SOUNDSCAPE ANALYSIS FOR EFFECTIVE SOUND DESIGN IN COMMERCIAL ENVIRONMENTS

Ian Stevenson
School of Humanities and Communication Arts
Western Sydney University

ABSTRACT
This paper reviews analytical literature concerned with retail and other commercial environments for the purposes of identifying effective sound design for ambient media including digital signage. The paper details the background to a proposed design project for the audio augmentation of digital signage in student services facilities on a university campus. In the paper, the term soundscape is used as a conceptual tool to explore the various dimensions of the experience of the acoustic environment that may be manipulated or accounted for in such a design.

1. INTRODUCTION
Sound design is considered here in relation to the problematic surrounding the definition of 'sound' (Grimshaw 2015) and the complex and unstable nature of the construct of 'soundscape' (ISO 2014). Therefore, the pragmatic notion of the sound effect (Augoyard and Torgue 2005, Stevenson 2015) is used as a basis on which to build a sound design practice. Proposed methods for the evaluation of effectiveness are considered in terms of branding, information delivery and the construction of an acoustic community (Schafer 1993; Truax 1996, 2001). A method that uses measurements of visual attention as a means of evaluating, or as a proxy for auditory attention is considered.

The concept of 'soundscape' is used to describe the multidimensional phenomenon associated with the "perception, experience or understanding" (ISO 2014) of the acoustic environment, its architecture and the sound sources it comprises; responses both psychoacoustic and cognitive; and the cultural and environmental context in which these factors play out. While individual responses to the perceptual construct of soundscape as set out in ISO standard 12913-1:2014 may be inherently unstable and unpredictable, over the longer term and across larger populations certain outcome trends may result for a given community. In the construction of soundscape experience, the physical, cultural and personal context are significant. The structure of the context is influenced by responses within the process of the perceptual construct of soundscape and it is this inherent feedback path that underlies the fundamental relationality of sonic experience, referred to by Augoyard as sonic effect.

2. ANALYSIS/EVALUATION
Soundscape analysis typically employs several simultaneous approaches in an attempt to achieve triangulation (Lercher and Schulte-Fortkamp 2013; Schafer 1993, p. 123; Truax, 1984 p. 75). Lercher and Schulte-Fortkamp provide an overview of several models that incorporate the expertise of inhabitant participants, soundscape researchers, and acousticians. These approaches include methods such as questionnaire/survey, narrative interview/focus group, and acoustic measurement. The advantage of this approach is that it pairs the values and perceptions of inhabitant groups—so-called inhabitant expression (Augoyard 2007)—with the objective measures of noise and other audible features.

An initial phase in the analysis of indoor spaces may include an architectural functional and material analysis combined with temporal mapping of acoustical measurements. An example of this approach applied to a large retail space and a university student services building is presented by Dökmeci and Kang (2011). The advantage of this approach is that it takes into account the designed and actual use of the spaces and their functional requirements, for example, to support social engagement or quiet study, or to promote shopper experience and retail sales. In addition to this, the focus on architectural design considers the articulation between spaces, the materials of construction, and the circulation patterns of the people using the space. In Dökmeci and Kang's study, binaural sound recordings were taken, and post-processing of these recordings produced time-series and statistical descriptions of sound pressure level, loudness, roughness, and sharpness. These measures were compared with the functional usage to provide a base-line description of the soundscapes of the sites over the period of a day incorporating an assessment of acoustic comfort and noise annoyance.

Studies such as these can be augmented by more detailed sound source classification employing taxonomies of semantic description such as that offered by Brown, Kang & Gjestland (2011) which details "places, categories and sound sources". Unlike studies of noise annoyance, in this model sound descriptions are
"carefully chosen to avoid value judgments, or connotations, regarding these sound sources, irrespective of the type of place" (p. 390). An application of this type of standardised taxonomic classification is shown in figure 1.

While advances in automated sound classification are progressing rapidly (Rychtarikova & Vermeir 2013), they may not yet be useful for preliminary analyses without being augmented by semantic description. However, these methods could be trained to provide ongoing monitoring of the quality of designed sounds environments to evaluate the long-term validity and operation of a given design.

3. DESIGN CONSIDERATIONS

The concept of soundscape as it has developed over the past almost 60 years (Schafer 1969/67), and specifically as summarised in the 2014 ISO standard, is highly nuanced. What it lacks in coherence, it makes up for in subtlety. This standard has been arrived at with some difficulty on the part of the researchers involved (see Brown, Kang & Gjestland, 2011, for an overview of the process). It proposes that soundscape is a "perceptual construct" as represented in figure 2 (ISO 2014). This implies a sort of top-down model of human auditory perception. Soundscape is set up in contradistinction to the physical phenomena of the acoustic environment which comprises "sound at the receiver from all sound sources as modified by the environment" (ISO 2014). The standard also highlights the significance of context which is "the interrelationships between person and activity and place, in space and time" (ISO 2014). The standard goes on to unpack these five complex relational concepts in terms of the following three forms of "influence" on soundscape, which in turn are influenced by various factors.

3.1. Auditory sensation

"Auditory sensation is a function of neurological processes that begin when auditory stimuli reach the receptors of the ear. This is the first stage in detecting and representing the acoustic environment" (ISO 2014). Auditory sensation is primarily influenced by the acoustic environment but also by psychoacoustic processes such as temporal, spectral and spatial masking. On the one hand, environmental factors such as meteorological conditions influence the acoustic environment, and on the other factors such as "hearing impairments and hearing aids" influence their reception.

Interestingly, the problematic notion of ‘representation’ (Dietrich 2007), resulting from auditory sensation, is invoked. This representation is presumably closely related, if not partly identical, with the soundscape, which must somehow, in turn, be represented to consciousness for subsequent interpretation and response.

3.2. The interpretation of auditory sensation (auditory perception)

The bottom-up narrative given above must be squared with the "perceptual construct" which stands for the acoustic environment. Several factors influence the interpretation of auditory sensation. These include the
"attitude to the sound source and to the producer of the sound" plus their "experience and expectations including cultural background, [and their] intentions or reason for being at a place" (ISO 2014). Interpretation is multi-modal encompassing "sensory factors, like visual impression and odour" (ISO 2014).

Interpretation "refers to unconscious and conscious processing ... to create useful information, which may lead to awareness or understanding of the acoustic environment. Awareness of the acoustic environment, in context, represents an experience of the acoustic environment" (ISO 2014).

This ‘experience’ is exactly what the sound designer is aiming to facilitate. However, the description given above suggests just how precarious this endeavour is. If attitudes to the sound source and its producer can affect its interpretation or even its perception, and these attitudes can easily be manipulated or affected by various means, what chance does the sound designer have in the selection and presentation of such sounds? Many sound designers, however, embrace this challenge and many of the features identified in this definition of soundscape such as multi-modal factors and the role of the unconscious are represented in the writings of professional sound designers. Commercial sound designers such as Beckerman (2014), Soars (2009) and Treasure (2007) are usually content to accept two sometimes opposing groups of factors that influence the interpretation of sounds within the soundscape. The first group of factors relies on a model of a universal listener defined by uniform cross-cultural responses to sound. The second group suggests that interpretation is largely place, culture, demographic or sub-culture specific. What all three authors agree on is that responses to sound are usually formed by sub-conscious or pre-conscious processes, and this leads to the third and final influence that context may have on soundscape.

3.3. Responses to the acoustic environment

The first point to note regarding responses to the acoustic environment is that they form a feedback path into the context that influences soundscape. This feedback path is foundational to the complexity and unpredictability of soundscape phenomena. As the ISO standard states: "responses include short-term reaction and emotion, as well as behaviour, which may change the context". Responses, in turn, may be influenced by "time of day, lighting and weather, emotional state, psychological and physiological resources to deal with the situation, perceived ability to control one's exposure to sounds, as well as personal activities and those of others". Not only are these responses unpredictable but they are difficult to manipulate from a design perspective.

One important aspect of soundscape that designers such as those cited above agree on is that objective methods of evaluating sound design interventions are unlikely to provide useful measures if they rely on participants to predict or describe their responses using instruments such as survey, questionnaire or interview. These methods rely on the expression of opinions or attitudes based on conscious and reasoned responses. However, as the ISO definition and conceptual framework suggests, the experience of soundscape as a perceptual construct in all its subtlety and complexity is likely to be too illusive to be rendered by such evaluative interventions. There is therefore a problem at the heart of formalised soundscape methods, and this has been noted by soundscape researchers themselves. As Brown and colleagues (2011, p.389) point out, the "measurement of preference ... is premised, to a large extent, on people being aware of the sounds around them and consciously attributing the particular outcome directly to the soundscape". They go on to note that "the soundscape of a place may enable certain outcomes/activities, without people consciously dissecting why it is that the environment of a place provides so well for that activity". Nevertheless, a range of formalised methods including sound walks, focus groups, simulation and others have been employed (Davies, et al 2013).

Most interestingly, nowhere in the ISO standard is the notion of a listener invoked. In fact, the description of soundscape seems to explicitly dissolve the listener into a network of relations and processes in which the boundaries of the organism are penetrated by culture and context in groundless complexity. Whether this seemingly post-modern situation arose from the dynamics of the standards committee process or if it is inherent in the very notion of soundscape is unclear. However, from the perspective of this paper, it seems a most appropriate outcome.

Ultimately however, sound designers are called on to manipulate aspects of the acoustic environment with a view to modifying listeners’ attitudes or behaviour. In the design context, certain outcomes are valued over others. The ISO standard recognises that soundscape can be a key determinant in outcomes such as the development of "attitudes, beliefs, judgments, habits, visitor/user experiences (e.g. activities, actions and mental states), health, well-being and quality of life, as well as reduced social costs for society". When soundscape concepts are operationalised in the context of specific designs; attitudes, beliefs and importantly actions and habits must be attributed to specific populations within a given physical context.

Much of the soundscape research in recent decades has situated itself as focused on "the positive aspects of sound environments" in distinction to earlier work on annoyance related to noise complaints (Brown, Kang & Gjestland 2011). However, it seems that within certain indoor environments noise may have more positive aspects. Music has long been used to enhance indoor environments, with mixed results, and some research
(Mehta 2012) suggests that there may be a "sweet spot" for ambient noise levels based on their impact on "creativity" and purchasing decisions. Mehta and colleagues propose that moderate noise levels (70dB) increase cognitive processing difficulty compared to lower noise levels and that this invokes a higher construal level resulting in increased abstract thinking. Higher than moderate noise levels (85dB), however, may result in cognitive processing difficulty at a level which impedes creative thinking. This observation suggests that total reduction in ambient noise levels may result in 'killing the vibe' in certain indoor environments and that working with reasonable background noise levels in some contexts may be worthwhile.

Clearly adding more competing sound material in environments where background music is already being used in environmental design or spatial branding must be done with considerable care. Methods should be selected that account for both variations in ambient sound level over time and the spectral content of the sound environment both in terms of perceived loudness and from the point of view of potential masking effects between competing sources. This suggests that signal-based measurements such as those used by Dökmeçi and Kang (2011) may be adapted for use in real-time for both level control and material selection rather than for description and evaluation.

Conventional approaches to information delivery based on existing audio-visual advertising strategies are unlikely to succeed in contemporary urban environments. Typical designs employing an animated or live-action picture track plus dialogue, music and effects audio tracks are presented with two problems. Firstly, there may be too much information contained in these four tracks, and secondly, contemporary audiences have already demonstrated their increasingly habituated responses to these design strategies resulting in reduced uptake of free-to-air television (White 2015). Competition for the limited attention of an audience in an indoor environment in which other activities take priority requires a more considered design approach.

4. CONTENT AND OBJECTIVES

The proposed approach to the audio augmentation of indoor digital signage fits within a larger brand strategy. An existing digital signage network provides information delivery, and event and service promotion. In recent times, this network has been employed to more effectively deliver structured branding. Branding is targeted at staff, students, partners and future prospective students. It asserts the institution's aspirations for quality and intellectual leadership in the region and globally. Branding is explicitly used to foster a sense of community with shared identity and aspirations. This notion of community mirrors the concept of acoustic community defined by Truax as a medium for shared meanings and "as a system within which acoustic information is exchanged" (Truax 2001, p. 178). This community is seen as dynamic and in a state of transformation rather than as something fixed.

The visual design employed in the current brand strategy is highly structured and focuses on text, brand logo and a limited palette of photographic images. This approach is in contrast to earlier visual design material employed in the signage network that exhibited the use of graphics and a greater variety of colours and content. In some ways, the current design approach is highly repetitive, presumably with the intention of effecting brand familiarity (Campbell & Keller 2003).

While repetition may work well for visual elements such as logos, in situated audio-visual media, repetition can have a negative effect (Belch 1982). Sound track elements in audio-visual media can have several functions. Primarily a voice or dialogue tracks are used to convey semantic information. Voice quality and characterisation can project brand image. Music in the form of jingles or sonic brands can play a roll in brand reinforcement whereas background music in advertising can influence attitude, attention and arousal (Huron 1989). Less is known about the effect of non-speech or non-musical material, however, some work has shown that "congruent" sound material that is spatially located near product displays can have a positive impact on attention, awareness and preference (Shen and Sengupta 2014). Furthermore, ambiguous sounds can activate a "conceptual network" that draws in visual stimuli and context and can operate across sensory modalities (Özcan and Egmond 2009). The use of non-obvious but congruent sound elements with a wide variety of individual sounds can avoid unwanted repetition effects such as annoyance and fatigue. It can also help avoid unexpected associations given the dynamic nature of the audience and their associated soundscape attitudes.

Many of these forms of sonic experience have been characterised as sonic effects in the research of Augoyard and his colleagues (2005). The sonic effect is located by Augoyard on a scale somewhere between the sound object and the soundscape. The sound effect is a form of jingles or sonic brands can play a roll in brand reinforcement whereas background music in advertising can influence attitude, attention and arousal (Huron 1989). Less is known about the effect of non-speech or non-musical material, however, some work has shown that "congruent" sound material that is spatially located near product displays can have a positive impact on attention, awareness and preference (Shen and Sengupta 2014). Furthermore, ambiguous sounds can activate a "conceptual network" that draws in visual stimuli and context and can operate across sensory modalities (Özcan and Egmond 2009). The use of non-obvious but congruent sound elements with a wide variety of individual sounds can avoid unwanted repetition effects such as annoyance and fatigue. It can also help avoid unexpected associations given the dynamic nature of the audience and their associated soundscape attitudes.

1 Note that a lack of reference level or weighting cited in this publication may bring the methodology and results into question.
5. DESIGN SOLUTION

A novel design solution is proposed that accounts for several important factors highlighted by soundscape research and aspects of professional practice. The design may be summarised by a series of requirements.

1. The design approach should incorporate automatic level control as part of a broader automated control of background music to suit variations in use of the space over the period of a day. In addition to amplitude-based control, a method of spectral selection should be used to adaptively fit audio material into available spectral niches within the acoustic environment.

2. Sound material should be designed not for arousal or for information delivery, but rather to engage attention and spatially direct visual engagement with signage.

3. The design should avoid repetition.

4. The design should not aim to simulate a voice track or music track but rather, should focus on suitable sound objects or "effects".

5. While principles of association may provide a basis for sound selection, this can not be relied upon as the notion of an acoustic community in a state of flux, and the unstable and unpredictable nature of soundscape are likely to override these effects.

6. Sound should be used sparingly at a rate to be determined by ongoing audience response measurement, so as not to add to an already crowded acoustic environment.

6. EVALUATION

Methods that elicit verbal responses are of limited value in the evaluation of a sound design intervention of this type. Therefore this proposal incorporates video-based audience measurement techniques to identify audience gaze and dwell times targeted at digital signage units (Ravnik and Solina 2013). In this approach, looking is understood as a proxy for listening where listening does not necessarily involve hearing. Audience measurement can be used to analyse the effectiveness of particular sound elements in the context of both the state of the acoustic environment at a given time, and the visual content of signage display. The success of the overall strategy can be observed over the medium term to identify audience habituation and to guide continuing modification to the sound design intervention.

7. CONCLUSIONS

The concept of soundscape is useful for exploring aspects of sonic experience and for critiquing accepted notions of source-receiver models of acoustic communication. However, soundscape analysis methods may not be appropriate where sound is used to influence unconscious behaviours and responses. Effective sound design for ambient media such as digital signage may incorporate novel approaches to the selection of sound material avoiding the conventions of traditional audio-visual media and there-by contributing to the information delivery and branding objectives of an institution. Ongoing automated acoustic and audience measurement are key to evaluating such a strategy and to keeping the design fresh and appealing.

8. REFERENCES


