The sound navigation system at Montparnasse station

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ABSTRACT

There are few information at French railway station. People have to take attention to the visual sign to get the information of train departure time, corridor number, change the train etc. However, some stations of SNCF, which is the national railway company, are very large and have many lines, for instance, TGV, domestic, international line, so that it takes long time to find the right way to corridor. Some people seem to lose their ways while they are moving at the station.
Then we thought that it was necessary to make the sound navigation system not to lose the way, and passengers were smoothly guided to their right destinations.
Before this experiment, some research had been done to find the problem at the station, and we got the conclusion that people felt difficult to go to another place from main platform. From these researches, we chose one place for the sound installation, which was the passage from main platform to another platform at Montparnasse station in Paris. This reason was that people had to use the long moving walkway for three times, there were some exits on this way, and they could not see the destination because another platform was upper stair.
After recording and analyzing the ambient sound of the station, we made some three types of sounds that were Attention, Feedback, and Time-line. Attention and Feedback sounds tell us the right way, and Time-line sound tells us the distance to the destination. 30 subjects selected the sound that went well with the sound navigation system in the laboratory. The highest score sounds were installed at the actual station, and the evaluation experiment was conducted. Consequently, some problems have been improved.

KEYWORDS

Sound installation, Earcon, Station, Ecological

1. INTRODUCTION

In public space, such as a station, there are frequent information using sound. For example, the departure bell of a train, a ticket machine, the error sound of an automatic ticket gate, etc. have emitted sound with each original apparatus by automatic service in recent years. In the niche of such public space, we can take our actions by using these sounds for communication. Moreover, in public space, since a visual sign is inadequate according to the structure of a building, an auditory sign, which spreads broadly, is a very effective. On the contrary, if new sound destroys this niche, many users might get confused. However, at present, such methodology is not established but disorderly installations like a departure bell of the railroad station in Japan have been made in many cases. Therefore, in this research, we decided to make the system of the sound installation for smooth guidance of a user at the SNCF Montparnasse station in Paris as a model station. This is the proposal of the design method of the sound for public space including the employment method.

2. BACKGROUND AND PURPOSE

The typical sound, which gives us certain information in public space, may be the sound of bell like a church bell in Western culture or a *bonshou* in Japanese one. This sound is very important to share time in the society or community. These bells have many sizes according to the dimension of their society or community. Big village has a big bell like Big-Ben in London, Notre Dame in Paris, Toudaiji in Nara, and so on. However, at recent, it may become a noise in public space, if exact application is not performed about the new sound that contains certain information. Especially the sound played from a speaker in the downtown where an institution and population crowd may become noise, therefore it is necessary to pay careful attention to use new sound in public space. It is because the sound for carrying out communication is an unrelated one for the user who does not need the information.
In the case of public space, we also have to take notice of a relation with the environmental, because various sound overflows and it is changing every moment in public space unlike closed space. In case the sound in such public space is considered, the paradigm that becomes important is Acoustical Ecology. An environmental sound is classified into three, *keynote*, *sound signal*, and *sound mark* (Schafer, 1977; Truax, 1978). Moreover, the spectrum analysis is carried out environmental sound, the frequency band for life, the spectrum niche, of various living things that live together there is analyzed, and the influence of new sound that enters into the environment is considered. This view is

excellent, and like this time, when installing new sound, it has a possibility of changing the sound environment before it, therefore the detail analysis of environment sound is necessary not to break it. Because we adjust to the affordance which we have used previously.
From such a viewpoint, research on classification and perception of sound in a station was done first (Tardieu et al., 2004a). In this study, subjects answered the place of station by only listening to the sound of place. These sounds was recorded at 6 places - Ticket offices, Corridors stairs, Waiting rooms, Platforms, Shops, and Halls- in 6 French stations. As a result, subjects could understand the place by only listening to the sound. This results show that we can listen to the space or place like as *Everyday listening* (Gaver, 1987), *Hearing shape* (Kunkler-Peck & Turvey, 2000), and *Psychomechanics* (McAdams, 2000) . This research supports the ecological paradigm – Our perception is not based on separate senses (modal specification) but amodal (Stoffregen & Bardy, 2001). Following on this research, the behavioral scenario in a train station was analyzed, which explain how users move in the train station to get their train and what they search to get the information (Tardieu et al., 2004b; 2006). This research appeared what users need as information, and where users need the auditory sign.
The purpose of this experiment is to realise these users' needs at the real station.

3. METHODS

3.1. Place to install

Based on the behavioral scenario of the user in a station, the actual behaviour of subjects was recorded on the video and the place where users need the sound information was decided. As the place of experiment, Montparnasse station of SNCF that is French Railway Company was decided. This station is one of big station in Paris, and it is very complexed to change the train because this stations have two big platforms. Some people seem to lose their way while they are moving at the station. As visual sign, there are some information bord which are writen for the name of plathome, number of corrido, direction to correspondant with the place around the station which is Metro,Taxi, Bus stops. As normal people can usually move looking at these visual sign, for the blind people and forigner, it is very difficult to get the right information from visual sign. As auditoy sign, there are few information at the station, which are some verbal messeges, the jingle before messege and the train departure bell. Except for these sound, we can listen to the train moter noise and other which passenger makes for example, talking with, foot steps, mobile phone, and so on.
So we thought that it was nessecary to make the sound navigation system not to lose the way, and we decided to install the sound navigation system at the passage between the main platform and Vaugirard platform. Because this passage has about 300 meters distance, and there are 3 moving walkways, and moreover Vaugirard platform is upper floor from main platform.

3.2. Soundscapes

Soundscapes of 10 spots along this passage were recorded with ambisonic microphones (Sound field: ST250) on DAT (Sony: PCAx) and sound pressure level was measured on 9 points of there with the sound and vibration analyse system (01dB-Stell: Symphonie) in daytime of usual weekday.

3.3. Speaker and Sound type

In this experiment, every two loud speakers were installed on each first three moving walkway and last escalator, so eight speakers were fixed on the ceiling and the side of passage. Four of them were installed near by the start points of each moving walkway and the gateway of Vaugirard platform, and others were done at the place where was about 20 meters away from the speakers near by each start point (Fig.1).
Three types of sound source were tried which are Attention Sound (AT), Feedback sound (FB), and Time-line sound (TL). AT gives users an attention that this way is to right destination, and FB tells them that you go the right way, so they can confirm by FB. These combination of AT and FB is used same sound on each place. TL tells them the length to their destination, so that sound of TL goes to change as the distance of destination. TL sounds after FB.
About speaker (TOA: Sound Repeater EV-20A), this speaker incorporates recording, playback, built-in amplifier and speaker, a microphone, sensor and an external input, therefore it plays the internal sound when someone pass by this speaker.

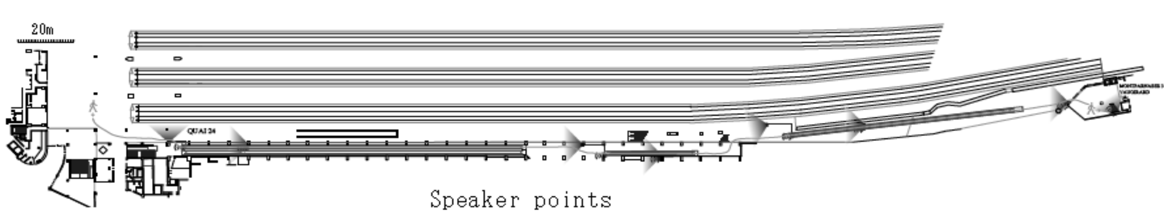

Figure 1. Map and loud speakers points from the main platform to Vaugirard

4. SOUND SOURCE

When the sound source is created, there are two possibility of the concept, which are Auditory Icon (Gaver, 1989) and Earcon (Blattner et al., 1989). On the view of Ecological paradigm, Auditory Icon is effective because it tells us the meanings of objects more directly than Earcon. However, this time, it is very difficult to express the meaning of Vaugirard platform as the destination, and if the Auditory Icon used with station sounds is played, it may be getting still more confused. From these reason, the method of Earcon was selected in this experiment. As refered to some articles about the creation of Earcon (e.g., Brewster et al., 1992; 1993; 1995), we had to consider the harmony with environment sound.

As Earcon is not related to environment sound, it may break the niche of place. Then in this experiment, all sounds were created mainly based on the paradigm of Acoustical Ecology. So we considered the relation among Keynote , Sound signal, Soundmark, and new Earcons.

4.1. Analysis of environment sound

From the data of sound pressure level, the range of environment sound as Keynote was between about 50 and 70dBA(*Leq*) , but the level while train like TGV is arriving and departing was increasing over 90dBA (Table 1). In these cases, it is more important to consider the frequency and its bands of Earcon than volume of sounds.

About spectrum data, almost noise frequency distributed under 1 kHz (Fig.2). Next, Keynote was determined with the spectral centroid methods. The frequency which got the square of spectrum average from environment sound in half was calculated as Keynote. When analysing the environment sound, some data like train arriving or leaving were eliminated, because these sound were considered not as Keynote but Sound signal. As a result of analysis, Keynote was turned out 511.6Hz whose note was about *Do* (C5: define C4 as the centre C).

As Soundmark, the famous jingle of SNCF, which was played before the announcement, was determined. The melody of this jingle has tonality of C minor so that its sound harmonizes with the note of *Do* as Keynote.

As other sound events, there were many sounds in this station, which were the sounds of train, departure bell, announcement, car noise near by station, voice of users, footsteps, mobile telephone, luggage carrier, and so on. Thinking as Sound signal in these sounds, departure bell and the sound that TGV pass by were characteristic one in this station. The peak frequency of train departure sound was from 64(C2) to 727Hz (Fis5) and this duration continued 50 seconds and the maximum sound pressure level was 91.9dBA. The train departure bell was ringing for about 50 seconds, and its frequency was 2470.6Hz（Eb7）.

Table 1. Sound pressure level near by the passage.

Point	Sources	Leq (dBA)
1	Background (Bg) noise	63,8
	Spoken announcement	72,9
	Arrival of a TGV	84,6
	TGV stand by and people walking	73,4
2	Bg noise	69,7
	TGV stand by and people walking	78,1
3	Bg noise	69,0
4	Bg noise	62,8
	TGV pass by	91,9
5	Bg noise and TGV stand by	72,9
	Bg noise	63,4
6	Bg noise and TGV stand by	65,0
7	Bg noise	70,0
	Bg noise and TGV stand by	73,0
8	Bg noise	63,6
	Bg noise and people walking	64,2
9	Bg noise	51,7
	TGV pass by	76,1
	TGV stand by (doors open)	60,4
	TGV stand by (doors closed)	52,8

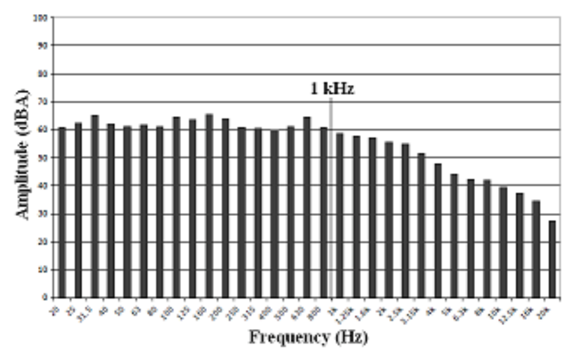

Figure 2. Spectre 1/3 oct. of background noise.

4.2. Making Earcons

From these results, the frequency of new Earcon was determined the note of G (near by 800Hz) or C (near by 1000Hz) because this note was consonant with Keynote and Soundmark and this frequency was not masked by big noise of TGV.

At first, 120 sounds were made for AT and FB sounds by MATLAB considering the relation which was the counter of melody, rhythm, and velocity according to the previous study of Earcon (Brewster et al., 1995). Finally, 20 combinations were selected from these.

Next, for TL sound, 10 patterns (Table 2) were made, which were considered the forms of melody, rhythm, harmony or the repeat time or the duration according to the distance of destination.
Timber of these sounds was made with the additive-synthesis methods. The series of harmonics was constructed with the golden rule, for example, [1, 2, 3, 5, 8], [2, 3, 5, 8, 13], and so on. Moreover, level of each harmonics was arranged with considering the spectrum of environment sound.

Table 2. Profiles of Time-line sounds.

No	profile	1st	2nd	3rd	4th
1	Cadence	SD	D	D 7th	T
2	Pitch interval (semi tones)	5	10	15	20
3	Harmony (number of notes)	5	4	3	2
4	Repeats (times)	4	3	2	1
5	Length (broken chord)	slow	mid slow	mid fast	fast
6	Melody direction 1 (up and down)	u	u-u-d	u-d-d	d
7	Melody direction 2	u-d	u	d	d-u
8	Accent	ooo**O**	oo**O**o	o**O**oo	**O**ooo
9	Vibration	slow	mid slow	mid fast	fast
10	Accent+repeat	ooo**O**	oo**O**	o**O**	**O**

5. EXPERIMENTS

5.1. At the laboratory

To select the best sound for real station, 30 subjects(15 female, 15 male, yr 26-49) took part in the experiment. They answered the three pairs of AT and FB in terms of best combination, and for TL, they arranged each four sound according to the distance of destination. Experiment was done in the double-walled IAC sound booth and sound was presented by Apple computer and headphone. Experimental session run using Max/MSP interface.
As a result, one combination of AT and FB was selected and the highest correct answer of TL was done. This AT and FB were made using the pentatonic scale and AT was ascending melody and FB was short descending one, whose relation was Tonic-Subdominant motion. For TL sound, the type of repeat time was selected, which rung 4 times at first speaker and the next was 3 times, so times of repeat decreased from start to end.

5.2. At Montparnasse station

The sounds that were selected by the experiment at the laboratory were installed in eight speakers at the place of passage from the main platform to Vaugirard one. All speakers were set up to play only while users passed around them by the infrared sensor whose detection range was about three meters. Other external sensors were added at the start points of each moving walkway, because these points had to cover the wide area where people walked around (Fig.3). This experiment was done in March of 2006.

Figure 3. Loud speaker and sensor setting at the start point of moving walkway.

Ten subjects (6 female, 4 male, yr 21-57) who were all the first visitors to Montparnasse station took part in this experiment and they simulated to get the certain train at Vaugirard platform from the exit of underground Metro station. 8 of them were told to listen to the sound navigation and others were not. Their behaviours were recorded on the video and they answered some questions after this experiment.
As results, all subjects could go to their destination in time and 8 of them did without missing their way.
As results of their answer for the all sounds, they all said that the navigation sounds were effective for moving at the station and all the sounds were easy to listenn to in the platform's noisy ambience. But the function of Time line sounds were not able to be understood by almost subjects, because repeat time of these TL sounds was supposed to be short to percept them in the noisy space.

6. CONCLUSION

This study is one of the proposition toward the question, "How do we make sounds for public space?" The validity of sound navigation system at a station was confirmed in this experiment and there were lot of opinions that showed the necessity to this type of installation.

Though Earcon were used as the attention sound in this time, it is considered that Auditory Icon also has a possibility for the public space. Especially, thinking about the term, Ecological, it might be the effective way. In either event, considering the harmony with environment is important as same as creating new sounds. But there were few research that solves such problem. It is considered that more experiments have been done from the paradigm of Ecological Acoustics and Acoustical Ecology.

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