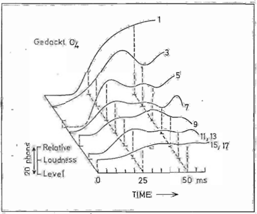
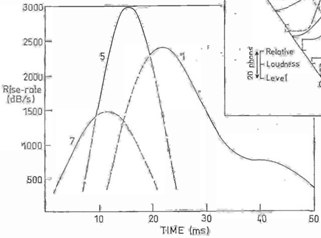
Acoustics Australia

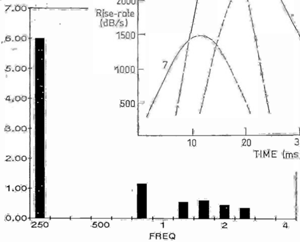
Vol. 18 No. 3 DECEMBER 1990

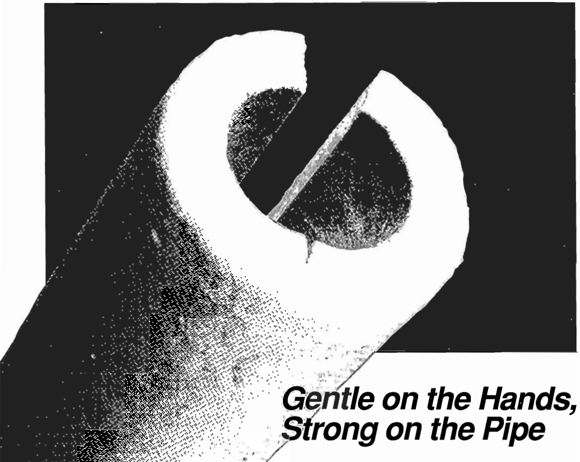
Australian Acoustical Society

- **TIMBRE MEASUREMENT**
- **1990 AAS ANNUAL CONFERENCE**









Acoustics Australia

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COVER . . . An acoustical portrait of an organ pipe (Gedackt pipe closed at the top): normalised loudness spectrum (characterises the steady state), loudness derivative curves and growth curves (characterise the starting transient).

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15 Taylors Road, DURAL 2158

NEWS

NSW

Technical Meetings

The acoustic design of the AOTEA Centre in Auckland was discussed by **Peter Knowland** on 11 July. This centre comprises a 2300 seat multipurpose auditorium and the variable acoustics is provided by added absorption and extension of reverberation by the use of electronic multi-channel reverberation, giving a total change from 1.2 to 2.1 seconds. The overall design philosophy of the auditorium was discussed, including how the natural acoustics predominates for the majority of the functions. To achieve the design goal of NR 18, special precautions were taken by providing an external cocoon to the main auditorium and incorporating the use of air conditioning from within the seating. This air distribution system, which employs a micro climate in the audience area, has been pioneered in Europe and provides quite low noise levels.

On 7 August, **Professor Peter Davies** from ISVR, Southampton, presented a talk on "Realistic models for predicting sound propagation in flow duct systems". He discussed the relevant physical factors which must be taken into consideration when adopting the analogy with electrical networks to model the acoustic characteristics of mufflers and silencers.

The AGM of the NSW Division was held on 26 September at NAL. Three committee members were re-elected at the AGM (Tony Hewett, Don Woolford and Ray Piesse); the remaining two positions on the committee will be filled by co-opting people. The first speaker at the technical meeting preceding the AGM was **Renzo Tonin** who discussed the use of personal computers in acoustics. He gave detailed presentations of the applications of two programmes: dBdox, an acoustic spreadsheet; and dBray, a ray tracing program for use in the design of auditoria and industrial spaces. The second speaker, **Geoffrey Bray** of Richard Heggie & Associates, described and illustrated the use of the latest generation of software for data gathering and analysis, display, structural modifications and reporting phases of a project involving vibration modal analysis.

Early in 1990, a questionnaire on Technical Meetings was sent to all members of the NSW Division. Although only 12% replied, it is considered that the responses indicate the feelings of those who are likely to attend meetings. The replies indicated that a greater emphasis on noise, architectural acoustics and acoustic measurement is desired. A number of interesting offers of papers were received and these will form the basis of the technical programme for the coming year. The present lecture format for the meeting was preferred, with several speakers where the topic is suitable.

Norm Carter

ACT

June Technical Meeting

On 25 June 1990, **Stephe Jitts**, from Stephe Jitts Audiology, spoke on "Hearing Aids - Present and Future". Stephe first explained the variety of hearing losses which can occur and showed the typical locations for the threshold levels, the most comfortable listening levels and the loudness discomfort levels. He gave a short historical review of the development of hearing aids and then discussed the limitations of the various types of hearing aids currently available in Australia. There is great hope that future developments, making use of digital techniques and introducing non linear amplification, will enable a more careful matching of the performance of the hearing aid to the needs of the user. The talk was followed by a lively question time which continued during the dinner at a nearby Malaysian restaurant.

August Technical Meeting

On 14 August, 28 attended a joint meeting with the Institution of Engineers, Mechanical Branch. The meeting was held at the Acoustics and Vibration Centre in the Department of Mechanical Engineering at the Australian Defence Force Academy on the topic "Sound Intensity - Measurements and Applications".

The principles involved in sound intensity measurements were first be outlined by **Dr Joseph Lai**, a senior lecturer in the Department. He then discussed some recent studies using the sound intensity technique for noise source identification, including noise from an air conditioning plant and a business machine. **Marion Burgess**, a research officer for the Centre, reported on the findings from studies on the application of the sound intensity technique to measurements of the transmission loss of partitions both under laboratory and field conditions.

An inspection of some of the facilities of the Acoustics and Vibration Centre, including the anechoic chamber, and a demonstration of the sound intensity instrumentation followed the presentation. Almost half of the group then continued on for an enjoyable dinner in the Officers Mess at the Academy.

Marion Burgess

VICTORIA

September Meeting and AGM

At the AGM, **Charles Rossiter** and **Charles Don** were elected on to the Victorian Divisional Committee to replace retiring members **Rob Burton** and **Mike Snell**. Following the AGM was a presentation from **Greg Michael** from the Environment Protection Authority on Noise from the Very Fast Train. Greg reported that the expected noise levels are approximately 95 dB(A) at a distance of 25 m and 80 dB(A) at 200 m. Whichever route from Melbourne to Canberra is chosen the existing rail track will not be followed as the radius of curvature required for high speed operation is approximately 7 km.

Mike Snell

WA

September Meeting

Sound recording studios are always fascinating places to visit, for here are created the sounds we hear every day. They are even more fascinating when made the subject of a technical visit, for here acoustician meets artisan on common ground. Not surprisingly, a good turnout of members (about 17) enjoyed the visit to Planet Sound Studios in Subiaco on 27 September.

Perth is fortunate to have arguably one of the top studios in the country, if the succession of national and international artists is any indication. Features of the visit were:

- enormous "bass traps" (low frequency absorbers) mounted in the 4 m high ceiling space to complement the range of mid and high frequency absorbers
- the use of natural rock, in both the studio and control room, for its good

mid to high frequency dispersion

• the high degree of digital processing used in today's recording studio. The main 32-channel desk is analogue with computer control. Thereafter the signal is digitised for recording onto the master tape. Many of the original signals are digitally sampled, some passing through six digital processes.

• perhaps most interesting of all is the creature known as the recording engineer. Known to inhabit his lair for days at a time, this creature develops perhaps the most highly discriminatory hearing of any of the human species - the engineers at Planet were able to detect minuscule differences between analogue and digital sounds that none of the visitors could!

The interesting and informative visit of Planet Studios was guided by **James Hugall** and **John Villani.** Following the visit was the AGM of the Division and then a Mexican Banquet.

John Macpherson

STANDARDS

Australian - New Zealand Agreement

In line with the Australia/New Zealand Closer Economic Relations (CER) Trade Agreement, Standards Australia and the Standards Association of New Zealand (SANZ) have signed a Memorandum of Understanding which links quality management systems accreditation in both countries with international benchmarks. This development will particularly benefit Australian and New Zealand companies wishing to enter the other's marketplace and avoid the need for multiple assessment and its associated costs, pending the introduction of a Joint Australian/New Zealand Accreditation Scheme being developed by the governments of both countries, certification bodies and users.

New Australian Standards

The following Standards have recently been released:

AS 2012 Measurement of airborne noise emitted by earth-moving machinery and agricultural tractors - Stationary test conditions.

Part 1 - Determination of compliance with limits for exterior noise and

Part 2 - Operator's position (Revision of 1977 edition)

AS 3781 Noise labelling of machinery and equipment (identical with ISO 4871)

AS 3782 Statistical methods for determining and verifying stated noise emission values for machinery and equiment (identical with ISO 7574)

Part 1 - General considerations and definitions

Part 2 - Methods for stated values for individual machines

Part 3 - Simple transitition method for stated values for batches of machines

Part 4 - Methods for stated values for batches of machines

American National Standards

American National Standards on Acoustics are available from the Acoustical Society of America (ASA) Standards Program. Discounts are available for members of the ASA, for standing orders and for bulk purchases. Details from: ASA Standards Secretariat, 335 East 45th Street, New York, NY 10017-3483, USA.

VIBRATION AND NOISE CONFERENCE

Over 150 delegates attended the Australian Vibration and Noise Conference, sponsored by the Institution of Engineers and co-sponsored by Monash University, which was held at Monash University, from 18 to 20 September. The seventy contributed papers were presented in the appropriate sessions given the following themes: Environment, Control of Noise and Vibration, Modal Analysis and Modelling, Dynamics of Machines and Signal Processing. The Opening address was given by **Prof White** from ISVR, UK on "Vibration control of machinery installation and structures: some design procedures and experimental diagnostic techniques:. The four keynote papers were given by **Dr David Bies** from University of Adelaide, **Mr C. Staker** from SDRC, USA, **Prof S. Ibrahim** from Old Dominion University, USA and **Prof D. Brown**, University of Cincinatti, USA.

During the Conference there was a technical exhibition. **Prof J.D. Crisp** from Monash University gave a very entertaining speech at the Conference Dinner.

NATO ADVISORY COMMITTEE

Ray Piesse recently stood down as Chairperson of the Acoustics and Vibration Measurement Registration Committee. Ray was appointed to the Chair in 1979. **David Symons**, from DSTO, has now taken the Chair of the Committee. Four new members have joined the committee and the composition is now: Louis Challis (Consultant), K. Hews-Taylor (CSIRO), K. Cook (RMIT), A. Brown (Vipac), B. Gore (Dept Health) and R. Harris (CSIRO).

A recent resolution of the committee states that: *"the minimum set of requirements for the verification procedure for sound level meters shall be as stipulated in Appendix 1 of the Organisation Internationale de Metrologie Legale Recommendation No 58 (Oct 1984) with the additional requirement for the verifcation of a.c. output".* It is hoped that this resolution will overcome some criticism of the past NATA requirements.

EXCHANGE PROGRAMMES

There are a variety of international awards, fellowships and exchange programmes which can provide funding for Australian scientists and engineers. The applications usually have to be submitted well in advance. Details can be obtained from: International Exchanges Officer, Australian Academy of Science, GPO Box 783 Canberra, ACT 2601.

ARTICLES OF ASSOCIATION

The Articles of Association of the Australian Acoustical Society have recently been reprinted. Copies are available from the General Secretary of the Society , AAS - Science Centre, Private Bag 1, Darlinghurst, NSW 2010.

FASTS

The Federation of Australian Scientific and Technological Societies has continued to open up channels of communication with the Government. At a meeting with Simon Crean, issues such as shortages of skilled personnel, award restructuring and the need for more post graduate awards were discussed. FASTS is also making submissions to the Opposition which is continuing to rework its policies.

People

New Members

• Interim Admissions

We have pleasure in welcoming the following who have been admitted to the grade of Subscriber while awaiting grading by the Council Standing Committee on Membership.

New South Wales
Ms Sun Chao, Dr R Chivers (UK)

Queensland
Mr D M Borgeaud, Mr A C Monkhouse, Mr R H Palmer, Mr M A Simpson

Victoria
Mr B T McEniery, Mr I C Shepherd

Western Australia
Mr S L H Litobaski, Mrs R J Macmillan, Mr D A Nunn, Mr M J Sharman

• Graded

We welcome the following new members whose gradings have now been approved.

Subscriber
Queensland
Mr J Dodds

Member
New South Wales
Mr K Mikl, Mrs N M Murray
Victoria
Ms W L Saunders, Mr D J Dolly, Mr N A J Goddard, Dr R Richardson

* * *

New Qld Office

Growing demand in Queensland for noise, vibration and blasting services has led to acoustical consultants Richard Heggie Associates opening a Brisbane branch office. Company Director, **Dick Godsen** said that "the main impetus for our work comes from the mining, quarrying and construction industries, although we also have a strong involvment in architectural acoustics and environmental noise control".

The company has recently completed a research study into the effects of vibration and overpressure, mainly from blasting, on buildings and their occupants. This work, funded by the Australian Mining Industry Research Association was conducted in conjunction with the Julius Kruttschnitt Minerals Research Centre at Queensland University. The results of this wide ranging study are likely to influence the development and revision of standards and regulations for control of blasting emissions throughout Australia.

* * *

Moves in NSW

Gary Woods has made the move from the Environmental Design Group of the Building Management Authority in WA to head up the Acoustics Group in the Public Works Dept. of NSW. **Paul Bridge** has recently rejoined Eden Dynamics after spending about 5 years travelling the world.

* * *

Italian Connection

David Eden of Eden Dynamics, has indicated that the sister company, Rotor Dynamics, has recently won a contract with Davy McKee-McDermott for Woodside Offshore Petroleum. David will be commissioning the vibration monitoring system for the gas compressor which is to be tested at the manufacturer's facilities in Italy. During this time in Florence David hopes to sample the cultural delights, including Michelangelo's statue of him.

* * *

Company Changes

Flakt Australia has acquired the fan engineering and sound control division of Richardson Pacific Ltd. These divisions have been formed into a new company, Flakt Richardson, which will operate out of the former Richardson offices and which will be the largest fan supplier in Australasia.

* * *

Membership Values

Peter Knowland recently found his first membership receipt, dated 30th October, 1964. His was the second receipt issued; it is understood that **John Irvine** received the first. Peter estimates that the five pound membership fee would be equivalent to at least eighty-two dollars today.

* * *

New Australian Hearing Aid Industry

The Federal government has announced the establishment of a major new export industry which will greatly assist the hearing impaired. Minister for Aged, Family and Health Services, **Peter Staples**, announced changes to the operations of the **National Acoustic Laboratories (NAL)** which will improve the provision of hearing disability services and provide a major opportunity for developing the hearing aid industry in Australia. He said under a collaborative arrangement with **Australian Hearing Aids (AHA)**, NAL was set to capture a major share of the international market in the production of quality hearing aids.

NAL will enter into a collaborative arrangement with AHA for research, development and manufacture of state-of-the-art hearing products. AHA is a 50/50 joint venture between **Crystalaid**, a wholly owned Australian company and **Ascom Audiosys**, a hearing aid manufacturer and subsidiary of the Swiss telecommunications company, Ascom.

AHA will manufacture the hearing aids in Australia under a supply contract with the Government. They will establish a new world class manufacturing facility in Brisbane, from which they will also export the new products to countries such as Japan and the United States.

The new plant will be the sole producer, world-wide, of hearing aid remote control units for Ascom's market with 100 per cent Australian content.

The world market for hearing aids is estimated at 4 million units a year. Mr Staples said the arrangement will provide hearing impaired people with state-of-the-art programmaole hearing aids. The changes include establishing NAL as a statutory authority over the next two years to achieve greater client focus for people with a hearing impairment and the adoption of improved business practices.

"A range of strategies have been developed to ensure that clients receive the highest level of professional service and that people requiring urgent attention receive priority appointments, " he said.

"The improved delivery of services to hearing impaired clients will be managed by a new position of National Operations Manager who will be responsible for introducing improved business practices throughout the network of 44 permanent and 65 visiting hearing centres throughout Australia."

* * *

INTER-NOISE 91

The Inter-noise 91 Committee would like to help meet some of the expenses of delegates from "Pacific Rim" countries who could not afford to attend Inter-noise 91 without financial assistance.

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If any readers could offer accommodation in Sydney from 2-4 December 1991; could make a donation or offer any other assistance please would they let Fergus Fricke or the Inter-noise Secretariat, know as soon as possible.

Conference Secretariat:
Christine Bourke, the IPACE Institute, PO Box 1, Kensington 2033, Tel: (02) 697 3178 Fax: (02) 662 6983.

Fergus Fricke,
Department of Architectural Science,
University of Sydney 2006
Tel: (02) 692 2490

INTER-NOISE 90

INTER-NOISE 90 held during August in Gothenburg , Sweden, was very successful, with over 800 participants. Gothenburg is Sweden's second largest city and is located on the West Coast. Apart from the Opening Plenary Session in the Gothenburg Concert Hall, the conference was held on the campus of Chalmers University of Technology, a short tram ride from the city centre. After introductory remarks from the General Chairman, Tor Kihlman, **Manfred Heckl** presented a paper on the main theme of the meeting "Science for Silence". Two other distinguished invited lectures were presented at the commencement of each day's proceedings, by **A. Flock** on "Active 'noise' in the hearing organ, an aide to auditory sensitivity" and by **A. Cummings** on "Prediction methods for the performance of flow duct silencers".

Contributed papers were presented in up to eight parallel sessions, many specially arranged by well-known experts in their fields. The broad topics covered included Building Acoustics (sound insulation, sound intensity, low frequency reverberation room acoustics, structure borne sounds and sound absorption and scattering); Environmental noise, (including wind turbines, sound propagation); Transportation noise (railways, aircraft and road vehicles); Requirements, including noise labelling; Duct acoustics; Noise control (various sources, aircraft cabins, launchers and other vehicles); Analysis (including engineering applications of SEA); Effects of noise; Low frequency noise and vibration; Active noise control; Vibration; Measurement techniques; Hearing Protectors; Signal analysis and sound power measurements.

About 330 papers are printed in the two-volume Proceedings, and delegates came from about 40 countries. I am pleased to say that Australia was well represented. I addition to the Proceedings, delegates received a booklet "Fight the Noise" by Elvhammar and Landstrom, published by the Swedish Work Environment Fund and giving examples and solutions within companies and institutions in Sweden.

Over 30 Exhibitors presented their wares at the Technical Exhibition, which was well attended and held in an adjoining space to the main venues for the technical program.

Social occasions included a Civic Reception at Gothenburg Town Hall, and a Banquet held in the Students' Dining Hall, which culminated in a display of "horizontal" fireworks viewed through the glass walls. At the closing Plenary Session, Australia was given the opportunity to invite delegates to Sydney next December for INTER-NOISE 91 - this included showing a short video of Sydney and the University of New South Wales (the venue for the meeting) and the opportunity for delegates to sample some great Australian wine, kindly donated by the local Swedish agent for the Wyndham Estate.

As well as tours arranged for accompanying members (including an all day excursion along the scenic West Coast) technical tours were arranged on the Thursday after the meeting - the most popular of these were to the Volvo truck and bus factories, and to Saab. At Volvo it was interesting to see that the method-of-vehicle-production wheel has apparently gone full circle, from the early gradual developments of coach-building techniques, through sophisticated computerised automation and now back to small groups of mechanics carrying out a fair degree of hand assembly of individual vehicles (supported by Just-In-Time robotic parts suppliers!)

I am sure that INTER-NOISE 91 in Sydney will be just as interesting as other meetings in this series, and I do hope that a large number of Australian acousticians will participate - the Announcement and Call for Papers is being distributed and **Abstracts are due in by March 1st.** Acceptance will be notified by May 1st and the final papers are due by August 1st.

Anita Lawrence
General Chairman
INTER-NOISE 91

ASPAK

Software, suitable for micro-computers and code-named ASPAK (atmospheric sound propagation), has been developed by the CSRIO Division of Mathematics and Statistics for computing the paths and intensities of sound as it propagates outwards from a given source. One possible use of the software is to assist noise producers in scheduling their activities so that disruption to the community is minimised. Comparison of results from the computer program with field measurements is being carried out by the National Acoustic Laboratories. Additional program features planned include a module for enhancing data entry and a module for including reflection and absorption at the ground surface. When current research is complete, ASPAK will be put on the market (contact Jeff Prentice, 01 542 2646).

CSIRO Industrial Research News
June1990

Timbre Measurement

Howard Pollard
Honorary Research Scientist, School of Physics
University of New South Wales
Kensington NSW 2033 Australia

ABSTRACT: Experimental methods appropriate for analysing both transient and steady-state features of musical sounds are discussed. Representative sets of notes from a musical instrument can be used to categorise the timbre of the instrument by means of either a normalised spectrum or tristimulus coordinates. Emphasis is placed on graphical presentation. The techniques are illustrated with sets of organ tones.

1. ANALYSIS PROCEDURES

The analysis of musical sounds can proceed on three levels: physical, psychophysical and feature analysis. Table 1 summarises the information that can be extracted at each level.

The aim of feature analysis is to develop measures that mimic the assessment procedures used by the brain.

For *steady* musical sounds a basic method of analysis is the sampled 1/3 octave filter method [Pollard & Jansson, 1982b]; a typical measurement taking 40 sample spectra averaged over an interval of 4 sec. The mean level and standard deviation is then available. At low frequencies, the 1/3 octave band levels are combined into broader bands according to the ISO method [ISO 1966]. After conversion into loudness units, the next stage is to extract features from the band loudness spectrum appropriate for musical sounds. In particular, measures are required that will identify the tonal centre of the spectrum and the balance between high and low frequency spectrum components. As will be discussed below, sharpness and tristimulus values have been found valuable for this purpose.

For *transient* musical sounds, the first 80 ms of a recorded sound is analysed by an FFT program with a sliding time window function [Pollard et al, 1982c] producing sets of spectra at 5 ms intervals with an equivalent window width of 10 ms. The FFT data are then grouped into 1/3 octave bands (into slightly narrower critical bands if desired) and the signal levels converted into loudness units. From this analysis, sets of loudness growth curves, one for each band involved in the analysis, and corresponding derivative curves are produced [Pollard & Jansson 1982b]. The latter are valuable for deriving a number of features relevant to the starting transient [Pollard et al 1982c, Pollard 1988a], including the start-time, rise-rate and time to reach steady state for each of the partial tones.

Figure 1 is an example of transient analysis for the first 50 ms of the sound from an organ pipe (a Gedackt closed pipe having only odd-numbered partial tones, pitch C4). Figure 1(a) shows a set of 1/3 octave loudness growth curves; Figure 1(b) shows corresponding loudness derivative curves. The start-time for each band is taken as the time for which the rise-rate equals 600 dB/s (a rise-rate of 3 dB in 5 ms, a convenient threshold value). For the sound shown in Figure 1 the rise-rates are as follows:

Partial Tone:	1	3	5	7	9	11,13
Start-time (ms):	9	3.5	4.5	0	2	2.5
Time to reach SS (ms):	33	28	16	16	10	14
Overall Duration of ST (ms):	42					

Another feature of a starting transient is the presence of *dominant tones* — tones that have maximum rise-rate in specific time intervals. In Figure 1(b) the dominant tones, shown by the heavy envelope curve, and corresponding time intervals are:

Dominant Tone:	7	5	1
Time Interval (ms):	0-6	6-16	16-

Four characteristic features have been found to be involved in the assessment of a starting transient [Pollard 1988a]:

- The duration of the starting transient
- The presence of early noise
- The dominant tones present
- The degree of synchronism present
  (related to the range of start-times, the range of times to maximum rise-rate, and the range of times to reach steady state).

TABLE 1 —
Three levels of analysis and the information each produces

PHYSICAL ANALYSIS	PSYCHOPHYSICAL ANALYSIS	FEATURE ANALYSIS
Spectrum analysis of a musical sound	*Spectrum analysis weighted by the ear's characteristics*	*Involves processing by the brain*
• mean steady state level (dB)	• mean steady state loudness (sones)	
• spectrum at specific times during the attack, steady state, decay	• loudness spectrum at specific times (response of the ear's critical bands) • masking effects	• loudness • pitch • timbre • sharpness • fluctuations of loudness, pitch, timbre
• starting times of each partial • rate of rise of level of each partial • times to reach steady state for each partial • overall duration of attack		• assessment of attack: • early sound • duration of attack • dominant tones • synchronism Other factors including • roughness • compactness • missing or inharmonic partials

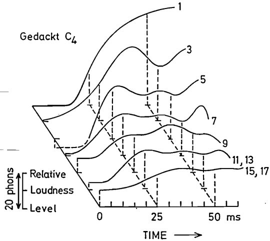


Figure 1(a): Growth curves for a Gedackt 8' organ pipe sounding middle C. The numbers adjacent to the curves indicate the partial tones present in each 1/3 octave filter band.

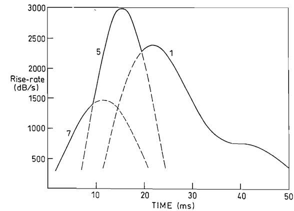


Figure 1(b): Derivative curves for the Gedackt organ pipe. The envelope curve shows the dominant partial tones at particular times.

2. TRISTIMULUS METHOD

From the evidence presented in the previous part of this article [Pollard 1990], three dimensions have been found sufficient to categorise timbre. An analytical procedure for representing timbre, both for the starting transient and in the steady state, has been introduced by Pollard and Jansson [1982a]. Spectral measurements are reduced to three normalised coordinates (called tristimulus coordinates) which then enable the data to be shown simply in graphical form. The 1/3 octave spectrum levels produced by either the sampled filter method [Pollard & Jansson 1982b] or from FFT analysis [Pollard et al 1982c] are converted into loudness units and then grouped as follows:

1 the loudness of the band containing the fundamental,
2 the equivalent loudness of the bands containing partial tones 2, 3, 4,
3 the equivalent loudness of the bands containing partials 5 and upwards.

This grouping acknowledges that the fundamental tone of a musical sound has special significance and that the first 5 or 6 partials of harmonic sounds occupy separate critical bands with more than one partial occupying each band for the higher partials. The higher partials are important for timbre but as a group rather than as individuals. Equivalent loudness is computed using Stevens Mark VII method [Stevens 1972].

The sum of the three loudness groups is then

$$N = N(1) + N(2,4) + N(5,n) \qquad (1)$$

where
N(1) is the loudness of the fundamental,
N(2,4) is the equivalent loudness of partials 2-4,
N(5,n) is the equivalent loudness of partials 5-n.

Each term on the right-hand side of Equation (1) is regarded as a tristimulus value from which a set of normalised coordinates x, y, z may be formed by dividing each term by N. Thus,

$$\begin{aligned} x &= N(5,n)/N \\ y &= N(2,4)/N \\ z &= N(1)/N \end{aligned} \qquad (2)$$

The advantage of normalising the coordinates (making $x + y + z = 1$) and of using the fundamental of the sound as reference is that this representation is now independent of both loudness and pitch: x, y and z represent only timbre. Since the coordinates are normalised, the data may be represented by two-dimensional section diagrams, graphing, for instance, $(x-y)$ or $(x-z)$.

A measure related to sharpness [Bismarck 1974] may be formed by taking the ratio x/z. The x/z ratio correlates highly with sharpness but there is a difference in meaning. x/z measures the proportion of high-frequency partials compared with the fundamental whereas sharpness determines the balance point around which the high- and low-frequency components of the spectrum have equal loudness "weight". x/z may be used to quantify the rather vague concept of the "brightness" of a sound.

The tristimulus method is useful in representing both the tonal changes that occur during the starting transient and the timbre of the steady state. Figure 2 shows an example of a tristimulus diagram for the starting transients of two organ pipes sounding middle C. Both the Principal (an open flue pipe with moderate harmonic development) and the Gedackt (a stopped flue pipe with only odd harmonics) show a progressive shift in emphasis from initial high frequency partials to predominance of lower order partials during the steady state (shown by a larger filled circle in the diagram).

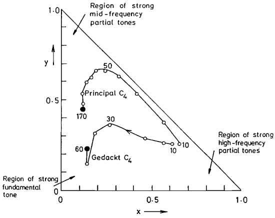


Figure 2: Tristimulus diagram showing timbre changes during the starting transient for a Gedackt 8' and a Principal 8' organ pipe both sounding middle C. The numbers adjacent to the curves indicate the time in milliseconds after the onset of the sound. The larger filled circles indicate the region corresponding to the steady state.

3. STEADY STATE ANALYSIS OF SETS OF NOTES

The tristimulus diagram has proven useful in studying a variety of tonal problems. For instance, the changes in timbre that occur when different singers sing the same note or different instrumentalists play the same note [Pollard 1988b] have been studied. The method can also be used to study sets of notes played on different instruments. The method has the potential to tackle the age-old problem of defining the overall "quality" of an instrument. Musicians often test an instrument by playing a series of scales or other sets of notes as well as a number of test pieces. For a keyboard instrument it is not necessary to analyse every available note, a representative subset is usually sufficient.

Pipe organ tones are popular in tonal studies since they have the advantage of reproducibility when testing new procedures. Choosing a representative set of sounds is rather complicated since there are a large number of separate ranks of pipes, each rank covering at least a 5-octave span. It is necessary to select both a limited number of ranks and a limited number of notes within each rank. A set of pipes designed to cover a 5-octave range from C2 (65 Hz) to C6 (1046 Hz) usually shows changes in timbre from bass to treble. Organ builders must juggle factors such as the length, diameter and shape of pipes in order to achieve the pitch and timbre of sound desired. From a technical viewpoint it might appear to be ideal for a given rank to have a uniform timbre throughout its range. In practice, for a variety of reasons, ranks of pipes have a different harmonic development in the bass than in the treble. This is especially so for reed pipes for which organ builders have always had problems maintaining both harmonic development in the bass than in the treble, but, of course, the reasons are different.

It has been found that a set of 7 notes, consisting of the C and G notes from C3 to C6, is adequate to characterise a chosen rank of pipes. The minimum number of ranks to be studied would normally include at least one representative of principal, flute and reed pipes. As an example of the technique applied to the organ, the following will describe the analysis of selected ranks of pipes from the organ in the Great Hall, University of Sydney.

Two procedures that may be used to analyse this type of problem are: (1) the use of a reference loudness spectrum, comparisons being made between the spectrum of each note and the reference, (2) the use of tristimulus values to compare each note with a reference value (which may be the mean of the set or an independent mean).

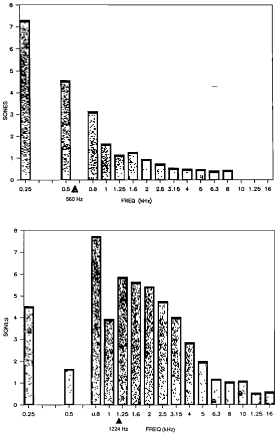


Figure 3: Normalised spectra for (a) a set of 7 Principal 8' pipes, (b) a set of 7 Cromorne 8' pipes.

The arrowhead marks the position of the relative sharpness value. Such spectra form a useful reference for the comparison of sounds from different instruments.

3.1 Normalised Spectrum

It is possible to take a representative note such as middle C (C4) as a reference but a more satisfactory reference spectrum is one that has been normalised with respect to pitch. Such a spectrum can be formed by frequency-shifting the individual loudness spectra of the different notes comprising a set. From the set of spectra for the C and G notes (C3 and C6) from a rank of principal pipes (the Principal 8' of the Great Hall, Sydney University, Positive division), the band loudness values were shifted to coincide with those for the note C4 and then the loudness values averaged. Figure 3(a) shows a normalised spectrum for a similar set of C and G notes from a rank of reed pipes (the Cromorne 8' of the Great Hall Positive division).

A comparison of the two normalised spectra reveal quite different overall spectral envelopes. The Principal pipes have strong low-order partial tones with a gradual tapering off in strength at higher frequencies. The tone is moderately bright with strong fundamental and octave sounds. The Cromorne pipes have strong middle-order partial tones and stronger higher partials. The tone is strong and bright with a somewhat light fundamental.

The same technique can be used to make comparisons between sets of notes from different instruments, for instance, sets of notes played on two or more violins as part of a comparison test, or sets of notes from different organs, and so on. From the point of view of an instrument maker, there is an advantage in studying the complete spectrum since the effects of changes to an instrument can be readily detected and evaluated.

3.2 Tristimulus Data

The tristimulus method provides a measure of the tonal effect produced by an instrument (with pitch and loudness normalised). The method is useful for comparing the timbre of sets of representative notes. Figure 4 shows the results of tristimulus measurements made on sets of Principal 8' and Cromorne 8' pipes from the organ in the Great Hall, Sydney University, together with the corresponding changes in sharpness and x/z.

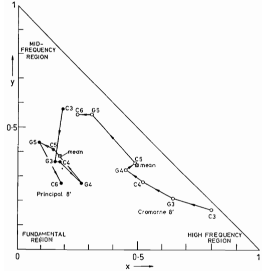
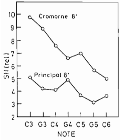


Figure 4(a): Tristimulus diagram showing the steady state coordinates for sets of C and G notes from a rank of Principal 8' flue pipes and the same notes from a rank of Cromorne 8' reed pipes. The sounds were recorded in the Great Hall, Sydney University at a distance of 9 m from the pipes. The notes played on the Positive division are designated C3, G3, C4, G4 . . . C6. There is a bass-to-treble trend (C3 to C6) in the Principal sounds from strong mid-frequencies towards a more fundamental flute-like tone. The Cromorne is brighter in the bass than in the treble.



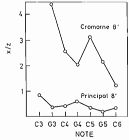


Figure 4(b): Relative Sharpness diagram for the notes shown in (a). The pitch corresponding to a given value of SH(rel) may be estimated by noting that the second harmonic (interval of an octave) lies in band 4; the fourth harmonic (interval of two octaves) lies in band 7. Thus, a sharpness value of 4.0 indicates that the centroid of the loudness spectrum lies one octave higher than the fundamental.

Figure 4(c): x/z diagram for the notes shown in (a). It may be noted that the kink in the graph for the Cromorne 8' rank (Figure 4(a)) corresponds with a marked peak in the x/z graph (representing a brighter sound) and a smaller peak in the sharpness graph.

As the pitch changes from C3 to C6, the changes in timbre in both cases are observed. The Principal 8' maintains its tone reasonably well although there are some substantial changes in timbre; notes G4 and C6 have a greater fundamental component and the sound tends to be more flute-like. The Cromorne 8' has bright sounds at lower pitches with a progressive shift towards mid- and low-frequency components at higher pitches. This behaviour is reflected in the sharpness and x/z graphs.

TABLE 2 —
Tristimulus data for the sets of 7 Principal 8' (flue) pipes and 7 Cromorne 8' (reed) pipes

	PRINCIPAL 8'		CROMORNE 8'	
	mean xyz	norm	mean xyz	norm
x	0.174	0.183	0.495	0.492
y	0.385	0.363	0.346	0.339
z	0.440	0.454	0.159	0.169
SH	4.1	4.5	7.2	7.9
x/z	0.43	0.40	2.6	2.9
% Coeff of variation:				
x	29		35	
y	26		42	
z	21		35	
SH	16		22	
x/z	46		39	

In Table 2 are shown the mean and coefficient of variation (mean divided by the standard deviation) for x, y, z, SH (rel), x/z for the sets of Principal and Cromorne notes.

Tristimulus values were computed for the normalised spectra; these are also shown in Table 2. The normalised values agree closely with those for the means of each set of notes. It therefore seems reasonable to use the normalised spectrum as a reference when comparing loudness spectra and the mean tristimulus coordinates when making timbre comparisons.

Tristimulus data may also be displayed in the form of a pie chart. Figure 5 shows pie charts for the mean tristimulus coordinates for the sets of Principal and Cromorne pipes previously described. The relative proportions of high frequency partials (x) and the fundamental (z) in the two cases are particularly noticeable (the sharpness values for the two sets are 4.5 and 7.9 respectively); the x/z ratios are 0.43 and 2.6.

4. DISSIMILARITY

The essential differences between two or more spectra or their tristimulus coordinates may be studied using dissimilarity measures [Plomp 1976]. When a sound is analysed with a set of n filters, the resulting n band levels may be regarded as coordinates of a point in n-dimensional space (with orthogonal axes). For instance, critical band analysis using all 24 filter bands would give rise to a point in 24-dimensional space. In practice a smaller number of bands usually suffices.

The spectral dissimilarity, D(i,j), between two tones i and j is given by (general Minkowski metrics):

$$D(i,j) = \left[\sum_{k=1}^{n} |L(i,k) - L(j,k)|^{a} \right]^{1/2} \qquad (3)$$

where L(i,k) is the level of tone i in band k. D(i,j) measures the distance between two points (the interpoint distance, ID) in the n-dimensional space.

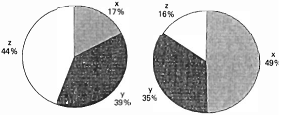


Figure 5: Pie chart representation of the tristimulus coordinates for (a) the set of 7 Principal 8' pipes, (b) the set of 7 Cromorne 8' pipes. Corresponding x/z ratios are 0.43 and 2.6. Both the charts and the ratios reflect the relative proportions of high frequency partials (x) and fundamental (z) in the two cases.

For the type of analysis discussed here, it is appropriate to put a = 2 (Euclidean metrics). It is clearly advantageous to reduce the number of dimensions, n, by some means: for instance, the tristimulus method reduces the analysis to three dimensions.

The D(i,j) in Equation (3) represent the *total dissimilarity* between the two sounds. This could include differences in pitch, loudness and timbre. Jansson [1976] has described a method in relation to two sounds having the same pitch in which the remaining dissimilarity due to loudness and timbre may be separated. The set of band levels for one sound is shifted progressively in small steps up or down until a minimum value of D(i,j) is found. The total spectrum dissimilarity is then considered to be made up of a *level dissimilarity* together with a spectrum *shape dissimilarity*.

Dissimilarity measures can be applied to two normalised spectra or to two sets of tristimulus coordinates. For normalised spectra, Jansson's method is needed since only pitch has been normalised leaving level and shape differences. For tristimulus coordinates Jansson's procedure is not necessary since both pitch and loudness have already been normalised.

Figure 6 shows the result of applying dissimilarity analysis to two normalised spectra: the set of Principal pipes shown in Figure 4(a) and a similar set from a previous analysis a few years earlier. The level dissimilarity is zero (the two sets of measurements have the same average loudness) and the shape dissimilarity (minimum interpoint distance) is 1.6 sones, thus reflecting only a minor tonal change. Figure 6 clearly reveals where the significant spectrum differences between the two sounds occur.

5. FLUCTUATIONS

Fluctuations in pitch, loudness and timbre, sometimes called the microstructure, are important properties of individual musical sounds. Without such fluctuations musical sounds are judged to be lifeless or artificial. When computing the initial sampled loudness band levels, the standard deviation and coefficient of variation for each measurement is determined, providing useful measures of the loudness variations in each band for each note. It is also possible to compute changes in pitch [Grey & Moorer 1977] for the individual signal samples or changes in timbre from the individual sample spectra [Segal 1983, Pollard 1988a].

A second type of variation is that which occurs from note to note in a set. As shown in Table 2, the values of the coefficient of variation provide a measure for this type of instrumental fluctuation.

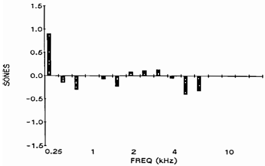


Figure 6: Spectrum shape dissimilarity diagram for two sets of measurements on the same 7 Principal 8' pipes from the same organ at an interval of 14 years. The diagram reveals no change in average loudness and only a small tonal change (a shape dissimilarity of 1.6 sones).

6. SUMMARY

By taking into account known properties of the ear and brain it is possible to analyse musical sounds in terms of a number of appropriate features. The starting transient is characterised by an assessment of four main features [Pollard 1988a, 1988b]: early sound that occurs in the first few ms, the duration of the starting transient, the presence of dominant tones and the degree of synchronism. The timbre of steady sounds may be specified using tristimulus coordinates, sharpness, x/z and coefficients of variation.

The normalised spectrum acts as a type of "machine signature" for a particular instrumental sound. By establishing a suitable reference spectrum, changes in the instrumental sound over a period of time, changes that occur before and after restoration, or comparisons between different instruments may be made. Dissimilarity analysis provides a useful way of emphasising the changes due to loudness variations and those due to timbre variations.

Tristimulus coordinates provide a useful measure of timbre and may be displayed in both graphical and tabular form for sets of representative notes from an instrument. The mean values for a limited number of representative notes may be used as a timbre reference when making tonal comparisons. Changes that occur, either with age or by instrumental adjustment, may be studied using dissimilarity analysis applied to the tristimulus values.

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Acoustics and Noise Control Activity

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The Acoustics and Noise Control project group at the CSIRO Division of Building, Construction and Engineering, based at Highett, have a long history of involvement in acoustics and fluid mechanics dating back more than 25 years. Eight staff currently comprise the Architectural Acoustics group of the former Division of Building Research and part of the Fluid Mechanics group of the former Division of Energy Technology (previously Mechanical Engineering). The current members of the group are Ian Shepherd, John Davy, Des Burton, Frank LaFontaine, Ian Pearson, Ian Dunn, Rex Broadbent and Tony Swallow. The range of staff expertise spans the areas of acoustics, vibration, fluid mechanics and electronics which are all necessary to contribute to world class research.

The groups' activities fall into one of three levels of research namely strategic research, tactical research and testing. Strategic research, of general relevance, is undertaken as an investment in the scientific future of the group but is not directly applicable to a particular problem. The output of such activity is in the form of published information such as journal or conference papers. Tactical research is aimed at solving a particular problem or group of problems and is normally undertaken as a collaborative project which is funded wholly or partially by the external beneficiaries. Testing is carried out on a fee-for-service basis for consultants and manufacturers and/or users of the product(s).

Listed below are some of the groups activities over the past few years:

- **Acoustic testing facilities.** The Division has one of the most comprehensive acoustic test facilities in Australia. A complex of five reverberant chambers, an anechoic chamber and three impedance tubes allows sound power, acoustic absorption and transmission loss measurements to be made on most types of construction and on machinery in general. The facilities are available for use on a fee- for- service basis.

- **Building Acoustics.** The acoustic characteristics of various building elements such as walls, doors, windows, floors and roofs have been measured and modelled mathematically.

- **Machinery noise control.** Various types of machinery have been successfully quietened. These include lawnmowers, air conditioners, vacuum cleaners, washing machines, hair dryers and ventilating fans for mining and automotive applications.

- **Duct acoustics.** Theoretical (Finite-Element and Finite-Difference techniques) and experimental research determined the acoustic transmission properties of various duct elements such as lined and rigid walled ducts, bends of various design, splitters and terminations. The elements were characterised in a way which allowed a "systems" approached to the acoustic design of duct systems.

- **Active Attenuation.** Several systems were developed which cancelled ductborne sound by injecting an artificially generated sound of opposite signature. Attenuation greater than 20 dB was achieved on random broad-band noise over the frequency range from 20 Hz to 700 Hz. The systems offered no resistance to air-flow in the duct and worked at low frequencies where conventional methods are ineffective.

- **Machine Dynamics.** The dynamic behaviour of machines has been modelled mathematically and the models solved numerically on computer. This has facilitated prediction of dynamic behaviour of machines without recourse to physical testing. Both time domain (transient response) and frequency domain solutions have been obtained.

- **Active Vibration Isolation.** Active vibration isolation mounts, which offer reduced transmission isolation at high frequencies while maintaining a low frequency restraint function, are under development. These are essentially low-pass filters for fluctuating forces, which have a steeper cut-off slope than conventional systems.

- **Combustion noise.** Sound generated by combustion has been investigated on several occasions. It has been possible, in some cases, to reduce the noise considerably by modifying the fuel-air mixing process. More fundamental research on the interaction of sound and combustion is current.

- **Fan noise.** The latest theories of aerodynamic sound generation have been applied to centrifugal and axial-flow fans. This has involved detailed measurement of the flow patterns in the fans, but enables the fan tonal noise to be predicted and has revealed strategies for noise minimisation.

- **Fluid Flow Mapping**. A new optical technique for mapping the distribution of fluid flow velocities over a plane has been developed. The technique is called Particle Image Velocimetry (PIV) and is many times faster than any other known method. The CSIRO system is being developed to increase its speed and convenience further. The system allows the measurement of instantaneous flow velocities at an indefinite number of points on a plane simultaneously and has been used with great success to measure flow patterns around bodies and in fans for calculations relating to the production of aerodynamic sound.

Enquiries relating to the activities of this group should be directed to Mr Ian Shepherd (03) 556 2674.

AAS Annual Conference

Perth, April 1990

Achieving consensus between the "linear' and "non-linear" people in a design team is essential for a high quality interior noise climate to be obtained, according to **Professor Harold Marshall** in his opening address to the Conference. Acousticians and engineers, of course are "linear" people, working from physical laws and physical constraints. Our physical laws, however, cannot always explain the experience of "non-linear" people such as the "craftspeople" (musicians etc.) and "power" people (finance, politics, media). We need to recognise their input if a satisfactory end result is to be achieved; and Professor Marshall went on to show how a fast acoustic modelling process can facilitate this interaction.

This presentation held about 75 delegates spellbound, and set the context for the following papers on the theme "Interior Noise Climates".

Louis Challis opened the second day with an historic "tour" through New Parliament House, Canberra. The Conference theme provided a fitting forum for him to illustrate the host of challenges which face the acoustical consultant on a project of that magnitude. To have Louis as a keynote speaker recognised his role in that project, and in overcoming the "cultural cringe" to be selected ahead of overseas consultants!

In the closing session Louis suggested that an appropriate theme for a future Conference, as a sequel to the "linear/non-linear" concept of Professor Marshall, would be "Politics and Acoustics".

But Where Were the Architects? . . . The Conference theme was an architectural one, so the organisers sent 750 brochures to RAIA members in Western Australia - we received not a single query, let alone a registration! We phoned up about 30 local architects and received a very lukewarm response, "if we have a problem, we get a consultant ...". One wonders what happens on all the projects consultants don't see! If this is typical of other states, then the Society has a major challenge before it in bridging the gap between acousticians and architects.

President's Prize . . . A highlight of the Conference was the awarding of the first President's Prize for the best paper by an A.A.S. member presented at the Conference. This was won by **Associate Professor Michael Norton** of the Department of Mechanical Engineering at UWA and his assistant **Jules Soria** (now at Stanford University) for their paper on the tape recording of sound intensity signals via the quarter - square multiplier principle.

The Best Conference Dinner I Have Been to . . . " . . . These words of Harold Marshall were echoed by many delegates who enjoyed superb food and local wines in the delightful visual setting of the Royal Freshwater Bay Yacht Club and the equally delightful acoustic environment provided by "Stringybach". Likewise, the Cottesloe Beach Resort proved a relaxed, intimate venue for the main sessions. Some of the more intrepid visitors were seen swimming on the Wednesday afternoon before the Sundowner!

Thanks, folks . . . The Conference received a set-back with the prolonged airlines dispute of 1989, the scheduled November Conference having to be postponed to April 1990. Fortunately, all but three of the authors were able to attend the postponed Conference, though many were undoubtedly inconvenienced to some extent. Hopefully the success of this Conference has erased memories of November 1989!

AAS Federal President Stephen Samuels presents Prof. Harold Marshall and Mrs. Marshall with a gift in appreciation of his contribution as keynote speaker.

Stephen Samuels, Federal President, presents a gift to Louis Challis in appreciation of his contribution as keynote speaker.

AAS Federal President Stephen Samuels presents Associate Professor Michael Norton with the inaugural President's Prize, for the most outstanding paper presented at the Conference - an historic moment?

Financially, the Conference produced a modest profit, thanks mainly to the support of the four major sponsors: Ansett Airlines, Bruel & Kjaer (Aust) Pty Ltd, CSR (Bradford Insulation) and Warburton Franki (Rion). Thanks also to the keynote speakers and authors for the hard work, and to those who helped with organisation.

Extra, Extra . . . Conference Proceedings are currently available from A.A.S. (W.A. Division), P.O. Box 7055, Cloisters Square, PERTH WA 6000.

Please enclose a cheque for (Australian) $45.00 each copy, which includes postage within Australia and New Zealand. For overseas orders, please add (Australian) $5.00 for each copy ordered. After 20 April 1991, any remaining copies of the proceedings will be available through the A.A.S. Publications Officer (see Information Page)

John Macpherson.

Focus Group Reports

Six focus groups were held - three on each day, with the aim of stimulating discussion on topical issues, drawing forth the anecdotes, opinions and ideas of delegates who were not presenting papers and fostering networking among people with common interests.

The groups were opened by introductory speakers who briefly discussed the topic from their own viewpoint. The facilitator then opened the topic to the group. A summary of each of the groups is presented below.

1. Open Plan Offices

Facilitator - **Louis Challis** (Challis & Associates Pty Ltd, NSW) Introductory speakers:- **Marion Burgess** (ADFA, Canberra), **Colin Nicholas** (Architect, WA) and **Peter Barrett** (Education Department WA).

The introductory remarks and subsequent discussion centred around four main issues:-

Acoustic Performance

- Laboratory data is available for many components but may have little relevance in practice;
- Detailed design guides are now available.

Acoustic Masking

- A view was put that masking noise should be avoided as it could result in increased worker stress levels over time;
- Counter view was that masking is necessary but must be carefully designed by experts;

Budget and Brief

- Architect has to realise the brief within a budget, which often dictates whether the result is "human" or "Spartan",
- Architect needs three levels of consultation at all stages; management - workers - acoustic consultant;
- Problems arise when the client's needs change, causing a design change which affects the acoustics;
- There is an unfortunate perception by some clients that detailed specification of acoustic and ergonomic requirements will make the project too costly.

Ergonomic and Personnel Factors

- Open plan is more flexible than enclosed offices but not necessarily cheaper as is commonly thought;
- There is a tendency to "open view" rather than open plan, using full height glass partitioning;
- Density of people is important. People complain less if they have their own "space";
- Amelioration of problems through behavioural change was discussed.

Summary

There appears to be a need for an Australian Standard to address some of the issues raised.

2. Industrial Buildings

Facilitator - **Paul Keswick** (Sound & Vibration Technology, WA)

Introductory speakers: **Barry Carson** (Bradford Insulation, WA) and **Robert Fiddoch** (Archiplan, WA).

This group looked at a specific issue:-

"Should statutory building approvals require that acoustically absorptive treatment be installed in new industrial buildings at the time of construction?"

Some typical dollar costings were presented for a new factory roof:-

- With zincalume and mesh gutters $18,500 - $19,000 installed;
- With 50 mm perforated Anticon included $25,000 - $26,000;
- To lift roof and insulate later $39,000 - $41,000.

Some of the benefits were identified:-

Energy Saving . . . Energy saving of 3-5% in a small factory (from group members' recollection) and improved light reflectance with foil facing.

Lower Occupational Noise Levels . . . Effective in the reverberant field but not at close operator positions and effective for large numbers of employees in a factory, not effective in quiet factories with few employees.

Lower Environmental Noise Levels . . . Factories with lining can sustain higher internal levels if near residential areas, representing greater flexibility in leasing and operating (especially if lining is combined with extra transmission barrier) and changing uses over the years represents a possible retrofit cost.

Other Benefits . . . Improved productivity due to improved speech intelligibility, general comfort and safety, lower workers' compensation payouts, increased production etc.; and addresses traditional inequality between blue collar workers in the "sweat shop" versus white collar workers in air-conditioned comfort.

Summary

It is common for absorptive treatment to be incorporated in new commercial industrial estates, as this becomes a marketing feature. The consensus was, however, that a requirement for absorptive treatment could not be justified on the grounds of any one benefit. However, the *combined* benefits are such that absorptive treatment is likely to be highly desirable in terms of cost benefits. There is a need for research to quantify the benefits of a treated factory against the standard reverberant factory. The group also felt governments could lead the way by treating all new industrial-type buildings. Developers need a simple guide as to the types of materials to use for industrial buildings where treatment is likely to be needed.

3. Acoustics in Schools

Facilitator - **Norbet Gabriels** (Building Management Authority, WA).
Introductory speakers:- **Anne Macpherson** (Deputy Principal, Australind S.H.S., WA), **Mike Kateifides** (P.W.D., NSW, **Geoff Barnes** (Acoustic Design, Vic.) and **Warwick Williams** (N.A.L., NSW).

This group provided an interesting example of Professor Marshall's "linear/non-linear" concept. Anne Macpherson, in the role of"craftperson", outlined the acoustical requirements from a teacher's viewpoint, while the Acousticians grappled with the technical implications.

Some of the issues raised and discussed were:-

- Need for total intelligibility of teacher's voice when teaching languages;
- Need for full modulation of teacher's voice to be audible in languages and other areas of teaching;
- Need for teaching rooms to be neither too absorptive nor too reverberant;
- External noise problems from other classes (especially cluster schools), outdoor activities, traffic, etc.

Planning issues were also raised, in particular a case in NSW where a new school is to be located under a flight path.

The group resolved:- That the A.A.S. adopt the following position regarding acoustics in schools:-

There is a need for acoustic evaluation to be an integral part of the site selection and site planning process. This early involvement is considered imperative if the acoustical needs of the learning environment are to be met.

The need for this evaluation should be brought to the attention of the Education Ministers for their action in modifying land acquisition processes and acoustic design procedures.

4. Noise and Urban Planning

Facilitator - **Stephen Samuels** (ARRB, Victoria).
Introductory speakers: **John Lambert** (E.P.A., S.A.), **Allan Herring** (Herring Storer Acoustics, W.A.) and **Tom Brazier** (Perth City Council, W.A.).

Historically, environmental agencies have been set up to patch up planning decisions made 50 - 100 years ago in a society where people walked to work. There is presently a need for effective land use planning so that the decisions made today don't saddle future generations with the same problems. Such planning leads to change and objection, with many projects ending up in lengthy legal battles. Councils and government agencies are called on to make courageous decisions - "politics versus engineering".

Several possible legislative strategies were discussed:-

- Maximum permanent noise levels rather than comparison with measured background levels; and
- Buffer zones - difficulty in establishing size, expensive.

Music from hotels, discos etc. and outdoor concerts was highlighted as a major current cause of complaint (85% of complaints in one case). This is both a planning problem (changed land uses e.g., football ground becomes a concert venue, with attendant parking problems) and an assessment problem.

Criteria for assessment were discussed in relation to both music and other noise, for example:-

- Leq, short periods down to 60 seconds possible, 15 minutes typical.
- Leq, plus peak, e.g., helicopters;
- For music, 8 dB above background in any octave band (previously 63Hz and 125 Hz).

Summary

There is a need for effective land use planning if past mistakes are not to be repeated. This calls for the careful detailing of planning application procedures, assessment parameters, and acceptability criteria. The involvement of non-technical people in the planning process needs to be approached creatively in line with Professor Marshall's "linear/non-linear" model.

5. Noise Labelling

Facilitator - **Stuart MacLachlan** (SPCC, NSW).
Introductory speakers: **Ian Eddington** (Toowoomba CAE, Qld.), **Owen Jeffries** (CWAI representative on Hearing Conservation Advisory Committee, W.A.) and **Neil Byrne** (AMWU, TLC representative on HCAC, W.A.).

In general, the group perceived two distinct forums for the labelling debate - environmental protection and occupational health. The "Green Spot" campaign for example aims at achieving a lower noise environment in the home or for the neighbours, while occupational noise legislation requiring "provision of information" aims to achieve lower occupational noise exposures. In both forums, the two important issues were:-

- Is labelling meant to assist an informed purchasing choice?
- Or, is labelling intended to advise immission levels to achieve compliance with an exposure standard?

In terms of occupational noise, labelling raised a number of concerns related to standardisation of measurement procedures, policing, and the practical difficulty and cost of labelling existing machines in operation in a workplace.

Labelling was, however, also seen to be desirable, even essential in the occupational context since present noise survey requirements were not getting the information to workers and trigger mechanisms are needed to make employees aware of noise hazards so appropriate action can be taken.

Several strategies for occupational noise labelling were discussed, including:-

- Provision of technical information in the form of a data sheet prior to or at the point of supply;
- A "hazard alert" label; and
- Noise labels on existing plant in the workplace, detailing noise exposure data.

While there was general agreement on the relevance of the first two strategies, the third raised concerns regarding the practical difficulties of providing a label with accurate data in an understandable form, especially when this data may be confused with environmental noise labelling data.

Summary

Noise labelling was seen to be far more advanced in the environmental context than in the occupational context. Simplicity is essential and dual systems need to be avoided if possible. The audience needs to be identified and the labels designed accordingly. A good public information campaign is needed for noise labelling to be successful.

Continued P 80

Neville Fletcher

Interviewed by Graham Caldersmith

The first part of this interview was published in Acoustics Australia, Vol 18 No 2, Sept 1990.

In addition to the activities described in my preface to Part A, Neville has served as a member of the Australian Research Grants Committee 1974-1978, on the Australian Academy of Science as Member of Council, 1979-1984 and Secretary for Physical Sciences, 1980-1984, as President, Australian Institute of Physics, 1981-1983, and continues on several advisory boards and councils. He was Professor of Physics at UNE, Armidale 1963-1983, Director of the Institute of Physical Sciences, CSIRO, 1983 - 1987 and is now a Chief Research Scientist, CSIRO Division of Radiophysics. He continues to augment his 121 publications including three books.

GC.

Part B - Organisation of Research

Do you think the popular appeal of these new theories will generate a bandwagon that will draw limited funds from sound mainstream projects like gravity wave detection and superconductivity?

No, I think esoteric work like chaos theory and fractal geometry requires pretty smart mathematicians and a few advanced computers and they do bring science to the public effectively, though only at one level, but they don't demand the sort of expenditure on equipment and technical staff that gravity wave detection and high temperature superconductivity need. It's hard to know what to do about our commitment to the sort of projects like superconductivity that soak up vast amounts of research time just to bring us into the race to commercial application - and there's no guarantee we will win the race, though we will run across some useful results on the way. Australia has taken a middle course in superconductivity funding from government and industry to the extent of several million dollars to date and I think this is a sensible course for us, given the lottery of finding commercial return.

One of the peculiar things about science funding today is that the contraction of funds for pure science, the pressure to go commercial with contracts, and so on, that we see in Australia is also evident in America, England, Germany, and even in China. It looks like the politicians have all read the same book. The push on science to get us into the high-tech industries for economic survival makes the swing to applied science inevitable. But, in my view, there isn't more or less joy in doing applied science and in fact the sort of problems you have to deal with and the methods used to tackle them are very similar. I find it just as exciting to do industrial research now as I did to do pure research in years past - and it's nice to know that someone is interested in the results! (You rarely even get requests for reprints now, with the availability of photocopiers.) The people in CSIRO that I work with are all enthusiastic about working with industry, although we find a lot of time is required to organise the cooperation - scientists are not terribly good at negotiating contracts etc. - but it really has to be this way now.

When you were Director of the Institute of Physical Sciences at CSIRO many divisions underwent traumatic restructuring - some even disappeared. What was that like?

Some divisions were practically oriented anyway; others were doing good academic work that one would be happy to see in a university department but they had become remote from the charter of the CSIRO. I think in a university the only obligation should be to do interesting, intellectually challenging research, the only restriction being that students should have good PhD prospects in the chosen fields. In CSIRO we should be doing something different, except when the opportunity to investigate a beaut, original, basic idea comes along and we happen to have the expertise and the equipment. But if that project stretches into decades and the people run out of steam I think we are off the rails.

But, yes, the cuts averaging four percent a year while I was there did create trauma. Some labs went down twenty five percent in staff, very demoralising, although one or two like information technology were even able to grow. The restructuring began gradually, but in the last two years I was there we were working hard on rationalising divisions and they were reduced from fifty to about forty which was pretty hard on the chiefs. My feeling now, three years later, is that the divisions have stabilised in their new forms and are working effectively. The Directors of the Institutes have now to spend most of their time with industry rather than concentrating on the science being done and that requires a different sort of person. I wouldn't feel comfortable in that role.

If one were to gauge the current state of physics in Australia by reading editorials in such journals as the Australian Physicist, one would conclude that an ongoing degradation of physics practice is being allowed here. Do you feel as pessimistic as your colleagues about the prospects for your profession in Australia?

Yes, the ASTEC report on the state of science in Australia, on the basis of a range of indicators as well as impressions from people like myself, concluded that physics was not in a good state in its own right and as compared to other sciences. Solid state, which is hugely important to industry has dropped off badly, although acoustics was given a big tick - I have a feeling because of medical acoustics: ultrasonic scanning and cochlear implants. In relation to the USA, Physics Today has been saying things similar to the ASTEC report for several years: physics is not being taught properly at school and so physics in all institutions and industry is declining. Now all those things are true but I have an idea in the back of my head that what we are seeing is part of a larger pattern in scientific evolution. Five or six hundred years ago most of learning was contained within philosophy which was taught together with theology and law. So philosophy was King until physics split off, taking cosmology with it, followed by mathematical logic, which took a lot of the formal part of philosophy with it. So philosophy was left with important but intractable problems like "what is the nature of being" - philosophy was stripped of all its useful bits. I wonder if something similar isn't happening to physics: electrical engineering has taken communications and lots of solid state physics; laser technology has taken state-of-the-art optics; computer technology has taken advanced circuit design; biophysics has hived off. Optics and Acoustics may still be regarded as part of physics but they have their own societies. It seems that physics is in danger of being left with fundamental fields like cosmology, elementary particles and gravitation. But since we can't expect to keep the same numbers working in reduced fields we see contraction in "physics" while in fact science and technology as a whole is maintaining its effectiveness. That is to say we are seeing a redefinition of science: in particular physics is feeding the generation of new fields in engineering and that may not be such a bad process.

The ecological movement has created a powerful ethos in the last decade: one that seeks to moderate and simplify our technology. Do you see any threat to progress in expensive, sophisticated research programs like high energy physics and superconductivity from the rising ecological consciousness?

Not really. Certainly at one end of physics research we are building superconducting supercolliders and so on. But at the other end we have developed very subtle devices: SQUIDS for detecting tiny magnetic fields, efficient semiconductors for solar technology, lasers for all sorts of applications, and all low power, efficient devices. Advanced technology is all about doing things in gentle, economical and beautiful ways quite compatible with ecological concerns.

Even mining can aim to take only what is necessary with complete restoration of the environment afterwards - that is not an unreasonable requirement. The biggest threat to the environment is population growth, but the regulation of that is a sociological problem rather than a scientific one.

What are your impressions of the effectiveness of the Academy of Sciences and what are its impacts on emerging populations of scientists?

The Academy has tried to become effective in science education at upper school level over the past, say, twenty years. I think they have been very successful in biological sciences and in geology. The chemistry materials they have brought out have been good but even though we keep talking about physics education nothing yet has been put together. It costs at least half a million dollars to put out a set of texts and a couple of years' work.

We've been rather less successful in influencing government, I think. The government doesn't seem to see the Academy as a resource - we are rarely consulted on areas of our expertise and overview. Government apparently favours hired consultants! Our other Academy - Technical Sciences and Engineering - has a more direct path to government because many of the members are influential industrialists who carry more weight with government. But even then their recent report on space sciences did not result in the action hoped for. All the Academies are working hard to communicate with government but we certainly have not reached the level of the Royal Society in England or the America Academy of Sciences in consulting with government.

How does the Academy see the state of science in Australia?

I don't know what the Academy's response to the ASTEC report was: it would have been a compound of the views of the Academy's specialist committees. The National Committee for Physics would have prepared an assessment of the reliability of ASTEC's conclusions on the state of physics. There was a general agreement that the report was about right: things are not looking good. I would expect the position of the Academy to be: yes, that's about the state of things. Now what's going to be done about it? That's what we all want to know.

So it's in the government's court now, and with the election process running, the response will be delayed. And now what are you doing at Research School of Physics Sciences at ANU while still working for CSRIO?

When I finished as Director of Physical Sciences in CSIRO I was fifty-eight and had about seven years' employment to look forward to. It was nice to come back to science practice working on any of CSIRO's projects to which I could contribute. I have several collaborative programs with CSIRO divisions in Sydney: I work with Warren King, a former PhD student, on Gallium Arsenide transistors at Radiophysics. I help with the theoretical side since I would have to be in Sydney to do anything else. I have a couple of acoustics projects with Suszanne Thwaites, also a former PhD student, at NML, Applied Physics in Sydney, both commercial projects so I can only say that they are not musical or medical but they are interesting. But I am doing a musical project with Moya Henderson, an Australian composer who was artist in residence at Applied Physics and has ideas for new percussion instruments. I am involved with work on membrane biosensors up at food research - the sensing of minute quantities of substances in the body. I also participate in a joint project between Telectronics, the heart pacemaker people, CSIRO and ANSTO at Lucas Heights on ceramic energy storage capacitors - back in the solid-state field.

That's a broad spectrum of work and there are a few little extras like the birdsong theory that I published recently, and the work at ADFA where my laboratory from UNE was transferred so I can follow up these ideas on nonlinearity and chaos in spare moments, or if someone like Bob Perrin comes visiting with the time to do the physical measurements.

The most enjoyable and valuable part of your career as a physicist: I suppose you will say it's what you are doing now.

It is! I was just about to say that. In terms of enjoyment it must be about what I am doing now. I suppose the other times that I remember were in the late sixties, early seventies when I had six graduate students working in various parts of solid state, some on ice, some on superionic crystals. It was when the physics department at New England was growing and things were humming with twenty-four PhD. students in the department. Then again in the mid seventies the acoustics projects were gathering pace with three or four people and new ideas were popping up. I always like it when things are starting to move in a new field after the initial struggle to master the existing knowledge and technique. That seems to happen about every ten years with me. So I have been back in research for about two years now. The first year was a bit grim, trying to get back to the special disciplines and new procedures. But now the projects are rolling and some are showing results. I look forward to continuing this way for the next five years.

The things I take on now are mostly shorter term projects. I look for results in six months or so and then can go on to another stage in the work: usually practical, applicable work. The chaos theory I do in spare moments is continuing and I find it stimulating. I enjoy keeping in touch with broader issues in science through the Academy committees. But I don't yet feel like the man who said "I don't care if this wine will repay further cellaring; at my age I don't even buy green bananas!"

You're not as pessimistic as that!

No. I'm not that pessimistic!

BOOK REVIEWS

FUNDAMENTALS OF NOISE AND VIBRATION ANALYSIS FOR ENGINEERS

Michael Norton

Cambridge University Press, 1989, pp 619, Soft Cover ISBN 0 521 34941 9, Hard Cover ISBN 0 521 34148 5 Distributor: Cambridge University Press, 10 Stanford Rd, Oakleigh, Vic, 3166. Price: Soft Covers A$49.50

There many good books on noise control and vibration control at the specialist levels and at the undergraduate levels. One may legitimately ask why there is a need for another book on the subject. In fact, the author used more than half of the book's preface to justify the publication of this book. After reading this book, I do agree that this is not just another book.

As the title suggests, this book is targeted for engineering students with its emphasis being placed on highlighting the relationships between noise and vibration, and the applications to industrial noise control. In order to treat the two inter-related fields of noise and vibration in one single volume, the author had to make a judgement on what is essential to the understanding and application of the fundamental principles and inevitably had to leave out some other topics which are normally covered in books that are written primarily on vibration or acoustics. On balance, I feel topics have been carefully chosen and have served to demonstrate the basic principles and their applications in practice.

The book is divided into eight chapters, each of which contains substantial material, has its own list of references and nomenclature, and is quite self-contained. Chapter 1, consisting of just over 100 pages, introduces the fundamentals of mechanical vibrations. Conventional topics such as Lagrange's equations, methods of influence coefficients and transfer matrices have been omitted, without compromising the basics. Chapter 2, dealing with the fundamentals of acoustics, includes the acoustic wave equation, acoustic source models and a discussion of the generation of aerodynamic sound. Chapter 3 draws on the fundamentals in the first two chapters to provide the link between the structural vibration field and the acoustic sound field and this has been accomplished in an elegant manner. Basic noise and vibration instrumentation and measurement techniques are introduced in Chapter 4 together with some noise and vibration control procedures. The author has rightly pointed out that there is a wide scope to be covered in noise and vibration control procedures. However, the inclusion of loudness contours would help to illustrate the response of the human ear and the various weighting functions used for noise measurements. Furthermore, this chapter could benefit from a brief description of the environmental aspects of noise such as traffic noise, community noise, hearing conservation, etc. The exclusion of mufflers comes as a real surprise especially because this book is intended for engineers. Techniques for signal analysis are described in Chapter 5 but are only limited to the basics. Digital filtering technique has not been mentioned. Two advanced topics are treated in Chapters 6 and 7. Chapter 6 introduces the technique of statistical energy analysis for noise and vibration analysis. Chapter 7 is a case study on flow-induced noise and vibrations in pipelines. The choice of this case study, while reflecting the authors own experience and expertise in the subject, does serve to demonstrate well the use of the concepts and tools introduced in the earlier chapters. The book concludes with Chapter 8 on the use of noise and vibration as a diagnostic tool. This chapter, supplemented with quite a number of practical examples, is very useful as the field of condition monitoring is of increasing interest to industry.

Adequate references to journal papers and specalist books have been provided for the reader to follow up details on some topics or derivation of some formulae-/equations. Although the approach adopted is basically mathematical, the author has successfully and consistently drawn on practical examples to illustrate important concepts. Some useful practical rules of thumb are also included. Unlike most textbooks, there is a lack of worked examples. However, this is largely offset by a good selection of problems for each chapter with answers provided.

Apart from some typographical mistakes in part of the text and equations which are almost unavoidable in text of this size, the book is very well written and structured and is a delight to read. Important concepts are reiterated throughout the text to keep the reader's mind in focus, which I have found very helpful and which unfortunately has often been found missing in most text books. From my own lecturing experience, undergraduate students often find it hard to intergrate the knowledge and tools learnt in different subjects. The book is an excellent attempt in providing an intergrated and coherent approach to noise and vibration analysis and the author should be highly commended for his efforts. This is certainly a textbook that I would recommend for undergraduate engineering students to use. Postgraduate students and practising engineers in noise control will also find it very useful. The book is a 'must' for every engineering library.

Joseph Lai

Joseph Lai is a Senior Lecturer in the Department of Mechanical Engineering at the Australian Defence Force Academy. In addition to his lecturing responsibilities, he is Director of the Acoustics and Vibration Centre which has been established in the Department.

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GUIDE TO ACOUSTIC PRACTICE, 2nd Edition

BBC Engineering

British Broadcasting Corporation, London, 1990, pp 144, spiral binding, ISBN 0 563 36079 8. Direct purchase from Business Manager, BBC Arch. and Civil Eng. Dept, Broadcasting House, London W1A 1AA, UK. Price (including airmail) £35.00.

The first edition of the BBC Guide to Acoustic Practice was produced in 1980 and this 2nd edition presents updated, reorganised and extended information. The content was prepared by Keith Rose with the assistance of staff from the research, architectural and engineering departments of the BBC.

The first three sections represent the categories in which studio acoustic surveys are undertaken; noise, sound insulation and room acoustics. The first section deals with such topics as construction noise, mechanical services noise, environmental noise and noise from electrical services. Each is dealt with somewhat briefly and the emphasis is on the relevance to studio design. The sound insulation section covers the performance of the range of components in studio buildings. As well as information of the types of suitable constructions, there are comments based on experience with flanking paths etc. The text of this section is followed by a number of typical sections and details. The room acoustics section discusses the various types of absorbers and their application to studios. Photographs of some installations complement the sketches and details. The last four sections deal with control room layouts, acoustic effect of studio furniture, timing of acoustic tests and a glossary of terms.

The information in the guide is clearly and concisely presented and it is very readable, with no mathematical equations. The style of the publication, with text followed by diagrams, is reminiscent of an internal report. This book is well described by its title; it is a "guide to acoustic practice" and provides the necessary background information to allow understanding of the basic principles and the reasons for particular aspects of the design. It also guides the reader to an appreciation of the importance of details for ensuring satisfactory acoustic performance.

The book would be of benefit to those who need an understanding of the acoustic requirements of studios and the type of constructions which have been found to be satisfactory. It would be a valuable addition to the library of a College or University, of an architect or designer and of interest to anyone working in the area of acoustic design. It certainly represents good value.

Marion Burgess

Marion Burgess is research officer at the Acoustics and Vibration Centre of the Australian Defence Force Academy. She has been, and still is, involved with the teaching of architecture students.

Basis Issues in Hearing

J Duifhuis, J W Horst & H P Wit (Editors)

Academic Press, 1988, pp 470, ISBN 0 12 223346 8

Australian Distributor: Harcourt Brace Jovanovich, Locked bag 16, Marrickville NSW 2204. Price: A$107.05

The book reports the proceedings of the 8th International Symposium on Hearing held at Pateswolde, Netherlands, April 5-9, 1988. The 470 page volume contains 55 papers in six sections titled, "Invited review papers", "Sensory cell physiology", "Analysing and modelling the periphery", "Neurophysiology and neural information", "Psychophysics of pure and complex tones", and "Hearing Impairment research". Diek Duifhuis (pronounced "Dowfhouse"), Wiebe Horst and Hero Wit are mathematicians and psychophysicists with a particularly broad appreciation of auditory non linear phenomena. The forward is by Manfred Schroeder and the review papers are by Reiner Plomp and Eberhard Zwicker; three of the most senior investigators of the question "Why do we hear sounds the way we do?"

The field of research into the basic mechanisms of hearing for the last decade has been exceedingly dynamic, with the discovery that the "sensory" cells in the cochler, are *not* simply sensory. The outer hair cells are motor cells and are probably the fastest moving cells in the body. What is not clear in 1990 is just how fast these cells are. Direct measurements of cochlear structures *in vivo* have been used to imply that they must drive the vibration of the cochlear partition up to the highest audible frequencies by bats (100 kHz), whereas the most convincing evidence *in vitro* suggests that they may respond up to about 3 kHz and one report suggests perhaps 8 kHz and another 30 kHz. The resolution of this conflict is absolutely central to the whole field of endeavour because it places constraints upon the actual mechanism responsible for fine frequency selectivity in mammals. In turn, the elucidation of this mechanism will critically determine models for explaining most psychophysical phenomena including masking phenomena and the origins of sensorineural hearing loss and how to treat and prevent it.

Since a popular view is that the outer hair cells must deliver energy at very high frequencies Kros and Crawford of Cambridge, England address the question of how fast they can move in response to cell depolarisation using patch clamp techniques and this inherently requires a detailed discussion of ion mobilities and membrane conductances. Gitter and Zenner of Tuebingen present evidence for both slow and fast motility of the outer hair cells. The Swedish group headed by Ake Flock are more interested in slow motility and analogies with other cell-shortening mechanisms in the body and the critical role of calcium control of the contractility.

The first unambiguous evidence of hair cell activity was otoacoustic emmisions, sounds being re-emitted into the ear canal either spontaneously or in response to acoustic stimuli and elucidation of these phenomena has involved a whole series of manipulations of these emissions by physical, e.g. tones (Norton et al); pharmacological, e.g. aspirin ingestion (Long et al) means and by contralateral stimulation (Kemp and Souter). The editors have produced advanced descriptions of the spontaneous emissions in terms of Van Der Pol oscillators.

Comparative auditory physiology is also covered; birds (Manley et al), amphibians (Narins and Wagner) and fish (Fay and Coombs). Dynamic aspects of the tuning are covered by Prijs while Delgutte separates masking into excitatory and suppressive aspects. Neural encoding has many facets, rate and temporal coding (Javel et al, Horst et al) the coding of vowel sounds (Palmer) and the importance of refractoriness in neural firing patterns (Karamanos and Miller). Higher centre neural interactions are the topics of Rees and also Eggermont, while binaural and spatial effects are treated by Melssen Stokkum and Schellart and Buwalda.

Psychophysical phenomena include descriptions of fine details of masking (Festen and Dreschler) signal detection of gaps (van den Brink and Houtgast; Green and Forrest), masking patterns of complex tones (Kohlrausch), and timbre cues in phase perception (Patterson). Pitch perception is represented, data (Fastl) and models (Gaik and Wolf)

Hearing impairments are treated from the points of view of loss of frequency selectivity (Florentine and Buus), pitch discrimination (Moore and Glasberg) and formant detection (Tyler et al) and the handling of temporal information (Rosen and Smith) in profound loss. Two of the most interesting topics covered in this section were the effects of outer hair cell lesions on frequency selectivity (Smith, Moody and Stebbins) and two tone effects in hydropic cochleas (Cazals and Horner).

The volume is a stimulating collection of pieces of a jigsaw puzzle which constitutes current basic hearing science, and for this reason is a valuable reference to add to many such volumes which have been produced beforehand and since. The field is certainly imbued with a high level of expectation that recent insights will give rise to a substantial piecing together of the puzzle before too long.

Eric Le Page

Eric Le Page is head of the Hearing Conservation Unit at the National Acoustic Laboratories. He is an engineer/physiologist/musician and his research interests include basic mechanisms of hearing, hair cell motility and individual human susceptibility to hearing loss.

Continued P 80

NEW PRODUCTS

BRADFORD

CSR Bradford Insulation has launched a new range of products onto the Australian market, produced at the most advanced glasswool factory in the world. The products are manufactured by the revolutionary 'TEL' process and a new $67 million factory has been built at Ingleburn in Sydney to house the hi-tech equipment necessary to manufacture the new products. The new process allows Bradford Insulation to produce an even greater range of products. Glasswool blankets, batts, slabs and preformed sections are all available in a range of densities to meet the needs of the industrial, commercial and retail markets. With the new products come added benefits. Softer to touch, the new products are better to handle for easier installation.

Further information: contact the Bradford office in your capital city.

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BRUEL & KJAER
Vibrometry System

During recent years there has been an increase in the incidence of hand-arm sensory impairment disorders, such as Carpal Tunnel Syndrome and Hand-Arm Vibration Syndrome. Causally related factors for these syndromes include repetitiveness of work, hand position, duration of usage, force of grip, and excessive exposure to vibration. Medical effects include tingling, numbness

and blanching in the fingers. Early identification is an important factor in the treatment of these disorders. Bruel & Kjaer's Vibrometry System Type 9627 provides a quick, reliable, non-invasive method for assessing the state of the sensory system in the hand, and thus provides early detection of these syndromes. The system measures the vibrotactile sensitivity of the hand across specified frequencies and automatically records the results. The menu-driven system is easy to use, and a complete test of one finger takes about five minutes.

Ear Simulator

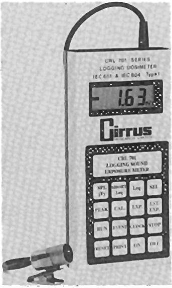
Ear Simulator for Telephonometry Type 4185 is designed for telephone measurements requiring an IEC 318 coupler. The 4185 converts the acoustic signal from an earphone into an electrical equivalent which takes into account the response of the human ear. This means measurements can be done under well defined acoustical conditions which is a great advantage when comparing different designs. A useful feature of the 4185 is the built-in minature sound source. This enables you to check the quality of the seal between the earphone and the 4185.

Further information: Bruel & Kjaer,
24 Tepko Rd, Terrey Hills, NSW 2084.
Tel: (02) 450 2066

* * *

CIRRUS
Sound Exposure Meter

The Cirrus CRL 701 Personal Sound Exposure meter is the first of a new generation of sound exposure meters combining the performance of older style dosimeters with conventional and integrating sound level meters, and data loggers. The units are designed to comply with the soon to be published IEC standard for such instruments, and offering unparalleled accuracy and performance.



The CRL 701 will provide a direct printout of it's stored data in a summary report onto a serial printer or directly into proprietary software, such as databases, allowing comprehensive worker monitoring programmes to be undertaken. It can also provide direct readout of any of it's chosen parameters via the units own display. The CRL 701 can acquire up to 18,000 "Short Leq" elements allowing 8 hours continual use at an acquisition rate of 2 second. This data can be transferred to an MS-DOS computer for analysis using Cirrus' Acoustic Editor software which will allow detail investigation of the logged noise environment.

Octave Analyser and SLM

The CRL 237B is a combined octave analyser and sound level meter. It has 10 octave bands centred on frequencies from 31.5Hz to 16kHz and may be used unweighted (linear) or, uniquely, weighted to either of the internationally accepted "A" or "C" curves over a full range from 20dB to 154dB. In common with many other Cirrus units the CRL 237B has a "Max Hold" function for all of it's response speeds - S(low), F(ast), and I (mpulse).

The 237B cannot only accept inputs from microphones, but can utilise special acceleration and velocity pick-ups to measure r.m.s. vibration. Additionally, the CRL 237B can use a CC182A Acoustic Coupler for Audiometer Calibration, to allow field calibration and verification of audiometers.

Integrating Sound Level Meter

The new Cirrus CRL 256 Integrating Sound Level Meter combines the proven design used in it's sister unit; the CRL 222, with the reliability of modern micro electronics. The unit is housed in a similar die-cast metal case to the one used for the CRL 254 Integrating meter suplied to the British Armed Forces. The British made CRL 256 has the capability to measure Leq, Peak as well as conventional Sound Level on both A and C weightings. With its big acquisition range the CRL 256 is perfect for those involved in industrial noise measurements as part of hearing protection programes.

Peters Screening Audiometer

The Peters Screening Audiometer, AP27, is a fully portable manual screening audiometer and has 8 test frequencies from 250 Hz to 8KHz thus covering the recommendations of both the IEC and the American OSHA specifications and complies with all the recommendations of the UK Health and Safety Executive. These frequencies are at 19 hearing levels which range from -10 to +80dB increments, allowing excellent discrimination of small hearing differences. The instruments is totally "user friendly" having simple, easy to use controls and a front panel indicator showing both the internal state of the batteries and also the presence of a signal during the tests procedure. In addition a patient response switch can be attached to allow the test to be conducted in silence.

Further information: MB & KJ Davidson, 17 Roberna St, Moorabbin Vic 3189
Tel: (03) 555 7277

6. Sound Intensity

Facilitator - **Marion Burgess** (ADFA, Canberra).

This group functioned as a "common-interest" group in which members were able to share experiences regarding measurement equipment, techniques and environments. Most of the 15 or so group members had access to sound intensity equipment and there was general agreement that this is a relevant technique today.

Some of the discussion points:-

There is a need for good quality, portable, one-third octave intensity systems for field use, as the "laboratory" type systems tend not to be truly portable.

Some of the practical uses to which sound intensity had been put by group members included:-

- noise exposure identification/ location;
- noise source ranking;
- sound power determination on sections of pipeline; and
- identifying enclosure leaks.

A new area of work is measurement of intensity under various flow conditions, for which there is now a probe available. Members mentioned problems of wind effects when using standard probes.

Most members preferred to use a "scanning" technique over a "point" measurement technique. There is a need for the proposed ISO standard to standardise scanning methods. The use of robotics for scanning was raised as a possibility.

Members were impressed by the work of F. J. Fahy. It was suggested that the A.A.S. should consider the possibility of bringing Fahy out to Australia, perhaps around the time of Internoise 1991, to run a sound intensity course. The course could be either research based or practically based. Melbourne was suggested as a possible venue.

John Macpherson

AWARDS

The Excellence in Acoustics Awards for 1990 have just been announced.

The winner for Category 1 - Acoustical Design is **Peter Knowland & Assoc** for the Aoteu Centre, Auckland, New Zealand.

The winner for Category 2 - Engineering Reports is **Dr. Qunli Wu** for the PhD thesis on "Determination of the size of an object, and its location in a cavity, by eigen frequency shifts".

More details on these awards will be included in the next issue.

BOOK REVIEWS . . .

Inter-noise 89 Proceedings

George C Mailing (Editor)
Noise Control Foundation, 1989, pp 1312,2
Orders: Noise Control Foundation, PO Box 2469 Arlington branch, Poughkeepsie, NY 12603, USA. Price US$100
(plus $45 for airmail)

The theme of Internoise 89, which was held at Newport Beach, USA, was "Engineering for Environmental Noise Control". The Proceedings contain 267 four to six page papers on a wide variety of topics.

"Criteria for Controlling Noise and Vibration", by Leo Beranek, was one of the distinguished papers. This 42 page paper provides an overview of the various criteria for indoor and outdoor exposures. He also refers to the non-logarithmic unit for sound exposure, the pasqual. The second distinguished paper was given by Jiri Tichy on "Noise Control Applications of Sound Intensity". This 23 page paper includes the applications to sound power measurements, transmission loss, sound absorption, source identification, propagation and diffraction.

The contributed papers are classified into nine main categories: General (9 papers), Emission: Noise Sources (46), Physical phenomena (9), Noise Control Elements (36), Vibration and Shock (16), Immission - Physical Aspects (39), Immission - Effects (28), Analysis (77) and Requirements (7). With such a large range of topics covered, the proceedings will be of interest to all those concerned with any aspect of noise control technology.

Marion Burgess

Waves in Random Media

In January 1991, the Institute of Physics is launching a new quarterly journal called Waves in Random Media which will provide a forum for the publication of papers covering new and original theoretical developments and new experimantal or numerical studies demonstrating basic principles and theories.

Further information: IOP Publishing Ltd,Techno House, Redcliffe Way, Bristol BS1 6NX, UK.

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FUTURE EVENTS

• Indicates an Australian Conference

1991

February 24-27, ATLANTA
35th CONVENTION OF AMERICAN INSTITUTE OF ULTRASOUND IN MEDICINE
Details: AIUM, 4405 East-West Highway, Suite 504, Bethesda, MD 20814, USA

April 29 - May 3, BALTIMORE
MEETING OF ACOUSTICAL SOCIETY OF AMERICA
Details: Acoustical Society of America, 500 Sunnyside Blvd, Woodbury, NY 11797, USA

May 4-5, ANNAPOLIS
INTERNATIONAL SYMPOSIUM ON MUSICAL ACOUSTICS
Details: Catgut Acoustical Society, 112 Essex Ave, Montclair, N.J. 07042, USA.

May 7-9, BALANTONFURED
9th FASE SYMPOSIUM
Details: Optical, Acoustical & Filmtechnical Soc., H-1371, Budapest, PP Box 433, Hungary.

July 1-4, LE TOUQUET
ULTRASONICS INTERNATIONAL 91
Details: Ultrasonics International 91, Butterworth Scientific Ltd, P.O. Box 63, Westbury House, Bury St, Guildford, Surrey GU2 5BH, U.K.

• July 8-12, SYDNEY
INTERNATIONAL MECHANICAL ENGINEERING CONGRESS
Details: Conference Manager, Institution of Engineers, 11 National Circuit,Barton, ACT 2600

July 15-19, SOUTHAMPTON
4TH CONFERENCE ON RECENT ADVANCES IN STRUCTURAL DYNAMICS
Details: Conference Secretary, ISVR, Southampton SO9 5NH, U.K.

August 19-24, AIX-EN-PROVENCE
12TH INTERNATIONAL CONFERENCE ON PHONETIC SCIENCES
Details: Secretariat, Universite de Provence, 29 Avenue Robert Schuman 13621, Aix-en-Provence Cedex 1, France.

October 8-10, THE HAGUE
3rd INTERNATIONAL SYMPOSIUM ON SHIPBOARD ACOUSTICS
Details: Ms Meinardi, TNO Corporate Communications Dept, P.O. Box 297, 2501 BD The Hague, The Netherlands.

November 4-8, HOUSTON
MEETING OF ACOUSTICAL SOCIETY OF AMERICA
Details: Acoustical Society of America, 500 Sunnyside Blvd, Woodbury, NY 11797, USA.

• November 25-29, MELBOURNE
ASIA - PACIFIC VIBRATION CONFERENCE 91
Details: Conference Convenor, Centre for Machine Condition Monitoring, Monash University, Clayton, Victoria 3168

• November 26-28, BRISBANE
WESTERN PACIFIC REGIONAL ACOUSTICS CONFERENCE IV
Details: Conference Convenor, P.O. Box 155, North Quay, Queensland 4002.

• December 2-4, SYDNEY
INTER-NOISE 91
Details: IPACE, P.O. Box 1, Kensington, NSW 2033

1992

May 11-15, SALT LAKE CITY
MEETING OF ACOUSTICAL SOCIETY OF AMERICA
Details: Acoustical Society of America, 500 Sunnyside Blvd, Woodbury, NY 11797, USA.

September 3-10, BEIJING
14th ICA
Details: Institute of Acoustics, Chinese Academy of Sciences, P.O. Box 2712, Beijing 100080, China

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