Urban Configuration and the Soundscape

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Abstract: The morphology of the urban environment and its experience is a topic with many facets, and urban planners and designers developed a rich palette of methods for describing the structural qualities of urban space. Many of these qualities are closely related to the visual experience of urban spaces. For example, Camillo Sitte's principles of urban design were to a large part justified by their visual effect (Sitte 1901). Consequently, there is a long history of modeling the sensory urban experience based on formal and structural measures of the built form. Not surprisingly, many of these approaches focus on the visual experience of urban space, while the sonic qualities play a secondary role. This paper investigates to what extent the existing urban morphological measures are applicable for understanding the acoustic qualities of urban spaces. This investigation includes a review of the role of sonic qualities in the existing urban design literature, following a framework by A. Sevtsuk (Sevtsuk 2010), dividing these urban form measures into five categories: topological measures, aggregate, morphological, cognitive and observational measures.

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Background - Sonic and Visual Perception

Many measures for urban shape contain implicit biases towards the visual sense, which presumably is our primary means of navigating and comprehending the shape and space of the city. For example, Philip Thiel's experience notation technique, *environtecture,* is entirely based on a diagrammatic abstraction of the visual field; acoustic qualities are not mentioned at all in this comprehensive volume on the topic (Thiel 1997).

However, the senses of seeing and hearing are very different from each other, and hearing is important enough to deserve closer investigation. Visual attention is always focused on a specific point, thus having a distancing effect between the observer and object of observation. Since it is impossible to observe multiple things in different locations at the same time, the focus of visual attention is constantly moving.

Hearing, on the other hand, covers almost 360 degrees, thus immersing the listener and removing any mental distance. As a result, the soundscape affects us more directly.

There are, however, auditory analogies to the focused nature of visual attention. Our hearing is sensitive to subtle shifts in phase, enough to detect timing differences of scattered sonic reflections as we turn our head in different directions. This ability enables the localization of sound sources, both in terms of estimation of depth and direction (Blauert 1997).

Furthermore, unlike the visual sense, hearing allows us to process multiple sources at the same time, while being able to mask out ambient noise such as the sounds of traffic or the ventilation infrastructure. At the same time, we can quickly bring acoustic information from the periphery of attention back into focus if the content is relevant, a phenomenon known as the cocktail party effect (Cherry 1966).

There are also interaction effects between visual and acoustic perception, situations where perceived visual information modifies the perception of sounds and vice versa. This has been demonstrated with the example of speech processing (McGurk and MacDonald 1976), but might apply to other situations as well.

What does that mean for the experience of urban environments? It has been argued that the sound plays an important role for the sense of place. Since most hearing happens in the periphery of attention, we constantly process multiple sources without necessarily being aware or being able to articulate them. However, as soon as our name is called or the horn of a car sounds behind our back, our attention is immediately captured.

The form of the city, in return, influences the soundscape, the built environment shapes everything we hear. While this might seem obvious, it is still poorly understood how the form of the city influences the sonic environment.

The Soundscape

The term *soundscape* was introduced by the Canadian composer Murray Shafer, who drew wide attention to the sonic qualities of urban environment. His tool of choice was field recording, capturing everyday sounds in their natural environment. The second contribution is a vocabulary that allows the description of acoustic phenomena. in Schafer's terminology, the 'keynote' would refer to the 'tuning of a space', the dominant frequency, signals - sound events in the foreground of attention and *soundmarks* as characteristic sonic signatures of a place (Schafer 1993).

The limits of Schafer's approach arguably lie in its ultimately conservationist nature of his attempt to map and isolate characteristic sounds of a place. In order to avoid these idiosyncrasies inherent in literal phenomenological descriptions, Jean-Francois Augoyard proposed a framework based on performative aspects: he focused on the relationship between spatial qualities and the specific "sonic effects" they generate (Augoyard and Torgue 2006).

Topological and Viewshed Measures

Even highly abstracted models of the configuration of the built environment often contain an implicit bias towards the mode of visual perception. Topological models such as street connectivity graphs might implicate vision in the way they discreticize urban space. For example, space syntax' axial analysis divides urban spaces into a network of connected linear elements based on the longest lines of sight from within the street (Hillier 1999). Viewshed (also called Isovist) models emphasize the visual sense even more explicitly by describing the geometric shape of the maximum visible volume projected from a specific point (Benedikt, 1979). These models are the basis for the protection of views of important landmarks or skylines, for example through zoning regulations imposing height restrictions for buildings located in the volume of a protected view (Tavernor & Gassner, 2010).

What could be the acoustic analogy of the viewshed – a model for describing the salient acoustic connections between different places? Compared to the geometrical nature of light, the diffusion of sound and its relationship with features of the built environment is less obvious. However, it turns out that sonic diffusion in urban space is less uniform than often assumed, and the built environment structures the soundscape in a profound way. Different configurations of buildings generate different sonic effects. Augyard & Torgue describe, among others, the "Cut Out" effect, which can be experienced when passing openings or narrow streets (Figure 1).

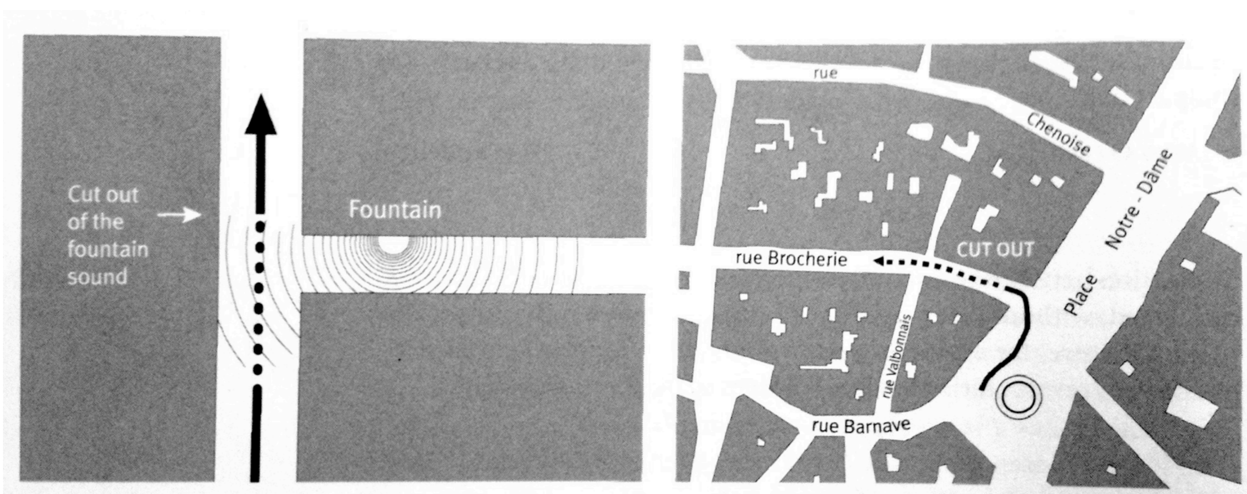

Figure 1 Illustration of the Cut out effect – a narrow street can act like a stencil for the ambient soundscape (Augoyard & Torgue, 2006)

Aggregate Measures

Aggregate measures of city form encompass measures of size, density and distribution for a large number of relevant variables, (Campoli and MacLean 2007), including infrastructure and amenities (Forsyth et al. 2008). While none of these studies mention acoustic parameters, many of these measures can be useful for a rough approximation of basic acoustic qualities, such as the amount of ambient noise. It can be assumed, that density and distribution of industrial facilities, highways or train tracks have a significant acoustic impact. Historically, the nuisance of industrial sound emissions was a contributing factor that has led to the establishment of zoning laws.

The most common aggregate measure used in acoustics is sound intensity, typically represented in isobel maps showing the distribution of noise levels across space at a specific time. However, the intensity level alone is not an adequate measure for noise, since different frequencies have a different contribution to the perception of noise (loudness would be the appropriate measure normalized for human hearing). Furthermore, sound dynamics, including unexpected changes in intensity, are often more troubling than sustained noise levels.

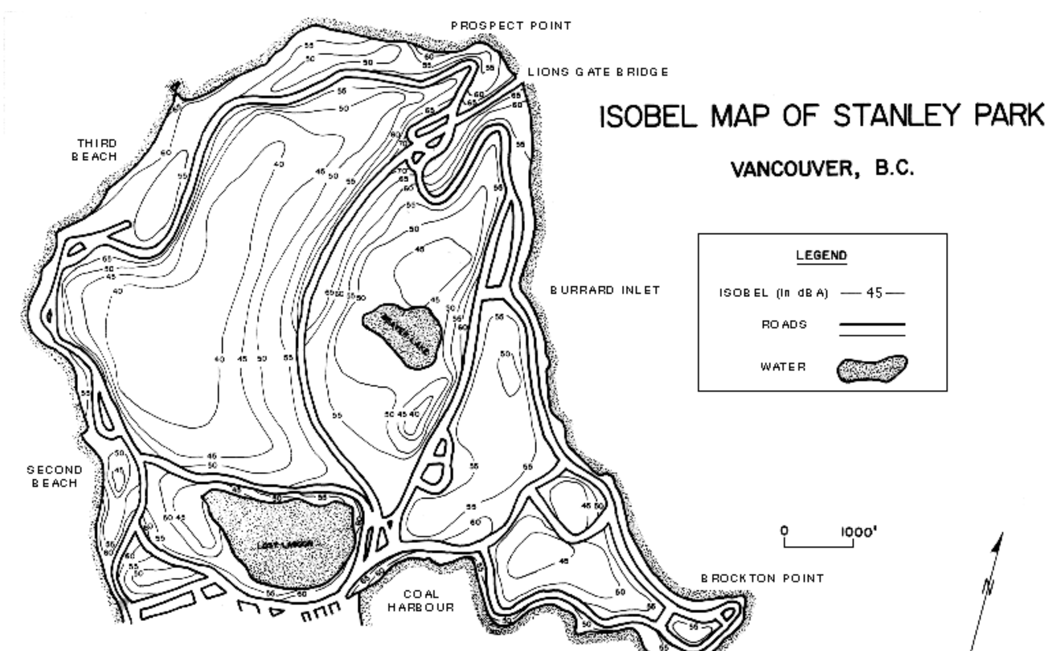

Figure 2 Muray Schafer, Isobel Map of Stanley Park, Vancouver (Schafer 1977)

While these elements can be easily measured, the classification of ambient sound as noise has also strong subjective component that is harder to measure. Sounds with similar physical characteristics, such as a similar level of intensity and frequency distribution, might be perceived as either comfortable or irritating. Sounds generated by the activity of other people might be perceived favorably up to a certain level, the sound of trains might be more tolerated than the noise of heavy truck traffic.

Morphological Measures

Morphological aspects are crucial for sound propagation in urban environments. Both the basic geometric properties of built blocks (Siksna 1998) and the spatial aspects of their social uses (Anderson 1978) have an impact on the soundscape.

Buildings and urban blocks act both as barriers, decreasing or blocking the sound volume, and reflectors, which in turn increase the perceived sound level. The impact of different spatial configurations on the soundscape can be easily examined: a street framed by perimeter blocks with continuous facades of a certain height increases reverberation and loudness. When walking along such a street and encountering an open space such as a park opening to one side of the street, the change in sonic characteristic can be easily noticed. Single, freestanding buildings along the street have a less effect, especially if one side of the street has open space. Plants and foliage generally reduce perceived loudness.

But also the position of the sound source relative to the facades of the building is important. Sonic features such as reverberation and echo change noticeably even with minor changes in position. This ability for echolocation allows blind persons to estimate overall shapes and qualities of spaces: whether a space is open or closed, the proximate location of walls and corners and the material quality of surfaces (Arias and Ramos 1997).

While the acoustics of closed indoor spaces is understood fairly well, the situation is different for the evaluation of sound propagation in urban spaces. Due to the amount and complexity of influencing parameters, research on descriptive mathematical models is still at an early stage (Ketcham et al. 2007).

Cognitive Measures

In “the image of the city”, Kevin Lynch briefly discusses sounds and their role in reinforcing of landmarks, but did not find that sounds could constitute landmarks themselves (Lynch 1960). This might be the case, but I think it might also be an artifact of the research design, which was based on semi-structured interviews and sketch maps. Arguably, in our visually oriented culture many people find it much harder to articulate sonic qualities of a place from memories and find it even harder to translate it into a visual notation like a sketch map.

Lynch’s student Michael Southworth focused specifically on the sonic envionment of cities (in his case again Boston). Similar in approach to D. Appleyard & Lynch (Appleyard, Lynch, and Myer 1964), Southworth described the sonic environment from the perspective of moving along a path through the city. In his study, he identified areas of common sonic identity, temporal changes and intensities, but resisted the trap to characterize individual sounds. His main concern was to identify places with a strong relationship to the soundscape which be seen as the sonic equivalent of the Lynchean notion of 'imagibility' (Southworth 1969).

Michael Southworth, "The Sonic Environment of Cities", *Environment and Behavior* 1:1(June 1969), pp. 49-70.

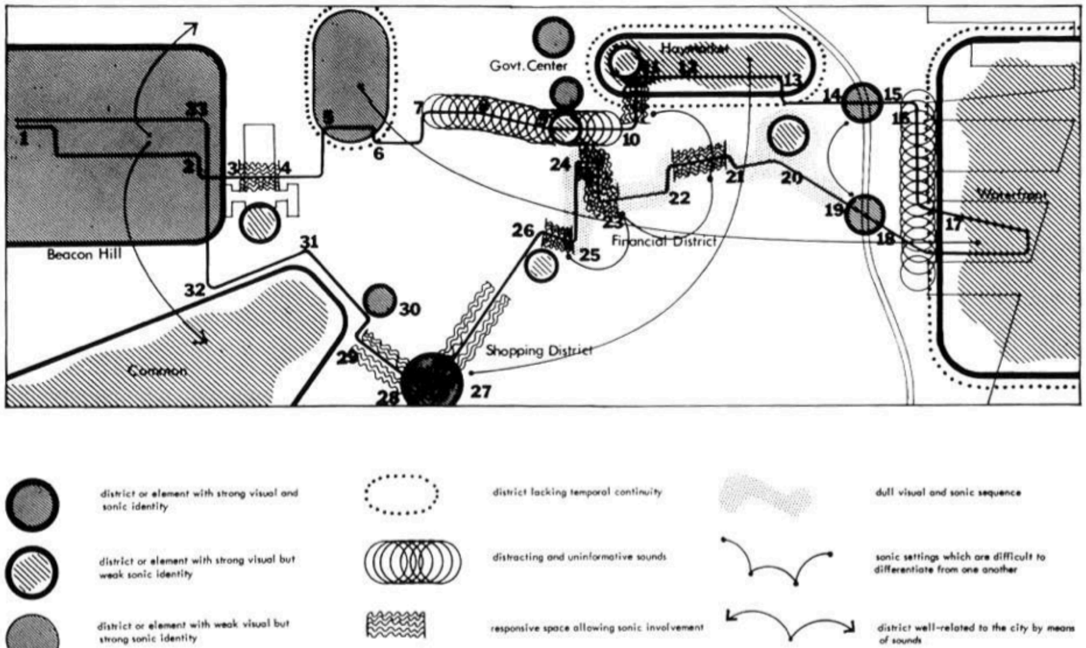

Figure 7 Evaluation of Part of the Boston Soundscape

Figure 3 Michael Southworth, Evaluation of the Boston Soundscape (Southworth 1969)

In general, it seems not entirely clear what role sounds play in mental representations of the physical environment, whether Schafer's soundmarks actually exist. My intuition is that it depends on context – environments that are strongly defined by sonic phenomena might be remembered differently than visually highly distinctive environments.

In reference to the studies of perceived distance (Golledge et al. 1992), it is worth exploring whether sounds influence the estimation of distances. Effects such as resonance and echo offer clues for the size of interior spaces, and the loudness of urban sound sources might play a role for the perception of urban distances as well.

From experience, bell towers, train lines, airports and stadiums can function like sonic landmarks providing spatial orientation, and, perhaps more importantly, a sense of place. As Brendon Labelle beautifully points out, certain spaces are dominated by specific sonic effects (rather than specific sounds). He describes the subway system as characterized by echoes and reverberation, streets by the rhythmic patterns created by cars and pedestrians, the suburb and the private home by the absence of sound (LaBelle 2010).

Observational Measures

Beyond the configurational aspects at the urban scale that I have discussed earlier, smaller urban details such as building materials, surface geometry and architectural elements have a strong influence on the urban soundscape. For example, smooth surfaces do not only reflect light rays, but also sound waves differently than dull, uneven surfaces. As a result, office buildings with even glass facades can make the streets of a Central Business District quite noisy even when traffic is weak. Resonance effects such as standing waves between such building facades can increase perceived loudness and have a disorienting effect, while architectural details can mitigate the effect (Figure 4). Street materials and surface qualities obviously are important, too, as are the geometric configuration of walls and surfaces. The elliptical cross-sectional shape of some Paris Metro stations amplifies sounds from certain positions, an effect exploited by many subway musicians.

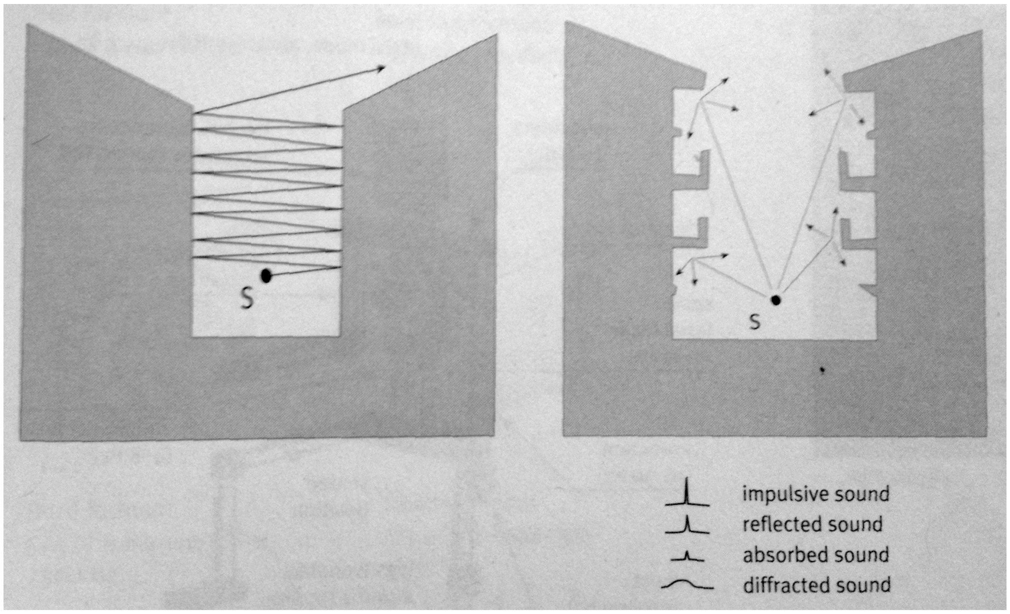

Figure 4 The surface details of buildings determine the sonic characteristics, i.e. whether the sound is diffused (right) or forms a standing wave (left). From (Augoyard and Torgue 2006)

Very few of these effects are mentioned in the literature. While Alan Jacobs, who devotes great attention to all kinds of architectural details, ignored the sonic aspects of urban space altogether (Jacobs 1985), Jan Gehl acknowledged the importance of the hearing sense and the acoustic qualities of urban spaces (Gehl 2008). Whyte notices the positive sound of fountains and water and muses about the potential of interactive sound installations in public space (Whyte 1980).

Beyond the architectural effects of the built environment, the soundscape is also shaped in a more direct way: muzak in malls and shops, public address systems, sirens and traffic signals are examples of a wide range of acoustic signals from public and private sources going unmentioned in the reviewed observational studies of public space. The Las Vegas strip has been extensively described in terms of visual signs, but surprisingly little has been written about its equally sophisticated and scripted soundscapes (Moffat 2004).

The visual and acoustic spheres sometimes are at conflict with each other. Architectural elements for the control of ambient sounds create a tradeoff between the acoustic and visual qualities of the built environment, such as sound walls along highways blocking both undesired traffic noise and more desired landscape vistas.

Conclusion

To conclude, the reviewed literature pays very little attention to the acoustic qualities of cities, in my opinion less then appropriate for the importance hearing in human perception. However, the framework of urban form measures can be easily adapted for investigating urban sound spaces on different levels. As each group of measures comes with its own set of methods, this provides a useful starting point for future research.

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