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# SOUND QUALITIES IN RAILWAY STATIONS

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## Abstract

This paper deals with the perception of sound qualities inside railway stations. My purpose is to describe sound qualities or sound failures perceived by users in the aim to create a prediction tool for architects. Sociological, acoustical and architectural surveys have been used to understand what users feel while taking several walks inside the stations. Sound quality is approached through acoustical criteria measurement and evaluation of subjective listening criteria. This research led surveys in Paris - Gare du Nord, Gare Montparnasse and Gare Haussmann (Eole line).

This paper shows how a specific methodology can be used to develop a catalogue which connects spatial forms, sound sources and social practices. As it is impossible to study *in situ* the same type of architecture in different stations, we choose to study a basic social practice which is common to the three stations : a walk of a person which crosses a station to use another mean of transport - for example, the walk between the suburbs trains platform and the entry of the subway. Several walks in each station have been chosen to value architectural devices, sound sources and social practices that can be observed. The same action was studied (1) at different time in the week -with or without public in the space- (2) in the 2 directions of the walk - go and back - and (3) in the three stations. This paper shows how sound quality perceived by users is depends on the co-existence of sociological, spatial and acoustical variables. It shows as well in which way the same space can create several sound qualities. All these results are feeding general thought on predictability of the sound quality inside public indoor spaces.

## 1. Introduction

This paper deals with sound perception in spatial transitions inside railway stations. My purpose is to describe sound qualities or sound failures perceived by users in the aim to create a prediction tool for architects.

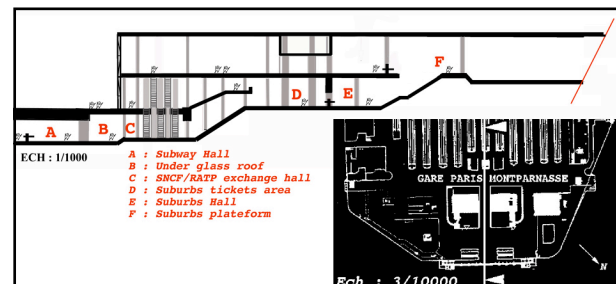


figure 1 : cross section on the walk "subway exit (A) to suburbs trains platform (F)". Montparnasse station.

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This paper shows how a specific methodology can be used to develop a catalogue which connects spatial forms, sound sources and social practices. Sociological, acoustical and architectural surveys help us to understand what users feel for several spatial transitions in stations. Sound quality is approached through acoustical criteria measurement and evaluation of subjective listening criteria. This research led surveys in Paris - Gare du Nord, Paris Gare Montparnasse and Paris - Gare Haussmann (Eole line).

## 2. Sound Quality

### 2.1 Theoretical background

This work is based on ecological theories of the perception and considers that there is no perception without action (Gibson, 1986). Action and perception are linked and we cannot understand what people feel inside railstation without understanding what people do. Cultural and sociological criteria have also a great influence on our perception. It is why it is difficult to define which type of sound could be annoying or not. It is always depends on the context, the culture and what people are doing at the moment. In other words, we cannot reduce all the complexity and richness of the sound world in a simple problematic which compares noise with silence.

In this way, this theoretical position implies studying acoustical criteria of sounds, but also how the sounds are perceived and how sounds interact with our behaviours. *Sound quality* deals with the interactions between sensitive phenomena (perceived sounds) and people's activities within the space. *Sound quality* indicates certain qualities of relationships between the sounds, space and social practices. *Sound quality* is not a fixed criterion of the environment. It embodies differently with people and time. Consequently, *sound quality* of a space involves a crossed analysis between space, acoustics and people's behaviours *in situ*.<sup>1</sup>

### 2.2 Sound Qualities descriptors

To describe *sounds qualities* we use two main concepts developed at Cresson.

Firstly, *Sound Quality Descriptors* have been categorised by Pascal Amphoux as depending on the relationship we have with the *Sound World*. In another words, Pascal

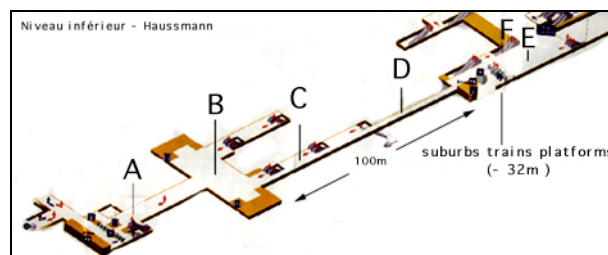
Amphoux describes mainly the way we listen to the sound phenomena (Amphoux, 1993)<sup>2</sup>:

- Sometimes, people describe the sounds or we measure them. Then, spatial, physical, temporal, semantic or cultural criteria can describe our *Environmental listening*.
- Sometimes we are "inside" the *Sound World* and several criteria help us to evaluate it and classify it: comfort, discomfort, fear, stress, etc.. Our relationship with sounds is not *environmental* but "*médiale*" that is to say we use a *Milieu listening*.

- And sometimes, the subjectivity is too strong and the beauty appears in the listening: soundscape escape from objectivity to encounter aesthetic perception. It is the *Landscape listening*.<sup>3</sup>

We use all these concepts to describe and name what people feel inside railstations. Sometimes users describe the reverberation, the clarity, the loudness, etc. of the sound environment. It can be described by several criteria and it's the results of an *Environmental listening*. Another time, people interviewed express some anxious feelings when they hear high activity inside the station. We can describe that kind of perception by criteria of the *Milieu listening*. And a few of them can describe the sound of the mechanical stairs which as musical. Again, criteria of *Landscape listening* can formalise these descriptions.

The second concept is a paradigm and it's named the *Sound Effect* (Augoyard et alii, 1995 and 1997). As Jean-François Augoyard says, the *Sound Effect* can describe the physical phenomena that create a specific perception and the context in which this perception takes place as well. For example, in railstations studied in Paris, we can observe a specific *Sound Effects* which appear in the transition between the platforms and public spaces. It is called the "remanence"<sup>4</sup> *sound effect* that it to say that the sounds of trains and sounds from platform activities are still heard in user's mind even if the sources are off. The context of the walk creates "false perception" in user's listening. Thus, *Sound Effect* appears as that tool to depict the context of sound in the sense that it embraces the interaction between human, spatial and physical dimensions (Augoyard, 1997).



<sup>2</sup> An English description of this theory has been made by Björn Hellström (Dep. of Architecture, Royal Institute of Technology, Stockholm) that will be published in 2001 by Professor Helmi Järvioluoma, Finland.

<sup>3</sup> The translation of the P. Amphoux's model (Environnement – Milieu – paysage) has been proposed by Björn Hellström, cf. note n°2.

<sup>4</sup> The English translation could be "retentivity" or "anchor effect"

<sup>1</sup> This theoretical background has been developed in several researches at Cresson: cf. the first research report by (Augoyard, 78) or cf. a report closer to our field of surveys with (Chelkoff and Thibaud, 1997).

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**figure 2** : axonometry between suburbs trains platform exit (F) and subway entry (A)" – Haussmann station – Eole line.

### 3. Methodology

As it is impossible to study *in situ* the same type of architecture in different stations, we choose to study a basic social practice which is common to the three stations : a walk of a person which crosses a station to use another mean of transport. Several walks in different stations have been chosen to value architectural devices, sound sources and social practices that can be observed. This very simple action is studied : (1) at different time of the week (with or without the presence of public) ; (2) in the 2 directions of the walk (go and back) and in 3 stations in Paris (Montparnasse, Gare du Nord and Eole-Haussmann).

Connections between bus (outside the stations), subway entries and exits, national trains and suburbs trains platforms have been studied in the same way. Same analyses have been led for each walk, each time and each place. The aim is to understand how *sound qualities* embodies in different architectures, at different times of the week and with several kind of public. Different types of surveys have been made in each station :

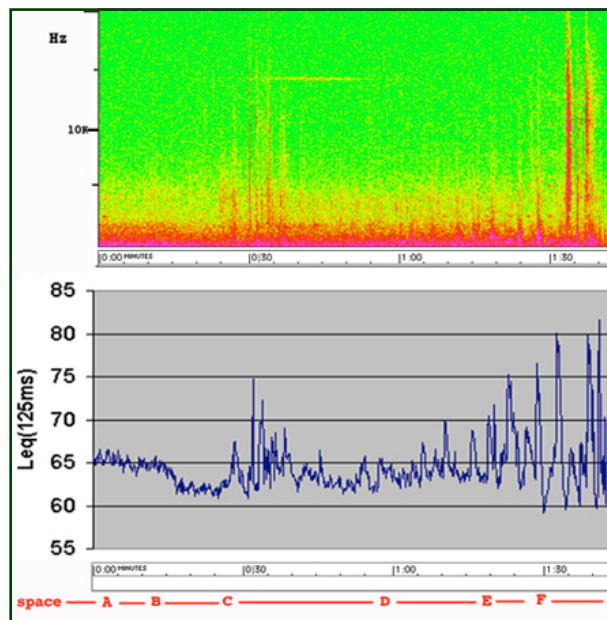
#### 3.1 Architectural analyse

Each sound walk is analysed in the relation to the architectural devices used in the station. This description is focused on "sound architecture", that is to say that all devices which interact with sound and social practices (materials, volumes, sound sources, but also benches where people can sit and talk, library, shops, etc...) are described.

#### 3.2 Acoustic criteria Measurements<sup>5</sup>

We proceed the followings measurements :

- room acoustic criteria : reverberation times (TR60, Early Decay Time), Clarity C80, STI, RASTI, Definition D50, Decreasing of the sound level with the distance – cf. table 1 below.
- environmental criteria : sound level pressure during the day, frequency analysis of the ambiances...
- sound recordings of specific walks in stations in the two directions, at different time of the day. These sound recordings have been used for the sociological interviews (cf. below). Measures of the sound level pressure and frequency analyses have also been led on these sound recordings – cf. figure 3 below.



**figure 3** : visualisation of a sound walk between subway (A) and suburbs trains platform (F) - cf. cross section above – low occupation in the station – Gare Montparnasse.

#### 3.3 Evaluation of the sound qualities perceived

*Interviews on reactivated listening* (Augoyard in Grosjean & Thibaud, 2001 ; Amphoux, 1993) with users of stations have been made based on the listening of different sound walks recorded in each station. To give the opportunity to listen is a way to help people to describe what it is not usual to describe (reactivated listening)<sup>6</sup>. We used an interactive tool to handle the interviews : sounds can be listened via html document – cf. figure below). All interviews began with very well known sound tracks. Then we played the same sound walk at different time, then the same walk but in the opposite way and finally the same walk in a another station. Interviews were recorded, transcribed and analysed by a recurrent semantic observation (Chalas, in Grosjean & Thibaud 2001) and with sound qualities described in § 2.2.

<sup>5</sup> softwares used are dBFa32, dBati32, dBTrait and dBEnv. Symphonic system. Sociéty 0 LdB Villeurbanne (Lyons) France

<sup>6</sup> this method is named "Ecoute Réactivée" and can be literally translated by "Reactivated Listening"

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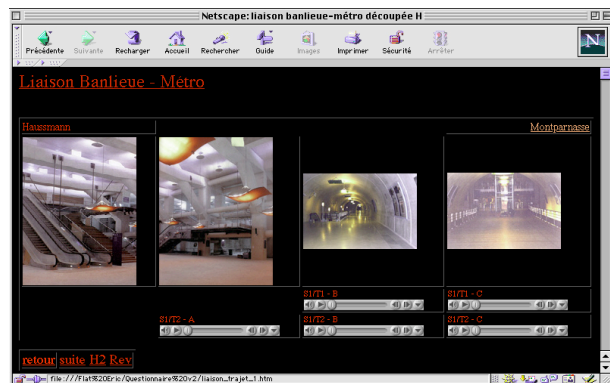


figure 4 : sample of screens used for interviews

#### 4. Case studies : Example<sup>7</sup>

Readers can understand how, with this methodology, sound qualities can be compared in different contexts - spatial, sound and human ones. If we look at the example shown in the different figures and tables of this paper, that is to say a walk between suburbs platform and the suburbs entry, we can compare what kind of sound qualities appears :

##### 4.1 At different time of the week<sup>8</sup> :

[same walk, same place, same way]

When they listen to the walk without a lot of public, most of the users talk about the "reverberation", or "echo" (*Sound effect of Reverberation*). "It's so obvious" and so clear that the reverberation of places is some kind of *sound signature*.

This sound quality is more frequently perceived in Montparnasse than in Haussmann even if measurements show stronger values of Reverberation Time in Haussmann station.

Listeners are lost in the stations (bad "Readability"). It's not easy to understand what's going on even there is no problem to recognise sound environment of the 2 stations. In Montparnasse, only sound signals let users understand the walk : "I can hear the "ticket-machine" ... so, I think we are close to the subway entry" or "at the beginning [of the sound track] I can hear the engine of the train ... so I imagine, I'm close to the suburbs platform..."

People who use Montparnasse early in the morning recognise very easily the birds that you can hear inside

<sup>7</sup> All the interviews are not all analysed : these results are still temporary and need to be completed by the whole panel of users interviewed. We focused in this part on main ideas to be explicit. Others results can be drawn and will be developed in the future.

<sup>8</sup> In this part, we copy meaningful sentences said by interviewers. We use inverted commas to quote them ; we use brackets to add some elements for a better understanding

the station. It's a sound signature that is only known by a specific category of users ("*sound emblem*")

When stations are very busy, *sound quality* of reverberation is less noticed. People describe in majority the "crazy co-existence" of a lot of sound sources. We can describe it as the sound effect of "metabole"<sup>9</sup>. In front of this quality, people can react in 2 ways : the first category likes it very much because it's close to their mental representation of the station and close to their own uses of the place. It's the symbol of life, of modernity and it is "the image of the City". The second category dislikes it strongly because it shows "how stupid we are ", "we look like animals" in a "crazy technical world". All these quotations show that listeners are in a "Milieu listening" where it's impossible to be outside.

Few users can describe sharply the "musicality of the stations sounds" : "Montparnasse and Haussmann don't sound with the same tonality, and I can say that I prefer the deeper one ... i.e. in Montparnasse with these specific sounds ... so musical for me..." (*Landscape Listening*)

With this first short example, we can see how sound qualities and way of listening can move during the day or the week for the same place.

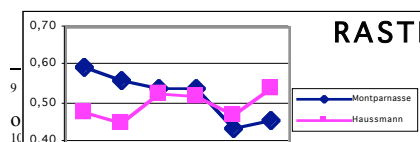
##### 4.2 According to the way of the walk

[same walk, same place, same time]

If we study only the walk in Montparnasse, people seem to better recognise the walk between subway and suburbs platform that the opposite. *Readability* of the space seems to be different according to the direction of the walk. Does it have any correlation with the evolution of the *intelligibility index* (RASTI – cf. table 1) ?

It's interesting to see as well that same basic qualities are still noticed : *reverberation*, *signature*, *metabole*, even acoustics measurements show that the values of Reverberation Time and acoustic pressure levels (Lp) are less loud in the beginning of the walk than in the end - cf. figure 3 and table 1. To be more explicit, when you enter in the station by the subway exit, reverberation time is comparatively quite low (TR = 1,8s). So, it's interesting to listen people describe the same quality than when they hear sounds from platforms, where the reverberation time is the around 4s.

We can observe a specific sound effect of *Remanance*<sup>10</sup> which appear when we ask people to stop the sound track that they are listening when they feel close to the

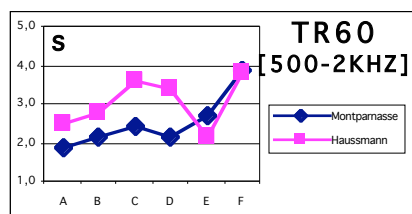


describes the instability

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platforms : all do mistakes to locate the appropriated time. We can see that sounds from trains engines seem to be heard even if they are not ! Different sound spaces are mixed and the limits are floating according to the way of your walk : as Jean-François Augoyard says, sound space is not symmetric !



**table 1** : TR60 and RASTI on the walk "subway (A) to suburbs trains platform (F)"- Montparnasse and Haussmann stations.

### 4.3 According to the space

[same walk, same way, same time]

If you compare the two stations with the same occupation of the places, one people can says: "*I can say that in Montparnasse, you'd better not be agoraphobic whereas in Haussmann, you'd better not be claustrophobic !*"<sup>11</sup>

So, in the global perception of sound quality of a space, criteria linked to space seem to be stronger in Haussmann whereas criteria linked to social practices are stronger in Montparnasse. In a way, it is quite well correlated to the measurements we did – reverberation time and intelligibility – cf. table 1. But in another hand, it is quite surprising to see that such a long reverberation time in Montparnasse can be masked by people's activities.

## 5- Conclusions

All measurements are finished but the analyses of sociological surveys are still in process. We cannot give any definitive results right now. Nevertheless, it is interesting to see that same "acoustic parameters" can create several sound qualities perceived by users. These tendencies can be described according to three dimensions : an acoustic one, a spatial and a social one. It can be summarised in a catalogue that can be a tool for architect to predict sound quality in new projects.

## Acknowledgements

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Augoyard, assisted by Grégoire Chelkoff and Jean-Jacques Delétré. Thanks for their advises.

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<sup>11</sup> "Je dirais qu'à Montparnasse, on n'a pas intérêt à être agoraphobe alors qu'à Haussmann on n'a pas intérêt à être claustrophobe !"