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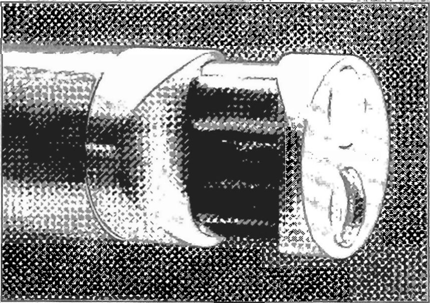

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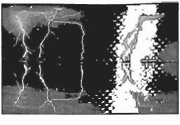

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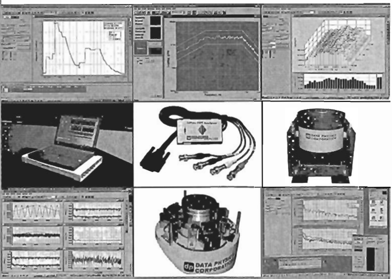

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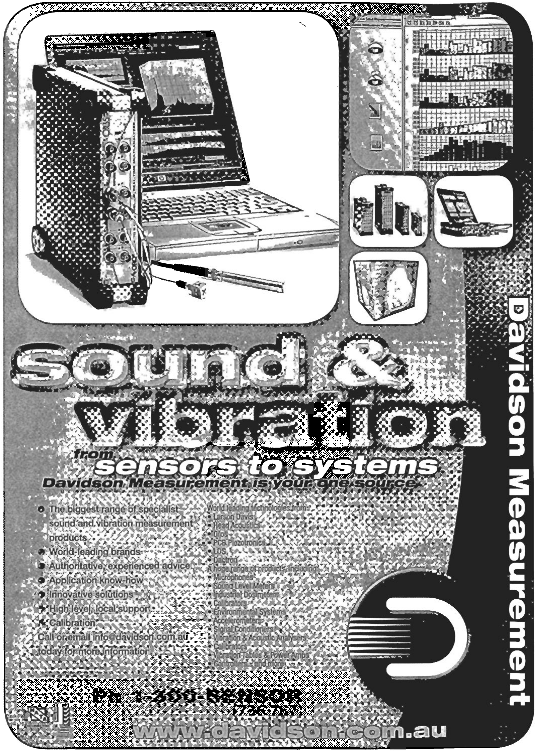
Vol 31 No 3 December 2003

CONTENTS

ACOUSTICS FORUM:

Cover illustration: The Microflown acoustic intensity probe --- see paper by de Bree.



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From the President

I trust you all enjoyed the festive season and are now beginning to wind up for another busier year. It seems that the same issues are facing all societies. I attended the Australian Institute of Occupational Hygienists annual conference in December and during a talk by the President of the American Industrial Hygiene Association (AIHA) he outlined the main issues that impacted on their society. They included a lack of volunteer time; the greying of the profession and membership; and the need to attract younger/newer professionals. Their approach to professional development and training is changing with a move from lectures and seminars to electronic distribution on CD and the internet. He stated that the X-Generation is not noted as joiners and this difficulty faces many organisations. In 2004 AIHA will no longer have a journal! They are combining the AIHA Journal and the ACGIH Journal into one journal for the profession, The Journal of Occupational and Environmental Hygiene. This will be available electronically on the web with continuous updates posted. Printed versions will be produced incrementally for Libraries and for those who wish to receive it in hard copy.

Thanks to the 90 members of the AAS who took part in the survey distributed with the last issue of the journal, I trust their views are representative of those who did not respond. A summary of the results is printed in this journal and more information will be available on the web. The priorities requested by the membership aligned well with the preliminary survey carried out by councillors at the Future Directions meeting. I am pleased to say that the AAS is not going to take the same route as the AIHA and dispense with a hard copy journal as this 'service' ranked top of the list.

Your councillors are responding by prioritising our efforts. Some projects underway include the preparation of bids for International Conferences, Internoise 2007 and ICA 2010 for Sydney. Also we are upgrading the Society web pages to include technical meeting dates under each division and improvements to the database of members including web access for members to update their membership details online. This will enable us to e-mail information rapidly. Also we are developing an area of expertise listing which will be initially be by self nomination after re-reading the Societies Code of Ethics and understanding its implications.

The Society's Federal budget covers items such as the GST, General Secretary's expenses, Accounts and Auditing, Council meetings, Acoustics Australia, Education Grant, Insurances, Membership of national and international bodies etc. The Federal Budget is stretched to the limit to provide these services and a special levy has been set on each Division this year to balance the distribution of funds across the divisions. The Annual membership subscription has been increased marginally for next year (full membership increased from $103.40 to $110.00). This is the first increase since 1998 (excluding GST) and well under the inflation rate over the same period. The Divisions and the Society as a whole are in an excellent financial position.

Thanks to the efforts and support of all those who are involved with the activities of our Society we have achieved a lot during 2003 and look forward to future growth in 2004.

Ken Mikl

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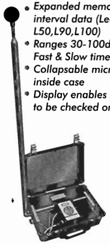

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From the Editor

This is our Christmas issue of Acoustics Australia, even though you will probably not receive it in the mail until mid-January, and this makes it appropriate to consider briefly the role of sound during the Christmas season, and indeed during festival occasions more generally. A moment's reflection should certainly convince us that, while a ceremony conducted in near-absolute silence can be very impressive, it really gains this effect through a contrast with joyful sounds at an earlier or later time.

There are many things that make organised sound, such as music, assume this influential role, some of them physical and some psychological. Consider first the physical aspects. Large buildings make a mental impression simply because they are large, though their visual features may make them attractive or repulsive. But when we are in a large building we can immediately sense this from its acoustic environment. Whether the sound is disorganised noise, sometimes called "acoustic daylight", or intricately patterned sequences of complex tones as in music, the relationship between the initial prompt sound and the subsequent reverberant sound gives us a subconscious feeling for the size and shape of the building. We may not be nearly as good at this as bats or dolphins, but we do it passively without needing our own sonar! Even on a mountain peak or in the midst of an empty plain we can experience appropriate spatial sensations.

Of course, we are not acoustically passive creatures and, even without modern technology, we delight in producing organised sounds to communicate with other humans. Much of this communication is to pass on precise information by way of coded speech sounds, but in the case of music the message to be communicated is almost subliminal and has to do with feelings that are almost inexpressible. An organ or a choir in a huge stone cathedral makes one feel the scope of one's own mental space and the immensity of physical space, even without any belief in gods; bells sounding in the evening create a feeling of community, whether one responds to their call or not; a concert of classical music brings admiration of structure and detailed pattern; and a rock concert anaesthetises the senses until all but the present moment is forgotten.

Going to a different cultural background, the peace of a Buddhist temple soothes the mind into meditation in which the cares of the world are dismissed and the inconsequence of many of our concerns becomes apparent, while the occasional deep boom of a bell struck with a huge wooden log or the sound of tiny bells moving in the wind serves to punctuate and emphasise the silence. If the temple is among the trees or near a waterfall, then the smooth sound provides a calming background.

So what does this all have to do with modern acoustics? Our role is, I think, many-fold. The first is to provide the physical background that will determine the acoustic environment: the shape of the space, the walls, the reflections, the isolation from unwanted sounds. The second is to provide the sounds that will decorate that space: the musical instruments, the voices, the background. The third is more technological, and that is to provide whatever is necessary in order that these sounds may achieve their desired balance and effect, whatever that may be. And of course this final advance also allows the preservation and reproduction of the whole acoustic picture in a remote and quite different environment through recording techniques.

Truly, acoustics has many roles to play during this festive season and throughout the year!

Neville Fletcher

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DIFFERENTIAL SENSITIVITY OF THE EAR FOR UNDERWATER PURE TONES

Kazuoki Kuramoto,[1] Shin'ya Kuwahara,[1] Kensei Oimatsu,[1] Shizuma Yamaguchi[2]
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[2]Faculty of Engineering, Yamaguchi University, 2557 Tokiwadai, Ube 755-8611
JAPAN

ABSTRACT: As a part of the research for constructing an underwater transmission system to divers, differential sensitivity of the ear in water to sound intensity and frequency was examined by listening experiments in a water tank. Although the value of minimum audible field (MAF) in water was considerably different from that in air, it is found that the dependence of differential sensitivity at the same sensation level (SL) is almost the same both in water and in air. Resolution of the auditory sense (i.e. number of steps in distinguishable sound) was estimated in the underwater auditory area by using existing results in air.

1. INTRODUCTION

The ability to discriminate sound intensity and frequency is one of the fundamental auditory senses in man. It is reported that the differential sensitivity of the ear is very high in air [1,2,3] and that the number of sounds we can discriminate in the audible range is about 340,000 [4].

On the other hand, there are very few studies researching the differential sensitivity in water, except the study of the ability of localization [5], probably because there was little necessity until now. Recently, the necessity of ensuring the safety of divers occurs with the popularization of marine leisure and it is said that a direct transmission to divers using an audible acoustic signal is the most effective way in water [6-10]. When we consider the realization of this transmission system, the differential sensitivity of the ear becomes an important problem in relation to type and quantity of information.

In this study, we examine the differential sensitivity of the ear to sound intensity and frequency by listening experiments in a water tank and estimate the resolution of auditory sense (i.e. number of steps in distinguishable sound) in the underwater auditory area.

2. LISTENING EXPERIMENTS

The listening experiments were carried out in a water tank with dimensions 1m×1m×2m equipped in a silent experimental room. The spectrum level of the background noise in the tank was almost constant at 52dB [re 1μ Pa $/\sqrt{Hz}$] in the frequency range from 1kHz to 5 kHz. The subjects were two men with normal hearing in air. As shown in Fig.1, the subject immersed only the whole head in the water to minimize the effects of the background noise and listened to the underwater sound. Two hydrophones were set up as close to both the subject's ears as possible and the average was obtained from these. The value of sound pressure level (SPL) was obtained by reading the data sheet on a level recorder (LION LR-4) calibrated by an underwater sound level meter (OKI SW1020). The measured SPL was actually variable from place to place owing to the effects of standing waves in the water tank. So we regarded that the subject heard the sound of SPL just measured at that moment by the hydrophones.

As the present experiments deal with the differential sensitivity of auditory sense, what is called the threshold of difference or the difference limen (DL) determined as a smallest detectable change in the sound intensity or the frequency [5], we introduce the sensation level $SL = 10\log(I/I_0)$ with reference value of I_0 as a standard of sound intensity which corresponds to the value of minimum audible field (MAF). Here, the sound intensities of I and I_0 were inferred respectively from the SPLs actually measured by the underwater sound level meter on the assumption that there was a plane wave in the water tank. Furthermore, the value of I_0 was obtained in advance at every measurement of DL because it usually depends on the experimental conditions or subjects.

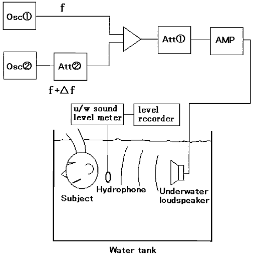

Fig. 1 Measurement of difference limen (DL) in the water tank

In order to obtain the value of DL to sound intensity, the listening experiment was carried out by a beat method [1]. A beat sound was synthesized from two pure tones, respectively, with slight different frequencies ($f, f + \Delta f$) and with different amplitudes (A, B). Therefore, the instantaneous pressure p of the beat is expressed as,

$$\begin{aligned} p &= A\sin\omega t + B\sin(\omega+\Delta\omega)t \\ &= \sqrt{A^2+B^2+2AB\cos\Delta\omega t}\cdot\sin(\omega t+\phi), \qquad \omega = 2\pi f. \end{aligned} \tag{1}$$

The subject listened to the beat sound and compared the fluctuation of amplitude between the maximum ($A + B$) and the minimum ($A - B$). When the beat was perceived to vanish, the threshold was determined. As the sound intensity I is in proportion to the square of amplitude of the instantaneous pressure p, i.e. $I = p^2/\rho c$ where ρc is the acoustic impedance, the value of relative DL ($\Delta I_{th} / I$) was obtained as,

$$\frac{\Delta I}{I} = \frac{(A+B)^2-(A-B)^2}{(A-B)^2} = \frac{4AB}{(A-B)^2}. \tag{2}$$

The frequency of the beat Δf was made to be 3 Hz (referring to Riesz [1]) and the carrier frequencies f were 1 kHz, 2 kHz, 4 kHz and 6 kHz. The above measurement was repeated five times per every sensation level for every frequency and the average value was used as an experimental result.

A similar listening experiment was also carried out by a modulation method [2] to obtain the value of DL to frequency. A pure tone, in which the carrier frequency f was modulated by triangular wave with frequency f_p as shown in Fig.2, was radiated in the water tank. The subject listened to the modulated sound in water and checked whether it fluctuates or not. As the judgment becomes ambiguous in the vicinity of DL, the width of fluctuation of frequency change Δf was randomly presented and the relative DL ($\Delta f_{th} / f$) was statistically determined. The carrier frequency of the pure tone was made to be 1 kHz and the modulation frequency f_p was determined to 5 Hz experimentally afterward.

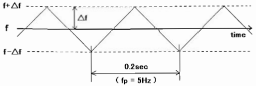

Fig. 2 Frequency change by the modulation method.

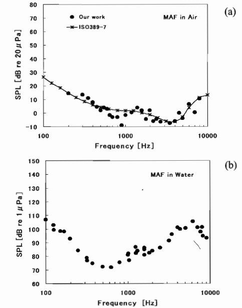

Fig. 3 Minimum audible field (MAF) measured (a) in the air at the anechoic room and (b) in water at the water tank.

3. RESULTS

Minimum Audible Field

Figure 3 shows the MAF for one subject measured (a) in air at anechoic room and (b) in water at the water tank. The MAF, which is also called the threshold value, is the absolute sensitivity of the ear determined as a minimal sound pressure in free space needed to excite a sensation of hearing [5]. The value of MAF in air obtained in the present work is in agreement with the ISO389-7 international standard [11]. Although the thresholds in water have been previously reported [7,10], the measurement frequency of them was limited above 500 Hz. The reporting of threshold in this paper is new data with respect to the fact that it was firstly measured in the wide audible frequency region. There are considerable differences in magnitude of SPL (44 – 64 dB) between air and water even though we take account of the factor of 26 dB (20log20) arising from the difference of the standard in SPL in each medium [9]. Furthermore, it is found that an essential difference occurs in the frequency dependences of MAF. This can be comprehended by a view that bone conduction is a main factor of the underwater hearing rather than air conduction, which is the usual mechanism in air.

Differential Sensitivity to Intensity

Figure 4 shows the relationship between the relative DL ($\Delta I_h / I$)) and the value of $SL = 10\log(I / I_0)$ at 4 kHz for two subjects. Above SL=30dB, $\Delta I_h / I$ shows a constant value in which Weber's law is established [4]. Near SL=0dB, namely, when the sound pressure level approaches the MAF, $\Delta I_h / I$ rapidly increases. The solid line in Fig.4 indicates the equation (3) proposed by Riesz [1] as,

$$\frac{\Delta I}{I} = S_\infty + (S_0 - S_\infty)\left(\frac{I_0}{I}\right)^\gamma \tag{3}$$

where S_∞, S_0 and γ are the parameters depending on the frequency. It is known that this equation represents the experimental results very well in air.

Although there is a scattering in experimental data, it can be said that our results in water (●) are in good agreement with the value in air (solid line). The differential sensitivity to sound intensity in water seems to be almost the same as in air at the same sensation level though the value of MAF is greatly different each other.

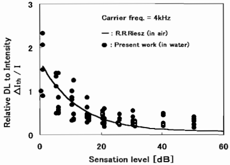

Fig. 4 Dependence of the relative DL to sound intensity $\Delta I_{th} / I$ for the sensation level $SL = 10\log(I / I_0)$.

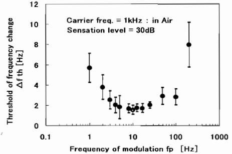

Fig. 5 Dependence of the threshold of difference Δf_{th} for the modulation frequency f_p.

Differential Sensitivity to Frequency

As an audible impression seems to change with increasing the modulation frequency f_p (for example, swing of frequency gradually changes into sideband wave sound and eventually muddy sound), the frequency f_p was determined experimentally as below. We examined the dependence of threshold of difference Δf_{th} for various modulation frequencies f_p at $SL = 40$dB in air. The carrier frequency was 1 kHz around which the tone was varied with frequency f_p. The value of Δf_{th} was determined statistically by randomly carrying out the frequency modulation for the various widths of fluctuations. Results thus obtained are indicated in Fig.5. It is found that the threshold of difference Δf_{th} minimizes when the modulation frequency f_p is 5–10 Hz, that is to say, the modulation frequency around this range is easiest to discriminate. Then, the modulation frequency f_p of 5 Hz was employed in the following experiments.

The experimental results of differential sensitivity to frequency obtained in this study are shown in Fig.6 denoted by (●) in water and by (○) in air. The horizontal axis is the sensation level $SL = 10\log(I / I_o)$ and the vertical one is the relative DL ($\Delta f_{th}/f$). The indicated results in the figure were the mean value of two subjects. The experimental data in air, which have already been published in literature [2,3], were also described in the same figure. The ratio $\Delta f_{th} / f$ has a constant value above 30dB, whereas it increases as the sensation level approaches 0dB.

Our results in air (○) are roughly close to the literature data in air (△: Shower & Biddulph or ◇: Harris) though we cannot compare these results directly from differences of the experimental methods. In water, the relative DL shows almost the same value and similar tendency as in air. Although the value of MAF itself varied with experimental situations, medium or subjects etc, the differential sensitivity to frequency at the same sensation level seems to be almost the same both in water and in air.

4. NUMBER OF DISTINGUISHABLE TONES

We can obtain the resolution of underwater auditory sense from the results of DL to the sound intensity and the frequency. Figure 7 shows the number of distinguishable tones in water in the frequency range from 31 Hz to 16kHz and in the sound pressure level above the MAF. A straight line in the figure is the formal curve of MAF in water derived from our experimental results shown in Fig.3(b). Here, the numbers of each cell were estimated from the results in air [4] assuming that the differential sensitivity of the ear in water is equal to that in air for the same sensation level. In each cell of 1/2 octave in width and 10dB in height, the upper left shows the distinguishable number of steps of sound intensity and the upper right shows the number of frequency steps. Then the bottom of the each cell shows the product of these two numbers, that is, the number of distinguishable tones. Let's use the case of $f = 1$ kHz and $SL = 40$dB as an example. From the present result of relative DL to intensity $\Delta I_{th}/I \cong 0.15$, the number of steps in distinguishable sound among the 10dB from 110dB to 120dB [re 1μ Pa] is $10/[10\log(1+0.15)] \cong 16$. On the other hand, from the result of relative DL to frequency $\Delta f_{th} / f \cong 0.004$ the number of steps in distinguishable sound among the 1/2 octave band from 1 kHz to 1.41 kHz is $410/4 \cong 100$. Then, the total number of distinguishable tones in the cell with 1/2 octave band frequency range from 1 kHz to 1.41 kHz and with 10dB in SPL from 110dB to 120dB is about $16 \times 100 = 1600$, which is close to $17 \times 90 = 1530$ denoted by the shadowed portion in Fig.7. It seems that the sounds around 2 kHz of 170dB are more excellent for differential sensitivity in water and these sounds are more suitable for information transmission to the divers.

5. CONCLUSION

As a part of the research for constructing the underwater transmission system to divers, differential sensitivity of the ear to sound intensity and frequency was examined by listening experiments in the water tank. The value of MAF in water was considerably different from that in air. However, it is found that differential sensitivity to sound intensity and frequency at the same sensation level is almost the same both in water and in air. This implies that the discrimination of the sound intensity and frequency is a phenomenon mainly related to the internal ear both in water and in air. Furthermore, the resolution of auditory sense (i.e. number of steps in distinguishable sound) was estimated in the underwater auditory area from the results in air assuming that the differential sensitivity of the ear in water is equal to that in air for the same sensation level.

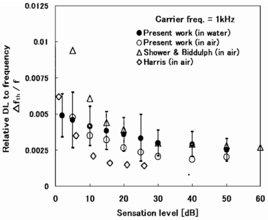

Fig. 6 Dependence of the relative DL to frequency $\Delta f/f$ for the sensation level SL=10log (I/I_0)

It is indispensable to carry out the listening experiments in water to investigate underwater hearing. In practice, however, many difficulties would be encountered for the reasons that audiometric equipment for underwater measurement is needed, diving equipment (SCUBA) for breathing of subjects is necessary, and the background noise from surroundings is unavoidable. Then, it is considered that an estimation by utilizing the experimental procedures or results in air like the present work is one of the effective methods in preparing underwater hearing data barely obtained until now.

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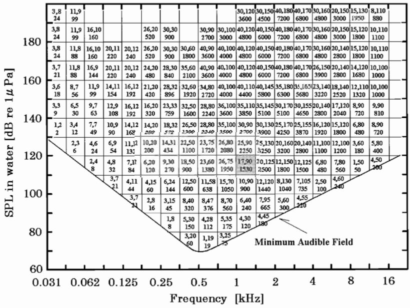

Fig. 7 The number of distinguishable tones in the underwater auditory area

THE MICROFLOWN: AN ACOUSTIC PARTICLE VELOCITY SENSOR

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ABSTRACT: The Microflown is an acoustic sensor directly measuring particle velocity instead of sound pressure, which is usually measured by conventional microphones. Since its invention in 1994 it is mostly used for measurement purposes (broadband 1D and 3D-sound intensity measurement and acoustic impedance). Possible applications are near and far field sound source localization, in-situ acoustic impedance determination and a non-contact method to measure structural vibrations (an alternative for a laser vibrometer). The Microflown, invented only a few years ago, is now commercially available.

1. INTRODUCTION

The search for a reliable particle velocity sensor started about a century ago. These sensors were based on the (single) hot wire anemometer concept. The single hot wire however is not linear, not very sensitive and not very directional [1].

A particle velocity sensor known as the Microflown was invented at the University of Twente in 1994 [2–4]. At first research efforts were aimed at finding construction and calibration methods. Later co-operation with several science groups and industry was established to find applications [5–7]. A few years after its invention, the Microflown became commercially available [11].

2. THE MICROFLOWN SENSOR

The Microflown sensor consists of two closely spaced heated wires. The length of the wires is 1mm, the width is 5mm and the thickness is 200nm platinum, see Fig. 1.

The temperature sensors of the Microflown are implemented as platinum resistors and are heated by an electrical power. An increase of the temperature of the sensors leads to an increase of the resistance as well because of the temperature dependence of their resistance [8,9]. The temperature difference of the two sensors quantifies the particle velocity in a linear manner.

Due to the construction method, micro-mechanics, the sensors are very robust. An assembled ½″ probe (see Fig. 3) for example is much more robust than a regular ½″ pressure microphone.

If no particle velocity is present the sensors have a typical operational temperature of about 300ºC. When particle velocity is present, it alters asymmetrically the temperature distribution.

Due to the operation principle based on the asymmetry of the temperature profile the Microflown can distinguish between positive and negative velocity direction.

There are three types of Microflown sensor elements, the Atlas, the Io and the Titan. The Titan element is optimised for higher frequencies than the Io element, see Fig 5. The Atlas is an element designed for low frequency, infrasonic applications.

Frequency response

The sensitivity of the Microflown decreases at higher frequencies. The first high-frequency roll-off is caused by diffusion effects which can be estimated by a first order low pass frequency response that has a (diffusion or thermal lag) corner frequency (f_d). The second high frequency roll-off is related to the heat capacity (thermal mass or thermal inertia). It shows an exact first order low pass behaviour that has a heat capacity corner frequency ($f_{heat\ cap}$).

The frequency response of a Microflown can be approximated by:

$$output = \frac{LFS}{\sqrt{1 + f^2 / f_{heatcap}^2}\sqrt{1 + f^2 / f_d^2}} \qquad (1)$$

LFS being the low frequency sensitivity, the output signal at frequencies below the thermal diffusion corner frequency.

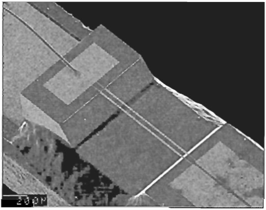

Fig. 1: SEM photo of a Microflown.

The phase response of a Microflown can be modelled by a similar double low pass system:

$$phase = K_1 \tan^{-1}\frac{f}{C_1} + K_2 \tan^{-1}\frac{f}{C_2} \qquad (2)$$

K and C being constants.

Amplitude and phase correction

There are three possibilities to correct for the amplitude and phase response. A dedicated preamplifier can correct both phase and amplitude response (A&P preamplifier). An analyser can be programmed in such way that the response is corrected [11]. It is also possible to store the uncorrected values and post-process the data afterwards.

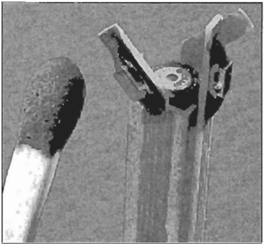

Fig. 2: The sensor part of the USP (it is slightly larger than a match) with the orthogonal orientations of the three Microflowns and the miniature pressure microphone in the middle.

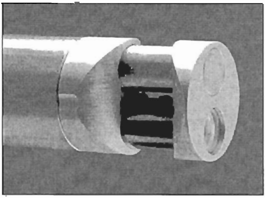

Fig. 3: The ½″ PU probe.

3. REALISATIONS

Three realisations are manufactured standard by Microflown Technologies. Numerous variations on these standards are possible.

The USP, the ultimate sound probe is a ½″ probe that contains three orthogonal Microflowns and a miniature pressure microphone, see Fig 2. It is the most advanced product that enables 3-dimensional broad-band sound (intensity) measurements.

The ½″ PU probe, a half-inch PU probe that contains a Microflown and a miniature pressure microphone, see Fig 3. It is a robust probe that is used for one dimensional sound (intensity) measurements.

The scanning velocity probe is used for example for measuring structural modes being an effective alternative for a laser vibrometer or accelerometer, see Fig 4.

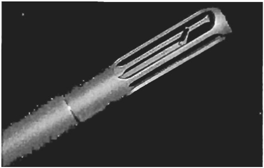

Fig. 4: The scanning velocity probe, the protective mounting can be removed.

4. ACOUSTIC PROPERTIES

With the standard Microflown realisations it is possible to measure broad band sound pressure (*p*) and the vector particle velocity (**u**) at one location and with an ultra miniature sound probe. Apart from the autospectra of sound pressure (S_{pp}) and the autospectra of particle velocity (S_{uu}) derivative acoustic properties are also directly available. *Sound intensity* is determined by the real part of the cross-spectrum: $I=Re(S_{pu})$, *sound energy* is given by: $E=[S^2_{pp}/(2\rho c^2)+½\rho S^2_{uu}]$ and the *acoustic impedance* by: $Z= S_{pu}/S_{uu}$

The *self-noise* of a half-inch Io and Titan Microflown is compared with a regular half inch pressure microphone and is shown in Fig 5. As can be seen at lower frequencies (f<1kHz) the Microflowns are better and at higher frequencies the Io Microflown becomes much worse and the Titan slightly worse. If the Microflowns are packaged with only a protective cap (such as the USP in Fig 2) the self-noise increases approximately 9dB.

The self-noise of the half inch Io PU intensity probe (the real part of the cross spectrum of p and u) is shown in Fig. 6. For comparison the threshold of hearing is put inside the figure as well: if one can hear the sound the Io PU intensity probe can detect it. The Titan probe performs better at higher frequencies than the shown Io probe.

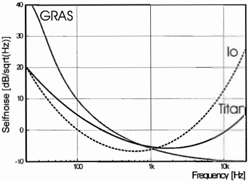

Fig. 5: Self-noise of a half inch packaged Io Microflown (dashed), a half inch packaged Titan Microflown (black line) and for comparison a regular half inch pressure microphone (GRAS 40AC, gray line).

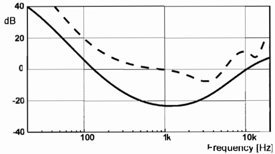

Fig. 6: Solid line: noise level of a half inch p-u Io sound intensity probe in dB SIL (re. 1pW)/√Hz.. Dashed line: threshold of hearing in dB SPL.

Polar pattern. Since the Microflown is sensitive to particle velocity, a vector value, the polar pattern (the directionality of sensitivity) has a full bandwidth cosϕ shape or a figure of eight response. Packages do not influence the polar pattern.

5. CALIBRATION

Several calibration methods to determine the frequency response of the Microflown have been tested over the years. Two methods came out best: an anechoic calibration and a standing wave tube (SWT) calibration [4,16,18] The SWT method is used for lower frequencies (10Hz–4kHz) and the anechoic calibration is used for higher frequencies (1kHz–20kHz). The anechoic calibration is well known and the SWT will be explained below.

The air in the tube is excited by a loudspeaker with amplitude *U* at the left-hand end and is terminated by a rigid boundary at the right hand end, see Fig 7.

The ratio of the particle velocity (uprobe=u(x)) and the sound pressure at the end of the tube is given by:

$$\frac{u_{probe}}{p_{ref.}} = \frac{i}{\rho c}\sin(k(l-x)) \qquad (3)$$

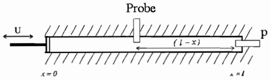

Fig. 7: A tube that is rigidly terminated at $x=l$ and in which the fluid is driven by a loudspeaker at $x=0$.

The relation of the particle velocity and the reference sound pressure at the end of the tube turns out to be a simple sine function, see Fig 8. The phase shift between them equals plus or minus 90 degrees.

The phase response of the Microflown can also be determined in a standing wave tube, see further [16].

PVL is the abbreviation of particle velocity level that has a reference of 50nm/s. In a plane wave a certain PVL in dB corresponds to the same amount number of SPL (re. 20μPa) in dB.

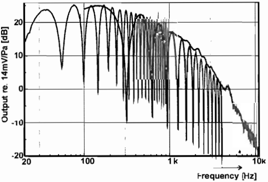

Fig. 8: Amplitude response of ½" Io probe relative to a pressure microphone with a sensitivity of 14mV/Pa. In a large (8m/16cm) standing wave tube (grey line, 20Hz-1kHz), in a short (75cm/4,5cm) standing wave tube (black line, 100Hz-4kHz) and in a small (1m³) anechoic room (grey line, 1kHz-12kHz).

Because of the materials choice (platinum and silicon) and the measurement method (differential temperature detection), the sensitivity of the Microflown is quite stable. The sensitivity deviation of a random picked ½" Microflown is in the order of 1dB.

The Microflown is sensitive to velocity (m/s) and not pressure (Pa). Therefore the sensitivity of a Microflown cannot be given in mV/Pa. To be compatible with pressure microphones we choose to express the sensitivity of a Microflown in mV/Pa*. The unit Pa* (velocity-Pascal) is the equivalent particle velocity for sound pressure in a plane wave: 1Pa*=1Pa/ρc=2.2mm/s particle velocity.

6. APPLICATIONS

Realisations of the Microflown are used in many applications. Apart from obvious applications like 1D and 3D broadband (20Hz-20kHz) sound intensity measurements [5,10,16] other will be presented here.

The first application, *a simple, fast and high resolution method for near-field sound source localisation* will be explained by an example [13,14], see Fig 9. A loudspeaker is put inside a 30cm by 20 cm rigid box with a small (20mm) hole in the front allowing sound to propagate.

Sound pressure is measured around the area of the hole (Fig 9A). The particle velocity measured in the direction of the box shows much more focussing (Fig 9B); a better source localisation is possible. The sound intensity perpendicular to a noise source is zero at the position of the source and the sign of the intensity alters when moving around the source (Fig 9C and D); this information locates the source very accurately. The USP is the most suitable probe for this method.

Far-field sound source localisation is possible by simply measuring the 3D sound intensity with an USP. However more advanced techniques are possible. From the cross spectrum of two orthogonal Microflowns more directional information can be derived, see further [12,13,15].

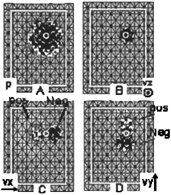

Fig. 9: Very near field sound source localisation.

In-situ impedance determination. The USP is able to measure both broadband the sound intensity vector (**I**) and sound energy (*E*) at the same time. When measured near to a surface and a sound source is aiming at this surface, the sound intensity is zero when the surface is fully reflecting. If the surface is absorbing, the intensity is dependent on the absorption and the level of the sound source. When the ratio **I**/*cE* is measured (with *c* the speed of sound) the value will be 1 if the surface is fully absorbing and 0 when it is fully reflecting [17].

Measurement of structural vibrations [11]. Very near (in the order of 5mm) to a vibrating surface the particle velocity of the surface equals the particle velocity of the sound field. The scanning velocity probe can be used to measure the particle velocity (contactless) and can therefore be used as an *alternative for a laser vibrometer*. Unlike a laser vibrometer, the Microflown is capable of: analyzing velocities in three dimensions around so-called non cooperative materials such as damping materials, foam, rubber, other black surfaces, scattering surfaces, airborne sound.

The three-dimensional impulse response can easily be measured with the USP but also other properties that relate to the time domain, like reverb time, speech transmission index, echo criteria and so on [11].

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VOCAL TRACT RESONANCES: A PRELIMINARY STUDY OF SEX DIFFERENCES FOR YOUNG AUSTRALIANS

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Abstract: We report direct measurements of the first two resonance frequencies of the vocal tracts of young women university students producing the vowels of Australian English. The resonances are determined from the response of the tract to a broad band, external, acoustic source. From these data we construct a vowel resonance map for these Australian women and compare it with the corresponding data for a sample of young Australian men, also university students.

1. INTRODUCTION

Each vowel sound in a language or dialect is characterised by a set of formants, which are broad maxima of acoustic power in the speech spectrum [1,2]. These formants are produced by resonances of the vocal tract, which in turn depend on its geometry, including the height of the jaw and the position and shapes of the tongue and lips. A plot that locates each vowel by the frequencies of the two formants or resonances with the lowest frequencies is called a vocal plane or vowel map. The formant frequencies of Australian English have been measured for male speakers [3,4]) and female speakers [5-7]. For reasons that we explain below, formants are more difficult to measure objectively in women than in men. Furthermore the precision of measurements can be improved considerably if the resonances of the tract rather than the formants of speech are measured. Recently the vocal tract resonances have been measured directly for a sample of young Australian men, who were students at the University of New South Wales in Sydney [8]. Here we measure directly, for the first time, the vocal tract resonances for vowels in Australian English as spoken by young Australian women. The sample was taken from students at the same university.

We begin with a brief overview of the source-filter model of voiced speech. In this model [1] (see Figure 1), the vibration of the vocal folds produces a periodic, harmonic-rich signal at the fundamental frequency f_o. This signal is transmitted to the radiation field outside the mouth by the vocal tract, which has a frequency dependent gain. Resonances of the vocal tract produce peaks in the gain spectrum that in turn give rise to maxima in the envelope of the speech spectrum. The broad peaks in the output sound spectrum are called formants. For non-nasalised speech, the human vocal tract may be approximated as a tube that is nearly closed at the glottis or vocal folds and open at the mouth. The radiated power of speech is increased (all else equal) when the tract acts as an impedance matcher from the low acoustic impedance of the radiation field at the mouth to the higher impedance at the glottis: in other words, for resonances with a pressure anti-node near the glottis and a node near the mouth. If the vocal tract were a tube of length L with uniform cross section, these resonances would occur at wavelengths $\lambda \cong 4L$, $4L/3$, $4L/5$ etc. Taking $L \sim 170$ mm, the resonance frequencies would be approximately 500, 1,500, 2,500 Hz, etc. (In fact a tract pronouncing the vowel [ɜ] as in "heard" has resonances at approximately these frequencies.) However, changing the shape of the tract varies considerably the frequencies of the resonances.

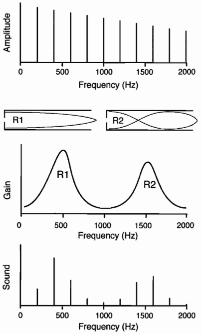

Figure 1. The source-filter model for voiced speech. The harmonic-rich signal from the vocal folds (top) is transmitted to the radiation field (bottom) via the tract. The tract most effectively matches the impedance at its resonances. The middle sketch represents the tract as a uniform cylinder and shows the pressure amplitudes. In practice, the resonance frequencies are modified by moving the jaw, tongue and lips.

The frequency *R1* of the first resonance is determined largely by the height of the jaw and thus the mouth opening. (As a tube is increasingly flared at the open end, the lowest resonance frequency rises, and the spacing of resonances is decreased.) The frequency *R2* of the second resonance is more strongly determined by the position at which the tongue constricts the mouth (high for tongue constriction forward and conversely). In languages (such as English and other European languages) that do not use lexical tone, *R1* and *R2* largely determine the vowel sound, while *R3* and *R4* mainly carry information characteristic of the speaker.

The vocal folds vibrate at a fundamental frequency f_o, which is typically in the range 80 to 200 Hz for men and about 150 to 300 Hz for women. f_o is also the spacing between harmonics in the speech sound. It is this spacing that limits the resolution in determination of the formants — the peaks in the spectral envelope — and which consequently makes determination of formants for women in general less precise than for men. Signal processing algorithms for determining the formants require parameters input by the experimenter, and when precisions substantially smaller than f_o are sought, the values of these parameters affect the values of formants measured. Fig 1 illustrates the difficulty of obtaining precise values of the formant frequencies when the harmonics are spaced by an f_o of 200 Hz, typical of women's speech. In this study, we overcome this problem by employing an external source of acoustic current at the mouth to excite the vocal tract while the subjects phonate. This allows determination of the resonances of the tract with a typical resolution of ± 10-20 Hz [8].

2. MATERIALS AND METHODS

The method is an adaptation of one described previously [8-10]. Briefly, a computer (Macintosh IIci) uses a analogue/digital card (National instruments NB-A2100) to synthesise a waveform as the sum of sine waves with frequencies from 200 to 4,500 Hz, with a spacing of 5.4 Hz. This waveform is amplified and passed to a loudspeaker that is matched via an exponential horn to a pipe of inner diameter 6 mm. The end of this pipe, filled with acoustic absorbing material, is an acoustic current source, whose characteristic output impedance is about 16 GPa s m^{-3} or 16 GΩ. This source is placed vertically so that the end of the pipe just touches the subject's lower lip. A microphone (8 mm diameter), whose signal is recorded by the same A/D card and computer, is attached to the end of the pipe.

For each subject, a calibration procedure is conducted, during which the amplitudes of the individual sine waves are adjusted so that the microphone signal measured with the subject's mouth closed is independent of frequency. During this calibration, the acoustic pressure p_{cal} at the microphone is $u_{cal}Z_{rad}$, where u_{cal} is the acoustic current and Z_{rad} the impedance of the radiation field at the (closed) mouth, as baffled by the subject's face. (The disturbance of the radiation field by the presence of the source and microphone shifts the measured resonance frequency by 11 Hz or less, which does not exceed the precision of the measurements.) Because of the high output impedance of the source, the current produced during a measurement is almost identical to that produced during calibration. During phonation, the microphone signal is the sum of that due to the subject's voice (which consists of harmonics of f_o) and that produced by the interaction of the injected acoustic current with the subject's vocal tract. The acoustic impedance of the subject's tract Z_{tract} is in parallel with Z_{rad}, so the broad band component of the acoustic pressure is thus $p_{meas} = u_{cal}Z_{rad}Z_{tract}/(Z_{rad} + Z_{tract})$. We plot the ratio γ of the microphone signals for measurement and calibration. For the broad band component of the signal, this yields

$$\gamma = \frac{p_{meas}}{p_{cal}} = \frac{Z_{tract}}{Z_{rad} + Z_{tract}} = \frac{1}{1 + Z_{rad}/Z_{tract}}$$

Making the assumption that the frequency variation of Z_{rad} is much less than that of Z_{tract}, γ has maxima when Z_{tract} has maxima.

The subjects were nine Australian women, aged from 18 to 20, who were first year physics students at the University of New South Wales in Sydney. Their data are thus suitable for comparison with those for males [8]. All had been born in Australia or had lived in Australia for longer than seven years and were recognised by the investigators as having unremarkable Australian accents. The vowels were presented in a /h_d/ or /h_t/ context. The words used (with phonetic vowel symbols in brackets) were "heed" [i], "hid" [ɪ], "head" [ɛ], "had" [æ], "hard" [ɑ], "hot" [ɒ], "hoard" [ɔ], "hood" [ʊ], "who'd" [u], "hut" [ʌ] and "heard" [ɜ]. They were asked to pronounce and to sustain the each of the words for four seconds, whilst each measurement was made. The series was then repeated.

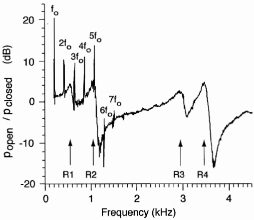

Figure 2. The ratio of the spectra measured with the mouth open to that with the mouth closed (p_{open}/p_{closed}) for the vowel /ɒ/ (in "hot"). Several harmonics of the voice signal with fundamental frequency f_o = 215 Hz can be seen. The maxima in the broad band signal corresponding to the resonances R1, R2, R3 and R4 are indicated by arrows.

3. RESULTS AND DISCUSSION

Figure 2 shows the magnitude of the measured ratio $\gamma = p_{meas}/p_{cal}$ for one of the subjects pronouncing the vowel [ɒ] in "hot". The narrow peaks are the harmonics of the fundamental $f_o = 215$ Hz. The broader peaks in the broad band signal at about 550, 1050, 2950 and 3450 Hz are due to the resonances of the tract. (In this example, note how the first resonance is more easily identified than the first formant.)

Figure 3 shows *R1* plotted against *R2*. (Plots of *F1 vs F2*, with axes inverted, are traditional in acoustic phonetics because phoneticians have traditionally plotted jaw height vs position of the tongue constriction.) The relative positions of the vowels are similar to those in the comparable resonance plot for young Australian men [8]. The relative positions are also similar to those reported for the formants of Australian English [5]. Apart from the intrinsic differences between resonances and formants, we measured sustained vowels in this study, whereas Cox [5] measured them in normal speech. The substantial overlap between "hard" [ɑ] and "hut" [ʌ], and between "heed" [i] and "hid" [ɪ] may seem surprising until one realises that these pairs are usually distinguished in normal speech by duration. The data are also included in the Table.

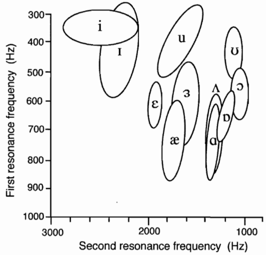

Figure 3. The distribution of (R2,R1) for the vowels of English as spoken by this sample of young Australian women. The centre of each ellipse is the mean of (R2,R1). The slope of the major axis indicates the regression of R2 on R1, and the semiaxes are the standard deviations in those directions.

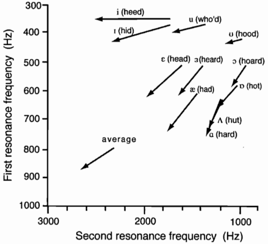

Figure 4. The displacement of the average resonance data for women reported herein from those reported for Australian men [8]. The displacement averaged over all vowels is also indicated.

In all cases, the frequencies *Ri* for the female subjects were higher than those for males, except for *R1* in "heed" [i]. Figure 4 shows that the average displacement of women's from men's data is thus approximately away from the origin of the vowel plane. The average value of the increase in *R* for the women's data was 12% (65 Hz) for *R1* and 20% (290 Hz) for *R2*. The displacements are comparable with the average increases in reported formant frequencies for Australian English (20% in *F1* and 15% in *F2* [5]) and Greater American English (16% in *F1* and 25% *F2* [11]). One possible explanation for the difference is a difference in the average lengths of male and female vocal tracts. However, social effects may be important, too, and people may learn to produce the resonances appropriate for their sex and f_o: a person with a relatively long vocal tract could readily raise *R1* and *R2* for each vowel simply by opening the mouth and advancing the tongue by a small amount.

Table. The mean and standard deviation for the resonant frequencies of the vowels spoken by Australian university students, male and female.

vowel	/i/	/ɪ/	/ɛ/	/æ/	/ɑ/	/ɒ/	/ɔ/	/ʊ/	/u/	/ʌ/	/ɜ/
word	heed	hid	head	had	hard	hot	hoard	hood	who'd	hut	heard
R1 female	350±60	420±80	600±60	730±110	740±130	650±70	570±70	430±70	390±80	710±100	600±40
R1 male	350±40	370±50	510±50	610±60	630±60	590±60	510±50	420±40	370±50	630±60	510±40
R2 female	2490±390	2300±250	1930±90	1740±150	1330±70	1200±100	1060±110	1110±120	1670±250	1300±130	1620±160
R2 male	1730±200	1720±170	1610±120	1440±120	1200±110	1030±80	940±130	980±210	1350±230	1180±140	1380±90

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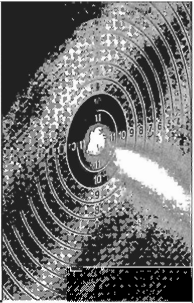

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RAILWAY BONUS FOR SOUNDS WITHOUT MEANING? *

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ABSTRACT. At same A-weighted energy-equivalent level, railway noise frequently is preferred to road traffic noise. This effect often is called railway bonus. Among possible reasons for the railway bonus, differences in spectrum, time structure, and meaning of sound are discussed. In order to largely "neutralize" the meaning of sound, a procedure was proposed as follows: the sound, e.g. railway noise, is analyzed by Fourier-Time-Transform (FTT) and – after spectral broadening – re-synthesized by inverse FTT. The procedure has the advantage that the loudness-time functions of original and neutralized sound are identical, but the meaning of the sound is removed. In psychoacoustic experiments, for original sounds of railway versus road traffic noise, a railway bonus could be ascertained. If for the same sounds, when deprived from their meaning, also a railway bonus would show up, then the meaning of sound would contribute to the railway bonus much less than differences in spectrum and/or time structure. If, on the other hand, the meaning of sound would be a dominant factor for the railway bonus, with neutralized sounds no railway bonus should show up. Results of corresponding psychoacoustic experiments are reported and discussed in view of the psychophysical method used.

1. INTRODUCTION

At same A-weighted energy equivalent level, railway noise is frequently preferred to road traffic noise. This effect often is called railway bonus (Möhler 1988 [11], Fastl et al. 1994 [4]). Among possible reasons for the railway bonus differences in spectrum, time structure and meaning of sound are discussed (Fastl et al. 1996 [5]). Spectral differences between road noise and rail noise at low frequencies can account for part of the railway bonus: the low frequency components of road noise are strongly attenuated by A-weighting. However, these components contribute to the loudness of road noise and therefore, despite same A-weighted level, road noise can be perceived as being louder than rail noise (Fastl 1996 [1]). The temporal structure of rail noise with long pauses between events also could contribute to its preference over road noise, in particular for busy roads with densely packed events.

A third alternative put forward in the literature as a possible cause of the railway bonus would be nostalgic feelings evoked by (howling) train sounds, leading to a preference of railway noise. This hypothesis was assessed as follows: a procedure was used which largely can "neutralize" the meaning of sound. Despite the fact that the loudness-time functions of original and neutralized sound are identical, the meaning of the sound is removed, i.e. the sound source can no longer be recognized.

In this paper, results of experiments are reported, in which original sounds as well as neutralized sounds were evaluated with respect to overall loudness or by a method of semantic differential. The results will be discussed in view of the following two questions:

(1) whether for neutralized sounds also a railway bonus shows up, and
(2) whether the recognition of specific sound sources like railways may influence the judgements.

2. EXPERIMENTS

Eight subjects with normal thresholds of hearing and an age between 24 and 58 (median 25) years participated in the psychoacoustic experiments. Sounds were presented in an anechoic chamber over a loudspeaker (Klein & Hummel O96) 1.5 meters in front of the subjects. Subjects were tested one after the other. Sounds presented had a duration of five minutes and were typical examples for noise emissions from road traffic noise or railway noise. Both sounds had the same energy equivalent A-weighted level of 55 dB(A).

In order to remove the meaning of the sounds, a procedure was used as follows (Fastl 2001 [2], Fastl 2002 [3]): The noise emissions of five minutes duration were spectrally analysed by an FTT procedure (Terhardt 1985 [12]), and — after spectral broadening – were re-synthesized by inverse FTT. The corresponding procedure is illustrated in figure 1.

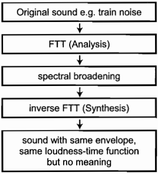

Fig. 1: Block diagram illustrating the procedure to neutralize the meaning of sound.

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* *Originally presented at WESPAC8, Melbourne, April 2003*

In this way, sounds were produced which have the same loudness-time function as the original sounds, but the information about the sound sources is removed (Fastl 2001 [2]). In essence, the neutralized sounds can be compared to amplitude modulated broadband noise.

With the four sounds of five minutes duration each, the following experiments were performed: (1) judgement of overall loudness by category scaling (Kuwano and Namba 1985 [8], Fastl et al. 1989 [6]); (2) evaluation by the method of semantic differential (Kuwano et al. 1997 [9]). Since both methods are described in the literature, for details the reader is referred to the references given.

3. RESULTS

Figure 2 shows the results obtained by category scaling of overall loudness. Seven categories from very soft to very loud are used. Filled symbols denote loudness judgements for road traffic noise, open symbols indicate loudness judgements for railway noise. Squares illustrate loudness judgements for original sounds, rhombs loudness judgements for neutralized sounds.

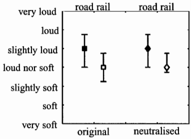

Fig. 2: Judgement of overall loudness for road traffic noise versus railway noise of five minute duration each with L_{Aeq} = 55 dB(A). Filled symbols: road traffic noise, unfilled symbols: railway noise. Squares: original sounds, rhombs: neutralized sounds.

The data displayed in figure 2 clearly show that despite the same A-weighted energy equivalent sound pressure level of 55 dB(A), railway noise is judged softer than road traffic noise (c.f. unfilled versus filled square). This result is in line with the concept of "railway bonus". When the meaning of the sounds is neutralized (rhombs), also a railway bonus shows up, i.e. the neutralized sound derived from road traffic noise is judged louder than the neutralized sound derived from railway noise. Since the original sounds and the neutralized sounds show the same loudness-time function, but for the neutralized sounds the sound sources can no longer be recognized, the results displayed in figure 2 could be interpreted as follows: the loudness differences seem to be the main cause for the railway bonus and the meaning of sounds, e.g. the nostalgic feelings connotated to railway noise seems to be less important.

In order to get more detailed information about possible reasons for the railway bonus, noise emissions of five minute duration were evaluated by the method of semantic differential. A list of adjectives was chosen, which had been successfully used in an international study (Kuwano et al. 2000 [10]).

Figure 3 gives the results for the original sounds. Filled squares indicate data for road traffic noise, unfilled squares show results for railway noise. From the data displayed in figure 3 it becomes clear that in comparison to railway noise, road traffic noise is louder, more frightening, more dangerous, more powerful, etc. This result could be interpreted in favour of a "railway bonus".

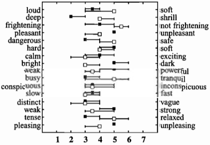

Fig. 3: Semantic differential for road traffic noise (filled squares) versus railway noise (unfilled squares).

Figure 4 gives the results for the corresponding neutralized sounds. Data for neutralized road traffic noise are indicated by filled rhombs, results for neutralized railway noise by unfilled rhombs. As for the original sounds, in comparison to the neutralized railway noise, the neutralized road traffic noise is louder, more frightening, dangerous, powerful etc.

These results indicate that also for neutralized sounds, a railway bonus shows up. Moreover, at first sight, these data could be interpreted that the meaning of sound does not influence the railway bonus.

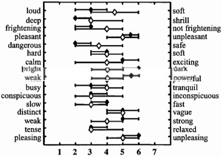

Fig 4: Semantic differential for neutralized road traffic noise (filled rhombs) versus neutralized railway noise (open rhombs).

Table I enables a closer inspection of the data. For both original and neutralized sounds, the statistical significance of the differences between road traffic noise and railway noise are given.

	original	**neutralized**
	road vs. rail	**road vs. rail**
loud/soft	**0.0185**	**0.0234**
deep/shrill	**0.0000**	**0.0017**
frightening/not frightening	**0.0197**	**0.0314**
pleasant/unpleasant	**0.0004**	0.1796
dangerous/safe	**0.0006**	**0.0298**
hard/soft	0.1400	0.1808
calm/exciting	**0.0147**	**0.0124**
bright/dark	**0.0000**	**0.0006**
weak/powerful	**0.0002**	**0.0002**
busy/tranquil	**0.0039**	**0.0145**
conspicuous/inconspicuous	0.9343	1.0000
slow/fast	0.2572	0.1742
distinct/vague	0.2268	0.4466
weak/strong	**0.0010**	**0.0004**
tense/relaxed	**0.0009**	0.1099
pleasing/unpleasing	**0.0001**	0.2373

Table I: Analysis of the statistical significance of differences between road traffic noise and railway noise for original sounds as well as neutralized sounds. Statistically significant differences ($p<0.05$) are given in bold.

The data displayed in Table I suggest the following conclusions: For both original sounds and neutralized sounds, road traffic noise produces statistically significant larger values than railway noise for the adjectives *loud, deep, frightening, dangerous, exciting, dark, powerful, busy, strong.*

Both original and neutralized sounds show no statistically significant differences between road traffic noise and railway noise for the adjectives *hard, conspicuous, slow, distinct.* Most interesting are the adjectives *pleasant, relaxed, pleasing*, which indicate a statistically highly significant difference ($p<0.001$) between road traffic noise and railway noise for the original sounds, but *not* for the corresponding neutralized sounds ($p>0.10$). These results can be interpreted that the loudness of sounds represents a dominant feature for the description of the railway bonus. However, some influence of the meaning of the sound source cannot completely be ruled out, since for the original sounds, where the sound sources rail versus road are easily recognized, there is a statistically significant difference with respect to the pleasantness of the sounds. If however, the sounds are neutralized, the differences in pleasantness disappear. In essence this means that the recognition of a railway as a sound source may contribute to some extent to a better rating.

4. CONCLUSION

The results of the experiments described in this paper clearly indicate that differences in loudness of sounds with same A-weighted energy equivalent level constitute a main reason for the railway bonus (cf. Fastl 1996 [1]). This holds true for both original sounds and neutralized sounds. Moreover, this conclusion is reached by the evaluation of overall loudness as well as by the method of semantic differential.

However, data from the latter method also indicate that some differences in the pleasantness of road traffic noise versus railway noise may play a role. In other words, some effects of the image of the sound source with respect to the railway bonus are possible. Hellbrück et al. (2002 [7]), when comparing original with neutralized sounds, also reported data, which point in a similar direction.

In conclusion then, some influence of the image of the sound source on the railway bonus may be possible. However, further experiments are necessary to explore the magnitude of these influences in detail, in particular in comparison to the dominant loudness differences.

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THE STATISTICAL ESTIMATION OF THE ATTENUATION OF IMPULSE PEAK LEVELS WITH RESPECT TO DISTANCE

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ABSTRACT: This paper presents a summary of experimental work carried out on impulsive noise propagation over distances up to 3.2 kilometers. The average attenuation of the maximum peak level (MAXP) is examined with respect to distance for all times of day and widely varying geographical and meteorological conditions. Formulae for predicting impulse attenuation are derived from the data using both spherical spreading and a curve of best-fit method. Possibly more important is the fact that the MAXP levels measured at any one location can lie over a wide range for example, up to 50 dB at 3.2 km. This has important implications for the prediction of annoyance and indicates that more consideration should be given to the statistical spread of results derived from experimental work.

1. INTRODUCTION

The propagation of peak impulse levels over distances in the order of a few kilometers can be very difficult to predict given the varying conditions of topography, terrain and weather. Many attempts have been made using basic ray trace methods[1], sophisticated computer models[2,3 ,4,5] and more recently statistical methods[8,9]. Of each of the techniques, the statistical methods seem to be more applicable in the field particularly with respect to impulse noise estimation. The prediction of peak levels is becoming a particular problem where urban areas are starting to encroach on locations that may have initially been considered remote in character, for example quarries on the outskirts of large country towns or cities.

There are many commercial noise prediction packages available that deal with predicted levels of noise from sources such as road traffic, industrial plant and other continuous noise operations. These will not be discussed here. The particular problem this project addresses is maximum peak impulse noise level (MAXP) during propagation. Specifically we address the impulse noise that originates from a source that commences as a shock wave from an explosion. The waveform of the impulse changes markedly during its propagation, with the most notable change being due to the rapid attenuation of the higher frequencies (this aspect of the study is not presented here as it is the subject of specific study and further analysis).

For this sort of environmental noise work what is often required in practice is not an 'accurate' prediction of noise levels but a range of possible noise levels that may be encountered over an extended period. This period will usually cover many and varied meteorological conditions and different times of day and night. These predictions may be required for operations from quarries located near urban areas, military test ranges and construction sites. The interest is in the annoyance these impulses have on the community and in many cases the specific noise level is of only secondary importance.

A brief report of a preliminary analysis of this data was presented in 1992[10,11] at a very basic level.

2. EXPERIMENTAL METHOD

The data was collected over an extended period from 1989 until 1991 from a series of seven field trips. The field trips consisted of eight days of measurements at each visit to each location.

Propagation is known to be greatly affected by meteorological and atmospheric conditions[1,5,14]. For this reason experimental measurement times were oriented over eight-hour periods that spanned sunrise and sunset as this covers the period when atmospheric conditions change most rapidly. For example if sunrise was at 6:30 am testing would commence around 4:00 am and conclude around mid-day. Afternoon measurements would commence around 2:00 pm and conclude around 10:00 pm.

An 'impulse' noise source was devised using a 125 gm mass of high explosive (Tovex, Powergel, Energex or similar). The explosive was located in an area of open ground and suspended on an open frame approximately two metres above the ground such that there was no impediment to propagation of the blast noise in any direction above ground level. The ground below the frame usually consisted of hard packed earth. Impulses were provided at the rate of about ten per hour.

Four manually operated recording stations were positioned at distances of 100 m, 800 m, 1,600 m and 3,200 m. The stations were positioned on a single radius from the source usually along a common access road. Each station had the capacity to store the Maximum Linear Peak Level (MAXP) of the impulse along with a record of the impulse waveform when it arrived at the site.

While local meteorological data could be obtained at each measurement location the overall meteorological conditions were monitored by the release of radiosonde balloons. The control and release of balloons and the recording of data from the radiosonde flights were co-ordinated by a meteorological unit from the School of Artillery of the Australian Army. The flight release point was located near but at a 'safe' distance from the impulse noise site.

The experimental sites were chosen from various locations around Australia and all, except for that at Bernacchi in the Central Highlands of Tasmania, were on military firing ranges. Sites were selected to represent different climactic zones ranging as far as practicable over as wide as possible Australian conditions from Northern Queensland to Central Tasmania. Military ranges were chosen as the Department of Defence was the main sponsor of the research and such areas have no difficulties with the use of explosives as impulse sources.

The Table 1 summarises the sites and the true direction of the measurement radius at each site. The site at Bernacchi was utilised twice, once in summer and once in winter.

Table 1. Summary of experimental site locations and propagation directions.

Summary of propagation directions (relative to geographical north)	
Innisfail, QLD	232°
Singleton, NSW	243°
Holsworthy, NSW	222°
Woomera, SA	184°
Port Wakefield, SA	0°
Bernacchi, TAS (x2)	143°

Thus while the propagation directions were not truly random they were only constrained by access and no other criteria.

The topography of the sites varied from rolling hills (Central Tasmania) to fairly flat (Port Wakefield and Woomera SA). Ground cover varied over all possibilities from dry, open grass with occasional trees to damp, muddy ground with snow patches and dense trees.

3. RESULTS

The results are presented in a 'concise' form and not in any way divided into regions, seasons or meteorological conditions (the subject of much more extensive studies carried out by NAL[6,7,10,12]). The data taken at altitude from the radiosonde flights are not reported here.

One of the objectives was to measure over the widest possible variation in meteorological conditions and hence give the widest range in impulse noise levels.

Meteorological data summary

Temperature – ground temperatures were in the range –5°C to +35°C.

Relative humidity – fell in the range of approximately 20% to 100%. Measurements were ceased when precipitation was such that equipment could be damaged. Otherwise measurements were carried out in reasonably damp conditions.

Wind direction and speed – Wind conditions varied over the complete spectrum in speed, from calm to very windy conditions, and direction, from 'up wind' to 'down wind' conditions. The only limitation was that measurements were unable to be carried out with wind speeds greater than 10 ms^{-1}. Various types of windshields were trialed for the receiving microphones used in the study until one particular type was found to be most satisfactory. This was a NAL (unpublished) design and in principle consisted of a square cross-section of side approximately 1.5m with an overall height of approximately 2.5m with an open top. A standard 200mm diameter, foam windscreen was also mounted directly on the microphone.)

The criteria for a satisfactory windshield was based on the impulse noise source reliably triggering the recording equipment (type 1 instrumentation with 'impulse' response time), while noise from the wind effects was ignored. The most critical position was the measuring location at 3,200 m as it usually had the lowest MAXP, although this was not always the case.

Acoustic data summary

In total there were about 2,500 impulse shots fired. However, not all of the shots provided data for all measurement locations at all times. The data was analysed statistically and a summary is provided in Table 2 below and illustrated in Figure 1. All data was normally distributed.

One point to note is that the minimum MAXP of 66.5 dB noted at the 3,200 m position does not necessarily imply that there were no MAXPs below this value. Under certain circumstances lower values of the MAXP at this position could be heard but were unable to be measured as they were effectively masked from the instrumentation by the background noise levels. Points that were uncertain and could not be positively identified were excluded from the study.

Table 2. Summary of average MAXP values against measurement distance.

Summary of the maximum peak level data					
Measurement Distance *d*	Average MAXP and standard deviation (σ) (dB)	Maximum MAXP (dB)	Maximum MAXP (dB)	No of valid data points N	95% Confidence Interval (dB)
100m	140.0 (1.8)	147.5	131.3	2103	(137.144)
800m	114.0 (5.1)	132.9	89.6	2148	(104,124)
1,600m	104.7 (7.4)	124.5	79.9	2147	(90,119)
3,200m	94.0 (8.9)	116.5	66.5	2035	(77,111)

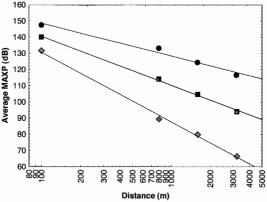

Figure 1 Average MAXP level (dB) with respect to distance (m) including upper and lower limits of MAXP: eqn 1 (square); eqn 2a (circle); eqn 2b (diamond)

The approximate relationship between MAXP and distance d, illustrated in Figure 1, can be written as:-

$$\text{MAXP (dB)} = 200 - 30 \log_{10} d\ (m) \quad (1)$$

Figure 1 also shows the approximate upper and lower limits of MAXP as given by equations (2a) and (2b).

$$\text{Upper limit of MAXP (dB)} = 189 - 20 \log_{10} d\ (m) \quad (2a)$$

$$\text{Lower limit of MAXP (dB)} = 217 - 43 \log_{10} d\ (m) \quad (2b)$$

4. DISCUSSION

A comparison of the results with the free field attenuation rate of 6 dB per doubling of distance, suggested by the inverse square law in free space, and that proposed by Embelton2 of 6 dB per doubling of distance plus 3 dB per kilometer to take account atmospheric absorption, shows that neither are satisfactory with respect to the measured data. This comparison is summarised in Table 3 and illustrated in Figure 2.

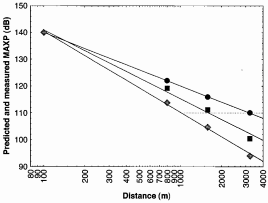

Figure 2 Predicted and measured values of MAXP (dB) with respect to distance (m) showing the 6 dB/doubling of distance (circle); 6 dB/doubling of distance + 3 dB/kilometer (square); and average measured values of MAXP (diamond)

All of the predicted values are greater than the average measured values, showing that the average attenuation is greater than that expected from simple spherical spreading including an absorption factor of 3 dB/kilometer.

The average attenuation of the MAXP with respect to distance is summarised in the last row of Table 4 and in Figure 3.

It can be calculated that for the data obtained the attenuation of MAXP, relative to the MAXP value at 100 m, with respect to distance can be reasonably approximated by the equation:-

$$\text{Attenuation of MAXP (dB)} = 27.6 \log_{10} (d/100) + 0.0014(d - 100), \quad (3)$$

where d is expressed in metres (see Figure 3, full curve). This represents an average attenuation of 8.3 dB/doubling of distance with an absorption rate of 1.4 dB/kilometer.

The closest approximation that can be drawn in terms of spherical spreading is a curve with 6 dB/doubling of distance and an absorption rate of 5.8 dB/kilometer. This curve is also

Table 3 Comparison of measured average MAXP and suggested predicted values at measurement distances

Attenuation conditions	Average MAXP (dB) measurement at distance			
	100 m	800 m	1,600 m	3,200 m
6 dB/ doubling of distance	140.0*	122.0	116.0	110.0
6 dB/doubling + 3 dB/kilometer	140.0*	119.6	111.2	100.4
Measured values	140.0	114.0	104.7	94.0

Note: * *value taken as reference*

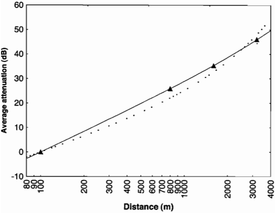

Figure 3 Line of best fit for the attenuation of MAXP (dB) and spherical spreading approximation for attenuation of MAXP including an absorption factor of 3 dB per kilometer with respect to distance (m): eqn 1 (full line), eqn 2 (dashed line)

illustrated in Figure 3 (dashed curve), and can be expressed as:-

Attenuation of MAXP (dB) =

$$20 \log_{10} (d/100) + 0.0058\,(d - 100) \qquad (4)$$

This absorption rate is almost double that previously suggested 2 of 3 dB/kilometer. It can be seen that the fitted, spherical spreading curve does not fit the data as well as the experimental curve derived above. However, considering the spread of the MAXP levels (discussed below) this curve could represent a reasonable first approximation.

A comparison of attenuation derived from spherical spreading with 3 dB/kilometer, 5.8 dB/kilometer, the experimentally derived "line of best fit" curve and the average measured values is presented in Table 4.

Perhaps the most important feature of the data summary is the spread in values of the MAXP. When the standard deviation at each distance is compared to the range of MAXPs respectively it can be seen that, while the standard deviation is of a reasonable size, the range of possible MAXP values is quite large due to the large sample size. These are summarised in Table 5.

Table 5 The range of MAXP values at each measurement distance compared to the range of the 95% confidence interval at each distance

Range of MAXP with respect to measurement distance and standard deviation		
Distance (m)	Range of MAXP (dB)	95% confidence interval (dB)
100	16.2 (+7.5 to –8.7)	7.0
800	43.3 (+18.9 to –24.4)	20.0
1,600	44.6 (+19.8 to –24.2)	29.0
3,200	50.0 (+22.5 to –27.5)	34.8

The average value of MAXP at a distance of 3,200 m may be 94.0 dB (standard deviation 8.9 dB), but the actual value could have been anywhere in the range of 116.5 dB to 66.5 dB. For an individual exposed to these impulse noise levels, the 66.5 dB may not represent any particular difficulty, however, a MAXP of 116.5 dB may represent a considerable problem.

5. CONCLUSION

For the general case the average attenuation of impulse noise levels can be estimated using the equations presented. As discussed equation (4) has been shown to fit the average values provided by the experimental data out to a distance of 3,200m.

While most of the time the average MAXP levels may be acceptable, the wide range of levels experienced illustrates that conditions can and do arise so as to produce exceptionally low attenuation compared to predicted values. The attenuation may be so low as cause high MAXP levels and hence

Table 4 Comparison of measured and calculated attenuation values from three sources

Attenuation value source	**Attenuation of MAXP (dB) with respect to distance (m)**			
	100 m	**800 m**	**1600 m**	**3200 m**
6 dB/doubling + 3 dB/kilometer	0	20.1	28.6	39.4
6 dB/doubling + 5.8 dB/kilometer Eq. (4)	0	22.1	32.8	48.1
Experimentally derived curve Eq. (3)	0	25.9	35.3	45.9
Average measured values	0	26.0	35.3	46.0

annoyance in the community. Thus when attempting to gauge the community annoyance from noise originating from high level impulse sources, greater consideration needs to be given to the possible wide variation in maximum peak levels that can occur under some meteorological conditions.

Careful consideration of the meteorological conditions favourable to propagation in the direction of interest should always be undertaken even if this is only on some sort of empirical basis. Attempts have been made to develop sound propagation packages for impulse noise but to date they are not as reliable as would be desirable for predicting noise annoyance[4,15,16].

Meteorological conditions considered favourable to propagation are discontinuities such as large temperature gradients (inversions), wind shear and high wind gradients, particularly in the direction of interest. Favourable propagating conditions will tend to cause annoyance in the direction of propagation.

As propagating conditions can vary greatly from time to time, when attempting to estimate annoyance, predicted values of MAXP levels at a distance should be considered as a guide only, while more serious consideration should be placed on data related to the possible spread of results derived experimentally.

If meteorological conditions are likely to cause annoyance action may be initiated so that the particular event is postponed until more acceptable conditions arise. This may be a very simple administrative noise control measure, implemented at a local level, capable of maintaining good community relations.

6. ACKNOWLEDGEMENTS

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75th
Anniversary
1926 - 2001

Obituary

SUSZANNE THWAITES

(1952–2003)

Suszanne Thwaites, one of Australia's leading acoustical scientists, died quietly and unexpectedly in her sleep in Ottawa on 7 October 2003. She was on the second day of a journey to which she had been looking forward and was, at the time, engaged in an audit of acoustical calibration facilities and procedures at the laboratories of the Canadian National Research Council. The trip would then have taken her on to visit Boeing Aircraft in the US, the Royal Aircraft Establishment at Farnborough in the UK, and relatives in the Åland islands in Scandinavia.

Suszanne was born on 23 September 1952, and was the eldest of six children. She undertook an honours degree in physics at the University of Western Australia, followed by an MSc with a research project on the growth of hailstones in storm clouds. In 1977 she came to the University of New England in Armidale NSW to work with me on a project in musical acoustics, and this began her future career and a collaboration between the two of us that continued throughout her life. She chose as her PhD topic the acoustics of jet excitation in organ pipes, and her thesis, presented in 1982, went a long way towards explaining the mechanisms involved. Her research interests were, however, wider than this thesis topic and she also built a clavichord, studied its acoustics, and incorporated this as an addition to her thesis. Together we also did work in biological acoustics, and published joint papers on the physics underlying the auditory abilities of crickets and other animals.

At the conclusion of her PhD, Suszanne left Armidale and returned to Perth for a while, before taking up an appointment in 1985 as a Research Scientist in the acoustics group of what was then the Division of Applied Physics (now the Division of Telecommunications and Industrial Physics) of CSIRO in Sydney. The National Measurement Laboratory, responsible for Australia's primary physical standards, is part of that Division, so that much of her work involved acoustical standards activities.

Over the next ten years her work began to expand and blossom, maintaining the diversity of interests that characterised her earlier activities. As well as increasing standards responsibilities, she was involved with aspects of the development of an ultrasonic gas-flow meter, with microphone design, and also with biological acoustics. Suszanne's real opportunity came with the award to the Division of a set of research contracts by Boeing Aircraft Corporation as part of a Government requirement in relation to industrial development and aircraft purchase in Australia.

Suszanne's project involved the development of a technique for detecting invisible impact damage in the honeycomb panels from which modern aircraft are constructed. With a small team, she developed a technique using a piezo-electric exciting probe and a similar near-by detecting probe (a "pitch-catch probe" set-up) together with sophisticated analysis software to examine wave propagation in the panel at a frequency of around 15 kHz. Over a few years the project attracted continuing interest and funding from Boeing and culminated in the development of a small but complex hand-held scanner, a little larger than a computer mouse, connected to an ordinary lap-top computer containing the software, and able to produce coloured images of any damage in the panel. The final design Suszanne named the "Bandicoot" after the cute little Australian marsupial that it resembled. It was the final stage of this project that was planned to take her, after Ottawa, to the US and the UK, where the level of interest by Boeing and the RAF in adopting the scanner for routine checks was very high, as it was also in Australia.

Suszanne's involvement in standards-related activities was also great. Among other things, she represented CSIRO-NML on the BIPM Consultative Committee on Acoustics, Ultrasonics and Vibration, which meets in Paris to manage the distribution and harmonisation of physical standards in this area, and was also the Australian representative on the IEC working group on measurement microphones. She was also an active NATA assessor in the acoustics area.

Suszanne was promoted to Senior Principal Research Scientist in 2002, was Project Leader for Acoustics and Vibrations, Deputy General Manager for a large section of the Division, Equal-Opportunities Officer, and much more. While she was mostly quiet and even self-effacing, she was strong and outspoken on matters of principle and in the interests of those for whom she felt responsibility.

Outside CSIRO, Suszanne had strong and continuing interests in music, visual and performing arts, literature, and nature, especially birds. She was a member of the local community fire-fighting group, and active in the Australian Acoustical Society. She also assisted the Sydney Powerhouse Museum in selection matters.

Suszanne will be sadly missed for her contributions to all these areas. She was in the prime of her career and had much still to contribute. But most of all she will be missed for herself as confidant, counsellor, mentor and friend to all those who knew her.

Neville Fletcher

Acoustics Forum

Note: Contributions published in "Acoustics Forum" are aimed at promoting discussion. The views expressed are not necessarily those of the Editors of Acoustics Australia or the Australian Acoustical Society. Contributions are not formally peer-reviewed.

SCIENCE MEETS PARLIAMENT

October 14-15, 2003

Marion Burgess and Joe Wolfe

1.0 INTRODUCTION

'Science Meets Parliament' is an annual event organized by the Federation of Australian Scientific and Technological Societies (FASTS). For the first time, the Australian Acoustical Society (AAS) considered it was in a position where it had a number of clearly defined issues which related to government policy and therefore should participate in this event. Expressions of interest were sought from the AAS membership and Marion Burgess and Joe Wolfe were selected to represent the Society.

2.0 BRIEFING DAY

The first day, Oct 14, was described as a briefing day at the National Press Club. This is Australia's largest lobbying exercise for scientists and technologists with over 250 participants. FASTS policy material was presented and we were advised how to engage politicians successfully by experienced scientists, lobbyists, parliamentary staffers and politicians themselves. Even though we were first time participants we felt that this day provided little information beyond the distributed notes: be prepared, find out about the politician you were to meet, be yourself, be enthusiastic about science and remember that this may be the first time the politician has spoken with a real working scientist. We were advised to sell the main global message rather than special pleading. It was suggested too that we invite the politicians to ask us questions, and possibly to build a rapport so that the politician thought s/he had a scientist who could be useful in future as a point of contact.

The lunch time debate between Science Minister Peter McGauran and Shadow spokesperson Senator Kim Carr provided some interest as they justified their party policy. It was like a miniature version of a parliamentary debate, and concentrated on using the issues to score points at the expense of the other side, rather than carefully assessing the issues. This is an important reminder of political exigencies: the good of the nation is not necessarily what gets the politician elected or what gets the party into government.

In an afternoon session, Snow Barlow introduced some members of the Wentworth Group: senior experts in fields related to water and agriculture who met (first in the Wentworth Hotel, whence the name) at a time when an influential radio shock jock was promoting, with considerable public support, the idea of a very major national project to turn rivers inland to 'drought proof' Australia. Key aspects of the operation of the group were the need for an interdisciplinary approach and the right of experts to veto in their own field. The scientifically conservative but impregnable report was distilled to 5 points for the media. While this part of the day was a little long it was satisfying to hear a story in which knowledge triumphs over ignorance (even if in part due to fortuitous circumstances) that few would have failed to enjoy it. The briefing day was completed with a talk about the newsworthiness of science and some tips on handling the media by a senior journalist.

An evening reception in Parliament House completed the day. This was attended by many politicians but they had no identification/name tags so it was only those who regularly appear in the media that were easily recognised. A photo book of politicians would have been a useful addition to our kit for the event. It also would have been valuable to have some knowledgeable FASTS people acting as hosts and facilitating chats between the politicians and the scientists. There were short speeches including one from the Minister for Education Science and Training during this reception.

3.0 MEET THE POLITICIANS DAY

Day two started with a continental breakfast in Old Parliament House and a final check on details of meetings and then it was on to Parliament House. As well as the scheduled meetings there were a number of media events; including an address by Jenny Macklin, Deputy-Leader of the Opposition, launch of Academy of Science review of Earth Sciences in Australia by Science Minister Peter McGauran, release of the ARC grants as well as some specific media conferences. In the evening was an optional extra dinner which was attended by scientists, industry representatives and politicians. During this dinner were speeches by IBM Extreme Blue team leader John Wolpert, and Graham McDonald from Merck Sharp and Dohme.

4.0 SCHEDULED MEETINGS WITH POLITICIANS

In view of the large interest in the event this year there were three scientists scheduled for each interview with a politician. All participants selected areas of interest from the list of national priorities in science. This is a short list of general areas like health, national security etc and while acoustics had a relationship with many it was not a focus of any. The 'matching' of scientists and politicians was attempted using this list. Consequently there was diverse group of three scientists meeting with each politician. The politician was not necessarily focussed on the particular area of interest of any of the scientists. The experiences of Burgess and Wolfe are summarised:

4.1 Burgess #1 with Labor Senator Steve Hutchins from NSW

My colleagues were an academic psychologist and a researcher in fire management. We were each given an opportunity to raise issues of concern to science in general, education and then our particular areas. In relation to the closing of publicly funded acoustic facilities he commented that we had little chance to reverse the wave of 'economic rationalism'. We were given a good hearing and an offer that if we sent him a submission he would consider including it in one of his senate speeches

4.2 Burgess #2 with Liberal Member Ross Cameron from NSW

My colleagues were an astronomer and physics academic. After a discussion on astronomy the interview focussed on education and the need to foster science right from primary school. We discussed and agreed on the need for a 'cultural change' and the lack of skilled science and maths teachers in schools. But when we began to talk of the problem with higher tertiary fees for science and engineering not encouraging students he began to diverge. The discussion ended with his strong endorsement of the current government proposals for tertiary education reform coupled with examples of a similar nature to those used by the Minister.

4.3 Burgess #3 with Advisor for Liberal Minister for Child and Youth Affairs Larry Anthony from NSW

My colleagues were a PhD student in entomology and a pharmacist. The advisor apologised for the inability of the member to meet with us and outlined the role of the Minister. As he has a rural electorate, he was very interested in development of education opportunities for rural youth.

4.4 Wolfe #1 with Dr Carmen Lawrence (Lab, WA)

My colleagues were a specialist in blue-green algae and a family psychologist. Dr Lawrence is rare in our parliament in having a PhD and being familiar with research. She is also very intelligent and needed little convincing of the importance of science. She was perturbed by the privatisation of scientific facilities, of which the NAL story is an example. She was also interested in the potential problems of hearing in an aging Australian population. Her interests in algal blooms and family psychology were greater than those in acoustics and proportionately more time was spent on those. I left wishing that there were more politicians like this one.

4.5 Wolfe #2 with Michael Johnson (Lib, Qld)

My colleagues were a limnologist and a nuclear engineer. Mr Johnson is a young backbencher whose electorate includes Queensland University. His sister is a scientist. His reply to our general points was that it all costs money and where would we like to cut. He was however aware of the surveys showing that Australians would prefer greater expenditure on education and health to tax cuts. He had little interest in acoustics, approved of privatisation, and no interest in limnology. He was however interested in space craft and nuclear reactors, so the engineer and I spoke to him about those topics.

5.0 COMMENTS ON EVENT

As this was the first time the Society has been involved in this event we perhaps had hopes of seeing some short term, albeit tiny, outcome. What we realise now is that that this was just the first step and the efforts must continue. The main benefit of participation is longer term. A couple of disappointments were the chance of the interview being useful was based on the luck of the 'matching' by FASTS and that there were limited opportunities to bring up specific issues. However looking at the broad picture it is important to support the increasing group of scientists and technologists that received political and media attention over the day. This is just one way to ensure that the politicians do not become complacent about the status of science and technology in Australia.

The many parts of the event proceeded well even though there was a very high number of participants. The briefing day could quite easily be reduced to less than half a day as most of the points were also in the printed information. While we were told it was important to prepare it was only after the first interview that we realised what this preparation involved. As each interview takes its own course it is essential to have a broad understanding of the majority of the issues – these include general support for education and research funding as proposed by FASTS plus general issues particular to acoustics. The briefing day could have been better spent giving us more background on the FASTS issues. The science and industry dinner was well attended but there was only limited opportunity to circulate. The seating plan ensured there was at least one politician per table but again there was limited opportunity to pursue particular topics and it was a matter of luck which politician was at the table.

We hope that the Society will continue to support at least one person to attend the main event of the FASTS Science Meets Parliament Day. The invitation to provide a submission was offered by two politicians and has been followed up. However there is only so much that the Council of the AAS and its representatives can do. It is clear there are a number of serious concerns among the membership of the Society. Talking about it amongst ourselves does have a role in that it helps to identify the issues and perhaps indicate solutions. But it should not stop there — every member of the Society can talk with or write a letter to their local member or the member for their place of work. Participation in the event has reminded us that all votes are important to our local members so they are interested in our concerns. The great response to 'Science Meets Parliament Day' shows that the politicians do realise the importance of the scientific community and that most are willing to spend time to discuss the problems and we should all try to capitalise on that.

Any comments or suggestions
for actions related
to political issues that the AAS can
follow up should be forwarded to:
GeneralSecretary@acoustics.asn.au

Acoustics Forum

Note: Contributions published in "Acoustics Forum" are aimed at promoting discussion. The views expressed are not necessarily those of the Editors of Acoustics Australia or the Australian Acoustical Society. Contributions are not formally peer-reviewed.

AUSTRALIAN ACOUSTICAL SOCIETY MEMBERSHIP SURVEY

David Watkins and Marion Burgess

INTRODUCTION

One of the outcomes of the Future Directions Workshop held by the Council in May 2003 was that a survey was needed to determine if the Society meets members needs and to find out how the services and activities can be improved. The questionnaire was developed by council with some advice from a social scientist. It was intentionally kept simple to encourage a high response. The two page form was distributed to members via the Society's journal Acoustics Australia and was also available on the website. The responses were analysed by David Watkins and the detailed results are available on the website (www.acoustics.asn.au). This report summarises the findings.

RESULTS

Response The response from 90 members represents 23% of the membership of the Society (excluding Sustaining Members). Responses to such surveys are generally not high and this rate, while disappointing in that we would like to hear from all of the membership, is about average for such surveys.

Activities of the Society The first three questions were designed to assess if members are aware of the services and activities provided by the Society. Respondents were asked:-

> *Are you aware of all of the activities of the Society?*
>
> *Are you aware of the Society's Code of Ethics?*
>
> *Are you aware of the Memorandum of Association, Articles of Association and By-Laws?*

The results indicate that most respondents are aware of the activities of the Society (Definitely 30% and Mostly 58%). Less were aware of the Code of Ethics (Definitely 36% and Mostly 37%) while most members are not familiar with the Memorandum of Association, Articles of Association and By-Laws (Definitely 19%, Mostly 23% and A Little 39%).

Whilst it is encouraging that most respondents are aware of the activities of the Society, it is disappointing that more respondents are not familiar with the Code of Ethics. The code is designed to encourage members to meet the highest standards of ethical conduct in their professional duties as acoustic consultants. The recent decision to print the Code of Ethics in the journal on an annual basis is well justified. It is not really surprising that the members are not familiar with the association documents as these are generally only used by office bearers.

The majority of members indicated they found membership to be beneficial (Definitely 49% and Mostly 31%). To assess members' involvement with the Society, respondents were asked:-

> *How involved are you with the Society's activities?*
>
> *When you are involved how satisfied are you with the activities?*

The results show that most members are not very active in the Society (Very 22%, Moderate 26%, A Little 40% and Not at All 11%). But when members are involved in the Society they are moderately satisfied with the activities (Very 24%, Moderate 62% and A Little 10%). Some of the comments made by members indicate that pressure of business workloads makes it difficult to attend Society functions and that meetings could be broader based and more relevant to members.

Communications with members. There was a clear preference for receipt of information from the Society electronically (Email or web 70% Mail 26% and Fax 3%). As the response to a later question on the 'usefulness' of the web does not indicate a high rating it can be inferred that members prefer email to the web.

Membership. The Council of the Society is concerned that membership has been stagnant for a number of years and there are many acousticians who have never joined the Society. Question 8 asked for suggestions for encouraging others to join the Society. Some of the most common responses to this open-ended question were:-

- Ask members to invite prospective non-members to join.
- Invite non-members to a Technical Meeting.
- Consider a professional accreditation and development scheme.
- Simplify membership application process – especially Associates, Subscribers and Students.
- Promote membership amongst students.
- Raise the profile of the Society - higher visibility in the media.
- Advertise in other journals and magazines.

Society Services Respondents were asked to rate the following six activities undertaken by the Society from 'very important' to 'not important'.

- Graded membership system
- Register of members
- Code of Ethics
- Participation in Australian and International Standards Committees

- Input into Government Policy
- Membership of FASTS.

The first five activities were rated either "very important" or "important" by around 90% of respondents while membership of FASTS was only rated by 50% with a significant number indicating they didn't know or just did not answer the FASTS question. The Society has been a member of FASTS for some time and there have been regular reports in the journal. However it is only this year that the Society has become more directly involved with FASTS and its activities so it will be interesting to see if the awareness of FASTS increases in future surveys.

Products The following is a list of the products in order of 'usefulness' as rated by the respondents:-

1. Acoustics Australia journal.
2. Annual Conferences.
3. International Conferences in Australia.
4. Division Technical Meetings.
5. Event Calendar.
6. Proceedings of Annual Conferences.
7. Website.
8. Division Networking Meetings.
9. Division Workshop.
10. Other Publications.

It can be seen that members find the Society journal and conferences the most beneficial services provided by the Society. Of concern is the low response regarding the usefulness of the Society website. Future surveys should attempt to determine why the website is not found to be more useful. The low rating of Division Network Meetings, Division Workshops and Other Publications may be due to the Society rarely providing products in these areas.

Administration of the Society Question 12 was designed to gauge members opinion about the Society employing staff to carry out the administration work of the Society. The Society needs more volunteers or paid staff if it is to become more involved in activities such as publicly promoting itself, introducing a scheme of professional accreditation, running more international conferences, contributing to government noise policy, Standards, etc. Respondents were asked:-

> *The majority of the work of the Society is done by volunteers – the only functions that are paid for are the General Secretary and the auditor. Do you consider the Society should pay for more of the fundamental administration type of services so that the volunteers have more time to expand its activities and products?*

Respondents were almost split three ways with 34% giving a definite yes, 28% a no and 38% indicating that it depends on the increase in membership fee.

Other comments A range of comments were received and the following were repeated by more than one respondent:-

- Some form of professional recognition or accreditation is needed in line with the AAAC.
- Concern about "split off" groups like the AAAC taking over the acoustic profession.
- The Society should encourage the AAAC to become part of the AAS.
- Pressure of work makes it difficult to attend meetings and carry out volunteer work for the Society.
- Technical Meetings should be more informative and on subjects that interest the membership.

Demographic Factors A higher percentage of responses were received from members residing in NSW, Victoria and Western Australia than from the Queensland and South Australia. Fellows, Graduates and Members provided the most responses while Associates and Students the least. This may indicate that Fellows, Members and Graduates are more interested, or actively involved, with the Society than the other grades.

CONCLUSION

The membership survey achieved a reasonable response and provided guidance for the direction for the Council. Those products such as the journal and the annual conferences which are clearly considered useful will continue to be supported. Constructive comments provided guidance on approaches to improving the services to the members in the other areas.

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News

Future of Acoustics in Australia

At the May meeting to work on the future directions for the AAS, FASTS suggested that the Society produce a Discussion Paper on the status of acoustics in Australia. This paper would be aimed at politicians and their advisers and outline the current situation and the long term effects this will have for Australia and give suggestions on what could be done to reverse the decline. From the paper on top ten issues of concern to the acoustic community (available in full from the www and a summary was published in Acoustics Australia, 31(2) p63) those which relate to government actions provided the basis for such a discussion paper. Burgess prepared a draft discussion paper which FASTS indicated would be the sort of document they would assist with finalising and then launching at Parliament House. The draft was discussed at the November Council meeting and the next step is for Burgess to work with those in FASTS who have the skills on producing documents that are likely to have some impact on the political scene to produce a document with a view to a launch in 2004. The current draft is available from www.acoustics.asn.au and comments are welcomed from all of the AAS membership.

Excellence in Acoustics Awards, 2004

A reminder that the Excellence in Acoustics award, sponsored by CSR Bradford Insulation will be presented at the Annual Conference of the Australian Acoustical Society in November 2004. The winner will be presented with a personalised plaque and a prize to the value of $2,500. In addition up to 3 finalists will also receive a gift to the value of $250. This award aims to foster and reward excellence in acoustics and entries will be judged on demonstrated innovation from within any field of acoustics. Any professional, student or layperson involved, or interested in, any area within the field of acoustics, with a body of work no older than 3 years, is eligible and encouraged to enter. Details are available from www.acoustics.asn.au and close 15 June 2004.

AAS Educational Grant, 2003

There were 7 applications for the 2003 Grant and the successful winners were announced at the AAS AGM in Brisbane in November.

A grant of $3,000 to Joe Wolfe, UNSW, will be used to support the doctoral research project of a distance-education student who is an amateur violin maker. The grant will enable the purchase of components of a small, multipurpose testing rig to measure the mechanical properties of the components used in the construction of a violin, the mechanoacoustic properties of the instrument at various stages during construction, and the effect on these properties of some of the changes made by makers to finished instruments.

A grant of $2,000 to Nicole Kessissoglou will be used to offer scholarships to final year students in the School of Mechanical and Manufacturing Engineering at the UNSW. The grants will attract high quality students to conduct thesis projects in acoustics, provide financial assistance to final year thesis students conducting their research project in the field on acoustics, and promote the field of acoustics and the AAS to all final year students.

AAS Educational Grant, 2004

The AAS Education Grant is awarded annually and aimed at promoting research and education in acoustics in Australia. The grant of up to $5,000 can be for scholarships, research projects, educational purposes or other worthwhile use related to acoustics. Submissions are due by 30 June 2004 by email to the General Secretary.

H Vivian Taylor Excellence Awards

Victoria Division AGM and Technical Meetings held on Sep 23 and Oct 21

The AAS Victoria Division in most years makes H Vivian Taylor Excellence Awards to one or more students in acoustics. In 2003, awards were made: to Julian Marwick on Jul 22 at RMIT, and to Andrew Dove on Sep 23 at the AGM.

Microflown Competition

For more than a century the acoustics world has only been working with pressure microphones that can be regarded as "acoustic voltage meters". It is only since the invention of the Microflown in 1994 that an "acoustic ampere meter" has become available. Using dimensions, acoustic voltage (sound pressure) and acoustic current (particle velocity), three dimensional sound intensity, sound power, sound energy, acoustic impedance and particle velocity measurements can be made over the range 20-20kHz.

Microflown Technologies B.V. want to familiarise the global acoustical community with its new technology, future potential applications and to develop application know how based upon its product range. Therefore, Microflown Technologies B.V. invites universities and non profit organisations to submit a proposal on an application of Microflown's technology. Three times a year, Microflown will select the best proposals and reward them with at least a 50% discount on their product range. Check the website www.Davidson.com.au for submissions made in the last round of proposals, details of the next deadline and the product range. Submit your proposal to mandy@davidson.com.au.

ICA Youth Grants for Young Scientists

The International Commission for Acoustics, ICA, will award 15 to 25 grants of between 500 and 1000 US Dollars to assist young researchers working in the discipline of acoustics to attend the forthcoming 18th ICA to be held in Kyoto, Japan from 4-9 April 2004. Details for submission on http://www.ica2004.or.jp

ICA Early Career Award

The ICA has established an Early Career Award and the first is to be presented at the 18th ICA in Kyoto, Japan. The Award comprises an honorarium, as determined by the Board, an Award Certificate, and a Medal. Full details and the nomination form http://www.ica2004.or.jp

Occupational Noise Updates

Amendments to the National Code [NOHSC:2009 (2000)]. The National Occupational Health and Safety Commission has released a public discussion paper seeking comment on proposed amendments to the National Code which are intended to minimise the risks and effects of occupational noise exposure by:

(a) addressing the issues of consistency between the National Code and national and international noise management models;

(b) encouraging national consistency by providing an up to date and practical OHS noise management tool; and in so doing

(c) reducing the burden on jurisdictional Governments to develop local codes of practice or guidance material.

See http://www.nohsc.gov.au/PublicComment for the document and details for submission of comment.

Review of AS/NZS 1269:1998 – Standards Australia has commenced its five-yearly review of Parts 0 to 4 of this standard. Public Comment will be sought so check www.standards.com.au/catalogue/Drafts/Search.asp early in 2004.

Additions to Safetyline, WA Three new items have been added to the Noise

Essentials page of SafetyLine www. safetyline.wa.gov.au/sub30.htm

Active Control of Fan Noise – case study on Active Control of Fan Noise supplied by the UWA School of Mechanical Engineering.

The Control Guide – Management of Noise at Work - provides step by step guidance to assist organisations to effectively manage workplace noise and prevent noise-induced hearing loss. This is a New Zealand Department of Labour adaptation of the Australian NOHSC Noise Management at Work Control Guide that is frequently referenced in the National Code.

NASA Buy Quiet Guide – shows how the NASA Glenn Research Center in the USA specifies equipment noise levels as part of its Buy Quiet Program.

Pam Gunn, WA

The Refereed Website for Sound Design in Public Space

The Australian Sound Design Website is now Australia's first fully refereed site focusing on the design of sound in public space in Australia. The website is providing leadership in the sound art and sound research communities and provides arts research links and services which are mutually beneficial to a wide range of interest groups including artists, designers, hosting bodies, curators, engineers, acoustic ecologists, composers, students, webdesigners and all types of multimedia practitioners. The publication of new on line digital sources about sound and search engines whereby artists and researchers can find out information about the nature and practice in the field is beneficial to all. The site has now published over 70 sound designs, five papers, collated a bibliography, designed search engines with key words and curated two exhibitions and international audiotheque, Hearing Place to coincide with the international symposium for the World Forum of Acoustic Ecology. http://www.sounddesign.unimelb.edu.au/site/news.htm

ARL have linked with **Occupational Safety Services** (OSS) Pty Ltd as Victorian and Tasmanian sales representatives. OSS is a sister company of Adelaide based Wavecom Instruments. Contact details for OSS are the former ARL Victorian tel and fax.

The **Catgut Acoustical Society** has merged forces with the **Violin Society of America** and will become the CAS Forum. The combined organization will have over 1,800 members, a greater audience for promoting their mission and shared ideas.

Prof Joe Wolfe from UNSW has received the prestigious Acoustical Society of America (ASA) science writing award for a website article on clarinet acoustics. This is the first time the ASA has recognized a web-based multimedia publication. Wolfe said the net is an important way to make research available to as wide an audience as possible.

New Members

Graduate

Emma Carlisle (Qld), Mark Cooke (Qld), Luke Zoontjens (Vic)

Member

Matthew Terlich (Qld), Joseph Nannariello (NSW), David Southgate (NSW), John Channon (NSW), David Luck (NSW)

Subscriber

Craig Hill (Qld)

Student

Richard Morgans (SA)

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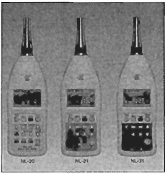

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Future Meetings

Acoustics 2004

The AAS Annual Conference, Acoustics 2004,with the theme "Transportation Noise & Vibration, the New Millenium" will be held at the Gold Coast International Hotel 3-5 November 2004. In addition to transport related papers the conference will provide a forum for papers on all areas of acoustics with sessions on Underwater, Occupational and Building Acoustics. Submitted papers will be peer reviewed, where requested, under the coordination of a scientific advisory panel. A series of workshops will focus on aspects of transportation noise. Information: aas2004@acran.com.au, www.acoustics.asn.au

Internoise 2004

Internoise 2004, is being organised by the Czech Acoustical Society and will be held in Prague, August 22 to 25, 2004. The theme for the Congress is "Progress in Noise Control for the 21st Century". The congress is open to all innovative contributions from a variety of topics in noise control engineering. There will be a comprehensive technical program and exhibition. The congress will be held at the campus of the Czech Technical University. Information: www.i-ince.org.

ICA 2004

International Congress on Acoustics, ICA 2004, has the theme "Acoustic Science and Technology for Quality of Life". The Congress will be held in Kyoto International Conference Hall (K.I.C.H.) in Kyoto city from 4–9 April. Kyoto is a beautiful city with traditional culture. The technical program will consist of plenary lectures, invited papers in structured sessions, contributed papers and exhibition from industries. The Congress will cover all the fields of acoustics: acoustical oceanography, acoustic signal processing, animal bioacoustics, architectural acoustics, ultrasound, engineering acoustics, measurements and standards, musical acoustics, noise and vibration control, psychological and physiological acoustics, speech and speech communication and underwater acoustics. Information: http://ica2004.or.jp

Satellite conferences include ISMA2004, International Symposium on Musical Acoustics 31 March – 3 April in Nara (http://www2.crl.go.jp/jt/a132/ISMA2004/) and International Symposium on Room Acoustics, 11–13 April in Hyogo (http://rads04.iis.u-tokyo.ac.jp)

Low Frequency 2004

This conference will be organised by Geoff Leventhall and Bill Tempest in conjunction with Members of the Editorial Board of the Journal of Low Frequency Noise, Vibration and Active Control. The conference will be held in the Hotel Van der Valk in Maastricht, 30th August 2004 – 1st September 2004 which is a few days after Internoise 2004. The conference will cover all topics in low frequency noise and vibration, its effects and control including: infrasound, low frequency noise and vibration, perception, detection measurement and analysis, propagation in the ground and in structures, effects on man and animals and vibroacoustic disease (VAD). Information: organiser@lowfrequency2004.org.uk and http://lowfrequency2004.org.uk/

Transport Noise And Vibration, 2004

The 7th International Symposium, Transport Noise And Vibration 2004 will be held in St. Petersburg, Russia, 8–10 June, 2004. The Symposium will be one of the events in the framework of the "High Technologies Week in St. Petersburg, 2004". The Symposium exhibition will be a part of the International Specialized Exhibition "New technologies in transport industry". During work of the Symposium you will have an opportunity to enjoy one of the best cities in the world at the most beautiful time of the year. Information http://webcenter.ru/~eeaa/tn04/.

Noise-Con04

Noise-Con04 will be the 20th in the series of national conferences and will be held in conjunction with A1F04 (Transportation-Related Noise Committee of the Transportation Research Board) in Baltimore, Maryland, 12–14 July 2004. This joint meeting will consist of technical sessions on all aspects of noise control engineering with an emphasis on transportation noise. Information: http://www.inceusa.org/NoiseCon04call.pdf.

ISMA2004

ISMA2004 is part of a sequence of annual courses and biennial international conferences on structural dynamics, modal analysis and noise and vibration engineering. The technical program includes keynote lectures, tutorial lectures, technical papers and poster sessions. ISMA2004 will be held in Leuven (Belgium) 20 to 22 September and authors receive a 50% reduction on the registration fee. Information http://www.isma-isaac.be

ICSV11

The 11th International Congress On Sound And Vibration to be held 5–8 July 2004, in St. Petersburg, Russia at the Hotel Pribaltiyskaya. ICSV11 participants will be able to take part in a congress with a first rate scientific program and also experience firsthand the considerable cultural attractions of St. Petersburg and the many sites of historical and general interest in and around the city. St. Petersburg. ICSV11 is sponsored by the International Institute of Acoustics and Vibration and the Noise and Vibration Control Society of Russia in cooperation with the Russian Acoustical Society, the East-European Acoustical Association and the American Society of Mechanical Engineers. Information: http://www.iiav.org

ICSV14 in Cairns

The Fourteenth International Congress on Sound and Vibration (ICSV14), sponsored by the International Institute of Acoustics and Vibration (IIAV) and the Australian Acoustical Society (AAS) will be held at the Cairns Convention Centre in Cairns, Australia, 9–12 July 2007. ICSV14 is part of a sequence of conferences held in the USA (1990, 1992, 2002), Russia (1993, 1996, to be held in 2004), Denmark (1999), Germany (2000), Hong Kong (2001), Sweden (2003), Lisbon (to be held in 2005), Vienna (to be held in 2006), and Australia (1997, to be held in 2007). The conference program will include keynote addresses, papers and workshops on special topics. In addition, structured industry forums will be presented. Contact Dr Nicole Kessissoglou at UNSW n.kessissoglou@unsw.edu.au

The AAS website has a wealth of information on it about the Society and its use is increasing. It now has details of divisional technical meetings – a service to members of that division but also provides an opportunity for you to meet with colleagues if you are traveling interstate.

www.acoustics.asn.au

Meeting Reports

Memorial at 10ICSV for Michael Norton

On 7–10, July 2003, the 10th International Congress on Sound and Vibration (ICSV) was held at the Royal Technical University, in Stockholm Sweden. It was claimed as the most successful congress with an attendance of 650 technical participants and 80 accompanying people. A special memorial session for the late Professor Michael Norton recognising the considerable contributions he has made to the sound and vibration research community was held on July 9. Michael was a founding director of the International Institute of Acoustics and Vibration (IIAV) which is the originator of ICSV.

The session was organised by Professor Jie Pan of the University of Western Australia and Dr Denis Karczub of SVT-Engineering. Before Pan's specialised keynote speech on "Further development of the acoustical wave propagator", he gave a brief overview of Michael Norton's contributions to the field of sound and vibration. Papers on flow induced noise in pipelines were given by Dr Mats Abom from KTH, Sweden ("Flow induced noise modelling for industrial piping systems") and Dr Denis Karczub from SVT ("Blow-down valve noise and the influence of downstream orifice plates"). Dr Kin Sum and Mr Shuzhi Peng from the UWA also presented papers on "Statistical energy analysis of the distribution of flexural vibration energy in asymmetric-periodic plates" and "Acoustical wave propagator for time-domain analysis of flexural wave scattering and dynamic stress concentration in a heterogeneous plate with multiple cylindrical patches". The session attracted many and was highly appreciated by Michael's colleagues and friends.

Jie Pan & Denis Karczub

Star Rating

The topic for the Queensland Division meeting on 4 August was the new AAAC Guide, "AAAC Acoustical Star Ratings for Apartments and Townhouses". Ron Rumble of Ron Rumble Pty Ltd detailed the philosophy behind, and some of the background to, the development of the new AAAC guide. His presentation also outlined some of the methodological and technical issues associated with current BCA acoustic proposals (particularly in regard to impact rating of walls). Practical technical aspects associated with the guide, such as how acoustical ratings should be assessed and tested were also canvassed.

There was a terrific turn out for the evening with over 30 AAS members in attendance. The evening was sponsored by CSR who provided the much appreciated beer and pizza. Once again the evening provided the opportunity for members to meet and discuss issues of interest. The guide "AAAC Acoustical Star Ratings for Apartments and Townhouses" can be obtained from http://www.aaac.org.au.

NSW AGM 2003

The NSW Division Annual General Meeting was held on 17 September 2003 at the Montien Thai Restaurant in Naremburn. Just over 20 members made the effort to attend an excellent evening meal with friends and colleagues from various avenues in acoustics. The evening started with a short summary of the past year's events and the actions for the forthcoming year by the NSW divisional chairperson, Neil Gross. The existing committee generously agreed to continue to volunteer their time and effort for the division. The Indigo Ridge wine flowed and the Thai food and exhilarating acoustical conversation continued until well into the night. A good time was had by all and many contentious divisional problems were resolved around the table.

Ken Scannell

Local Government Noise Guide

On Wednesday 14 May 2003 approximately 50 members and guests attended a NSW Divisional Meeting on the Draft Noise Guide for Local Government presented by Mr Roger Treagus of Department of Environment and Conservation (then NSW Environment Protection Authority) at the National Acoustic Laboratories in Chatswood.

Roger summarised and provided a discussion of elements of the Draft Guide that may be of interest to acoustic professionals when preparing reports that would be submitted to local government (ie councils).

Some points of interest to attendees were:

- How the document would reflect current fines and other updated information;
- How the document would focus on the "cause" rather than the "symptoms" of noise issues;
- How the document would assist council officers in improved noise management and use of the noise legislation
- Subjective noise tests of offensive noise versus noise measurements;
- The useful and practical case studies appended to the Draft Guide.

The Noise Guide for Local Government is available from /www.epa.nsw.gov.au/publications/noise.htm.

Temperature Effects

On Wednesday 27th November 2003 almost 50 members attended a NSW Division meeting at Arup Acoustics Office in Sydney. Roger Treagus of the NSW Department of Environment and Conservation (DEC) formally known as the NSW EPA spoke on *'Temperature Inversions and their Effect on Noise Propagation'*. Roger's background, with a degree in Meteorology, a Masters in Environmental Studies and six years experience within the EPA Noise Policy Section made him the ideal speaker to clarify this complex part of noise propagation.

Roger explained the concept of temperature lapse and temperature inversions with the latter causing an increase in noise levels of as much as 15 dB between about 300 metres and up to 4 km (others later reported effects up to 30 km!). The inversions are measured either directly using a 50 metre high pole, finding the standard deviation of the wind direction or simply noting clear sky and negligible wind conditions in winter or spring (although they can even occur in the summer months). Recent research has found that there are several focal points with quiet zones between foci. One of the problems with the prediction of noise propagation is that the zones can significantly change in both time and space!

Ken Scannell

Vic AGM and SBS Tour

The Victoria Division AGM was held on Sep 23 in conjunction with an ANCE/AAS technical site visit to the Melbourne studios of radio/TV SBS and 35 attended. The site visit to SBS, under the guidance of George Papakotsias, consisted in seeing the studios and other rooms from which the various radio and TV broadcasts emanate. While much of his descriptive commentary was concerned with broadcasting procedures, of acoustic interest was the fact that some studios were designed to have minimum reverberation, while others, mostly for musical performances, had adjustable wall vanes to control and direct the reverberant sound. At the conclusion of the visit, Charles Don thanked our guide, thanks which were carried with acclamation.

aas

Excellence in Acoustics

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Entries due June 2004

www.acoustics.asn.au

Donkey

The technical meeting held on Oct 21 at the Collingwood offices of Marshall Day Acoustics, with an attendance of 20, was a combined AAS/AIRAH/ANCE meeting to hear Murray Mason of the ACADS Building Services Group, and Tim Marks of Marshall Day Acoustics describe and demonstrate the computer program, *Donkey*. Mason described this program which, when set up to operate via a set of add-on menus in AutoCAD, can be used for calculating the dimensions of an air duct system, carrying out a complete acoustical analysis, and determining material quantities for costing purposes.

The input data to the program include the duct layout (as a line diagram), positions of fan, fittings and terminals, air flows, room dimensions and acoustics, fan sound power levels, and duct lining insulation type. The program can provide as outputs optimum duct sizes and noise levels throughout the system (including the effects of airflow generated noise). In this way, several alternative designs can be readily produced and investigated in order to find the most cost-effective design with minimum noise output. Tim Marks followed, by describing the use and application of *Donkey* and also of the *Cogen* program for a range of projects.

Fricke Dinner

The final Victoria Division meeting for 2003 on Dec 2 at the Malvern Valley Golf and Reception Centre was a dinner with Fergus Fricke as after-dinner speaker. Thirty-one members and friends attended. Fergus recently retired as Professor, and Director of the Sydney University Acoustics Laboratory and spoke on *A Hitchhiker's Guide; the answer to life, the universe and everything, including acoustics.* In doing so he made several references to Douglas Adams' *The Hitchhiker's Guide to the Galaxy.* In an interesting and entertaining talk Fergus described our life experiences under the metaphor of hitchhiking; a good one because we all at some time or other either hitch rides from, or give them to others.

Louis Fouvy

Education Grant

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The *AERO*PAC® ventilator is a compact and innovative ventilation unit that efficiently provides fresh air (30-110 m^3/h) and controls unwanted noise intrusion. The ventilator incorporates a silencer, fan and active carbon filter in a compact unit that can be easily installed in both new and existing building facades. It is energy efficient (9-25 Watt) and operates on standard 240 V power supply. A variable speed fan control allows occupants to easily adjust the level of ventilation to suit current ambient conditions. The *AERO*PAC® ventilator is used extensively in Europe and the US for effective control of transportation and industrial noise.

For more information contact acoustica Tel: 1300 722 825 or info@acoustica.com.au, www.acoustica.com.au

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Kingdom Pty Ltd have released the Dytran 5313A Triaxial Seat Pad comprising a 100 mV/g triaxial accelerometer with a frequency range of 0.5 to 3000 Hz, built into a molded rubber cushion to rest on the top of a seat but under the body of a person. The Seat Pad enables directional whole body acceleration/vibration measurements which conform to ISO8041 to be made in real working conditions. It has full scale performance of ±50 g's for ±5 volt output and is suitable for environments which have a maximum vibration of 400 g's and a maximum shock of 1500 g's Peak. The Seat Pad is connected to an analyser or recorder via a 3 core 3 m cable providing BNC connectors.

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The 4151HL is an advanced vibration meter from Dytran Instruments and utilises a true RMS to DC converter to transform the input, from standardized Dytran LIVM accelerometers to a DC voltage displayed on a large analog front panel meter calibrated directly in g's RMS. A 4 position rotary switch and a choice of two sensor sensitivities (10 or 100 mV/g) provide 6 ranges from 1 g to 500 g's full scale. A self contained DC current source supplies power to a voltage mode constant current (ICP) accelerometer. A variable High Limit point can be set from the front panel and a Red LED indicates when this has been exceeded. The rear panel terminal block has a normally open or normally closed option to make or break a circuit. In that way the 4151HL can be used to shut down a machine due to excessive vibration if the limit is reached perhaps from failed bearing or start up a machine or to sound an alarm due perhaps to earth shake in addition to shutting down machinery if the limit is reached. The 4151HL is suitable for laboratory, research and OEM applications.

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Information: Air Met Scientific on 1800 000 744, sonia.lo@airmet.com.au

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Information: sales@cirrusresearch.co.uk

Items for inclusion in
New Products
should be sent to:
AcousticsAustralia@acoustics.asn.au

Book Reviews

Engineering Noise Control 3rd Edition

David Bies and Colin Hansen

Spon Press, London and New York 2003. 719 pp. ISBN 0-415-26714-5 (soft cover). Distributor DA Information Services, 648 Whitehorse Rd, Mitcham 3132, Australia, tel 03 9210 7777, fax 03 9210 7788, Price A$92.77

The growth in knowledge is apparent by tracking the number of pages from the first edition of this book in 1988 with 414 pages, through the second edition in 1996 of 613 pages to the current edition of 719 pages in a smaller type font. The latest edition follows the same style and format as the previous editions but there has been substantial updating and expansion of the content. The detailed contents page and the list of 'learning objectives' at the commencement of each chapter, which were introduced in the second edition are continued in this latest edition. While the emphasis is on passive control there is an enhanced section on active control which reflects the advances made in this area.

Like most textbooks the early chapters deal with the fundamentals of the production, measurement and hearing of sound. Then there are chapters on sound sources and the effects of their location outside or in rooms. These are followed by chapters on the control of noise and vibration with barriers, mufflers and isolation. Active control is a separate chapter and the final chapter is a survey of analytical techniques.

The Appendix with problems from previous editions has been replaced with a derivation of the wave equation and problems are available from a www address (at no charge). The other Appendices have been updated and combined. The extensive list of acoustical standards includes ANSI, ASTM, AS, IEC and ISO reflecting the international market for the book. The different approaches to criteria and assessment around the world are discussed which again is of benefit to the international reader not a source for criteria in your local area.

The authors have integrated the new content well into the book and maintained the easy to read style even though there are all the details in formulae that are necessary for an engineering readership. The figures and diagrams are clear. The slightly smaller font requires just a bit more concentration when reading long paragraphs but is preferable to a larger and heavier book.

I have found the previous edition to be an essential reference book and hence have been reluctant to loan it to others. I would suggest that all acoustical engineers should have their own copy of such a valuable resource and not rely on the office or library copy. If you have a copy of a former edition then this new edition offers the opportunity to treat yourself and get the latest updated and expanded version.

Marion Burgess

Marion has been involved with teaching, research and consulting in many aspects of acoustics.

Orchestral and Keyboard Instruments

Howard Pollard

Publisher and distributor: Howard Pollard, 6 Wren Place, Cronulla, NSW 2230, tel 02 9523 4655, howardpollard@bigpond.com. 213 pages, soft cover, ISBN 0 646 42350 9 Price A$39.50 plus postage within Australia

Two reviewers were asked for their comments on this book

Review 1 Back in 1999 Howard Pollard wrote and published "Acoustics Applied to Music: The Evolution of Ideas and Methods". It was a book written for the non-specialists in the field acousticians with little knowledge of music or musicians with little knowledge of acoustics and I think it was very successful for these people, as well as being enjoyable for others. Writing a review for The Physicist at the time, however, I expressed some disappointment that the book stopped short of any detailed discussion of musical instruments. The present volume remedies this omission and covers the history, mechanics and acoustics of musical instruments in a way that is complementary to the earlier volume.

While I know that you should not judge a book by its cover, the colour reproduction of an eighteenth-century painting of a chamber music group does convey much of the flavour of what follows, where the history of the development of each instrument is traced in moderate detail. There are also 25 short biographical sketches of some of the principal people involved and an appendix on baroque organists. The emphasis is, however, on understanding what is happening when the instrument makes its characteristic sounds, so it is here that the present book diverges greatly from the "coffee-table" type of volume others have written. Thus, while there is no mathematics presented, the reader is reminded about the precise meanings of terms such as "overtones", "harmonics" and "cents" in short footnotes and in 14 short Appendices, and there are various tables and spectral graphs to make things specific.

All classes of musical instruments get attention, but the discussion of the pipe organ (Howard's own performance instrument) is the most detailed. There is also a short section on the human voice and another on scales and tunings. Electronic instruments receive only brief mention, which is a good decision since they are so entirely different from "acoustic" instruments. The explanations are all admirably brief and clear.

The overall appearance of the book is pleasant, though perhaps a little "old-fashioned" in style, and there are many photographs and diagrams, nearly all drawn from other books (with appropriate acknowledgment). There is an adequate index and a list of about a hundred references. The production standard is good and the price is extremely reasonable.

This book will be an ideal text or informal reference for music students at all levels from High School to University Conservatorium. It will also provide interesting and informative reading for others with a general interest in music I intend to use it myself as a text to supplement an informal course I am giving for the University of the Third Age (U3A) next year, and I am sure that members of the class will enjoy and benefit from reading it. You will too!

Neville Fletcher

Neville Fletcher is a Visiting Fellow at the Australian National University and has worked in many areas of acoustics. He has published (with Tom Rossing) a thick book on the Physics of Musical Instruments, but it has too many equations to be attractive to musicians!

Review 2 *Orchestral and Keyboard Instruments* provides a brief history of many musical instruments and describes the production of sound from each instrument, including the human voice. Scales and tuning systems are outlined and biographical information concerning important personalities is also included.

This volume explores the origins of most types of musical instrument, clearly summarised under the four main classes of instrument. Included is an outline of relevant physical characteristics and the development of these instruments. The text and illustrations are both clearly presented. This book examines how sound is produced through the operating principles of each instrument, also covering vocal sounds. The section of the book on scales is highly technical and much of it may not be relevant to many students. Nevertheless, the descriptions of the tuning

Diary...

2004

31 March-3 April, Nara
ISMA2004, Int Symp On Musical Acoustics
http://www2.crl.go.jp/jt/a132/ISMA2004/

4-9 April, Kyoto,
ICA2004, 18th Int Cong on Acoustics
http://ica2004.or.jp

11-13 April, Hyogo
Int Symp Room Acoustics
http://rads04.iis.u-tokyo.ac.jp

27-28 April, Teddington
Adv Metrology for Ultrasound Medicine
http://www.amum2004.npl.co.uk

17-21 May, Montréal
Int Conf on Acoustics, Speech, and Signal Processing.
http://www.icassp2004.com

6-9 June, Gdynia
XIII Int Conf Noise Control 04
www.ciop.pl/noise_04

8-10 June St. Petersburg
Transport Noise & Vib 2004
http://webcenter.ru/~eeaa/tn04/.

5-8 July, St Petersburg
ICSV11, 11th Int Cong Sound & Vib
http://www.iiav.org

11-16 July, Cambridge
12th Int Symp Acoustic Remote Sensing.
http://www.isars.org.uk

12-14 July, Baltimore
Noise-Con04
http://www.inceusa.org/NoiseCon04call.pdf.

3-7 August, Evanston
8th Int Conf of Music Perception and Cognition.
http://www.icmpc.org/conferences.html

24-27 August, Prague
Inter-Noise 2004.
www.i-ince.org

30 Aug-1 Sept, Maastricht
Low Frequency 2004
http://lowfrequency2004.org.uk,
organiser@lowfrequency2004.org.uk,

8-10 September, Athens
From Scientific Computing to Computational Eng
http://ic-scce.upatras.gr/

14-16 September, Turkey
WSEAS Conferences
http://wseas-conferences.50megs.com

20-22 September, Leuven
ISMA2004
http://www.isma-isaac.be

20-22 September, Williamsburg
Active 2004.
www.inceusa.org

3-5 November, Gold Coast
Acoustics 2004
AAS Annual Conference
PO Box 760, Spring Hill, QLD 4004,
AUSTRALIA,
www.acoustics.asn.au, aas2004@acran.com.au

2005

31 Jan-4 Feb, Canberra
AIP Conf, Physics for the nation
www.aip.org.au

19-23 March, Philadelphia
Int Conf Acoustics, Speech, and Signal Processing.
http://www.icassp2005.com

11-14 July Lisbon
ICSV12
www.iiav.org, icsv12@ist.utl.pt.

18-21 July, PenState
Int Symp Non Linear Acoustics.
atchley@eng.psu.edu

6-10 August, Rio de Janeiro
Inter-Noise 2005.
www.internoise2005.ufsc.br, samir@emc.ufsc.br

2006

26-28 June, Seoul
Wespac9
www.wespac8.com/wespacIX.html

3-6 December, Honolulu
Inter-Noise 2006.
www.i-ince.org

2007

9-12 July, Cairns
ICSV14
n.kessissoglou@unsw.edu.au

2-7 September, Madrid
ICA2007
www.ia.csic.es/sea/index.html

Meeting Calendars are available on www.icacommission.org/calendar.html and www.i-ince.org

Book Reviews (continued)

systems could be useful to higher grade music students. There are also many helpful illustrations and charts together with biographical profiles of prominent instrument makers and musicians.

Orchestral and Keyboard Instruments is a book which could be used from early high school to university. The younger students could benefit from parts of this book, for example the general characteristics of each instrument. However, given the high degree of technical information included throughout, it would be particularly useful to senior high school and university music students and a great reference book for music teachers.

Lara Galbraith

Lara graduated from ANU School of Music and has taught music at the high school level in both public and private schools.

ANNUAL INDEX
Vol 31 2003

Brown A L and Bullen R B
Road Traffic Noise Exposure in Australian Capital Cities, No 1, 11-16

Bullen RB
Long-term Environmental Monitoring and Noise Source Identification, No 1, 23-27

Burgess M and Renew W
Overview of Environmental Noise Policies in Australia, No 1, 5-9

de Bree H-E
The Microflown: An Acoustic Particle Velocity Sensor, No. 3 91-94

Donaldson T, Wang D, Smith J & Wolfe J
Vocal Tract Resonances: A Preliminary Study of Sex Differences for Young Australians No. 3, 95-98

Fastl H, Fruhmann M & Ache S
Railway Bonus for Sounds Without Meaning? No. 3, 99-101

Fletcher NH
Australian Aboriginal Musical Instruments: the Didjeridu, the Bullroarer and the Gumleaf, No 2, 51-54

Haines M M and Stansfield S A
The Effects of Environmental Noise on Child Health and Learning A Review of International Research, No 1, 17-22

Jones AD, McCauley RD & Cato DH
Observations and Explanation of Low Frequency Clicks in Blue Whale Calls, No 2, 45-50

Kuramoto K, Kuwahara S, Oimatsu K, Yamaguchi S
Differential Sensitivity of the Ear for Underwater Pure Tones, No. 3, 87-90

Lavan D, Hogg S & Wolfe J
Why do Bell Plates Ring?, No 2, 55-58

Williams W
An Explanation for the Apparent Poor Performance of Some Hearing Protectors, No 2, 59-62

Williams W
The Statistical Estimation of the Attenuation of Impulse Peak Levels with Respect to Distance, No. 3, 103-107

Acoustics Forum
Australian Acoustical Society Membership Survey, Watkins D and Burgess M, No. 3, 111-112

Australian Environmental Noise Issues, No 1, 28-30

Science Meets Parliament, Burgess M and Wolfe J, No 3, 109-110

The 'A' Frequency Weighting, K Scannell, No 1, 31-32

Top Ten Issues for Acoustics in Australia, Burgess M and Lai J, No 2, 63-66

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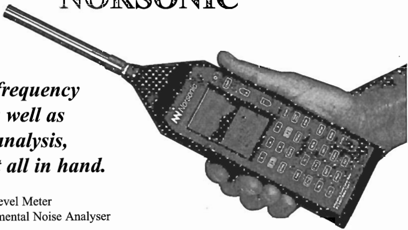

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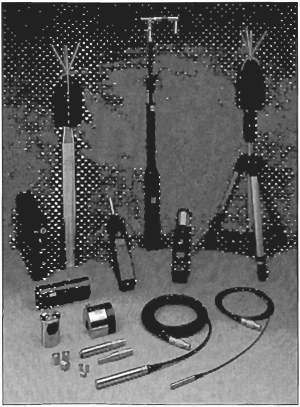

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