Developments in the use of noise monitoring/recording and expert opinion in reliable and cost effective assessment and prosecution of dog barking nuisance

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1.0 Background

1.1 Acoustic engineering expert opinion

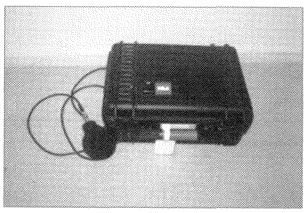
Acoustic engineers are commonly involved in providing opinions about noise related aspects of proposed developments.Where decisions of planning authorities have been appealed to the planning courts, such acoustic engineers provide an opinion which has the status of an expert witness. An expert opinion is relied upon in legal related matters where the subject matter extends beyond lay interpretation, and, in usual cases, the expertise of the decision maker. Where a respondent seeks to counter an expert opinion, it is usually necessary to engage another expert witness who has formed a contrary view. Lay opinions are unlikely to sufficiently refute an expert view, save for gross errors in approach or reasoning of an expert witness.

It is common for acoustic engineers to utilise measurements obtained by unattended instruments left to monitor for a period of time. Such instruments are termed noise loggers.

1.2 Advances in noise logging instrumentation

Recent advances in such instrumentation enable very sophisticated noise measurements, and now, audible recordings. These developments bring this instrumentation to be potentially very useful in dog barking assessments and prosecution. Photograph 1 shows the SVAN 957 instrumentation used in recent dog noise software development and day barking investigations by the author.

The instrument saves to a memory stick. There is potential for Councils having this facility to send the memory stick for processing. Memory requirements are far too large for ordinary electronic transfer.



Photograph 1

1.3 Development of software

It is not however sufficient to have noise measurement information in a form replicating a witness standing at the measurement position. It is necessary to find a way to simplify the information to extract its useful parts and not require processing time equivalent to witnessing the period of measurement. It is thus necessary to supplement the capacity of the instrumentation with a programme or other intelligent means of cost effectively identifying periods and attributes of dog barking activity.

It was desirable to:

1. Provide a means of assessment of dog barking without alerting the owner or dog to the assessment, and thereby by that mechanism avoid any potential to alter the behaviour of the dog.
2. Reliably detect barking.
3. Separate the barking from other similar short term environmental noises such as from birds.
4. Quantifying barking periods and times in a way which may be used to assess the correlation with complainants' records.
5. Differentiate barking of the subject dog from other dogs in the neighbourhood.
6. Record audible evidence of dog barking to assist with proving barking of the subject dog.
7. Avoid allegations of audible recordings for illegal purpose.
8. Determine approximate numbers of dog barks on an hourly basis to enable comparison with accepted dog barking standards.
9. To identify relevant noise measurement to enable comparison with recognised acoustic standards.
10. To thereby enable the emission to be positioned and supported in legal action as the subject of independent expert opinion having the status of an expert witness.
11. To be cost effective.

One of the significant practical problems in software development is the need to deal with millions of individual measurements.

2.0 Results of research and development

The results of the work undertaken to investigate dog barking and develop a suitable programme have been strongly encouraging. I refer below to the essential reasons for the positive result. I thank the City of Onkaparinga and, in particular, Chris Button for his expertise and support in the evolution and the development of this technique.

2.1 *Three independent sets of measurement types*

The typical results of an acoustic assessment for the subject purpose include three distinct components. These three elements result from three independent types of measurements from the one instrument (Photograph 1).

These three independent measurements cross check one another and further are potentially correlated with a diary of the complainant forming a fourth element. I discuss these in turn in the following.

2.2 *The first measurement component: Charts giving noise level versus time of day for each day*

A typical chart giving values of noise level versus time showing dog barking period is given in figure 1 on the following page. By focussing on particular statistical parameters which were found in the study to most usefully indicate intermittent dog barking noise (the $L_{1\text{-}5\%}$ levels – the levels exceeded from 1% to 5% of the time), periods of likely barking were able to be:

1. Defined in terms of time of day and length of time of the potential barking.
2. Potentially correlated with the diary of the complainant.
3. Potentially correlated with the dog barking number determinations (arrived at by different measurement as part of the same process) to be considered below.
4. Potentially correlated with the audible records to be considered below.

Figure 1: Statistical parameter time trace

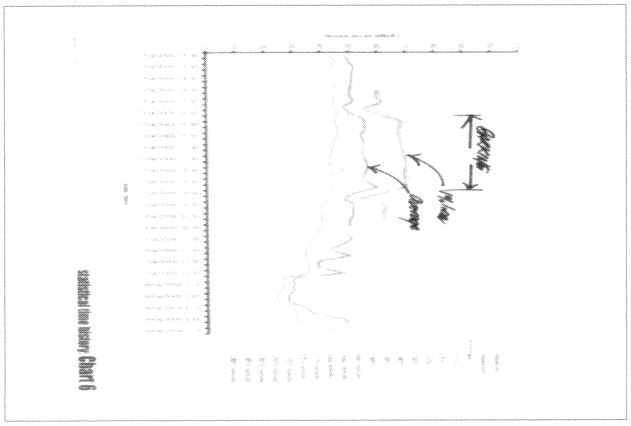
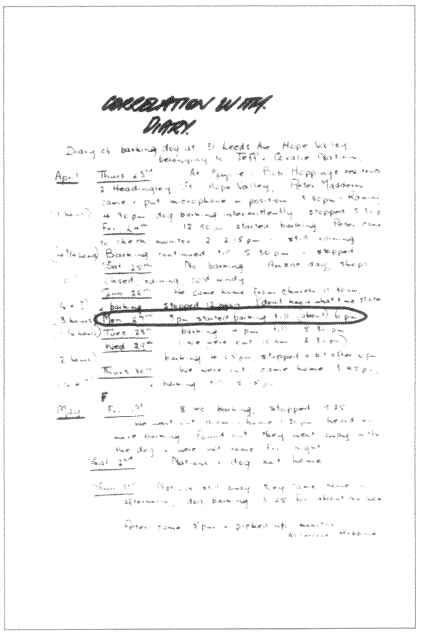
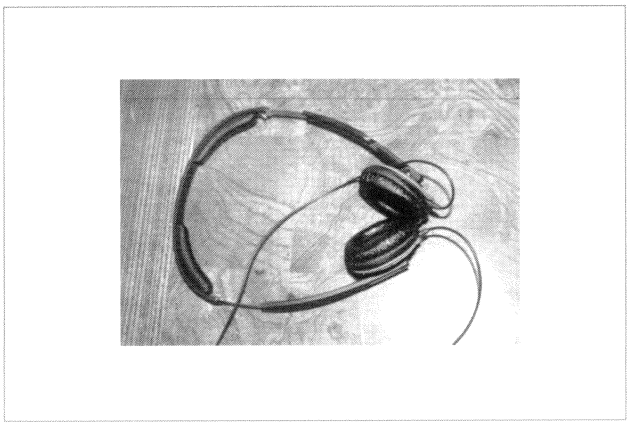


Figure 2: Diary



Cross check



Audible record of barks

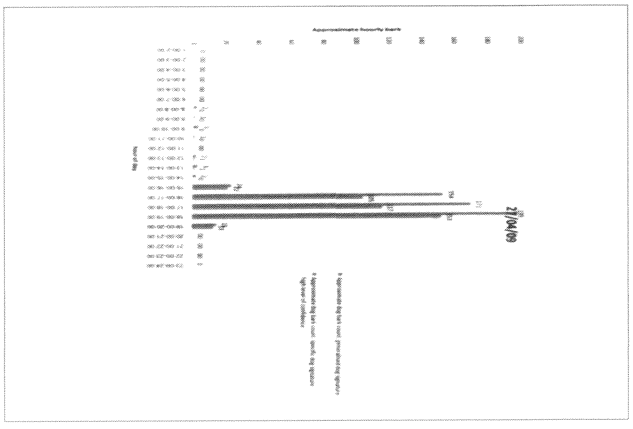


Figure 3: Bark count
Record from bark shape/spectrum recognition

The chart recordings (Figure 1) alone are not decisive of barking. Alone they may merely indicate significant intermittent noise which may be dog noise. (The statistical parameters do however separate intermittent types of noises from more continuous ones).

2.2.1 Chart recordings assisting to show nuisance

However, the chart recordings assume a different and far more useful perspective when they correlate with other aspects of the determinations that demonstrate the intermittent noise is dog barking. If the barking is significant, they then define the period of barking and time of significant barking and they further give the associated noise descriptors to which reference is made in relating the emission to accepted acoustic standards.

2.2.2 Charts recordings assisting where the barking does not constitute nuisance

Of equal importance, but on the other hand, if known barking is not sufficient to make obvious change to the acoustic environment, as is effectively defined by the chart recording descriptors, there are grounds to reasonably dismiss the claim. In that case, whilst barking may be audible there is probably undue significance being placed by the claimant on the recognition of the character of the noise in the circumstances of the competing noises (which, of course, are also recognisable).

Note that whilst Figure 1 shows circumstances of obvious nuisance, there are circumstances, usually where the dog is further away, where it is necessary to establish how significant the barking is. The chart recordings are also useful for this purpose, but it is then necessary to rely on the other detection processes discussed below to define the extent and periods of barking. The chart recordings are not sufficient alone. This is especially for criminal prosecution where the standard of proof is beyond reasonable doubt. Usual acoustic approaches by acoustic engineers in civil planning cases may not be sufficient in criminal cases.

2.3 Audible records of barking

The second significant output from the measurements is audible records of barking.

In usual measurement circumstances, each and every significant noise above a selected threshold is recorded as a separate audio file. Thus, at times of indicated barking, the noise can be positively identified.

Further, where there are multiple dogs involved, differences in audible sounds can be identified. This is useful in the section which follows relating to identification of the individual dog.

The recorded audible sounds are potentially convincing to dog owners who have taken the position that their dog does not bark.

There is thus the opportunity to confirm undeniably that periods of potential barking identified by reference to charts is barking, if indeed, it is.

There are essentially two ways of arranging the audible records:

1. Time stamped audible records can be automatically recorded above a threshold such that only the barks and similar short term sounds (say for a second each) are recorded;
2. Alternatively, the complainant can be asked to press a remote control to record for a period of say 15 minutes per sample.

The former approach is preferred, but it is only practical where the dog is close to the instrument, such as next door. The problem at remote locations is that the threshold level has to be low and, in that event, the audible records and other logged information become overwhelming. Where the dog is quite remote from the measurement, say three houses away in usual urban environments, the only practicable way is to record for selected continuous periods using the remote control.

Note that where the preferred approach of only recording above a particular noise threshold is adopted, conversations and the like are not generally recorded. There is, however, the potential to detect loud actions that may inspire the dog to bark.

There are two ways of hearing the recorded sounds. Firstly, the noise instrument software enables the sequential sounds to be easily heard whilst simultaneously watching a time labelled screen view of technical noise traces. (However, there is not a hard copy documentation of that information from the instrument supplier).

Secondly, the individual recorded sounds (termed "events") are able to be easily saved as time labelled audio files. (There is a minor complication that these files need to be converted to a form which most computers will be able to play, but that process is not difficult). It is in that form of time labelled audio files that the information would be most suitable for Council and prosecution use.

2.4 Dog Barking: Bark numbers and times

The third output of the measurement relates to a means of identifying dog barks by the use of a programme which scans all of the recorded noise measurement information and detects sounds which fit the "mould" of a dog bark.

The typical output from such a process is given in Figure 3 which shows periods of barking at particular times of the day.That graphical representation of dog barking can be compared with the chart recordings and, of course, correlates with them. It is also correlated with the audible records.

The development of the programme has facilitated two types of detection:

a) The detection of a sound which fits the mould of a dog generally as against a bird, car, etc; and

b) The bark which fits the mould of the specific dog. By reference to audible records, individual bark characteristics can be applied to the programme to detect the particular dog within some statistical bounds.The instrument saves frequency (pitch) information as well as noise level. This enables the developed software to isolate sounds on the basis of

frequency (pitch) composition as well as level. In other words, it can work on the way in which the sound sounds.

The result of measurement then produces generally an integrated and correlated set of results that are persuasive based on:

1. Statistical measurements of noise displayed as noise level against time of day.
2. Audible, saved records of barking.
3. Determination of bark numbers and times from the noise recorded results. This determination is made from sounds fitting the acoustic mould of:
   a) A typical dog bark;
   b) Bark character of the specific dog.

An expert opinion is able to be based on all three of these approaches, but in addition is able to be based on accepted acoustic standards applied to the measured dog noise.

3.0 Technical issues

The study involved progressing the technical issues relating to:

1. Acoustic issues;
2. Programming/instrument issues;
3. Cost effectiveness.

3.1 Acoustic issues

There are many sources of intermittent noise in the community. There are also many forms of intermittent noise from the slowly varying noise of passing vehicles, for example, to the shorter, sharper sounds, more characteristic of dog barking like birds. It is necessary in processing the acoustic data to a form which is useful that there is some means of separating dog noise from other somewhat similar noises. There are a number of potential ways of doing this in combination. The most useful are:

Bark levels

1. On the basis of noise level;

Bark shape

2. On the basis of the shape of the bark in the time domain, that is, how quickly the bark typically rises and falls typically;

Bark spectral composition

3. The spectral composition of the sound. Generally, dog barks sound different to bird calls, etc. They do so because they have different frequency or pitch components which are potentially able to be separated. Finally, there are many situations in the community where it is desirable to separate out the contribution of a particular dog from other nearby dogs. The same considerations above are used to enable this differentiation.

3.1.1 Bark level

I deal with these issues in turn. Separation on the basis of noise level is not in itself a complex issue. However, it is important from the point of view of minimising the amount of data that is necessary to be stored and processed. Dog barks in general last an exceedingly sort time, a very small proportion of a second. To measure and store measurements made many times a second over lengthy periods in excess of a week implies very large amounts of data to store and process. In turn, these issues generate difficulties with instrumentation and with cost effectively processing data.

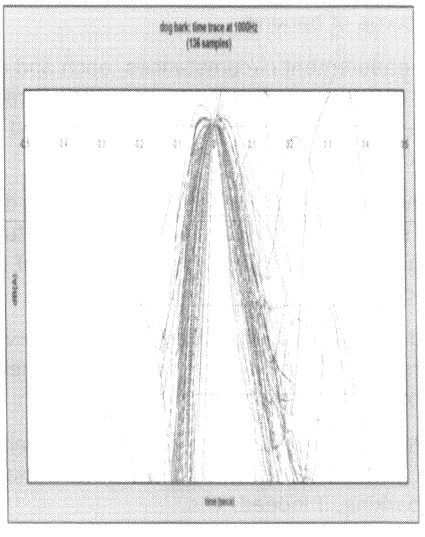
One of the experiences that has come solidly from the study is the desirability of measuring at a position of having the subject dog at a level of sound that exceeds other dogs. Note that simultaneous measurements can occur at different locations.

Measuring close to the dog simplifies the assessment and increases the accuracy. A setting of the instrument to take into account sufficient level to detect the subject dog, but high enough to exclude most of the remaining noise, as is practicable, is desirable. That is the essential task of setting up the instrument. With practice and instrumentation, Council officers could do this.

Bark shape

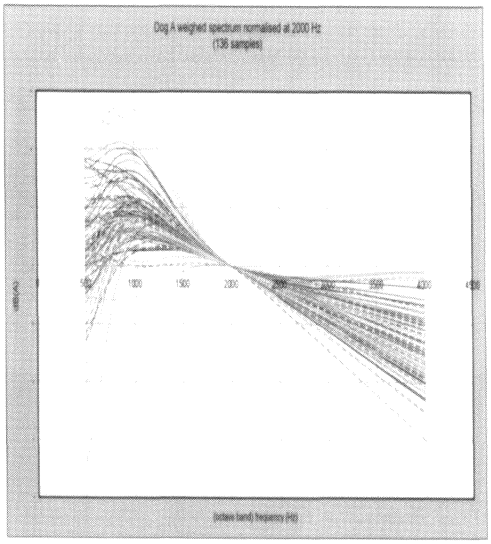
The bark lasts an exceedingly short period of time, and it appears generally consistent between dogs. The following figure is a graph of noise level versus time for 136 dogs. Clearly, this shape of very quick rise and fall is quite different to many other sounds, for example, of passing vehicles, etc.On this basis, some degree of separation of dog noise from other broadly similar noises is possible. However, many birds have similar short lasting sounds.

Some dogs have a characteristic double bark repeated within a very short time span. It was necessary to accommodate that characteristic in the detection software algorithm.



3.1.2 Spectral composition

The ability to separate dog sounds from similar sounds, such as those from birds, is a crucial aspect of the subject study. It was indeed found that dogs have a characteristic bark which, whilst varying between the small dogs and large dogs, was such that it was able to be separated from the sounds of birds and insects relatively easily.



The above figure 2 shows the sound spectrum of a large sample of dogs. The vertical axis is noise level. The horizontal axis is different frequency (pitch) bands. The low sounds are to the left and the high frequency is to the right. The graphs then show the combinations of frequency (pitch) in a day bark.

The graphs in the form above are known as spectrums. It was established that dogs generally, by measurement of a large number of dogs, have a spectral shape that is more prominent at the low frequencies than birds, and less prominent at the higher frequencies than birds.

In practice, this spectral shape is subject to some environmental constraints. For example, the spectral shape was determined by measurement in open circumstances, where the sound from the dog was able to be picked up directly by the instrument.

In practical situations, dogs are often located behind buildings or fences, etc. and these environmental aspects change to some degree the spectral shape determined by the instrument. This is because some frequencies of sound pass around corners etc. more easily than other frequencies. Sometimes, of course, the dog is facing the position of the microphone and, at other times, facing directly away from it. These types of considerations needed some degree of allowance.

It also became apparent that because a bark is so quick in time and it is necessary to measure quickly, there was some potential for different path lengths of noise from different spectral components. Some refinements in the program to deal with this aspect also proved desirable.

4.0 Practicable results

Todate, the technique has been used in three matters earmarked for potential prosecution.

The first settled with the respondent retiring from the contest.The second elected to destroy the dog faced with the evidence.The third involved a property three houses apart from the dog, although in an arc such that the distance was diminished. Whilst repetitive barking was found, it was not at a loud enough level to make a noticeable change to the acoustic environment (at the frequency of occurrence), or saying the same thing in a different way, not barking frequently enough at the actual level of barking to make a noticeable change to the acoustic environment.

In the circumstance, I did not think nuisance would be able to be made out.Nearer neighbours were not aggrieved.

Fees for these matters were generally in the order of $1,000 - $2,000 per matter. The economics is continuously improving. There is potential for Councils to set up the instrumentation, but send the results for processing.

About the author

Peter Maddern has the following formal qualifications - Bachelor of Mechanical Engineering (1974); Master of Environmental Law, University of Adelaide (1998) and Master of Regional and Urban Planning, University of South Australia (2002), and is accredited by the: Institution of Engineers Australia; Australian Acoustical Society; Planning Institute of Australia (February 2004). He has practiced as a Consulting Engineer providing advice on acoustic and other mechanical engineering matters such as this since 1980, and has appeared as an expert witness on well in excess of 50 occasions, since the early 1980's, inclusive of appearances (in South Australia) before the South Australian Supreme Court; South Australian District Court (Civil and Criminal); Environment, Resources & Development Court; Planning Appeals Tribunal; Liquor Licensing Court; Magistrates Court and the Industrial Court. He is the Court appointed acoustic expert for the South Australian Magistrates Court.