to expand the sound topology

However, this first representation of sound topology has the limit of any diagrammatic reduction. Fortunately, the limit of these sound topologies coincides with the limit of the built spaces in many cases except those of opened doors and windows or loud sources.
In the urban space the sound maps shows that the traffic sound topologies are also shaped by the buildings (Figure.5) [2].

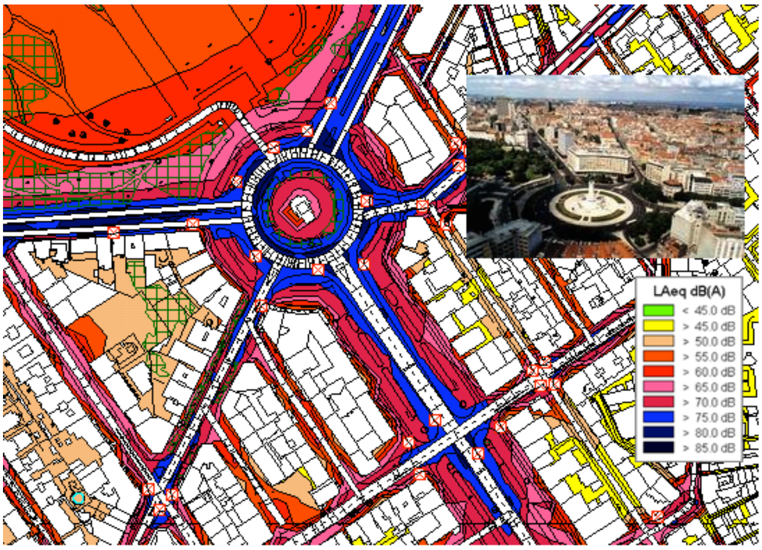

Figure 5 – Part of the noise map of Lisbon (CAPS-IST)

In some other situations, the sound topology is shaped by the acoustic power of the source itself like it is shown in (Figure.6). The airports are quickly recognizable on sound maps.

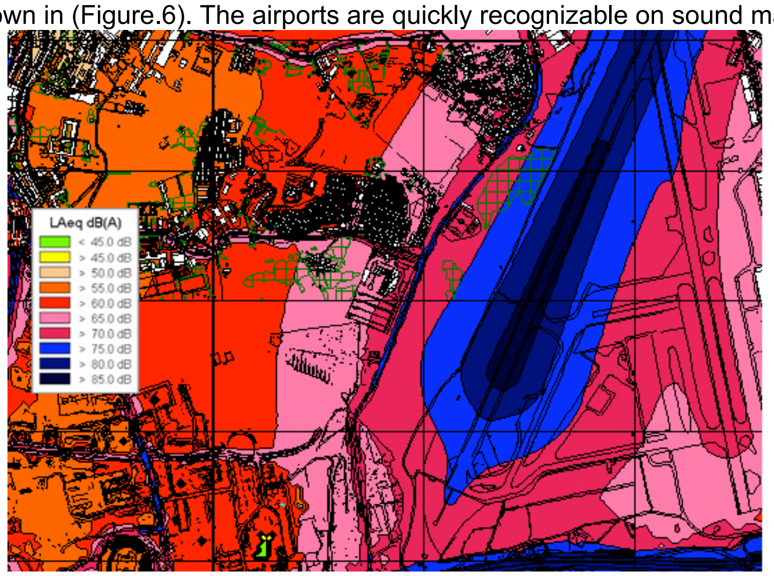

Figure 6 – Airport, Part of the noise map of Lisbon (CAPS-IST)

Even if software that allows such sound maps are able to calculate the sound diffusion of each source of the urban environment, it is still difficult to calculate the inter masking of the sources and the limit of audibility of each.
An experiment was conducted in Cresson laboratory (Grenoble) to simulate that inter masking. In the center of a room, a music device (CD player) was diffusing a very known music. A pink noise was emitted in the reverberating field, respectively with 50 and 56 dB. It was asked to some listeners to turn around the music player and indicate the music limit of audibility. Two curves were obtained for the two values of the masking noise (Figure.7). This results show that the sound topology is shaped by the background noise of the source depending of their sound level pressure. This result also shows that sound topology is linked with perception. The topologic limit of a sounding object is the limit of its audibility even if its acoustic energy is diffused crossover that limit.

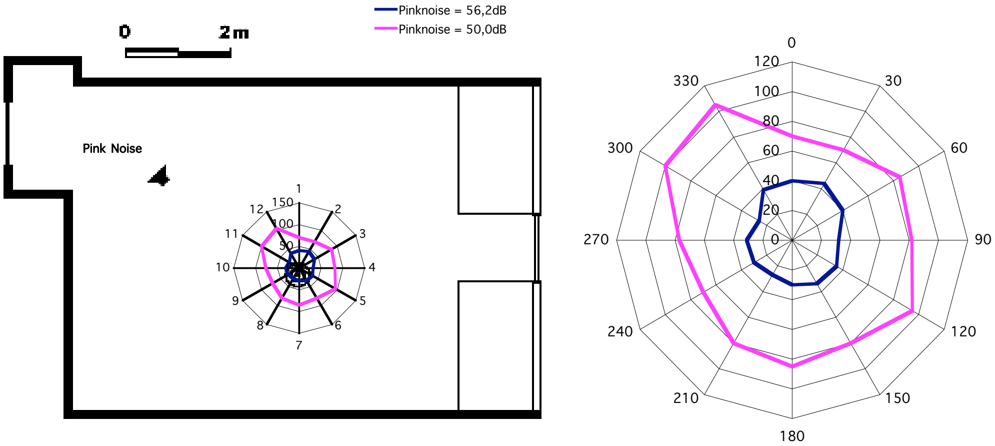

Figure 7 – Limit of audibility around a music device in a closed space

MEASURING TOOL

A measuring method, that takes into account the inter-masking of the sources, has been developed. It is based on the human perception as semantic filter and an introduced masking noise that brings the measure. The whole method is explained with details in another paper of this same congress [3]. A measuring tool has been developed and a patent was deposited [4].
The first test *in situ*, were conducted at Rossio square of Lisbon and analyzed in CAPS-IST laboratory (Lisbon). It was possible to measure separately the sound topologies and to distinguish them on a qualitative sound map (Figure.8).

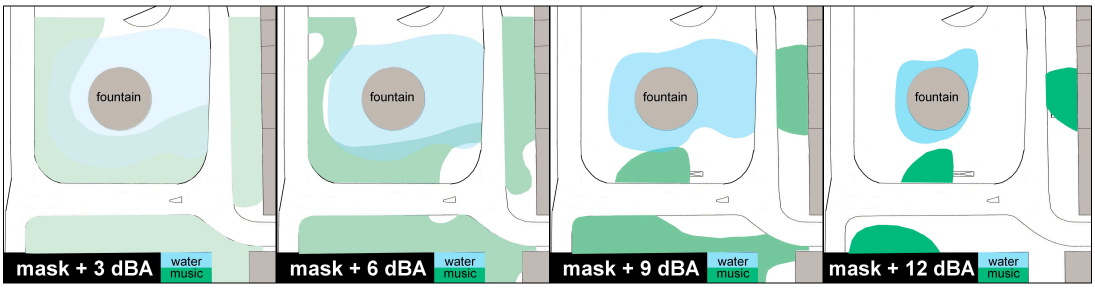

Figure 8 – Water and ambient music topologies in situ.

In order to obtain an outline of the fluctuations of sound topologies, one can gradually introduce a masking noise in steps of 3 dB. The levels of the masking signal deferred on the map allow, by interpolation, to draw the curves of fluctuation of sound topology. That is equivalent to an increase in the background noise, which is a permanent natural mask.

DEFINITION

Without going into mathematical considerations, specific to the geometrical topologies developed firstly by Poincarré [5], one restricts himself with the intuitive and sensitive approach of this author. However nothing prevents the same mathematical developments for sound topologies. One do not do it because there is no interest of it in this work, but also because the sound topologies are very unstable in time. They are not immutable like a solid body; they are **the whole of the points of space where one can have the same sensitive and semantic impression by hearing**. For example, the whole of the points where the limit of audibility of a sounding object occurs is the topological limit of this object. The limit of pain is also another topological limit included in the first one. Between which many other topologies can be found by the instrument referred to above, for example. The qualitative rupture of perception, as described by Rene Thom [6], at a local point of space is a sign of presence of a sound topology in that sound space.

VISUO-TACTILE TOPOLOGIES VERSUS SOUND TOPOLOGIES

As defined above, sound topology is a rupture with the visible and tangible qualities of space. One is acoustumsed with tangible topologies and their mathematical models. They are first of all visuo-tactile experiences that describe a continuity in the sensation of touch. The end of tangible sensation around a solid object define the topology of that object exactely as the limit of audibility define the sound topology.

Contrary to the psychoacoustic model that describes similar phenomenon as a suite of a sounding object (material) emitting an acoustic signal that reach the audition system and finally cause a perception, sound topology suggest the inverse process that misses: Perception, based on the audition system that is in a sound contact with a sound topology reveal a significant object. Finally, instead of considering that one perceive objects through the signal that they emit, sound topology is the perceived object. The signal is a whole and constituent share of the perceived object.

This is just a different representation of the same sound phenomenon that could be more appropriate for the architectural approaches for two reasons:

• The sound phenomenon is spatially represented and allows a quick perception by the architects

• Sound topology is an acoustic, perceived, semantic and spatial phenomenon in the same time.

ARCHITECTS LIMIT OF COMPETENCY IN SOUND DESIGN. (CONCLUSION)

Returning to the first interest of this paper, where sound topologies were observed firstly, some questions arise concerning the role of the architect in the design process of sound space. Contrary to the built space that refers to tangible perception and visible space that refers to the glance – even if these perceptions are coupled – the sound space is continiously fluctuant, and the most of the sources are the perceivers themselves. One have observed that they have some competency to oraganize and combine the built device with the sounds to obtain a comfortable ambiancy of being. Contrary to the room acousics studies (whitch is a very developped field of knowlaedge and investigation), the aim of the architectural sound design is not the quality of the signal (regarding to the psychoacoustic criteria of quality) but its composition. One mean, a composition of those sound topologies. But as one shown above, the sound topologies are shaped depending to many factors that are contoled by the inhabitant: opening/closing for example and sound space is continuously in transformation. It is not solidified and thus canot participate in a strategy of architectural design. However, as the built space allow multiple possibilities of modelling the sound space, the sound design strategy could consist in bringing the inhabitant the most plastic built device that helps sound space composition. Sound design is an inhabitant competency, but architects (as well as Stradivarius for violonists) could bring the best tools for that. Built space is a sonic tool.

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