An approach to soundscape planning

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AN APPROACH TO SOUNDSCAPE PLANNING

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Abstract

This paper focuses on *soundscape planning*, or *acoustic design*, in the planning and management of open space in both urban and non-urban areas. It is based on notions, promoted over several decades, that the acoustic aspects of open space can, and should be, subject to design in the same way as are the visual dimensions. The current paradigm for the management of the outdoor acoustic environment is *noise control* and *soundscape planning* needs to adopt quite different practices from noise control with respect to acoustic criteria and measurement. The paper explores the specification of *acoustic objectives* for outdoor soundscapes and the translation of these objectives into acoustic criteria that are amenable to measurement and prediction as part of the design process. Such objectives, termed *Proposed Acoustic Environments*, focus on the *information content* in sounds in a particular space and, only indirectly, on characteristics such as level or loudness. Outdoor acoustic design is mostly concerned with avoiding, or achieving, the *masking* of one set of information in the acoustic signal with other sets of information in the same signal. These are critical methodological issues if soundscape planning is to move from being a good idea to common practice.

Acoustic Design of Outdoor Space

This paper concerns sound in the planning and management of outdoor space. This may be constructed space - parks, squares, malls, residential precincts or other urban open space - or space in non-urban environments such as rural, wilderness or recreational areas. Since Schafer [1] produced 'The Tuning of the World', the term *soundscape* [2] has entered the lexicons of a range of disciplines and educators interested in the acoustic environment, and it is the soundscape of these constructed or managed spaces that is of interest here. The soundscape of a place is simply its sonic, or acoustic, environment, with the receiver, or listener, at the centre of the sonic landscape [3]. Schafer argued, amongst other matters, that soundscapes are amenable to analysis and design. To him, *acoustic design* meant discovering the principles by which the aesthetic qualities of the acoustic environment may be improved. These principles could include elimination or restriction of certain sounds through noise abatement, the preservation of sounds that give character or sense of place to a location (*soundmarks* as the acoustical equivalent of visual landmarks) or imaginative placement of sounds to create attractive and stimulating environments.

Various authors link these principles to physical planning and design [4]. Bohme [5] argues that, " *...city planning can no longer be content with noise control and abatement, but must pay attention to the character of the acoustic atmosphere of squares, pedestrian zones, of whole cities"*, and others advocate

- *"Urban and landscape architects should take auditory perception into account. The perceptions of all senses should be dealt with to the same degree and the visual should not be favoured ... .*
- *Urban and landscape planners and designers should create sonic environments which form part of their context over both time and space..*
- *Design tools dealing with auditory aspects should be developed to fit into the process of urban and landscape planning and design ... ."*

While there is a growing interest in, and literature about, soundscapes, much of it has been high in vision but rather short in means for implementation. The objective of this paper is to move this conceptual field forward by providing a pragmatic approach for planners, landscape architects, engineers, acousticians and others involved in the planning and design of the built environment, and for managers of rural, natural and recreational landscapes. The approach is also relevant to those interested in public installations that may have an acoustic component.

Soundscape Planning *vis-a-vis* Noise Control

Acoustic design of outdoor space should be seen as complementary to *noise management, abatement* or *control*. Noise management is the current paradigm for management of the outdoor acoustic environment, involving a large body of knowledge, practice, law, policing and control activities and most municipal authorities and provincial governments are active in this to varying degrees. The complementarity of soundscape planning and noise control is best illustrated by three essential differences between them.

Firstly, noise control in urban areas deals largely with 'sounds of discomfort' [6] – sounds that disturb sleep, interfere with communication, distract or annoy people. Limits to these sounds are based on acceptable risk, and noise abatement seeks to minimise negative effects on people in high exposure situations. These negative effects are well known, as are the levels recommended to limit them. By contrast, soundscape planning focuses on acoustic environments that are regarded positively - that people prefer or consider as desirable environments.

Historically, noise control has been little concerned with these types of acceptable noise environments. It is only in the particular case of internal room acoustics, and more recently with the emerging interest in Sound Quality for product design [7] that noise criteria are based on acceptability or listening preference - in all other cases they are based on minimising the negative effects of noise. Noise criteria control some effect such as communication or sleep disturbance and have little direct application in the design of preferred acoustic conditions for outdoor space. The issue of suitable acoustic objectives, or preferred listening environments for soundscape planning of cities and countrysides, must be examined. An approach to this problem, currently a major impediment to acoustic design of outdoor space in practice, is proposed in this paper.

Secondly, there is a difference between noise control and soundscape planning in the locus of application, though in this difference there is more overlap. Noise control uses three strategies for action: control at the source, management of the transmission path between source and receiver, and protection of the receiver. While noise control practice is active in each of these strategies, its aim is largely protection of people who are indoors, particularly in residential dwellings, from noise generated outdoors – road traffic and aircraft noise heard indoors, for example (exceptions are physiologically damaging noise in the workplace, noises generated in and between buildings and rooms and, to a very limited extent, noise in recreational and wilderness areas). By contrast to the focus on outdoor sound heard indoors, soundscape planning is likely to be the planning and management of sound heard in open spaces, though not exclusively so.

The third difference is that, in noise control, sound is seen as a by-product, a waste to be managed. By contrast, soundscape planning approaches sound as a resource, one to be utilised and, as in the sustainable use of all resources, one whose depletion or degradation is to be avoided. Hedfors [8] provides an example, in the context of rural landscapes in Sweden, of sound as a resource in planning and as an element of design. This resource-oriented view of sound is most easily appreciated in the context of wilderness or recreational areas, as illustrated by the US National Park Service [9]: *"Preservation and restoration of diminishing natural sound environments or soundscapes has become a foremost challenge in the protection of park resources"* and "*Natural sounds are part of the special places we preserve. Rustling winds in canyons and the rush of waters in the rivers are the heartbeat and breath of some of our most valuable resources*." Sound can also be regarded as a resource, though rarely recognised as such, within cities, towns and rural areas. Quiet, generally thought of as the absence of sound, but much better thought of as a particular characteristic of sound, is a clear example of sound as a scarce resource in urban areas, but there are many other examples, such as sounds conveying a city's identity (the chimes of Big Ben in London) and other sounds that form parts of a society's culture.

Acoustic Objectives for Outdoor Spaces

Specification of the acoustic objective must be the first step for soundscape planning and management. We need to assume that there will be, for many situations and places, particular acoustic environments that will increase human enjoyment, well being, amenity, quality-of-experience, or quality-of-life. This should not be a contentious notion. We have a similar notion about visual preference and incorporate these into design – whether for urban spaces or non-urban environments. For example, form and colour figure prominently as parameters in most design processes and there is an accumulation of knowledge regarding what would, and would not be, good visual design practice. The authors in no way underestimate the complexity of most soundscapes, nor the conflicting and contradictory opinions that will be found, but, putting aside the important issue of the diversity of preferences that will exist amongst different individuals and groups of people (for visual, acoustic, or any other dimension of a place), what guidance exists regarding specification of acoustic objectives for outdoor environments?

Preferred acoustic environments outdoors has had little attention from the scientific community to date, primarily because of the over-riding emphasis in acoustic research on environmental noise. For example, there is copious data collected over decades on *What noises do you hear around here?* or *What noises annoy you the most?* (even as long ago as the New York Noise Abatement Commission of 1930 [10]) but very little on *What sounds do you enjoy/prefer to hear in this place?* A study in Yokohama [11] is an exception, reporting not only sounds (outdoor sounds heard indoors) that were observed by and were annoying to residents, but also sounds that they found favourable. Sounds regarded as favourable included the twittering of birds and sounds of insects and frogs, the sounds of festivals and fireworks, wind movement in trees and grasses, wind chimes, bells of temples and churches, whistles of ships and the sounds of streams and sea waves. Favoured sounds were mainly natural sounds and some specific cultural sounds, and distinct from sounds that people did not prefer. Sasaki [12] also sought to measure opinions on outdoor sounds that people preferred in urban areas, with somewhat similar results.

Other scientific investigations into perceived quality of soundscapes include Berglund *et al* [13] and Berglund and Nilsson [14]. Their work, in residential areas, is directed towards new tools to measure the way people perceive soundscapes, including sound-source

identification, quantification of loudness, and attribute profiling of sound quality. There is also interest in Sweden [15] in perceived quality of soundscape with respect to understanding how preferred soundscapes (particularly access to quiet in courtyards) can be supportive of health and well being.

While these research results are in no way counter-intuitive, to date they provide little guidance to any prospective designer/manager of outdoor space. How then to set acoustic objectives? The solution, it is suggested, is to depart radically from the nature of most acoustic criteria in practice (which are almost exclusively based on overall sound level set to limit unwanted human responses) and instead to adopt acoustic objectives for soundscape design based on the *information content* of sounds. Postulated, in Table 1, are acoustic objectives of this sort for different outdoor spaces. This is a list, based on personal experience and intuition, but it does embody much of the observation, opinion, and commentary found in the soundscape literature to date and in the limited research regarding human acoustic preference. Most of the objectives in Table 1 relate to natural sounds, particularly the sounds generated by wind, by moving water, or by animals, or to ensuring human sounds predominate over mechanical or amplified sounds. They also relate to good communication environments for speech or music or to geographical or cultural identity of place. Some relate to 'quiet' situations; others to vibrant, 'noisy' places.

Table 1: Example acoustic objectives for outdoor spaces

Moving water should be the *dominant* sound heard.
A particular (iconic) sound should be clearly audible over some area.
Hear, *mostly*, (non-mechanical, non-amplified) sounds made by people.
Not be able to hear the sounds of people.
The sounds of nature should be the *dominant* sound heard.
Only the sounds of nature should be heard.
Suitable to hear *unamplified* speech (or music).
Suitable to hear *amplified* speech (or music).
Acoustic sculpture/installation sounds should be clearly *audible*.
Sounds conveying a city's vitality should be the *dominant* sounds heard.
Sounds that convey the identity of place should be the *dominant* sounds heard.

This list should cover the majority of outdoor spaces where acoustic design or management is appropriate. It includes, for example, objectives for urban spaces where one may wish to provide respite from the sounds of traffic, for parks or gardens that include water structures or specific acoustic installations, for spaces that are intended for speech or musical communication, for amenity in pedestrianised areas of both old and new cities and villages, and for wilderness and outdoor recreational areas. Identity of place may be appropriate in both cities and rural areas. Identities may include, say, the pealing of a bell, the call to prayer from a mosque, the lowing of cattle or the tinkling of sheep bells, or motor vessels moving along canals.

It must be emphasised that these objectives have been carefully crafted to specify only the *information content* in the sounds to be heard in the particular place. They deliberately do not specify other acoustic dimensions (loudness, for example) though the acoustic dimensions that must eventually be available for design can be derived from the information content objectives and the specific site context. Specification of the information content ensures there is absolute clarity as to the intent. For example, the objective *moving water should be the dominant sound heard*, is unambiguous and appropriate both for a space intended for peace and tranquillity where the users can hear the quiet murmuring of a brook or the trickle of a water structure, and for a space intended for appreciation of the forces of nature in the crash of waves on a cliff or the thunder of a waterfall. Similarly, the objective *suitable to hear unamplified speech (or music),* applies equally to a bench in a park, to a pedestrian thoroughfare where buskers may be encouraged to locate, or to space for dining alfresco. The lack of ambiguity in acoustic objectives specified in this way is designed to assist in planning and design. The objectives use a language that is common to everyone, a far cry from the complex technical jargon used by acoustic specialists. In this way the objectives for a space can be debated, alternatives suggested, and compromises reached, yet they provide outcomes that are not in the least acoustically equivocal, and ones that are suitable to write directly into design or management briefs. The loudness of the different sounds, their duration, the reverberant characteristics of the space, the nature of surface materials to be used, the potential to control source levels or to provide attenuating structures etc, are then matters that acoustic specialists can subsequently attempt to manipulate, once the objective is agreed, to achieve the desired outcome.

Table 1 provides a starting point for designers and managers to use in practice. It is suggested that the acoustic objectives of this type be referred to in the design or management process as the *Proposed Acoustic Environment* for a particular place and context**.** They are a response, in soundscape design, to counter the legacy of decades of noise control approaches on which Bohme [5] comments "*... it is a matter of overcoming the narrow natural science based approach which remains at best capable of grasping noise as a function of decibels, and to ask instead what type of acoustic character the spaces in which we live should have.*"

Translating *Proposed Acoustic Environments* to Measurable Acoustic Parameters

Specifying *Proposed Acoustic Environments* is not a trivial exercise. Unambiguous specification of the objective in this way is a critical starting point for establishing quantifiable acoustic parameters that can be measured, predicted and assessed as part of acoustic design. It needs to be recognised that each objective in Table 1, while the essence of simplicity in intent, is actually a statement about a quite complex acoustic outcome concerning *two components of sound* within the space – the *wanted signals* and the *unwanted signals*. They recognise that these two sound components are present, specifying the sound that we want (or in some cases the sounds that we do not want) but implicitly recognise that other sounds will also be present. The statements also indicate the required relationship between these different sound signals.

The context obviously dictates whether a sound is wanted or not wanted, and in different contexts the same sound may be one or the other. For example, in a pedestrian mall, the Proposed Acoustic Environment may be *hear (non-mechanical, non-amplified) sounds made by people*. Here, the sounds of voices and footsteps may be wanted, but amplified music and traffic noise is likely to be unwanted, and the design would ensure that the former were not masked by the latter. By contrast, for a space intended for contemplation or reflection, the Proposed Acoustic Environment may be *not be able to hear the sounds of people.* Here the sounds of voices and footsteps would be unwanted, and the design would aim to ensure that no voices or footsteps were present, or that these were masked by some other acceptable sound.

In summary, for every context, specification of the Proposed Acoustic Environment enables one to disaggregate:

- the wanted sounds (for example, church bells, sounds of nature, sounds of city vitality, footsteps, sounds of running water, music, etc); and
- the unwanted sounds (for example, road traffic, human sounds, amplified music, machinery noises, etc).

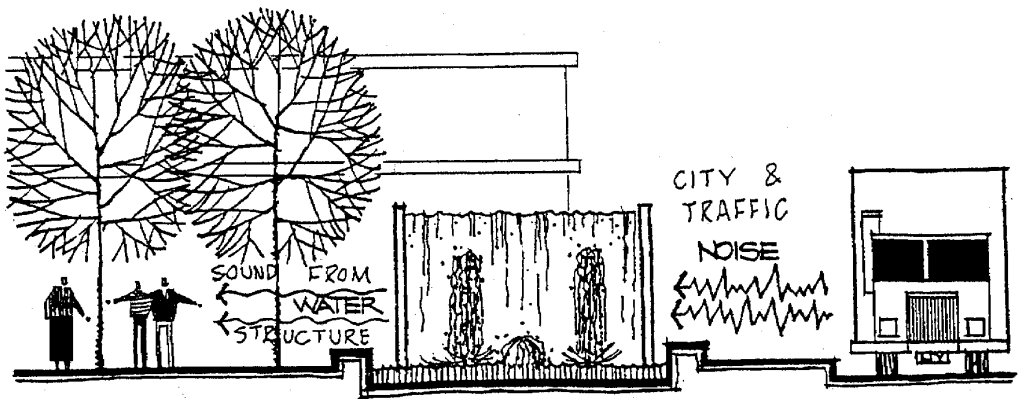
In some circumstances there may also be sounds to which one is indifferent (say incidental bird calls) but these can simply be included in the wanted category. It is this requirement for disaggregation of sound by sources in soundscape planning that is a specific, and critical, divergence between it and the traditional approaches to noise measurement and assessment. However, this does create a significant difficulty in measurement.

Most acoustic descriptors common in noise management have no interest in, and make no recognition of, the *information content* in the sound. They measure the overall level and loudness of all the sound present at a specific location. Noise scales that rely on concepts such as equivalent continuous sound level (L_{eq} and L_{den}) simply integrate all the sound signals present, irrespective of their source. Scales based on exceedance levels (such as L_{10} and L_{90}) are equally non-discriminatory with respect to different sound sources. While microphones faithfully transduce, and tapes faithfully record, the sounds that are present, immediately these signals are processed through most noise measurement equipment used for assessment (sound level meters, level recorders, and noise level analysers – all of which measure only the *level* of the sound) - all source discrimination is lost.

A new approach is required in the measurement of sound in outdoor space that differs from that used in noise control, one that separately assesses the wanted sounds and the unwanted sounds. At present there is nothing in planning practice for acoustic design of outdoor situations akin to what is available for visual simulations where the use of realistic renderings is already a standard in the communication process between planners, clients, and the public.

An Urban Example

The Figure shows a small urban square that has (or in which is planned) a water structure. This is located, typical of most urban areas, in the proximity of a



roadway. The example can be used to demonstrate hypothetical acoustic design scenarios.

The first scenario is the intent to create a pleasant place in an inner city area in which users may have some respite from city noises. This intended "activity" suggests a Proposed Acoustic Environment of *moving water should be the dominant sound heard*. The wanted sounds can be identified as the sound from the water structure. Similarly the unwanted sound is that from the traffic. Achieving the objective requires that, by and large, the sound of water must mask the sound of traffic. Measurement and/or estimation of the relative levels, time histories and other characteristics of the two sounds is required, and measures put in place for either the reduction in the level of road traffic to ensure it remains masked, or to increase the levels of the sound emitted from the water structure to achieve the same end. What should actually be implemented depends on the context of the place, technical possibilities, and funding available, but what the approach described in this paper does is to make absolutely clear what the objective is, and then breaks down a complex situation into a series of specific technical tasks which the planners, the acousticians, the traffic engineers and others involved can subsequently tackle: proposing and evaluating different solutions until one that achieves the objective of the sound of water dominating is identified.

The second scenario could be a quite different intent, but in the same situation as the figure. The intent now may be to create a place in which the people under the trees can communicate easily – perhaps the plan is to place park benches or street theatre there. This intended "activity" suggests a Proposed Acoustic Environment of *suitable to hear unamplified speech.* (Note that one could even specify the likely distance between speaker and listener as part of this objective). Now the wanted sounds can be identified as the sounds of speech, and the "unwanted" sounds being from both the water structure and traffic. Achieving this objective requires that, by and large, the sounds of water and traffic must *not* mask the sounds of speech. Again, measurement and/or estimation of the relative levels, time histories and other characteristics of the three sounds is required, and measures put in place to ensure speech sounds are not masked by the unwanted sounds. In this situation, once more, the approach has broken down the complex situation to one that is tractable for a design team, and from which a potential design solution can emerge.

A Wilderness Example

The same design approach is also illustrated by an example from the literature, but in a completely different context. The US National Park Service reported their initial steps in the development of a Soundscape Management Plan for Biscayne National Park [9]. In this park the planners clearly recognised that sound was a resource – "*Preservation and restoration of diminishing natural sound environments or soundscapes has become a foremost challenge in the protection of park resources"* and "*Natural sounds are part of the special places we preserve. Rustling winds in canyons and the rush of waters in the rivers are the heartbeat and breadth of some of our most valuable resources*". While they did not use this author's terminology, in the first place they identified Proposed Acoustic Objectives for the intended activities of the park – *"the ability to hear clearly the quieter intermittent sounds of nature, for extended periods of time"*. They also recognised that this may not be the appropriate objective over the entire park and used a zoning scheme to accommodate different types of activities with different soundscape possibilities. For example, the visitor centre was zoned differently to the hiking trails in terms of acoustic objectives. Secondly, they noted that the sounds needed to be separated into the wanted sounds (*natural ambient sounds* or, in some zones, the *sounds that reflect Biscayne National Park's marine heritage* such as those of small motor vessels or of a yacht's sails flapping) and the unwanted sounds (*noises of civilization and technological conveniences,* such as vehicles or rangers' mobile radio sets). Thirdly, they identified that the objectives would be achieved through appropriate management of these different sounds to achieve the design objective, rather than relying on setting some overall measure of acoustic level as the design objective.

Conclusions

Acoustic design of outdoor space needs new tools and ideas if the visions so often described in the acoustic ecology literature are to have more widespread application. One of the major impediments to wider implementation is the gap in concepts, thought processes and skills between the soundscape approaches and the conventional environmental noise management approaches. The latter is, by far, the paradigm that dominates most acoustic discourse and action amongst those who are in a position to promote, influence and design our urban environments and manage our rural and wilderness areas. The approach suggested in this paper is intended as far more than a design tool, as important as that is in its own right, and more a bridge between these currently disparate fields. Its further development and trial may help to convert, then harness, the large body of people, knowledge, tools and energy, that resides in both the *environmental noise* and *design* professional areas, to *soundscape* design.

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Note

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