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SOUND QUALITY: A DEFINITION FOR A SONIC ARCHITECTURE

Abstract

This paper is based on several works that aims to improve sound quality in the architectural project. Architectural practices are mainly dominated by the visual modality. Architects need tools to develop new projects considering sound criteria. Our purpose is basically beyond regulations and aims to manage sound phenomena when they are not necessarily synonymous of noise and annoyances. In other words, we cannot reduce all this complexity and richness of the sound world in a simple problematic that compares noise with silence.

This paper will demonstrate that the sound quality deals with the interactions between sensitive phenomena (perceived sounds) and people's activities within the space. Sound quality indicates certain qualities of the relations between sounds, space and social practices. Sound quality is not a fixed criterion of the environment. It embodies differently according to people and time. Consequently, sound quality of a space involves a crossed analysis between space, acoustics and human behaviours in situ.

This paper will argue different definitions of the concept of "sound quality" used by acoustic community and defend a position for a sonic architecture.

INTRODUCTION

The aim of this paper is to discuss the definition of the *sound quality* notion. Used in many disciplines of the acoustics, this notion doesn't have the same meaning. We'll try to update the fundamental differences that underlie the use of the *sound quality* term. We'll try to clarify them and aim to propose a definition that can be used in acoustics applied to architectural design. This paper is based mainly on my PhD thesis [Remy, 2001] and fundamentals works elaborated in CRESSON [Augoyard, 1995], [Amphoux, 1992]. This paper tries also to prolong works and discussions that have been published in the thematic session "Soundscape" of the joint congress of the French and German acoustics society in 2004 at Strasbourg [papers from C. Semidor, D. Dubois, A. Fiebig and B. Schulte-Fortkamp, M. Boubezari and J. L. Bento Coelho, B. Defreville, C. Lavandier and M. Laniray].

1- ACTUAL USES OF SOUND QUALITY TERM

Quality and Quantity

In the common language, one tends to oppose quality to quantity. If the quantity indicates *the thing itself considered from the point of view of measurement* [1], quality returns to several definitions:

- As a first definition, quality, *it is what is not expressible in quantitative terms and which concerns description* [1]. For example, it's the difference between the measurement of a noise level (*quantity*) and the evaluation (*quality*) that a listener can make (noisy, silent, reverberating, pleasant, etc...). This way of thinking sound quality defends the main followings ideas: qualities are "contained" in the object and qualities appear with the perception in the same way that they already exist. For example, one would say that this sound is bass because its "inner structure" is bass.
- The term of quality also returns to *a sensitive property belonged to a reality and able to affect the feelings of that which perceives this reality* [1]. Two aspects in this definition are meaningful for us. The first indicates that quality does belong to the object and the other indicates only one person who is listening it can perceive it. In this meaning of quality, there are not equivalences in the qualitative properties of the object and the way in which the individual hears them. But there is the idea of a ratio; *these qualities are not just as they are in the objects but depend on the perceptive act* [1].

These simple definitions, found in philosophical dictionaries, can easily be applied to the different definitions used by the acoustics community. Room acoustics researchers first of all worked out the concept of *acoustic quality*. Since works of W. C. Sabine then the ones of L. Beranek, one sees very clearly, through the research subjects developed since the beginning of the 20th century, that the concept of quality moves from a definition only centred on the characterisation of the rooms acoustics criteria to a definition that includes the reception of these criteria by listeners. For example, the quality of an listening room can nowadays be described by the following criteria: "heaviness", "vivacity" of the sound, the "presence", the "diffusion", the "envelopment" of the room. All these qualitative descriptors are also correlated with measurable, physical and quantitative criteria like reverberation time (or the reverberation time calculated on a part of the impulse response and for a frequency band), the wide direct sound (DirE), Early Decay Time, etc... In other words, rooms acoustics theoretical background says that sound quality of a room depends firstly from the structure itself of the sound. This structure can be modelised and predicted for the physical part and need to be evaluate (perceived) by an audience.

In environmental acoustics, we saw in the recent years the apparition of the Leq day, the Leq night and now, the Leq day and night (Lden). These criteria can also be

interpreted as the introduction of the quality in the quantity. Sound level averages, as the Leq is, doesn't have the same meaning if it takes place in the middle of the day or in the middle of the night. Depending of the context, the same quantity doesn't refer to the same evaluation. For this example, does it mean that the sound in itself does not carry the whole properties of its qualities (or its defaults) since it has to be replaced in a temporal context? Doesn't it mean that this criteria refers more to the second definition of the sound quality?

We can also look to the sound design sector more recently developed around car industry and household appliances market. Sound design aims to modify the emitted sound of the technical objects not only in term of level but also in the signature and the image that the sound offers to our perception. Main works are organized around the research for quantitative criteria (as vibroacoustic parameters) correlated to the answers of a panel of listeners. As Steven McAdams says: "sound quality depends on the properties of the sounds and the properties of the listeners who perceives them"[2]. Rigorous methodological principles allow, on a representative sample of listener, to extract the role of certain factors and finally to have a "indirect measurement of sound quality" [2]. We see also in this example that, once again, the sound doesn't carry all the properties of the sound quality. The spatial, social and cultural situations are also very important and need to be studied as the physical signal. To design a sound means to understand the whole interactions that the users build everyday with the objects.

From physical signal to the *lived sound*

More basically, this rapid sweeping of the different uses of sound quality term reveal to us a fundamental divergence. To explain it, we base our argument on a criticism formulated by Jean-François Augoyard [3] on the scheme "stimulus answer" that organizes the majority of the studies on the sound environment. This criticism is also based on a part of the "treaty of musical objects" written by Pierre Schaeffer [4].

One can criticises the experimental psychology of listening by saying that the signal is the reference to the whole evaluation of perception. However, like Schaeffer says, "it is the *sound object* given in the perception that indicates the signal to be studied"[4]. The physical signal cannot explain "alone" all the richness of perception. Thus, even if the studies in psychoacoustics concede that perception is not reduced to comprehension of perceptive and cognitive phenomena, sound quality is mainly approached within this framework. We interpret it as the resistance of a stimulus answer scheme.

As Schaeffer underlines it, "the sound object can be defined at the meeting point of two intentions: one acoustic intention and one intention of listening"[4]. We think that this can be also applied to the study of sound quality, specifically in the context of the architectural design. To quote again the words of Schaeffer, we say, *sound quality appears at the meeting point between an acoustic action and an intention of*

listening. In another words, again by adapting a quotation of Schaeffer, it is the intention of listening that indicates the signal to be studied.

There is not a radical opposition with the studies in psychoacoustics. But there is, however, an important inversion of the problem: "any psychological approach of sound perception should start according to the order of *lived sound*"[3]. It is the *lived sound* that organizes the definition of a significant quality. Thus, as Jean-François Augoyard proposes it, "one cannot always says: at the beginning, was the signal" but rather, "according to the order of lived time, at the beginning, is the listening of the phenomenon" [3]. Consequently, it implies that the study of the sound phenomena "is deployed in as many fields of investigation than the dimensions of the phenomenon of listening in situation"[3]. If the situation is the laboratory, the *lived sound* is then analyzed according to an axis that privileges the physical signal. *The analysis cannot say more than what the situation contains already* [3]. If the situation is the urban space, what will be the axes of analysis of the phenomenon? Of course the physical signal, but also the lived space, the social representations and social interactions, codes, standards and regulations [3].

2- SOUND QUALITY AS A QUALIA AND AS AN ACTION

Sound quality as a qualia

To move on this concept, it is possible to refer to Roberto Casati and Jerome Dokic works [5]. The authors substitute the concept of sound quality to the one of "qualia" that, by definition, describes the qualitative aspects of the experiments of perception.

A part of their works aims to define the state of the qualia starting from a theoretical point of view. Dokic and Casati want to test the two following assumptions:

- Qualia or sound qualities, are they organised? In others words, can we find any inner organisation in sound qualities? Do relations exist between them, as we know the relation between un bass, medium or treble sound or does the suite "do-ré-mi-fa-sol-la-si-do" has any existence outside our culture?
- Or, qualia are they not organised? that means if sound qualities can also be defined in absolutist way without any relations. the logical suite "do-ré.." does not have any inner existence.

They want to understand if those kinds of relation imply that such relations are constitutive of sound qualities. Finally they demonstrate that:

- the qualia or sound qualities do not have a pre-established organization and,
- the organization that we find to them (more or less bass, but we could say more or less noisy, reverberating, stressing, etc...) are not inherent properties of their existence.

Perception is one action

The whole of this discussion is also correlated to recent progress of the neurophysiology. For Alain Berthoz [6], the movement is the minimal action for any perception. "It is necessary to remove distinctions between perception and action. Perception is a simulated action"[6]. Alain Berthoz based on results from kinaesthetic experiments, shows how much anticipation is an essential characteristic of the process of the senses. As he says, "perception has to be conceived as active". Consequently, one cannot neglect any more this fundamental aspect of the process of senses. "Perception is not only one interpretation of the sensory messages: it is judgement and decision-making, it is an anticipation of the consequences of the action" [6]. Adapted to our topic, I would say that *our listening builds sound qualities as much as sound qualities model our listening*. Thus, whatever the situation, there is always a movement of the subject which perceives. Action and perception cannot be dissociated. For example, when one listens to a metabolic sound environment or the noise of a fountain, one can easily perceives a melody or a draft of melody. There is the feeling that, during a few seconds, one could hear some melody. If we check by listening more carefully, we realise that there is nothing organised to ear but we thought it was.

In another words, to quote again Pierre Schaeffer, by default the ear is on the mode of hearing continuously ("ouïr" in French), but if the body decides, because the sound matter has some organisations, we can start to listen (hearing, attending, listening and understanding as Schaeffer would says [7]).

3- SOUND QUALITY DEFINITION

Three dimensions of the sound phenomena

To move on the definition of sound quality, we also remember also that, as Jean-François Augoyard says [8], sound phenomena can be analyzed according to three dimensions:

- the physical signal (measurable and quantifiable acoustically),
- the lived sound (interpreted by the movements of perception),
- the represented sound (in reference to cultural and collective codes).

If sound qualities do not have an obvious internal organisation, analysing a sound means analysing also the action and the perception of the users. People inevitably hear sound in a situation, people live with it, can interact with it and according to their mental representations, people can make an assessment (or not). The physical signal doesn't cause the whole perception of a quality and all the parameters related to the situation are not only some unwanted noise in this stimulus answer scheme. The phenomenon observed is already the result of a complex interaction. Even it could sound a little provocative, we might say: the physical signal doesn't matter and let's study first the perceived phenomena.

This discussion around the meanings of the sound quality term leads us to propose the following definition: the study of the sound quality of a space returns to the description of situations of interactions between a built space, audible physical signals and uses. Thus, studying the sound quality of a place means study how sound dimension of the space authorises, facilitates, prevents or contradicts certain uses and certain representations related to this space. We can draw the following diagram to explain it:

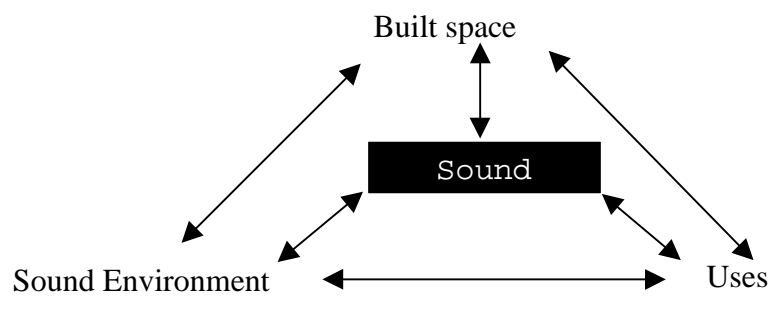


Figure *Erreur! Argument de commutateur inconnu.* : Sound quality definition diagram

- The sound environment interacts with our perceptions and our actions (uses). It authorizes our behaviours and our behaviours feed the sound environment. Our way of appearing from a sound point of view (intensity of the voice, noises related to our movement, sound sources that we can play, etc.) in the site depends on the possibilities offered by the place, and in the same time these productions take part in the sound environment. To quote again the terms of the neurophysiology, if perception is only one simulated action, the sensitive matter of different places does not anticipate the same type of actions (interactions sound environment - uses).
- In the same way, the sound environment sounds with to the colours of the built space in the same way that built space, by its functions mainly, organizes the sound productions (interactions between sound environment and built space).
- Finally, built space and uses are also defined mutually. We do not behave in the same way depending of the place. At the opposite, uses can also configure also the built place. For example, in railway station, we all observed how the crowd can re-configure the accessibility of the place (movements, intelligibility of the sound advertisements, etc...)

CONCLUSIONS

We try, in this paper to demonstrate the following points:

- Sound quality refers to several definitions. One definition says that quality of sound belong from properties of the sound itself. We think that the main acoustic researches are focused on this definition.
- Sound quality refers also to another definition. Qualities are not just as they are in the objects but depend on the perceptive act. Our listening, with all the context, model what we are listening
- In the aim to define tools and concept to improve sound quality in architectural design, we define sound quality as the interaction between a built space, an sound environment et uses.

Sound quality deals with the interactions between sensitive phenomena (perceived sounds) and people's activities within the space. Sound quality indicates certain qualities of the relations between sounds, space and social practices. Sound quality is not a fixed criterion of the environment. It embodies differently according to people and time. Consequently, sound quality of a space involves a crossed analysis between space, acoustics and human behaviours in situ. This definition need to lead any approaches that concerns the architecture design of building and towns if we want to respect all the richness of our sonic cultures.

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