NOISE NARRATIVES – SENSE AND SENSIBILITY OF SOUNDSCAPES

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1 INTRODUCTION

This paper describes an approach to acoustic design, including soundscapes, that considers other sensory perception, and context, as well as just auditory cues. Acoustics are important because humans perceive the acoustic environment subconsciously as well as cogitatively, as part of communication, intellectual and emotional activity. Acoustic cues are also processed in conjunction with other, non-acoustic cues, and this may explain why our response to an acoustic environment may not be accurately defined by objective acoustic parameters alone.

2 ACOUSTIC PERCEPTION

2.1 PRIMARY ACOUSTIC PERCEPTION

Hearing is essential for speech communication and for music appreciation, and a considerable amount of research has sought to identify the objective acoustic parameters that are required for good speech communication and music appreciation. However, hearing is also a primary defence mechanism [1] – we continue to listen for and hear sounds even when we shut our eyes and fall asleep. Therefore to create a good acoustic environment we must not only satisfy the objective requirements for good speech communication and music appreciation, which can be seen as more sophisticated acoustic perception, we must also satisfy our basic hearing perception as well.

As a primary defence mechanism our hearing identifies possible threats – the noise of a twig breaking in a forest, or the distant noise of an animal approaching, which triggers an initial reaction and threat assessment – is the noise from a person or animal that could cause harm? As hunters we also use our hearing to identify possible prey. Where line of sight vision is obscured, such as in a wood or forest (a typical hunting or foraging ground for pre-historic people), hearing is essential to identify threats before they become inescapable. This initial assessment considers what may be making the noise and where it may be coming form- if the sound source is of interest, either as a threat or as possible prey, then all our senses will be used to confirm the initial assessment and location. A number of animal have adapted the sounds they make to allow for the cues their sound may give to predators – birds sing elaborate songs across a wide range of frequencies to alert other birds of their territory, when they consider the environment secure, but issue shorter, less easy to locate alarm calls when a threat approaches.

In addition to perceiving sounds from other animals as threats or prey, we also assess the acoustic environment, and the more environmental noise the less easy it can be to assess a noise as threat or prey; and again there may be complex trade-offs – sheltering in a cave makes it less easy to hear threats approaching from a distance, but also provides more protection form threats, so can be more secure. If the front of the cave is blocked up we can't hear the world outside, but it is less likely to cause us a threat, so the level of threat depends not only on the sounds we can hear, but the context we hear them in.

Normally the acoustic environment will behave predictably and we can gain useful information from it – the most obvious example of this is the "law of the first wavefront" [2, 3]– a sound will normally be located in the direction of the first wavefront of that sound as it has travelled along the direct path. However, sometimes the acoustic environment will not behave as it normally does and we may then feel a little less secure in our environment – for example if we are in a canyon, or separated from a source by a cliff or boulder, the first wavefront may not have travelled by the direct path. When this occurs we need to devote more attention to analysing our acoustic environment and this leaves less time for more intellectual perception, such as speech recognition or music appreciation.

2.2 SECONDARY ACOUSTIC PERCEPTION

Our perception of the acoustic environment can be considered as “instinctive” perception – the continuous assessment of threats and opportunities, and “cognitive” perception – the receiving of speech or music communication, once the environment is considered secure.

Cognitive perception is actually a secondary level of perception, although in our large societies, where communication is vitally important, it is often considered to be of primary importance, and the design criteria for building acoustics and reproduced sound systems are set to achieve cognitive acoustic perception targets, on the assumption that the instinctive perception requirements have been met. Thus the metrics and parameters that are used to describe acoustic performance are developed in controlled situations so that the effects of the parameters on cognitive perception can be measured and assessed. However in practical situations, these effects may be significant.

It is interesting to consider the development of the acoustic environment in parallel with the built environment: Early hunter-gathers probably travelled to find available prey or forgeable crops, sleeping wherever they found themselves. Over time we know that they settled in caves and natural refuges, where they gained an increase in physical protection, but caves reduced their ability to receive distant threats – fine if they could create a barrier to protect themselves, but not so good if the threat could overcome the barrier, or was not detected until it was close – the mythical threat of “the wolf at the door”.

Over time people began to supplement hunting and gathering with basic agriculture. They began to organize themselves, build shelters and protect the boundaries of their settlements. When these boundaries were threatened, by neighbours or by large animals, they often built refuges (keeps). When not threatened these spaces or buildings could be used for organisation or entertainment.

The more organized the society, and the larger the settlement, the more buildings could be created for social functions rather than defence, and the need to address large numbers of people arose.

From the relics of these buildings that remain, it is certain that one function that these buildings performed was to impress members of the society, acoustically as well as visually.

Identifying the acoustic requirements of ancient buildings, even when they are largely intact, is not easy and for a long time acoustic design was a very empirical and secondary process, with a general view that providing a building was aesthetically pleasing to the eye, it would also be acoustically satisfying.

At the beginning of the last century the science of architectural acoustics was born as Sabine investigated an art lecture theatre that had been designed to be pleasing to the eye, but was not easy on the ear.

Having identified reverberation as a key factor in acoustic design, much of the twentieth century was occupied in the pursuit of objective parameters that could effectively define good acoustics.

The introduction, in the second half of the twentieth century, of electro-acoustics and reproduced sound, appeared to offer a way to ensure good acoustic quality, but also created the possibility for an acoustic environment that could not exist in a natural form [4]. Whilst this may not be a problem for the perception of speech and music, as we are able to set aside the difference between real and artificial in a range of media, there is still a problem if the acoustic environment does not satisfy our instinctive perception requirements.

2.3 TIRTIARY (NON) ACOUSTIC PERCEPTION

In addition to instinctive and cognitive perception of auditory cues, we also receive a number of non-auditory cues, considered here as tertiary perception, which may help, or hinder, our interpretation of the primary and secondary acoustic cues.

A picture is often claimed to be more effective than a thousand words, but one of the reasons it can be so effective is that a picture does not have to be as convincing as an acoustic image – we are easily convinced by a wide range of optical illusions – we use our vision to study in detail a threat or prey that we have initially assessed through hearing, and it is much more difficult to maintain a good look out than to listen out for danger. A visual image can also help make an acoustic image more convincing, so actor's voices appear to come from their mouths on television and film, even though they are usually all on the centre channel of a film soundtrack, or in mono on a stereo television image.

We use all our senses to help our perception, and also some non-sensory perception, such as historical or remembered information: a sound that may be disturbing to one person may be pleasant to another depending on the event, activity, or location they associate it with, consciously or sub-consciously.

Sound localisation is an example of non-acoustic perception – early electro-acoustic designers soon learned that if a reinforced sound appeared to come from the sound system and not the talker the audience was easily distracted, in churches and lecture rooms.

3 ACOUSTIC DESIGN

3.1 Design principles

Acoustic design seeks to provide a comfortable acoustic environment and to allow good acoustic perception of speech and music. In order for people to be comfortable in their environment, and to concentrate on the cognitive perception, they must feel they are in a correct environment without any threats, and also without any conflicts between primary, secondary and tertiary perceptions.

These conditions are usually, but not always, met in the natural environment and also in a well designed built environment. However, with reproduced sound and sound reinforcement it is possible to create conflicts which make the acoustic environment less comfortable, and listening to speech or music more difficult.

Good acoustics then, and especially good electro-acoustics, is not simply a case of designing by numbers to meet objective parameters, but requires attention to more subtle effects and a holistic approach.

Theatre, film and television sound designers seek to support a dramatic performance by the careful placement of sound sources, reproducing sound effects to suggest or create an environment, and reinforcing sounds where there may otherwise be problems with communications. Theatre sound design may involve deliberately creating a disturbing acoustic environment, say for a Jacobean tragedy or a horror film, as well as creating a supportive acoustic to suggest an environment that could not easily be created physically or visually, and there are a number of useful lessons that can be learned from sound designers.

Theatre sound design [5] originally developed as part of the prop department, with an assistant stage manager playing records in the wings instead of physically creating the sounds – in radio a mixture of recorded and "practical" effects are still used, and in television and film foley - creating practical sound effects "live" in a specialist studio - is a specialist skill.

However, as the effects and reproduction equipment became more complex, and as live sound also began to be reinforced, the job of the sound designer moved from stage management to the electricians, and some of the ideas of lighting design became incorporated into the sound design.

Theatre lighting allows the performers to be seen by the audience, and the actor is always eager to stand in the spotlight, making the lighting designer a welcome member of the technical team; the sound designer, who may play sound effects between or during the actor's speech, or if amplified come between the artist and their audience, may not be so welcome. The methods' necessary to create a convincing sound design can be applied throughout acoustic design, where communication is required. The theatre sound designer attempts to support the production, and uses a number of techniques borrowed from other performance design disciplines, which can be applied more widely across acoustic design, whether natural or reproduced sound.

3.2 Don't get in the way.

The microphone is the performer's friend when it allows everyone in the audience to hear the performer, but the sound engineer is everyone's enemy if the mic stops working! – it goes without saying that if a design relies on an electronic system as part of the signal path between the performer and the audience it has got to work and work reliably. Some performers will expect the sound reinforcement system to do lots of work for them, and others will want a steady system that will allow them to control their performance without someone else affecting it.

The most direct form of communication is usually the best: physically the ear listens for the first sound and assumes that this is the direct sound from the original source. This is the law of the first wavefront mentioned above, and has been known for a long time to be a key factor in "localising" a sound source. Where there is an electronic sound path, there is a risk of the amplified sound arriving before the direct sound, and this can cause the brain to receive conflicting visual and aural signals: the eye tells you that the person at the front of the stage is speaking, but the ear tells you that the voice is coming from the side, or from overhead. In some cases the brain can ignore the audio location and connect the sound together, but this extra effort may affect concentration of the message the speaker is delivering. This is likely to occur without problems when the speaker or musician is on a stage and the loudspeakers are reasonably close to the stage, but when a voice announcement is made at a sporting event with the spectators looking at the pitch and not the speakers this can be more confusing. The message is more likely to be understood if it comes from the direction the listener is facing, rather than from the side, from behind, or some other direction. If a message comes from another direction, rather than being processed as part of the action, event or performance, it may be considered as a threat by the defence mechanism, and cause alarm or distraction.

3.3 Allow the speaker to be heard.

Since the early days of electro-acoustics signal to noise ratio has been a key factor in good communications and there is a considerable amount of expertise and theory developed to describe and predict this, from the early days of the telephone, through radar and digital communications, and most recently in speech intelligibility. A good signal to noise ratio can be obtained by increasing the signal or reducing the noise but in a complex three dimensional acoustic environment, increasing the signal may also increase the noise. This becomes even more complex in the electro-acoustic environment, where the electronic signal travels a million times faster than the acoustic signal, but often they both interact!

A reasonably low background noise should ensure that the signal can be heard without too much effort, and allow the performer to vary their own dynamic range. However, once a good signal to noise ratio is ensured, there may not be any benefit in further reducing the noise floor, as this may allow other sounds to be distracting:

3.4 Avoid the unexpected

In order to concentrate on the intended communication (whether speech or music) the acoustic environment should not accidentally be perceived as a threat. This can occur if a sound does not accord with other sensory cues, or even with remembered perceptions – sometimes the absence of a sound can be disturbing if the listener is expecting to hear it – an extreme example of this is if the engine cuts out in an aeroplane!

Within a building, any noise from outside the room can be a distraction, but steady state noise is easier to disregard than varying or intermittent noise. Therefore steady noise, such as services noise, can be used to mask occasional noises that may otherwise be distracting.

Where an open window ventilation strategy is adopted, there may be little that can be done to block out external sounds, so noise control will rely either on masking noise within the room, or trying to arrange that potentially distracting noise sources are located away from sensitive rooms. Another approach may be to allow a continuous general background noise so that individual noises do not become too distracting.

Masking noise has been identified as useful to avoid distraction and is included in British and international Standards [6, 7]

Masking noise is usually generated by “de-tuning” the services noise, or it can be provided by not mitigating activity noise, typically in offices or restaurants. However, it can also be tailored to create a soundscape, either by introducing sounds or by controlling the existing environmental sounds.

3.5 Keep it Real

The more the acoustic environment matches the physical environment and our general perceptions and expectations, the more satisfied we are likely to be. A sound that is unusually high or low, quiet or loud may be distracting – over-reinforcement can be a problem as well as under-reinforcement, so achieving a suitable signal to noise ratio isn’t always a case of “everything louder than everything else!” [8].

However, sometimes only the real sound, whether an explosion, the tinkle of a bell or a breaking twig, will do.

It is also important that the content of the sound in appropriate for the time and place: if sounds are introduced to provide masking or atmosphere they should not unsettle the listeners, and this may require careful knowledge – there are a small but significant minority whose enjoyment of period dramas is disturbed by the inappropriate background cooing of collared doves, unheard in Britain before 1953! [9]

However, accuracy in audio does not always produce the clearest communication, and depending on the application the requirement may be for clarity, accuracy, or naturalness[10]. The same sound system may have different requirements depending on the individual application.

3.6 Noise Narrative

In instinctive perception, the mind is trying to identify and make sense of the environment the listener is in, and in cognitive perception the mind is trying to make sense of the environment communicated by the speech or music signal. In both cases the environment perceived is not static, and the effort of perception will be greater when the environment changes unexpectedly or if there appear to be conflicts or threats in the environment. Therefore to allow good cognitive perception there should be no threats or challenges in the instinctive perception. It may be better for a noise to be heard regularly so that the “threat” can be recognised and discounted, than suddenly noticed during a quiet or intense passage.

Allowing the “threat” to be recognised may be achieved by increasing the sound as well as trying to eliminate it – complaints from pop concerts are more likely from people who can hear the beat of the event, but not the melody or lyrics, so people closer to the event who are exposed to higher sound levels do not complain but those further away do, perhaps because being partly able to hear the music encourages more effort in trying to recognise the music, whereas those closer can easily hear the music and choose to listen or ignore it.

Sometimes sound designers use the “threat” to deliberately increase the unease in the audience, dramatically for a horror film, but this can also be done subtlety, even by selecting different birdsong for a background, or by suddenly stopping a sound – like the dog that didn’t bark in the night!

Creating a suitable environment can also be important for building acoustics – if rooms are created that allow the occupant to make any noise without being heard, they do not need to consider their neighbour. If the room is inside, but feels like you are outside, you may feel insecure because you see walls but do not hear any reflections from them. If you have lots of visual activity behind a glazed partition, but cannot hear an appropriate sound, you may need to spend longer looking at the scene to take it in and feel secure. There are many instances where there may be a conflict with visual (or other sensory) perception and acoustic perception.

In designing the acoustic environment of large buildings it is also worth considering whether the same environment is required for all rooms and spaces; Are all corridors the same? Do all classrooms or consulting rooms want to be exactly the same or is it better to provide a variety of acoustic environments to cater for different tastes?

4 CONCLUSION

An acoustic environment is rarely one-dimensional and requires a more subtle description than a simple scalar number. Our perception of the environment is more complex still, depending on our own local geographical, historical and cultural knowledge, as well as instinctive mechanisms.

Creating a sensible acoustic narrative allows us to make sense of our acoustic environment and makes the perception of speech and music easier.

5 REFERENCES

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