Functional soundscape, outdoors and indoors

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Abstract

Soundscape has many definitions, too many. Regarded as a tool to design measures for the improvement of environments for people, it can be an important addition to 'old-fashioned noise control'. Until now the main focus of research has been on outdoor spaces, and the physical -and psycho-acoustical- properties of the audible sounds as such: spectrum, levels, but also roughness, sharpness, etc. It is proposed to take the information content of the composite sounds into consideration, and in particular their meaning to people, and their impact on them. This approach seems even more appropriate for indoor use, because it combines the properties of the building -sound reduction, sound absorption, sound production- and the specific sound sources of the users. Many items of the total 'choir' of sound sources can be manipulated to some extent, thus enabling designers to enhance positive impacts and to reduce unwanted sounds. This will be illustrated for hotel rooms and hospital rooms.

Introduction

The art of acoustics may be described as: "taking care that is heard what should be heard, and that is not heard what shouldn't be heard".

For acoustical consultants the question "what *is* soundscape?" might be less interesting than "what is the *use* of soundscape?" In the discipline of environmental impact, only noise as a negative factor existed, just like toxic gases, fluids etc. And just like the chemical pollutants can be characterised by concentration values, noise exposure is expressed in dB(A).

Noise, regarded as a pollutant, must be controlled. Therefore guidelines or laws are necessary, and they were developed in all European countries.

Sound in urban environment also can have a function in orientation, and other favourable effects. [1]

Noise Control

In noise control a simple model for the description of noise has been in use: the spectral aspect is basically expressed in A-weighting; the temporal aspect in the energy-equivalent value. For non-tonal, gently fluctuating noise no further correction is used.

But... there is more. Sound influences people both consciously and unconsciously. A variety of non-acoustic variables play a role: character, recognisability of the source and relationship to the source, necessity, etc. It is difficult to take these factors into account.

Soundscape

The (short) history of soundscape research is described by Lercher and Schulte-Fortkamp [2], while Axelsson [3] reports on the progress of the international standard ISO 12913, containing this definition: *Soundscape: An environment of sound (or sonic environment) with emphasis on the way it is perceived and understood by the individual, or by a society.*

Other meanings of soundscape, like certain special types of music or sound art, are not addressed here.

Functional soundscape

While human perception of sound is very complex, soundscape may offer a useful and practicable approach to noise control, both outdoors and indoors. From many investigations the general preferences outdoors are clear: sound of nature (birds, water) are regarded positive; traffic noise, construction noise and other mechanical sounds are annoying.

For indoor sounds there is a larger variety. But also here, the properties of the sources and the (individual) relationship of the observer to them are essential.

Sound sources

Analysis

We can try to deduct the properties of the mix of sounds in a certain place from the sound signal as such: the psycho-acoustical approach. Because in this case the total soundscape is judged, this can be regarded as holistic. The intricacy of the human hearing system, however, is a major complication in the necessary analysis. This analysis is necessary to determine not only the quality of the soundscape as a whole, but also the positive and negative elements in it. From these constituting elements measures for improvement -if necessary- can be designed. This procedure is sketched in figure 1, comparable to a proposal by Brown and Muhar [4]

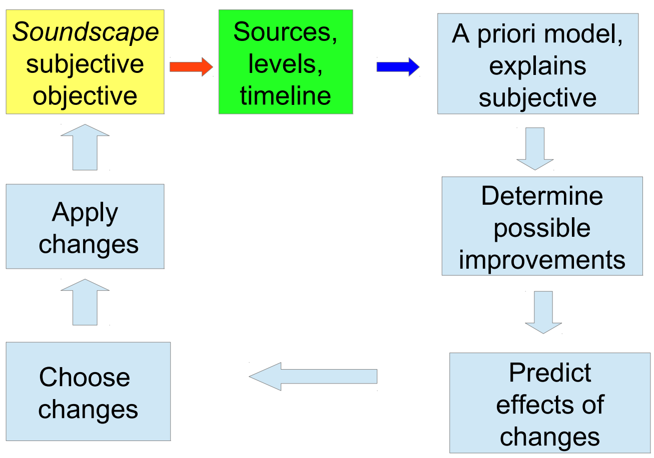

Fig. 1: Improving a soundscape

Synthesis

Starting from an a priori inventory of the relevant sources, and their acoustical properties, the contributions to the physical sound field can be calculated. They can be judged separately, based on preferred values for each (type of) source. This can be regarded as a reductionist approach.

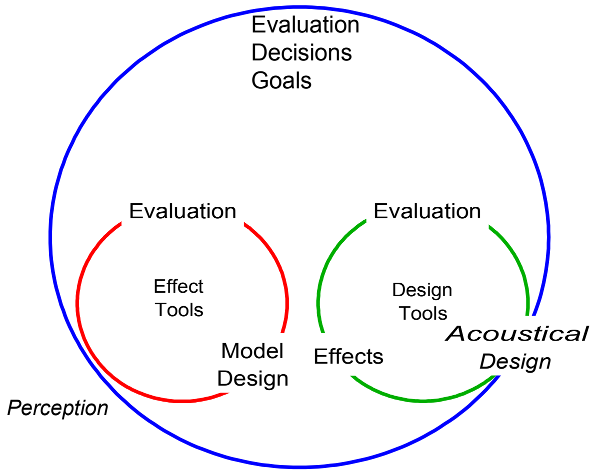

Fig. 2: Double loop learning cycle

Practice has learned that it is not easy to extract an overall judgement from the contributions of the sources. We would have to consider different sensitivities, masking effects. For functional soundscape we can do without the overall judgement.

The difference in approaches is visualised in Figures 3 and 4. The "holistic" approach, starting from the complex soundscape requires analysis a posteriori of the sources and their contributions. The reductionist approach starts from the a priori knowledge of the sources, their strength and character.

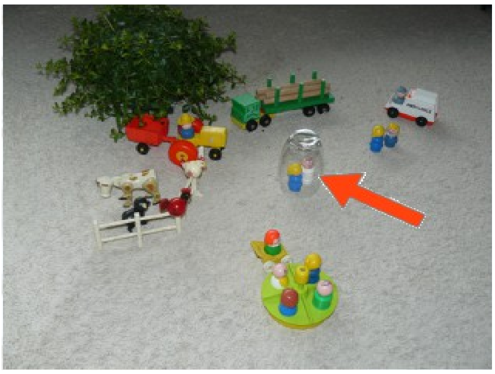

Fig. 3: Complex soundscape-holistic approach.

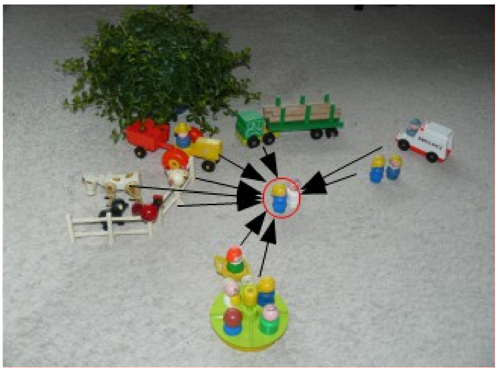

Fig. 4: Contributions of sources-reductionist approach.

Effect tools

Determination of the preferred values for each type of source is dependent on context including the other sources and must be learnt from practice. The scheme in fig. 2 shows the inner circles of developing the tools for design and effect assessment, within the outer circle of application in practice. [5]. The effect tools are aimed at perception. Besides some acoustical variables (spectrum levels, time history), descriptors are subjective. Two kinds of descriptors could be identified: description of the (complex) sound itself, like sharpness, roughness, etc., or description of the meaning of the sound source for the receiver, like: informative, pleasant, reassuring, alarming, matching visual ambiance, etcetera or their negations. The second type fits best in the chosen approach.

Design tools

In general terms the options for soundscape design are limited: manipulation of sources, (elimination, adapting, adding), of transmission (screening and reflecting) and sometimes the immission (sound insulation of façades).

Examples

Developing tools by experiment is troublesome in case of outdoor soundscape. Manipulating sources and transmission is often too expensive; almost identical sites where the effects of different measures could be compared are rare.

Indoor soundscapes are much easier. For instance identical hotel rooms exist in large numbers. They may already differ in orientation with respect to noisy roads; other differences can be applied, like adding or reducing sound absorption, more quiet equipment etc. This applies to hospital bed rooms as well.

On the other hand, more or less public spaces will have more properties of outdoor soundscape, as indicated by Dökmeci and Kang [6]

Hotel rooms

In Table 1 a possible inventory for relevant noise sources is given. For some sources it is useful to formulate a noise criterion, specified for the day and night period; for others, only the peak values are relevant. A third category concerns non-mechanical sounds, mostly of human origin. There sound insulation values seem the most appropriate way to state requirements.

Most of the sound sources in the table can be labelled as negative, annoying.

Fan coil units belong to an interesting category. They can be switched on and off by the occupants of the room, at different speeds. In this way the occupant can swiftly adapt the room temperature to his desires, and the sound reassures him that it is in (full) operation. At low speed it should be just audible, at high speed it should be noisy enough!

The usual finishing of hotel rooms with carpets, curtains, beds requires no special attention for sound absorption, let alone for the reverberation time.

Source	**Day**	**Night**
Street traffic	L_{eq}= 40 dB(A)	L_{eq}= 30 dB(A)
Elevator	L_{max}= 45 dB(A)	
General ventilation	L_p= 35 dB(A)	L_p= 25 dB(A)
Fan coil unit	L_p= 40/45/50 dB(A)	
Corridor	Wall + door: R'_w= 30 dB	
Airborne neighbour noise	Partitions: R'_w= 50 dB	
Sanitary neighbour noise	L_{max}= 40 dB(A)	
Partner	-	p.m. (snoring?)

Table 1: Sources and tentative noise criteria for a hotel room

Noise produced by a room mate -partner- is mentioned for completeness; it is a phenomenon beyond the influence of hotel design.

Hospital rooms

The number of potential sound sources in hospital bed rooms is much larger. Joseph and Ulrich [7] give an extensive, but mostly qualitative survey of acoustical aspects of hospitals. In table 2 a possible inventory is given for the most common sound sources in a hospital bed room. Next to the direct noise level criteria and sound insulation demands, for a number of sources the architectural design is paramount.

Ice cube dispensers are widely used in USA, [8] but hardly in The Netherlands. The tinkling noise of ice cubes can be annoying, and therefore would require a separate closet, which however not always is available, it seems.

Source	**day**	**night**
Street traffic	L_p= 35 dB(A)	L_p= 25 dB(A)
General ventilation	L_p= 35 dB(A)	L_p= 30 dB(A)
Corridor	Partition + door: R'_w= 25 dB	
Elevator	L_{max}= 40 dB(A)	
Medical equipment	L_{eq}= 35..40 dB(A)	L_{eq}= 30..40 dB(A)
Alarms, telephone ringing	L_{max}= 60 dB(A)	silent
Sanitary noise	L_{max}= 40 dB(A)	
Doors slamming	Architectural design *Lay out, organisation, room acoustics*	
Staff conversation		
Visitors conversation		
Roommates		
Neighbour room (mates)	Partitions: R'_w= 43 dB	
Ice cube dispenser	L_{max}= 50 dB(A)	?

Table 2: Sources and tentative noise criteria for a hospital room

Conversation of visitors and staff are multifaceted elements. At a very low level they can just be reassuring, confirming the presence of other people. At a level where the conversation is almost intelligible it can be annoying, and even dangerous if messages are misunderstood. Good intelligibility is required if the patient is addressed by staff, but not if not addressed.

Conclusion

This approach may differ from “normal” soundscape, as it stems from noise control - in buildings. But it is a more integrated approach than usual, which is new in this field. On the other hand, application of the soundscape concept indoors offers chances for experimentation and field research that can be useful for the development of tools for outdoor soundscape.

In the cases where acoustical measures are considered or designed, specifications are necessary, not globally, but for each source separately. So, despite the holistic character of the soundscape approach, in the end measures of a physical nature must be specified in a reductionistic way, with noise impact values and target values for each source separately.

References

[1] Ruiter, E. de: Soundscape, privacy, communication and orientation, International Congress 'Doing, thinking, feeling home: the mental geography of residential environments', October 2005, Delft, The Netherlands.

[2] Lercher, P., Schulte-Fortkamp, B.: The relevance of soundscape research to the assessment of noise annoyance at the community level. ICBEN 2003.

[3] Axelssön, Ö.: The ISO 12913 series on soundscape. Forum Acusticum 2011.

[4] Brown, A.L., Muhar A.: An approach to the acoustic design of outdoor space, Journal of Environmental planning and managemant, vol. 47, no. 6, November 2004.

[5] Müller, D. B., Tjallingii, S.P., Canters, K.J., 2005: A transdisciplinary learning approach to foster convergence of design, science and deliberation in urban and regional planning. Systems Research and Behavioural Science 22.

[6] Dökmeci, P.N., Kang, J.: Classification of architectural spaces from the viewpoint of acoustical comfort. Inter Noise 2010.

[7] Anjali, J., Ulrich, R.: Sound control for improved outcomes in healthcare settings, Issue paper #4, January 2007, The Center for Health Design

[8] Hospital acoustics group on LinkedIn:

http://www.linkedin.com/groups/Hospital-Acoustics-2480179?trk=myg_ugrp_ovr