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NEW METHODS AND TECHNIQUES FOR MEASURING ENVIRONMENTAL NOISE.

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1. INTRODUCTION.

New measurement techniques can only arise if their desired methodology can be implemented into practical instrumentation solutions. Hence, new methods and techniques for noise measurements are inexorably linked to the theoretical skills of the expert user and the design excellence of the instrument manufacturer.

In the 1979, in a report to the EEC, Komorn and Luquet (1) proposed a new method of storing acoustic data on computer disk - "Short Leq" - recording short duration energy integrals as a true representation of a noise event. This data could then be post-processed to yield acoustic parameters such as Leq and L10. Initially, it was inconceivable to store large amounts of data in a hand held sound level meter, so the measurement technique was constrained by the available instrument technology. By the mid 1980's, a joint development had produced an instrument capable of not only measuring and recording short Leq but also complying with globally defined standards such as IEC 804. This achievement was made possible using the Wallis/Holding method (2) to calculate the Leq value to a high order of accuracy before actually digitising the value.

This was first evidenced in the Cirrus CRL 236, which confirmed the suitability of "Outbox Processing" as a technique. No longer was it necessary to constrain one's measurement to a few field selected parameters, illustrating the inflexibility of the classical acoustic analyser. A further power of the Outbox Processing Technique was still to evidence itself - data re-analysis : with classical analysers data was measured and the output was presented on a chart recorder so losing basic data. Outbox processing allows the raw data to be stored and re-analysed as often as required to reflect changing regulations or revised analysis requirements.

Modern electronics has resulted in today's position where well proven short Leq meters have expanded into long-term monitoring systems, impulsive noise assessment (3) and have become complete acoustic measurement systems (4)

2. HOW CAN THESE ADVANCES APPLY TO THE MEASUREMENT OF ENVIRONMENTAL NOISE ?

Assessing environmental noise is normally concerned with one of the following rationales

Classification of an Existing Noise Source.
Identification of A Noise Nuisance.
Routine Measurement of Known Noise Problems.

2.1 Classification Of An Existing Noise Problem.

Generally, when existing noise problems are being assessed, it is with one eye to the future -

defining the baseline for future expansions or to assess the implications of increasing problems.

These surveys are normally relatively short term and concentrate on determining potential noise nuisance and focus on parameters such as periodic Leq's and L10's. Whilst summary data is useful it does not reveal the full picture obtained by the use of a level recorder or the detailed time history from a short Leq storing meter. This lack of definition is illustrated by the figures below :

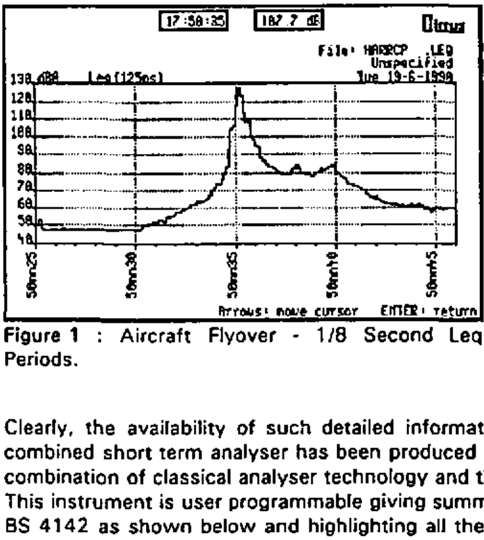

Figure 1 : Aircraft Flyover - 1/8 Second Leq Periods.

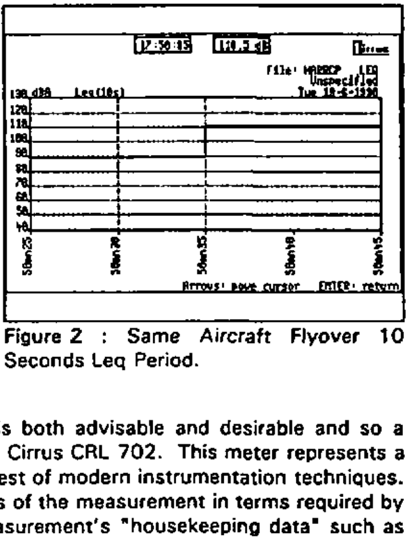

Figure 2 : Same Aircraft Flyover 10 Seconds Leq Period.

Clearly, the availability of such detailed information is both advisable and desirable and so a combined short term analyser has been produced - the Cirrus CRL 702. This meter represents a combination of classical analyser technology and the best of modern instrumentation techniques. This instrument is user programmable giving summaries of the measurement in terms required by BS 4142 as shown below and highlighting all the measurement's "housekeeping data" such as calibration times and battery condition along with the essentials measurement data such as event Leq's, SEL's and Ln's.

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Cirrus Research Ltd
CRL 702   012961

Baud              9600          Calibration Due  8/8/91
Time Constant     Fast          Ln          Fast
Reset Time 13:57:22  8/12/90    Battery     Ok
Time Integrator      2.00 sec   # Events    4
                     Run        Stop   120.0 Thresh. Overload
Time                 1:26:37    50:39    1:25:43      00:00 hr:min:sec

           Peak     Max     Min    Cal 1   Offset 1 Cal 2
Level      123.9    75.2    45.3    94.0 -  2.5         0 dB
Time       13:57   15:11   15:18   13:57              00:00 hr:min

Total      Start   Run Time   Leq  LEPd   SEL   L 10  L 90   Max   Min
           13:57    1:26:37  49.6  42.2   86.6  50.4  44.8  75.2  45.3
[
 Event     Start   Run Time   Leq  LEPd   SEL   L 10  L 90   Max   Min
  1        13:57      01:06  58.3  54.6   76.5  61.3  47.1  71.2  46.0
  2        13:58      32:54  49.5  37.9   82.3  48.1  44.8  75.2  45.4
  3        14:37      20:30  46.5  55.5   77.3  51.2  44.8  67.0  45.5
  4        15:04      32:06  50.0  38.3   82.8  50.6  44.7  75.2  45.3
]
```

Such requirements are enhanced by categorisation of the assessment into types e.g trains, cars, and aircraft. The original Cirrus CRL 236 and the enhanced CRL 236A feature code keys as part of the instrument keypad. The code buttons allow the user to categorise data and the downloaded data retains a code attached to the basic short Leq data. Hence, an urban survey can be analysed in terms of overall levels and constituent parts. The power of coding has been further increased by the addition of Partial Leq calculation to the Acoustic Editor analysis software, thereby allowing the impact of each source to be categorised as below :

UNKNOWN Leq elem..: 1 s dBA
from 09h 10mn23s
until 09h 13mn14s Tue 08-10-1991

Source	Leq proper	Leq partial	%
cars	52.1	46.2	26
aircraft	69.8	54.5	3
train	52.3	44.8	18
other	51.3	48.6	53
Overall	56.3 dBA		

So partial Leq combined with coding allows us to evaluate not only the overall noise climate but also to assess the individual noise sources' contribution to that of the global level.

2.2 IDENTIFICATION OF A NOISE NUISANCE.

Identifying a source of noise nuisance can involve considerable time and effort involving lengthy tape recording and narrow band analysis procedures. Eventually, such a process will identify a noise source but proving that a particular source was active during the problem period requires more diplomatic skills than acoustic expertise.

Obviously, in the ideal world we could record the noise indefinitely and choose a particular timed segment of the record for analysis purposes. However, tape analysis is time consuming and before

the advent of DAT recorders was liable to suffer degreadation.

The problem is therefore one of logging the data in a format that allows distinct analysis possibilities and contains a true time history grid. Two alternative methodologies can be used -

Event recognition by Short Leq profile.
Event recognition by Digital Recording Techniques.

2.2.1. Event recognition by Short Leq Profile

The use of short Leq as a method of event detection has been successfully implemented in the Southern hemisphere's largest integrated noise and flight path monitoring system - the Cirrus Adacel CA 1000 system in Sydney, Australia. The premise of such systems is that events conform to known short Leq profiles and use sophisticated detection algorithms to filter out unwanted events (5). Whilst short Leq event detection has been mainly used for aircraft detection it is equally applicable in other event differentiation situations such as train movements and is limited only by the event detection profiler's ingenuity.

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2.2.2. Event Recognition by Digital Recording Techniques.

01dB's ARIA system originally evolved as a large memory short Leq data logger using a computer hard disk as it's datastore. As digital recording techniques have advanced so it is now possible to record sound onto the same hard disk. The software module dBTRIG operates by triggering into a recording mode and stores both the short Leq data and the noise signal when predefined noise levels are exceeded. By cross referencing the audio data to the short Leq time history, it is possible to directly replay the noise nuisance's audio record. A typical time history is shown below :

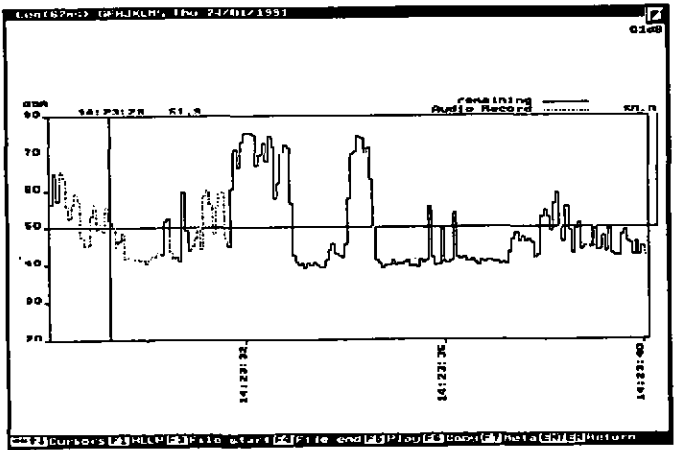

Figure 3 : ARIA Short Leq Time History With Audio Record.

Clearly such a record is ideal for identification purposes and should frequency analysis be required then the signal file can be analysed with ARIA's FFT module. It is a measure of the power of this methodology that many French municipalities now use this method to identify problem noise sources.

2.3 ROUTINE MEASUREMENT OF KNOWN NOISE PROBLEMS.

Routine monitoring of known noise sources is primarily confined to sensitive applications such as airports and quarry blasting. Normally, these units are self-contained installations which communicate with their user via computer links such as modems and provide data in a format that is ameniable to manipulation by proprietary database or spreadsheet products.

Such installations normally have automated report generation features and combine excellence in acoustics, communications, and computer equipment. A classic example of such a system is the Australian C A A 's aircraft flight path and noise monitoring system (6). This system uses the event detection algorithms outlined earlier to detect aircraft movements and report the data not only to local control centres, but also provides the data to central government in Canberra and for public consumption on large concourse display maps. Such installations are by nature highly complex and demand excellence in communications engineering along with acoustic expertise.

The same basic technology may be applied to the detection and monitoring of blast noise problems such as exist close to the world's quarries, with the exception that the monitoring units are normally single self contained outstations and may be interrogated manually or by radio telephony techniques. Such technology has been harnessed to provide a comprehensive blast monitoring system.

3. SUMMARY

Many powerful techniques have been evolved to aid the acoustic practitioner in the measurement of environmental noise and these are inexorably linked to computerised instrumentation excellence. Undoubtably more will evolve limited only by the ingenuity of acoustic scholars and the design skills of acoustic metrology manufacturers.

In Britain, we have developed technology to address the needs of "Noise in The Nineties", all that is required is for us to apply it with vigour and enthusiasm.

4. REFERENCES

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