The Bulletin

AUSTRALIAN ACOUSTICAL SOCIETY

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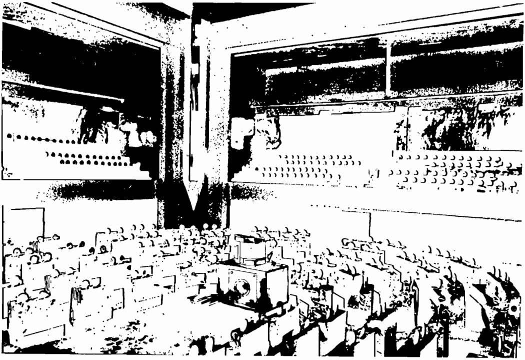

New Parliament House, Canberra

Acoustic Modelling of the House Chamber

Louis Challis

Digital Techniques in Acoustics

Robert Harris

Learned Society or Professional Institution?

Ferge Fricke

BULLETIN OF THE AUSTRALIAN ACOUSTICAL SOCIETY

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Cover photographic reduction by Peter Elliston and Jane Campbell of U.NSW.

EDITORIAL

Louis Challis is the acoustical consultant for the new Parliament House in Canberra. Following a talk given to the N.S.W. Division, Louis has written an article describing the model techniques he is using in this project. The cover illustration has been derived from a photograph of the model for the House Chamber showing a surprisingly large number of our political friends present in the chamber (model representation only).

Robert Harris from CSIRO Division of Mineral Physics has written a two-part article on digital techniques in acoustics. With so many new instruments now in digital form, and often designed to interface with a small computer, Bob's contribution should be helpful in understanding this new technology. The first part deals with basic issues while the second part will treat the major headache in this area: what to do with the mass of data that invariably emerges whenever a computer gets into the act. Computer algorithms will be discussed together with some applications of digital methods to acoustical problems.

Another outcome of a Society meeting is **Ferge Fricke's** amusingly provocative article on the great debate: Learned Society or Professional Institution? Judging by the low temperature so far registered by this dichotomy, there is a strong suspicion that someone has raised a non-issue.

A number of members have sent **short reports** on their current activities. We would like to receive many more of these; writing such a report should be a much easier task than having to compose a full technical paper. These brief reports will help to keep readers informed about the many interesting projects and investigations that are being pursued. Three included in this issue deal with aircraft noise (Andrew Hede and Robert Bullen), an experimental building (Anita Lawrence and Marion Burgess), and some fascinating whale songs (Doug Cato).

The Council of the Australian Acoustical Society has initiated moves through General Secretary Bob Boyce to extend contact with other acoustical societies, particularly in the Western Pacific Area. We have recently received from the **New Zealand Acoustical Society** an advance notice regarding their 7th Conference to be held in Christchurch, 7-8 July, 1983. Further details will be available in our next issue.

A recent news item referred to the efforts of the Bell Telephone Laboratories to develop an automatic telephone directory service that would eliminate the need for human operators. This seems to be just another move in the current universal drive to render people redundant, at least in industry where robots and automatic machinery are gradually taking over. An interesting corollary would seem to be that industrial noise problems might disappear in the process (and presumably some acoustical consulting firms). It would not be expected that robots would become subjects for hearing damage claims! There is also the interesting philosophical question: does noise exist if there is no-one to hear it? This question is on a par with the old one: what colour is a red tie when it is in a dark cupboard?

HOWARD POLLARD

AUSTRALIAN NEWS

• NEW SOUTH WALES DIVISION

Chairman's Report 1981/82:

The Division Committee has met 14 times since the last Annual General Meeting, which was held on 27th May, 1981. The later Annual General Meeting date has been brought about by changes in our financial year calendar. The committee has been fairly active during this period and I wish to summarise some of their activities.

First, to the housekeeping activities which are an important function of any society professing to maintain a professional status. Receipt and answering of correspondence has become quite voluminous and taxing on the position of an honorary secretary. I'd like to thank George Patterson whom we have exhausted in this line of duty. The Treasurer and Registrar, John Whitlock has maintained these functions in his usual efficient manner. Membership grading has been carried out by a sub-committee convened by Ray Piesse and this committee has met regularly, almost monthly to keep abreast of an encouraging flow of applications for membership. I feel we are still reaping the benefits of a Sydney I.C.A. A further administrative function is in representing the Division on the A.A.S. Council. Here we are represented by three councillors—Ray Piesse, Anita Lawrence, John Dunlop. Council has met twice in the past year—at Phillip Island in September and at Adelaide in March.

During the year we have done some soul searching and given some thought to the aims of the Society—fostering and promoting the science of acoustics. Perhaps the most visible of our activities here is in the conduct of technical meetings. These serve members in education, re-education and as a forum for meeting fellow acousticians and exchanging ideas. However, during the year we have had some problems in running our technical program—there was a serious fall off in attendances which caused some alterations to our program, e.g.:

July 81	— 5 starters: meeting postponed to September.
March 82	— 7 starters: Hunter Valley trip cancelled.
October 81	— Postponed at request of speaker.
November 81	— Combined with U.N.S.W. Symposium to ensure numbers.

Apart from this the remaining meetings were well received and served well their function:

July 82	— Community Noise Analysis (Panel).
August 81	— Office Design.
September 81	— Statistical Energy Analysis (Bies).
October 81	— Acoustic Emission Symposium.
November 81	— Shock and Vibration (Goldberg).
April 82	— Ultrasonic Diagnosis (Kossof).
May 82	— Parliament House Acoustics (Challis).

Our attendances vary in the 20-30 range or about 15 per cent of membership. This may be the maximum we can expect and compares favourably with the Institute of Physics and more than favourably with Institutes of Engineers.

Apart from the regular technical meetings we have initiated several other activities to involve the membership with the Society and to raise its public image. In December 1982 we are planning a semi-public forum on aircraft noise. This will be held at the Institute of Technology and we expect wide publicity in the news media. It will also coincide with the Society's AGM. Maurie Nelmes is convenor of the organising committee.

The First Conference of the West Pacific Region has been actively supported by the Division, two of its members (Jack Rose and John Dunlop) being on the international organising committee. About 20 Australian delegates attended the Conference in Singapore, 1-3 September, 1982.

N.S.W. Deafness Week is held in September each year and we expect to be involved as we were last year.

Careers Markets. The Society was represented at two of these markets in 1982. This has caused us to give some further attention to Society publicity — material and displays. We are encouraging various organisations to develop display boards showing their involvement with acoustics, also suitable for Society presentation.

Prizes, Awards. The committee has taken the first steps towards setting a framework for regular awards and prizes. Suggestions have been: best student thesis on acoustics, best technical paper from an Australian establishment or worker.

Bulletin. The Bulletin is being produced in N.S.W. by Division members Marion Burgess and Howard Pollard. Howard is editor and his influence on the journal should be obvious from the 1982 issues. Marion is is keeping an efficient eye on the business management side.

In conclusion we have had a busy year and I'd like to thank both the retiring committee members and those elected at last AGM.

JOHN I. DUNLOP,
Chairman.

Committee for 1982/83:

At the AGM in August the following committee was elected:

Chairman: Dr. J. I. Dunlop.
Deputy Chairman: A. R. G. Hewitt.
Treasurer and Registrar: J. A. Whitlock.
Secretary: L. C. Kenna.
Committee Members: R. Piesse, M. Nelmes, M. Rogers, A. Gale, S. Hlistunov, A. Lawrence.

The various sub-committees are being convened by R. Piesse (Membership), M. Nelmes (Aircraft Noise Symposium), A. Hewitt (Technical), M. Kateifides (Directory).

Federal Councillors are: A. Lawrence, R. Piesse, J. Dunlop.

Panel Discussion:

"A.A.S. — Professional Society?"

Report of panel discussion held by N.S.W. Division, 18th August, 1982 following the Division A.G.M. Contrasting views on the topic were first presented by Jack Rose and Ferg Fricke followed by a general discussion.

Jack Rose made the following points:

- The theoretical as well as practical aspects of a field of endeavour should be encompassed by a profession.
- A professional outlook presupposes the ability to practice and earn a living from the skills.
- Society requires standards for employment, legal judgments, practicing consultants and Professional Societies are often the last resort for adjudicating such.
- Acoustics involve too wide a range of descriptions for simplified academic qualifications as engineers maintain, but an example of a similar Society successful in achieving professional status is the Audiological Society.

● The origins of the A.A.S. rested heavily on the concept of a professional society.

Ferg Fricke spoke at length on the distinctions between a learned society and a professional society or institute (see the article by Ferg in this issue). Comments and views were received from the floor.

E. T. Weston: contested Fricke's statement that deciding on the "public interest" was too complex.

C. Steele: supported the idea that the primary qualification (engineer, physicist, psychologist) was more important than a specialisation such as acoustics, and that the acoustics qualification should be seen as a supplement.

R. A. Piesse: produced statistics which indicated that the A.A.S. was primarily a professional body — it had a stable corporate membership, small turnover occurring at subscriber and affiliate level.

Madden: raised the issue of the role of noncorporate members (subscribers, affiliates) which appeared to have been avoided by both speakers.

JOHN I. DUNLOP.

● SOUTH AUSTRALIA DIVISION

Committee for 1982/83:

At the AGM on July 21, the following committee was elected for the 1982-3 term:

Chairman: P. Swift.
Vice Chairman: D. Bies.
Secretary: A. Jones (c/- Hills Industries, P.O. Box 78, Clarence Gardens 5039).
Treasurer/Registrar: K. Martin.
Minute Secretary: M. Lane.
Bulletin Liaison/Newsletter: R. Williamson.
Councillors: R. Boyce, P. Swift.
Committee: H. Dean, M. Zockel, G. Wild.

The concept of a specialised acoustics library has been discussed further at both State and Federal Committee level. Since the Barr Smith Library already has a comprehensive journals section, including most acoustics periodicals, it has been recommended that the society be registered as a "borrower", for an annual subscription of $50.00, with a borrowers card allowing access for any member of the society. The Secretary will act as custodian of the library card. The library will be approached to add good reference material and conference proceedings to its collection. The arrangement will be reviewed at the end of 1983.

A divisional sub-committee is currently examining the nature and content of acoustics courses available in South Australia. This will form part of a submission to the Federal body detailing all acoustics orientated courses in Australia.

Technical Meetings:

June 1982 —

"RECIPROCATING INTERNAL COMBUSTION ENGINE EXHAUST NOISE AND MUFFLING"

Speaker: Dr. Adrian D. Jones, Automotive Research Engineer, Hills Industries Limited, South Australia.

Synopsis: In spite of many years research into related subjects the analytical determination of the exhaust noise radiated from reciprocating internal combustion engines and the accurate prediction of muffler performance on actual engines have proved to be elusive goals.

Linear acoustic analysis has been used successfully to determine the action of mufflers in idealised exhaust systems. However the linear approach has then relied upon extensive measurements of sound source and atmospheric characteristics in the few cases that radiated noise has been so determined. Also solutions obtained by modelling the full non linear unsteady exhaust gas flow have proven unweildy for complex engine and exhaust system combinations but radiated exhaust noise has been determined by this method.

The fundamentals of both of these methods of analysis and their application in modelling reciprocating engine exhaust noise and muffler action was described together with their limitations and preliminary details of some recent work in this field.

July 1982 —

Following the AGM, a novel presentation was made by Mr. J. D. Kendrick, Senior Lecturer in Building Science, Department of Architecture, The University of Adelaide of some "ANECDOTES ON ACOUSTIC SPACE DESIGN".

The first three described incidents which involved a social or human aspect together with an architectural, acoustic space design concept and proposed a solution. The fourth was in the form of a play which he had developed as a new way of teaching architectural students. Derrick skillfully played all four voices in the play centred around the attempts of a student to apply Marshall's Theory of Concert Hall Acoustics to a design project. Featuring in starring roles were STUart DENT, ARCHIbald TECT and CON SULTANT.

At the technical meeting on 15th September, Mr. A. Driscoll from Telecom spoke about extraneous noise in telephonists' headsets, the possible risk of resulting hearing damage and the causes and solutions to this problem.

Pre-Technical Meeting Dinners

Prior to the April and July technical meetings a small group dined at the University of Adelaide Staff Club with the guest speaker. This set an informal atmosphere for the evening and all members and guests are invited to avail themselves of these excellent facilities.

Newsletter

A regular newsletter is being prepared featuring committee news, forthcoming events, recently published papers and other items of interest. This is circulated to all members along with notices of technical meetings.

BOB WILLIAMSON.

● VICTORIA DIVISION

Australian Road Research Board Laboratories

On 28th July a visit of inspection was made to the Vermont Laboratories of the Australian Road Research Board where our guide and host was Mr. Stephen Samuels, member. We were first shown the **tilt test facility** where investigations are being carried out into the overturning characteristics of semi-trailers and similar vehicles. Next we were given an introduction to the research activities aimed at improving the life of **bitumen road surfaces** and the incorporation of rubber into bitumen roads to improve resilience and life. The main acoustical item on the agenda was a resumé of Stephen's own work in the generation and control of **tyre/road noise** and more recently his participation in a study of the applicability to Australian conditions of the UKDOE **traffic noise prediction** method. (A paper on the tyre/road noise work and a joint paper with R. Saunders on the noise prediction work were published at the recent ARRB Conference.) We were then shown over the establishment's computer facilities and finally the impressive library and resource centre. Welcome refreshments supplied by our hosts completed an evening which not only provided matters of specific acoustic interest but broadened members' knowledge into related areas.

A.G.M.

The Victoria Division Annual General Meeting was held on 20th September at the National Science Centre. The election to fill the Committee vacancies took place, and the office-bearers in Victoria are now:

Chairman .... G. E. Harding
Vice-Chairman .... W. J. Kirkhope
Secretary .... J. H. Watson
Treasurer/Registrar .... G. A. Barnes
Minute Secretary .... J. B. Fowler
Federal Council's .... G. E. Harding, W. J. Kirkhope, J. H. Watson
Committee Members .... H. Sin Chan, G. Bernie Cooper, R. C. Lam, D. C. Rennison, J. F. Upton

Following the A.G.M. the members were enlightened by **Mr. Doug Growcott** of Watson, Moss Growcott Acoustics Pty. Ltd. on the life and times of an Acoustical Consultant. Doug presented a series of case histories from his file illustrating some of the difficult assignments. These included chorusing cockerels, a complaining hospital matron, and shrieking standby generators. All problems were to be solved in the shortest amount of time, with the utmost diplomacy, and always involving the minimal financial outlay by the noise-hassled client.

Bruel & Kjaer (Australia) Pty. Ltd. followed Doug's presentation with an informative Audiovisual on Building Acoustics for which we thank **Daryl Bowker.** Members and guests then retired to the Sciences Club for refreshments, and further reminiscences from the files of the acoustical consultant members.

Hearing Conservation

In Victoria, industries which have noise hazard areas within their plant are required to erect warning signs. These are to comply with AS 1319-1972 and the now familiar white ear-muffed head in the royal blue circle.

On a visit recently to a local textile company in response to their introduction of a Hearing Conservation Programme, the factory manager proudly showed me his company's contribution to Hearing Conservation. An elaborately painted sign was erected in the noisy plant, from which I quote verbatim:

> "All employees have now been issued with earmuffs for their own hearing protection — The noisiest areas are spinning and twisting. Exposure to noise in these areas over a long period will probably lead to deafness. It is essential that operators in these areas wear some sort of Hearing Protection if they don't want to go deaf. — In other areas the noise level is not over the limit, you have your ear muffs if you want to wear them or not. It's up to you. If you would like to wear another type of Hearing Protection such as ear plugs the choice is yours. You may buy them at the Chemist.
> REMEMBER YOUR EARS ARE IMPORTANT.
> The Management."

Some notice!

GEOFF. BARNES

• WEST AUSTRALIA DIVISION

At the AGM in August, the following committee was elected:

Chairman: Mr. F. Jamieson.
Vice Chairman: Dr. V. Alder.
Secretary: Dr. M. P. Norton (c/- Dept. of Mechanical Engineering, University of W.A., Nedlands, W.A. 6009).
Treasurer/Registrar: Mr. J. Spillman.
Members: Mr. L. O. Kirkham, Dr. G. Yates, Dr. D. Carruthers, Ms P. Gunn, Mr. T. Vass, Mr. N. Gabriels.

MICHAEL NORTON.

• REPORT ON WESTERN PACIFIC ACOUSTICAL CONFERENCE

The 1st Acoustic Conference of the West Pacific Region was held September 1, 2, 3 at the Hyatt Hotel, Singapore. The conference was hosted by a local group headed by Prof. Bill Lim of the Building Science Department, and Dr. Raymond Heng of the Engineering Department of the National University of Singapore. Although the organisation was undertaken by the Singapore group, the A.A.S. and the A.S.J. had undertaken to act as guarantors and to provide subsidies — the A.A.S. monies to be used to subsidise travel by delegates from developing countries and the A.S.J. for printing and other costs. About one year of lead time had been given to organise the conference due to the restraints placed by the 11th ICA being held July 1983.

Some 75 delegates from 10 countries attended. There was good publicity in Singapore (the Conference was opened by the Minister for the Environment and received coverage in the Singapore Press) and a financial break-even appears to have been achieved. The organisation of the Conference was most efficient — no notable breakdowns, omissions occurring — and the Singapore group must be commended on this, together with the decision to choose Singapore as the venue.

JOHN I. DUNLOP.

SYMPOSIUM:

"AIRCRAFT NOISE TO THE YEAR 2000"

- The symposium is being convened by the New South Wales Division of the Australian Acoustical Society.
- Aircraft noise is one of the major forms of environmental pollution. In the face of increased public awareness, it has become an important issue for planning and research.
- The symposium covers a broad range of topics related to aircraft noise, and the speakers represent a wide cross-section of those with expertise in this field.
- The programme has been designed to be of value to acousticians and to all who have an interest in aircraft noise.

Keynote Address

Mr. Noel Peart of the Boeing Commercial Airplane Company in U.S.A. will deliver the keynote address. Mr. Peart is the Manager — Community Noise Technology, an organisation which conducts studies of existing airport noise exposure, and works with airlines to assess specific airport noise situations.

Panel Discussion

The symposium speakers will participate in a panel discussion of issues relating to aircraft noise. Members of the audience will be invited to make comments and to direct questions to the panel.

Full registration fee $25
Student registration $10

Enquiries: The Symposium Chairman, Mr. M. Nelmes — Phone (02) 270 4821

- **AUSTRALIAN ACOUSTICAL SOCIETY**

ANNUAL CONFERENCE

"The Economics of Noise Control"
Tanunda, South Australia

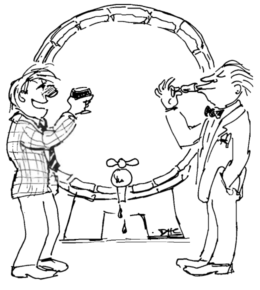
24-25 February, 1983

The theme of the Conference is:
"THE ECONOMICS OF NOISE CONTROL"
Commonly asked questions in the noise control field are: "What will it cost!" "What are the benefits!" and "What are the disadvantages!" Generally, decisions are made on the basis of economics.
Papers will be sought from insurance bodies, union and employer groups as well as from the research and applied engineering fields.

PROGRAMME
One keynote paper and 15 to 20 submitted papers are to be presented over 1½ days.

Invited Speaker: Dr. Eric Bender

Details: Dr. P. B. Swift, Pryce Goodale & Duncan Pty. Ltd., 65 Fullarton Road, KENT TOWN, S.A. 5067.



"This makes the 15th Winery we've checked out for economics of noise control."

* * *

Australian General Electric Ltd., one of our sustaining members, have notified us of a change of address. There will be two buildings situated at North Ryde within a few hundred metres of each other. The Head Office is at Cnr. Lane Cove and Epping Roads, North Ryde. Engineering Systems and Mobile Radio will be at 5 Byfield Street, North Ryde.
The new mail address is: P.O. Box 174, Willoughby, N.S.W. 2068. Telephone No.: (02) 888 8111.

Master of Science (Acoustics) — University of New South Wales

This course provides for graduate study and research in several important areas of acoustics, such as community noise control, noise control in industry and in buildings, auditorium design and physical acoustics. It is designed primarily for graduates in engineering, architecture, science or building who wish to specialize in acoustics and it is suitable for those who wish to find employment with noise control authorities, or in industry, to practise as consultants, to undertake research or to become part of a multidisciplinary team in an architectural or engineering practice.

The course is normally taken over four part-time sessions (two academic years) and admission into the first year of the course will be available in **1983.**

An applicant for registration for the degree course of Master of Science (Acoustics) shall have been admitted to the degree of Bachelor of Science (Architecture) at honours level, Bachelor of Architecture, Bachelor of Building, Bachelor of Science at honours level, or Bachelor of Engineering at the University of New South Wales, **or** an equivalent degree from another university or tertiary institution. In exceptional cases an applicant may be registered as a candidate for the degree if he submits evidence of such academic and professional attainment as may be approved by the Higher Degree Committee of the Faculty of Architecture. Notwithstanding any other provisions of these conditions the Higher Degree Committee of the Faculty of Architecture may require an applicant to demonstrate fitness for registration by carrying out such work and sitting for such examinations as the Higher Degree Committee of the Faculty of Architecture may determine.

Enquiries regarding the course should be addressed to The Head, Graduate School of the Built Environment, The University of New South Wales, P.O. Box 1, Kensington, N.S.W., Australia 2033. Telephone (02) 663 0351, extension 2301.

Application forms for registration for the Master of Science (Acoustics) degree are available from The Registrar, The University of New South Wales, P.O. Box 1, Kensington, N.S.W., Australia 2033.

* * *

AUSTRALIAN JOURNAL OF AUDIOLOGY

The Australian Journal of Audiology has been published in May and November each year since 1979. Each volume (two issues) consists of about 80 pages of original, scientific articles. The major purpose of the journal is to report Australian research but overseas contributions are also published. Subject areas include: hearing; audiometry; hearing handicap; amplification for the hearing-impaired; detection and incidence of deafness; auditory rehabilitation; hearing conservation. A list of published articles can be supplied on request.

Subscriptions (A.$10.00 per year) or enquiries should be directed to: The Business Manager, Australian Journal of Audiology, c/- National Acoustic Laboratories, 5 Hickson Road, Sydney 2000.

* * *

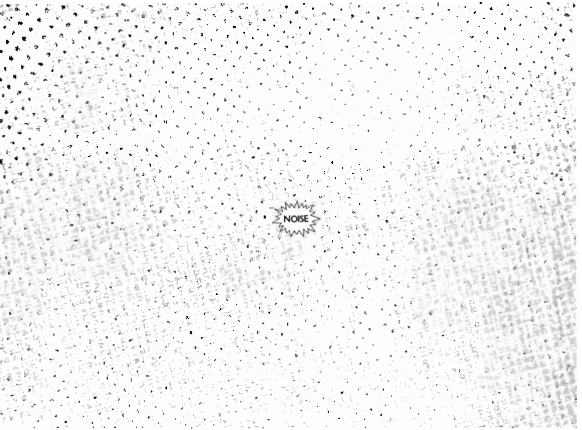
6th Australian Conference on Coastal and Ocean Engineering 1983
Gold Coast, July 13-15, 1983
Call for papers

THEME OF THE CONFERENCE
"RESOURCES DEVELOPMENT —
ROLE OF COASTAL AND OCEAN ENGINEERS"

The coastal and ocean engineer has a vital role to play in resource development whether it be in the investigation, design or construction of facilities related to export or to management of the natural resources of the coastal and ocean environment.

Papers will be accepted in all phases of coastal development. It is proposed to conduct sessions on the following topics:
1. Theoretical considerations for coastal and ocean engineers. 2. Planning and organisation of data collection programmes. 3. Design and construction of coastal and offshore works. 4. Coastal management. Deadline for receipt of synopses — 13 August, 1982.

Details: The Conference Manager, 6th Australian Conference on Coastal and Ocean Engineering 1983, The Institution of Engineers, Australia, 11 National Circuit, Barton, A.C.T. 2600.



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Sometimes the PEOPLE column is reminiscent of my old Gossip Column; but this issue will see plenty of People mentioned.

* * *

DIVISION ELECTIONS

The Divisions have held their Annual General Meetings, and have now elected their Office Bearers. To all those elected to position of Secretary must go the thanks of all Society Members for the word load they undertake. To all those elected to nice cushy jobs like Chairman must go our congratulations on achieving such exalted positions. Who is that that says the Chairman's job is not a cushy job; that's what they told me before they elected me!

* * *

CONSULTANT GROUP CHANGES NAME

First announcement on the Business Scene of this issue is the change in name of the Carr Acoustic Group, to WATSON MOSS GROWCOTT ACOUSTICS PTY. LTD. Jim Watson, Graeme Moss and Doug Growcott have made the change to their company's name to show more clearly who their organisation represents.

* * *

G. A. B. RILEY RETIRES FROM R, B & K

Whilst talking about Consulting Organisations we should mention that GERALD RILEY has retired from RILEY, BARDEN AND KIRKHOPE PTY. LTD. Gerald started the AUSTRALIAN ACOUSTICAL LABORATORY so long ago that your Peoples Columnist can not even be sure when: but it was sometime around 1960. Gerald continues to be Principal of the Australian Acoustical Laboratory which is a separate entity from Riley, Barden & Kirkhope Pty. Ltd. RON BARDEN and JIM KIRKHOPE, and the rest of the staff of Riley, Barden & Kirkhope continue to operate their consulting organisation.

* * *

A LETTER RECEIVED

Following the policy of mentioning all letters and communications received, I include the following letter because it serves as an introduction to the person to follow.

FERGUS FRICKE of the Dept. of Architectural Science, The University of Sydney, writes:

> "Congratulations on your 'People' column; it is a marvellous way of keeping in touch with who is doing what.
>
> For your next 'People' column I hope you might announce that you have been appointed to the SAA AK/4 Committee on Architectural Acoustics, which is a roundabout way of asking would you consider going on the committee. I am looking for a replacement for Carolyn Mather and although you are not as beautiful I am sure you would do handsomely. As you have been involved with standards produced by the committee and have commented on many of the draft standards I would like to have you on the committee.
>
> May I assure you that there will be only two meetings a year, one of which will be in Melbourne, that you will not be required to undergo a sex change, and that AK/4 lunches are a marvellous source of gossip.
>
> I look forward to an early reply or a favourable notice in the next Bulletin."

Needless to say with such a persuasive letter, I had to agree to Fergus's request.

CAROLYN MATHER MOVES UP

This leads me conveniently to CAROLYN MATHER who for some years has been Chief Noise Control Officer with the Environment Protection Authority in Victoria. I have been waiting for Carolyn or someone to tell me (in writing, so that I do not have to rely on my memory) exactly what Carolyn's current position is. Suffice it to say that she has gone in the direction of up, and is now with the Public Service Board, and probably best be described as "The Lord High Executioner". Mikado-type puns apart, I gather her job does indeed involve assessment of efficiency of various Government Departments so that our past President is moving in high places.

* * *

RONALD REAGAN'S EARS

Talking about high places, leads to the highest office on earth, that is to the President of the U.S.A. To start at the beginning, ERIC KOOP, M.A.A.S., has been involved in trying to solve a problem that occasionally occurs in the Telecom telephone system, which results in very high and damaging noise levels to Telecom operators. Whilst ARAM GLORIG of the U.S.A. was in Australia, Telecom had him look at the problem of their high noise levels. And what has all this to do with President Reagan? The following is a complete extract from the Melbourne Sun.

> "People who complain that U.S. President Ronald Reagan won't listen to good advice could be right— he's partially deaf in both ears.
>
> A visiting ear expert who has examined Mr. Reagan says he has trouble hearing in conference and should wear hearing aids in both ears.
>
> Dr. Aram Glorig said Mr. Reagan was reluctant to wear his hearing aid in public because he was vain.
>
> Mr. Reagan's hearing problem was due to the ageing process, Dr. Glorig said.
>
> He compared the President to a man who drank beer to solve his hearing problem—When they asked the man why he wouldn't stop drinking he said, "I like what I drink better than what I hear", said Dr. Glorig.
>
> Dr. Glorig, 76, who specialises in industrial and forensic deafness in Los Angeles, yesterday looked into the mystery phone shriek that has plagued Telecom operators.

> He said the problem was "more between the ears than in the ears" and he thought the operators had been a bit hysterical. He doubted that the noise could cause ear damage. New limiting equipment should solve the problem, Dr. Glorig said."

Need we add that Union Leaders and Safety Officers were not very pleased to be told that the problem was more between the ears than in the ears.

NEW HEAD FOR THE E.P.A. VICTORIA

NORM PARIS is acting head of the Noise Control Branch, Environment Protection Authority, now that Carolyn has left. If and when a permanent appointment is made your "People" column will inform you of who the appointee is, and if he or she is not a Member of the Society we might see what we can do about rectifying that omission or error.

* * *

MORE ON HARVEY FLETCHER

The last issue of the Bulletin contained an obituary for HARVEY FLETCHER. Harvey Fletcher is known to acousticians throughout the world for his work which resulted in the Fletcher-Munson equal loudness contours. More surprising is the article published in "Physics Today" after his death which revealed the large if not principal part that he played in the so-called Millikan's oil drop experiment. Those readers who have an interest in physics should read this most interesting and very readable account of Fletcher's development of an apparatus to measure the charge on an electron.

* * *

DON'T FORGET CHURCHER AND KING

As well as the Fletcher-Munson curves, we also had Churcher and King equal-loudness curves from the United Kingdom. Only recently did I realise that the King of Churcher and King was A. J. KING of Metropolitan Vickers who did so much work on noise from transformers and rotating electrical machines, and in the measurement of the sound attenuation of splitters in ducts. As well, A. J. King was author of that very good little book "The Measurement and Suppression of Noise" with the subtitle "With special reference to electrical machines."

* * *

R. NEIL REILLY

It is with sadness that we must belatedly note the death of NEIL REILLY, M.A.A.S., of the South Australian Division. Neil was a founding member of the Australian Acoustical Society and a member of the Acoustics Standards Committee. Your "People" columnist only learnt of Neil's death from the June issue of the Medical Journal of Australia; although from that same issue I learnt that he died in October 1980.

* * *

HARRY F. OLSON

It is sad also to see the departure of HARRY F. OLSON of the Acoustical Society of America. Harry F. Olson was "Mr. Acoustics" at the R.C.A. Laboratories from 1928 until his retirement in 1967. During this time he and his staff were pioneers in the development of microphones, loudspeakers, etc., right up to the development of the first video tape recording machine. Perhaps he is best known for his book "Elements of Acoustical Engineering" which many oldies in the Society know.

* * *

A HAPPY EVENT

We have to have at least one happy event recorded in the "Peoples Column". So what better than to mention that the only other female member of the Victoria Division, JILL HULME, has become a mother. Did some members think that they recalled this same item in the Gossip Column before? YES they did; now Jill is a mother twice over.

NEVILLE FLETCHER'S MANY HATS

One would imagine that Professor NEVILLE FLETCHER would find enough to keep himself busy as Professor of Physics at the University of New England in Armidale and as leader of an active acoustics group that has distinguished itself for research into musical instruments, insect acoustics, not to mention motor bikes (see our last issue). However, Neville enjoys wearing more than one hat and somehow finds time to be President of the Australian Institute of Physics and Secretary of the Australian Academy of Science (Physical Sciences). In his spare time he may be found playing at a professional level of competence on the flute, organ or harpsichord. He claims to have time to grow and eat his own vegetables. Surely there must be more than one Neville Fletcher!

* * *

JOHN LAMBERT MOVES

JOHN LAMBERT has now taken up his appointment as Manager of the Noise Control Section in the Division of Pollution Management of the S.A. Department for the Environment.

John joined the Victorian E.P.A. in 1972 and was involved in many aspects of environmental noise including the development of the current E.P.A. method of zoning in noise control. As a Senior Noise Control Officer in Victoria, involved in a number of working groups, including domestic airconditioner noise, motor vehicle noise and construction noise, John brings considerable experience to this new position. One of his first tasks will be a major overhaul and update of the S.A. Noise Control Act and Regulations.

* * *

RETURN OF GRAEME YATES

Dr. GRAEME YATES has recently returned to Western Australia after spending four years with the auditory physiology group in the Medical Research Council's Institute of Hearing Research in Nottingham, U.K. Graeme has taken up an appointment as a Senior Research Officer in the Department of Physiology at the University of Western Australia. He will be giving a Seminar in November on some of the history leading to the establishment of the I.H.R. and will describe some of the scientific and technical research programmes adopted by various members.

The Medical Research Council's Institute of Hearing Research was formally established in 1976 with the appointment of its Director, Professor M. P. HAGGARD. Since then it has grown to accommodate up to six senior scientists initiating their own research programmes and a support staff of approximately forty. The Headquarters in Nottingham has access to a clinical population through its four Out-stations located in major city hospitals in Nottingham, Southampton, Glasgow and Cardiff, and pilot-scale research projects requiring the participation of patients are conducted through these centres. A major epidemiological study, to determine the degree of hearing impairment in the U.K. population, is now in its fourth year and is already providing significant new information on the incidence of perceived and objectively measured hearing disabilities. Other research ranges from applied to purely scientific and includes novel diagnostic audiometric tests through to animal physiology of hearing.

PAUL DUBOUT BACK AT WORK

PAUL DUBOUT of C.S.I.R.O. fame; not to forget his work as General Secretary, Convenor of the Federal Membership Grading Committee, and Chairman of Standards Committees AK/1 and AK/2 and membership of other Standards Committee, is now back at work after suffering a heart-attack. Paul and his wife Val, were supposed to be holidaying in China at around this time; after his next visit Paul will give a slide evening to the Society.

* * *

MONEY REFUSED

Finally the gossip. Did you know that the Federal Council on receipt of $200 from an organisation seeking sustaining membership in the society, actually returned the $200 with a request for information about the credentials of the organisation. Some questions will be asked at the next Council Meeting.

* * *

During May of this year, PROFESSOR C. A. TAYLOR, Head of the Physics Department, University College, Cardiff, visited Australia and gave a number of lectures. Professor Taylor, a distinguished acustician, has an enviable reputation for giving entertaining lectures replete with fascinating demonstrations. It seems a pity that his visit to this country, which was sponsored by the Australian Academy of Science, did not include an address to the Acoustical Society. A video recording of his illustrated talk on Science and the Sounds of Music has been made by the Sydney University Television Unit.

MYSTERY ITEM

Your "People Columnist" throughout the year makes collections of clippings from various journals and the like, ready for when the time comes to put it all together as a "People Column". You will be pleased to note that I have made a note for myself to see the Journal of Acoustical Society of America, Volume 71, issue No. 2, on page 483. Writing this column at home in the evening I do not know what it is about and will leave those readers who have access to J.A.S.A. to look it up. (It is worth looking up, it is an interesting paper by Leigh Kenna, M.A.A.S.)

* * *

APPEAL

Once again an appeal to all readers and members to send me news of activities of our members and of Acousticians abroad. Send them to me at Graeme E. Harding & Associates Pty. Ltd., 22a Liddiard Street, Hawthorn, Victoria 3122.

ANNOUNCEMENT

The **International Commission on Biological Effects of Noise** is pleased to announce the Fourth International Congress on Noise as a Public Health Problem: Biological and Behavioural Effects. The Congress is scheduled to be held during the week of **June 20-25, 1983**, in Turin (Italy) in the BIT-ILO Centre. Major discussions are planned on governmental and industrial needs and problems. Other discussions will be held on ways to develop procedures that will permit practical solutions both for governments and for industries.
Details: Prof. Giovanni Rossi—Head, Dept. of Audiology
Via Genova 3—10126 Torino—(Italy)

A GLOSSARY FOR RESEARCH REPORTS

AS WRITTEN	TRANSLATION
It has long been known that . . .	*I haven't bothered to look up the original reference*
. . . of great theoretical and practical importance	*. . . interesting to me*
While it has not been possible to provide definite answers to these questions . . .	*The experiments didn't work out, but I figured I could at least get a publication out of it*
The W-Pb system was chosen as especially suitable to show the predicted behaviour . . .	*The fellow in the next lab had some already made up*
High-purity . . . Very high purity . . . Extremely high purity . . . Super-purity . . . Spectroscopically pure . . .	*Composition unknown except for the exaggerated claims of the supplier*
A fiducial reference line . . .	*A scratch*
Three of the samples were chosen for detailed study . . .	*The results on the others didn't make sense and were ignored*
. . . accidentally strained during mounting	*. . . dropped on the floor*
. . . handled with extreme care throughout the experiments	*. . . not dropped on the floor*
Typical results are shown . . .	*The best results are shown*
Although some detail has been lost in reproduction, it is clear from the original micrograph that . . .	*It is impossible to tell from the micrograph*
Presumably at longer times . . .	*I didn't take time to find out*
The agreement with the predicted curve is excellent	*fair*
good	*poor*
satisfactory	*doubtful*
fair	*imaginary*
. . . as good as could be expected	*non-existent*
These results will be reported at a later date	*I might possibly get around to this sometime*
The most reliable values are those of Jones	*He was a student of mine*
It is suggested that . . . It is believed that . . . It may be that . . .	*I think*
It is generally believed that . . .	*A couple of other guys think so too*
It might be argued that . . .	*I have such a good answer to this objection that I shall now raise it*
It is clear that much additional work will be required before a complete understanding . . .	*I don't understand it*
Unfortunately, a quantitative theory to account for these effects has not been formulated	*Neither does anybody else*
Correct within an order of magnitude	*Wrong*
It is to be hoped that this work will stimulate further work in the field	*This paper isn't very good, but neither are any of the others in this miserable subject*
Thank are due to Joe Glotz for assistance with the experiments and to John Doe for valuable discussions	*Glotz did the work and Doe explained what it meant*

C. D. Graham

(From Metal Progress **71**, *75, 1957)*

FUTURE EVENTS

AUSTRALIA

1982

December 10-11, SYDNEY

N.S.W. Division
Public Forum — Aircraft Noise
Friday evening: Public Address. Saturday morning: Workshop, visit to Tempe Public School. Saturday afternoon: Australian Acoustical Society A.G.M.

1983

February 24-25,

SOUTH AUSTRALIA

A.A.S. Annual Conference
"Economics of Noise Control"
Weinthal Conference Centre,
TANUNDA
Members intending to attend should notify Dr. P. B. Swift, Pryce Goodale and Duncan Pty. Ltd., 65 Fullarton Road, Kent Town, S.A. 5067.

July
Environmental Engineering Conference
Details: The Conference Manager, The Institution of Engineers, Australia, 11 National Circuit, BARTON, A.C.T. 2600.

September 19-22, BRISBANE

Second National Local Government Engineering Conference. Topics include Traffic Control, Structures, Soil Mechanics, Coastal Protection, Water Supply & Sewerage, Urban Planning, Environment Management, Computer Systems, etc.

Details: The Conference Manager, Conference on Local Government Engineering 1983, The Institution of Engineers, Australia, 11 National Circuit, Barton, A.C.T. 2600.

INTERNATIONAL

1982

December 14-17, SINGAPORE

First International Conference on Industrial Pollution and Control.
Topics: Air pollution and control, water pollution, noise pollution, industrial health, industrial waste and treatment system.
Details: The Conference Secretary, Dr. Raymond B. W. Heng, Senior Lecturer, Dept. of Mechanical and Production Engineering, National University of Singapore, Singapore 0511.

1983

April 26-29,
SZOMBATHELY, HUNGARY

4th Seminar and Exhibition on Noise Control.
Topics: Noise measurements, machine noise, exposure to work noise, transportation noise, outdoor industrial plant noise and construction noise, noise control engineering in buildings, legislation and perception.
Details: Optical, Acoustical and Film Technical Society, Budapest, Anker, Koz 1, H-1061—Hungary.

May 9-13, CINCINNATI, U.S.A.
Meeting of the Acoustical Society of America.
Chairman: Horst Hehmann, 119 Glenmary, Cincinnati, OH 45220.

June 20-25, TURIN, ITALY
Congress of the International Commission on Biological Effects of Noise.
Secretariat: TNO Research Institute for Environmental Hygiene, P.O. Box 214, 2600 AE Delft. Secretary, ir. Jan van den Eijk.

July 7, 8,
CHRISTCHURCH, N.Z.

7th New Zealand Acoustical Society Conference, University of Canterbury, Christchurch.
Details: Professor D. C. Stevenson, Mechanical Engineering Department, University of Canterbury, Private Bag, Christchurch, New Zealand.

July 12-14, SURREY, U.K.
Ultrasonics International '83.
Details: Z. Novak, IPC Science & Technology Press, P.O. Box 63, Guildford, Surrey GU2 5BH, U.K.

July 13-15, EDINBURGH
Internoise 83.
Secretariat: Institute of Acoustics, 25 Chambers Street, Edinburgh EH1 1HU.

July 19-27, PARIS, FRANCE
11th ICA—International Congress on Acoustics.
Satellite Symposia:
July 12-13, MARSEILLE, Active Sound Absorption and Acoustic Feedback Control.
July 15-16, LYON, Acoustic Radiations from Vibrating Structures.
July 15-16, TOULOUSE, Oral Communication.
Details: Secretariat SOCFI, 7 rue Michel-Ange, F.75016 PARIS.

July 29-August 1,
STOCKHOLM, SWEDEN
Music Acoustics Conference.
Principal themes of the conference will be acoustics of stringed instruments and singing.
Details: Stockholm Music Acoustic Conference 1983, C/o Dept. of Speech Communication KTH, S-100 44 Stockholm 70.

August 1-6,
UTRECHT, NETHERLANDS
10th International Congress on Phonetic Sciences.
Contact: Organizing Secretariat, C/o QLT Convention Services, Keizeasgracht 792 1017, EC Amsterdam.

August 1-6, TOKYO, JAPAN
4th World Congress of Phoneticians.
Contact: Secretariat, Phonetic Society of Japan, 12-13, Daita-2, Setegaya, Tokyo-55.

September 4-7, LONDON
4th Conference of the British Society of Audiology.
Details: above society, M. C. Martin, The Secretary, 105 Gower Street, London WC1E 6AH.

September, PARIS
Information Processing Congress.
Contact: M. Hermieu, 6 Place de Valois, F 75001 Paris.

October, HIGH TATRA, CZECHOSLOVAKIA
22nd Acoustical Conference on Electroacoustics and Signal Processing.
Preliminary Information: Acoustical Commission of Czechosl. Academy of Science, Secr. Dr. I. Januska, Provaznicka 8, 11000 Prague 1.

November 7-11, SAN DIEGO
Meeting of the Acoustical Society of America.
Chairman: Robert S. Gales, Code 5152, Naval Ocean Systems Centre, San Diego, California 92152.

1984

May 7-11, NORFOLK, VIRGINIA
Meeting of the Acoustical Society of America.
Chairman: Harvey H. Hubbard, Acoustics and Noise Reduction Div., NASA Langley Research Center, Langley Station, Mail Stop 462, Hampton, Virginia 23665.

New Parliament House, Canberra Acoustical Modelling of the House Chamber

Louis A. Challis
Louis Challis and Associates, Sydney

1. INTRODUCTION

There are very few projects which provide acousticians with the opportunity to implement new technology or even evaluate the most noteworthy aspects of previous technology in the acoustical assessment of auditoria. The most notable exceptions to this have been the Sydney Opera House, and more recently New Parliament House Canberra.

2. PHILOSOPHY OF MODELLING

The modelling of acoustical problems is quite a broad concept and can mean almost any procedure, computational, graphical or experimental, which is designed to mimic the acoustical behaviour of a situation. Acoustical scale modelling is a procedure that uses physical scale models in a simulation of the full-scale sound propagation. Acoustical scale models are useful for both interior and exterior spaces. Indoor models are used to study the acoustical performance of auditoria. Outdoor models may simulate the complex geometrics of buildings and streets, barriers and berms, enclosures and pits.

The kind of modelling used will depend upon the conditions of the "real" situation. Simple cases of sound propagation involving geometric divergence of sound and air absorption can be modelled with simple formulae or graphs. When the situation is more complicated, for example when buildings, walls and variations in land topography are involved, particularly when modelling outdoor conditions or when precise data are required the situation is normally different. This is even more pronounced when the distributions of sound inside rooms of complex shapes are required, as normal analytical calculations or computer-based procedures are generally not accurate enough. It is in situations like this that scale modelling has a unique role, for simulating complex phenomena in what should be a straightforward manner.

To predict the absolute sound levels resulting from a given distribution of sources in either an interior or exterior situation, it is necessary to calibrate the modelling system to the sound level for a source at a known full scale position. The sound levels received from a combination of sources and locations are then combined to produce a predicted noise level.

Often one is not interested in predicting the absolute sound level, but rather the effect of some change in layout or materials on the sound levels. Under these conditions absolute levels of sound are of no great significance and may therefore generally be ignored. This change may result from the reorientation of buildings or changes in building design, including the nature and extent of surfaces with specific acoustical properties. In such cases system calibration is not needed. It is, however, necessary to simulate the spectral content of the source as sound levels from sources with different spectral contents are not necessarily affected in the same way by changes in layout or materials.

The earliest scale models developed to understand the behaviour of sound waves employed shallow water waves in a "ripple tank". In the tank, a vertically oscillating paddle produces a wave train which may be reflected and diffracted. When light is passed perpendicularly through the tank and transmitted onto a screen, the black lines corresponding to each ripple can be followed. Propagation phenomena are easily visualized with this technique, which was first reported in 1843, but probably existed as a curiosity much earlier.

Spark shadowgraph/schlieren photography presents a way of viewing the progression of wave fronts in a model of an auditorium or other space. The spark emits a strong sound pulse which propagates through the model. The spark discharge is also used to trigger a flash lamp, thus producing a picture of acoustical wavefronts. Obviously, the large number of reflections that will show up in the picture, as time goes on, becomes difficult to interpret. Visualizations of sound produced by ripple tanks or spark shadowgraphs are useful in providing a feel for wave propagation, but have little quantitative value.

In contrast to these techniques, scale modelling describes physical processes quantitatively, although wave fronts are not visualized.

If a scale model is to represent the behaviour of sound in the full scale situation, a number of conditions must be met. Geometric similarity requires that the ratio of wavelength to dimension be kept fixed. If air is the medium in both the model and the full-scale situation, the frequency must be scaled up in the same ratio as the dimensions are scaled down to ensure that geometric spreading, scattering, and diffraction are reproduced properly. The directivity and placement of sound sources (such as vehicles, for example) may also have to be simulated to get the proper distribution of sound levels in the space.

To evaluate the subjective acoustic performance of interior spaces using scale modelling, geometric similarity is not sufficient. In order to simulate the audible qualities of a space, it appears that it is necessary to preserve the rather subtle variations in phase and amplitude caused by diffraction around the head and upper body of the listener. Rather remarkable full scale binaural recordings using an artificial head have been made in Germany and more recently in Australia. Practical systems for conducting such recording sessions have been produced by both Sennheizer and A.K.G. whilst students in Germany working under Spandock have produced scale model systems for use in model auditoria. In the German system the source of sound is a tape recording of music and it is played into the model by specially designed high frequency loudspeakers with a speed of playback scaled up to match the frequency scaling of the model. The sound is received by a scale model head and recorded on magnetic tape. Judgments can then be made regarding the quality of sound in the hall as various changes in the geometry of the space and locations of major absorbing and reflecting surfaces are made. Such a technique allows one to select the desired auditory qualities of a proposed space before it is built and to make choices regarding design options. We set out to emulate Spandock's work in the House Chamber model, but only using a monaural recording system.

Environmental studies show that the impact of noise on people can be correlated quite well with the intensity, spectrum (frequency content) and temporal variation of the noise. Subtleties in phase that are important in the appreciation of music seem to be unimportant in assessing noise, so an elaboration of binaural recording is not needed.

The use of acoustical scale models for studying noise propagation within buildings and outdoors has received much of its impetus from European laboratories. The work of Delaney at the National Physical Laboratory near London deserves special mention. Delaney and his co-workers have studied the propagation of road traffic down side streets, away from main traffic arteries, and a variety of other situations. They have also carried out extensive field studies and have been able to get good correspondence between model and full scale studies.

Lyon at MIT began working with scale models early in 1971 as a way of understanding the noise penetration into city streets from overflying aircraft. At the time, there was interest in the possible development of V/STOL ports near urban centres to provide better inter-city transportation. The accurate prediction of noise levels was however precluded by the lack of information on the effect that the buildings would have on the flyover noise. Model studies appeared to be the way to obtain the data, so small air jets were traversed over models of urban canyons. Comparisons with a similar flyby over flat or open terrain were made. Fortunately, arrangements were made for a series of overflights of a Boston street by a helicopter for a comparison of field and laboratory results. The results predicted from the model study were in good agreement with the field data.

Studies were also made of noise penetration into an urban area. A small scale "city" of plywood boxes was constructed, and a sound source was flown along its edge at various altitudes. The resulting noise levels were measured at a variety of locations and compared with what they would have been in the absence of the boxes.

From the results of the model study it was found that the sound is enhanced when channelled along a street while some areas are shielded by the buildings. The model studies showed that the buildings may cause the levels in their vicinity to be greater than in open terrain, but only by a few decibels, and demonstrated that there is a significant amount of variation in the levels.

In the course of these studies, it was discovered that there were a number of basic questions regarding noise propagation that looked amenable to scale modelling. Such questions were:

What are the effects of shape and materials on the sound reduction provided by a barrier?

How does building or surface roughness affect the propagation of noise along a street or within a room?

What do trees do to sound—are they a barrier to noise or do they provide a means for noise to get into otherwise quiet areas? (The answer is that they apparently do both.)

The attenuation of sound expected in large models, due to geometric spreading, air absorption and blockage by the model itself, necessitates the use of a high energy sound source. This requirement led to the selection of an electrical spark as the preferred sound source. Since it provides an impulse, it has other benefits, in particular that the times at which the various sound pulses arrive at the microphone may be recorded. Spurious pulses that arrive after reflection from nearby walls or fixtures can be identified and then ignored or eliminated by the judicious placement of sound absorbing treatment. Depending on the scale of the model, the absorption of sound by the air in the full-scale situation may be simulated by changing the humidity. Alternatively, by using an impulsive signal, the gain of the microphone amplifier may be adjusted to compensate for the extra air absorption. Such adjustment can be done either mathematically or electrically.

3. MODELLING PROCEDURES

Scale modelling involves simulation of the source of sound, the transmission path and the receiver. Exact simulation of the "real source" is extremely difficult in that the original (or full scale) source may be a person, a choir, a musical instrument or, in our specific case, a vocal politician. The directivity of such a source (and particularly a person speaking) is very difficult to reproduce. It can however be replicated adequately by means of special ultra high-frequency loudspeakers whose frequency response can be designed to extend up to 100 kHz. Other alternative sound sources which have been used by other researchers include miniature air jets and electronic spark sources whose basically omnidirectional sound fields may be converted to directional fields by the addition of suitable reflectors or screens.

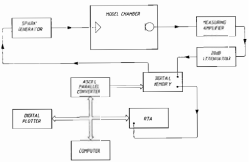
We made use of both directional loudspeaker sources for the reproduction of both frequency and time-scaled sounds of speech. We also used omnidirectional electronic spark sources to investigate the time/space spectrometry and build up or decaying reverberation characteristics of the chamber. Such analysis is required when it is necessary to evaluate the sound propagation in the presence of multiple reflections from a large number of alternative and simultaneous paths. In the case of the House Chamber this type of analysis proved to be particularly important, for whilst it is possible to achieve the same nominal reverberation time by various combinations of surface treatments, the resulting sound fields and their quality would not necessarily be the same for each combination.

4. SOUND FIELD ANALYSIS

The procedure that we followed can be subdivided in the following sequential steps:—

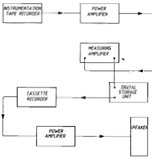
(a) Evaluation of the scaled model surface treatments in a miniature glass reverberation chamber with a volume of 1.8 cubic metres. The majority of treatments that we evaluated have been pre-evaluated by other researchers, but the exact details of the surface treatments are usually inadequately specified to allow direct use of their results.

HIGH SPEED REVERBERATION MEASUREMENT EQUIPMENT SET UP



(b) Making use of the data acquired in (a) above, the modelled treatments for walls, floors, ceilings, seats and people was applied in various configurations to the bare acoustically reflective House Chamber model. This made it possible to determine the reverberation characteristics over the frequency range 630 Hz to 80 kHz (corresponding to full scale frequency range of 63 Hz to 8 kHz). By testing with a range of acoustic treatments it was possible to determine the best distribution and location of such treatments. The evaluation of speech (recorded under anechoic conditions) played in the model at 10 x normal frequency and the subsequent monitoring of the recorded sound when replayed at normal speed made it possible to evaluate directly the subjective quality of that speech as received at typical listening positions within the chamber.

SPEECH RECORDING IN MODEL
EQUIPMENT SET UP



(c) The comparison of the results of these analytical procedures with the design criteria made it possible for us to present recommendations for the practical acoustical solutions to real problems discerned during the modelling process.

(d) Through the evaluation of our results the architects were able to assess the implications of the various options available to them in the design of the ceiling configuration and the choice of available treatments for the various walls, floor and other surfaces.

5. INSTRUMENTATION

5.1 Sound Sources

(a) The first sound source that we made use of was an electronic spark generator with the capability of producing a 15 Joule spark with a peak sound pressure level in excess of 140 dB at a 1.5 metre radius. This source proved to be essentially omni-directional and as such was well suited for both the evaluation of reverberation time and time domain spectrometry.

(b) The second sound source we used was a miniature phase coherent loudspeaker system with a frequency response which extends from 150 Hz to 100 kHz. With such a wide frequency response it was possible to replay speech, music and other transient signals at 10 x normal frequency without significant loss of fidelity.

(c) The third sound source was a small starting pistol whose output although not entirely consistent from shot to shot, had the ability to replicate broad band energy over the most significant frequency region, 1 kHz to 60 kHz in the model (corresponding to 100 Hz to 6 kHz in the House Chamber).

5.2 Recording System

The recording systems that we had available were as follows:—

(a) The first system is a digital memory containing a 12 bit analog to digital converter, a 4.608 megabyte digital memory, and a 12 bit digital to analog converter. This memory was capable of operating with sampling speeds as high as 400 kHz for recording and with speeds as low as 10 kHz during replay. By this means it was possible to slow down extremely fast transients of the type generated by the electronic spark source, the starting pistol, or from the loudspeaker system. We were then in a position to use automated processing techniques already developed and proven to analyse the "slowed-down" replayed signal.

(b) An instrumentation tape recorder with a dynamic range in excess of 60 dB and a frequency response from 25 Hz to 35 kHz ± 1 dB at a tape speed of 38 cm/sec. The tape recorder was employed in both the recording and replaying of signals, utilising the full range of tape speeds of which it is capable (3.8 to 38 cm/sec.).

5.3 Processing of Results

We developed new software for our computer to allow the automatic storage and averaging of the results obtained from multiple samples to provide statistically accurate results. These results were then plotted out in the form of conventional reverberation graphs, as well as being presented as sound level/time spectrograms to evaluate the dominant reflection characteristics of the various surfaces within the chamber.

6. GENERAL COMMENTS ON THE TECHNIQUES UTILIZED

Acoustical modelling is not a panacea for the problems that we experienced were many and varied, and a discussion of their implications and solutions goes beyond this paper. Notwithstanding, we found that many problems of the type discerned by us during the modelling programme would not have been detected nor foreseen utilizing conventional mathematical modelling.

The correlation we achieved between our modelling and mathematical forecasting was far better and closer than we would have expected, in particular, provided the absorptive performance of our scale surfaces were accurately determined in our model reverberation chamber.

The primary problems that we experienced related to electronic interference from our electronic spark source and separately the impact of air absorption which creates so many problems with air that has not been dehumidified to provide reliable results at frequencies above 20 kHz.

Whilst the technique is relatively "cost effective" the cost of the instrumentation and equally significantly the quality of the model used in the evaluation will always remain the major stumbling block to the universal use of this technique.

Digital Techniques in Acoustics

Part 1: Digital Data Acquisition and Data Handling

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ABSTRACT: A discussion on the sampling, digitising, storage and basic manipulation of data for analysis is presented. The limitations and restrictions that must be considered are emphasised.

1. INTRODUCTION

The explosion in electronic developments, particularly in digital techniques, has had a profound effect on data analysis. This article is an introduction to digital techniques as applied to the acquisition and subsequent handling of data in a form suitable for digital analysis, so that some understanding of the operation, advantages, and limitations of digital techniques can be acquired. Digital computing used to be limited to large "mainframe" computers such as IBM and CDC, but this changed with the emergence of the minicomputers (eg. PDP, DATA GENERAL, HP) which allowed more people to purchase computers. The advent of the microcomputer (e.g. APPLE, COMMODORE, TANDY, PEACH) brought affordable computing to the ordinary householder who can now contemplate digital signal analysis. The advances in VLSI (very large scale integration) is another significant factor since it has enabled, for example, an entire microprocessor together with data storage and input/output for analog signals to be implemented on a single semiconductor chip.

2. ANALOG TO DIGITAL CONVERSION

The first stage in any digital analysis system is to take the data which will be in the form of an analog voltage and change it to a format suitable for analysis by a digital processor. The process of changing an analog signal to a digital format is carried by a device called an ADC (analog to digital converter). An ADC takes a small but finite time to carry out the conversion and, during this time, the analog signal may have changed so that the final digital output represents the signal at some unspecified point during the conversion time. To ensure that the signal at only a specified point in time is being studied, an ADC is usually preceded by a sample-and-hold amplifier so that a very short time slice can be captured and retained for the subsequent conversion. Many situations provide several channels of data and so instead of providing multiple ADC units, a single unit is preceded by a fast computer controllable switch called a multiplexer (MUX). The problem when using a MUX is that the different channels are not examined at the same time, which is illustrated in Fig. 1, unless a battery of sample-and-hold amplifiers is used before the MUX.

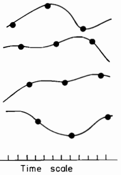

Fig. 1 Multiplexed sampling of 4 signals

The process is digitisation by its very nature represents a continuous signal by discrete time samples. One important limitation to be observed in time sampling, to ensure that the discrete representation is reasonable, is the Nyquist criterion. This criterion requires the sampling frequency to be at least double the highest frequency present in the signal, otherwise aliasing will occur when the higher frequencies will be folded back. This is illustrated by the apparent backward motion of wheels on TV when the sampling rate is not twice some of the frequencies associated with the rotating wheel. Fig. 2 shows how a too slow sample rate can indicate an apparent lower frequency.

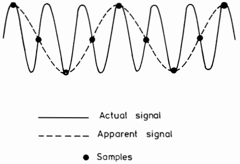

Fig. 2 Example of Aliasing

When trying to achieve faithful recording of a signal an important parameter is the dynamic range, and in a digital representation this depends on the number of binary digits (bits) used. A binary number in each digit has only two values: 1 or 0. For example, the binary number 1 0 1 1 0 1 is equivalent to $2^5 + 2^3 + 2^2 + 2^0 = 45$. The largest decimal number corresponding to N binary digits is $2^N - 1$, and since the smallest number is 1, the dynamic ranges in dB for positive signals only goes as $20 \log (2^N - 1)$. Table 1 gives the dynamic range for different numbers of bits (word length) in the converter.

Table 1: Dynamic Range for Different Word Lengths

No. of bits	Dynamic Range (dB)
8	48
12	72
16	93

Most signals have both positive and negative values, and so some means of both converting and representing the sign of the signal are needed. A simple way is to provide an extra d.c. bias prior to conversion so that a signal in the range—5 to +5 volts becomes a signal in the range 0 to +10 volts. Alternative approaches employ some convention where the bit representing the highest value (most significant bit or MSB) is 1 only for negative signals. The capability of handling both positive and negative voltages (bipolar operation) has effectively halved (—3 dB) the dynamic range.

An ADC is set to handle a specific voltage range (say 0 to 10 volts) but this may be too large for the signals encountered in practice, so the range may be changed by either manually changing a link on the ADC or using an amplifier having a gain that may be set by the computer before the ADC. Although it is desirable to have many binary digits for an ADC to get both the highest dynamic range and the best resolution (resolution is the smallest change in voltage that can be measured), the penalty paid for more binary digits is longer conversion times so that the highest frequency a signal can contain is lowered. Specifications for an ADC usually express the resolution as ±½ LSB (least significant bit) indicating a quantisation error where a voltage which lies in the voltage interval between quantisation levels (specified by the LSB) will, on average, register for half the time at either of the two levels. This is illustrated by the simple example given in Fig. 3.

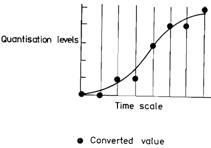

Fig. 3 Demonstration of quantisation limits.

3. DATA STORAGE

Once the analog signals have been sampled and digitised, the resulting binary numbers must be stored for later retrieval. The immediate way of saving data is in "core" storage where the bits making up each binary word are used to set "switches" which were originally tiny ferrite cores (hence the name "core storage") whose direction of magnetism specifies whether a bit is a 0 or 1. Core storage now usually employs transistor switches since many thousands of these transistors can be constructed on small silicon chips, unlike the bulky ferrite core assembly. The magnetic state of ferrite core memory is not altered when the computer is turned off (non-volatile memory), whereas semiconductor memory using transistor switches does not retain its state (volatile memory) on loss of power unless a special back-up power supply is used.

Permanent demountable (so any user can retain his data locally) means of storing large amounts of data is needed and this can be met by using punched cards and/or paper tape; however, the current trend is to use the magnetic properties of iron oxide on a suitable substrate. Magnetic tapes can be used and may be large reels of ½-inch tape on sophisticated tape drives (used on mainframe and minicomputers) or simple ¼-inch cassette tapes on cheap audio recorders (used with microcomputers). The difficulty with magnetic tape is that if the data required is at one end of the tape and the replay head is positioned at the other end, the tape has to be advanced to where the data is, and this takes time. Tape drives are sequential access devices because data must be placed on the tape in a fixed sequence and taken off in the same sequence.

If the iron oxide coating is placed on a disk, then data can be placed on this disk by causing it to rotate and moving the sensing head in and out to select a given track. Since data can be stored and retrieved from different tracks simply by moving the sensing head, disk drive units are random access devices. The substrate may be a plastic sheet in a cardboard protective cover (flexible or floppy disk) which has either a 5-inch diameter (used in microcomputer systems) or a 8-inch diameter disk (used to some degree in all size computer systems), or an aluminium disk (either single or in stacks) which is usually removable from the disk drive. Fixed rigid disk drives (Winchester units) are now available for microcomputers.

4. DATA HANDLING

Data which is stored in a computer has to be handled, i.e., there are operations to be carried out on the data and it will have to be transmitted to some display unit such as a printer or a plotter. The operations on the data are under the control of a program which resides in the memory. The processor brings down sequential instructions from memory and decodes them. Although programs can be constructed so that the actual commands as binary words will be loaded directly into memory (machine language), the usual procedure is to use some high level language such as FORTRAN or BASIC, and then this high level language is translated into the form the processor understands (machine language).

All the arithmetic operations on data such as addition, subtraction, multiplication and division can be constructed from combinations of the binary operations of addition, complementation (replace 1 by 0 and 0 by 1), and bit shifting right and left.

Since binary words are of a finite length there will arise the situation after some operations where the number will be larger than that allowed for the given word length (see Table 2), and then an overflow occurs. One way to overcome this problem is to increase the precision by using more than one word to represent a number; however, eventually an overflow situation could again occur. An alternative approach is to represent a number using floating-point arithmetic where the number of significant figures is constant, independent of the magnitude of the number. This is achieved by expressing a number as a fraction and an exponent which is demonstrated in Table 3 for four significant figures.

Table 2: Size of Largest Number for Given Word Length

Word Length (bits)	Largest Number
8	256
12	4096
16	65536
24	16777216
32	4294967296

Table 3: Floating Point Representation of Numbers (numbers to left of E are exponent of 10)

Number	Floating Point Notation
6 782 547	0.6783 E+7
58 467	0.5847 E+5
.0034782	0.3478 E—2
.0000267	0.2670 E—4

Although floating-point arithmetic ensures that the number of significant figures remains constant, problems can still arise if, for example, the difference between two numbers which are almost equal is required, when the limit in the number of significant figures can give a wrong result (truncation error). If care is not taken in programming the limitations of the length of the binary word will become evident when a number becomes too small (underflow) or too large (overflow) for the representation.

5. DATA TRANSMISSION

Digital data is moved around inside the computer using a group of wires called a bus. One wire is needed for each binary digit and there are control lines to signal the operation that is taking place. Most computers have both an address bus which specifies which location in, say, core storage, information is to either be read from or written to, and a data bus for the information. The control lines usually initiate a handshake sequence to ensure that data transfers only take place when both the processor and memory (or any other device) are ready. Data transfers are often asynchronous in that they are not constrained to occur in synchronism with some clock, but only when both receiver and sender are ready. Data transmission from the computer to an external device such as a telephone link often requires the information to be in step with a clock signal and so the transfer is synchronous.

If a wire is provided for each bit in a binary word, an entire word can be sent each time (parallel transfer); however, for long distance transfers (telephone link) it is desirable to minimise the number of wires and this is achieved by using a serial mode. In serial transmission a digital word is sent as a time sequence; a bit at a time as illustrated in Fig. 4. The simplest serial line

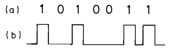

Fig. 4 Binary number (a) and serial version (b).

needs only two wires to send data (used in teletypes) and more sophisticated systems have various control lines. Often data has to represent all the alphanumeric characters, so that a coding scheme is used. Each byte (8 bits) represents a character, and Table 4 gives the internationally accepted ASCII code for some characters. The code in Table 4 is stated in base 10 (decimal —the customary number system: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9) and also for bases 8 (octal: 0, 1, 2, 3, 4, 5, 6, 7) and 16 (hexadecimal: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F) which are used to describe numbers in a computer since they are powers of 2.

Table 4: ASCII Representation of Characters

ASCII Code Representation			
Character	Decimal	Octal	Hexadecimal
1	49	61	31
2	50	62	32
A	65	101	41
B	66	102	42
a	97	141	61
b	98	142	62

6. INPUT/OUTPUT

A user needs some way of talking to a computer and outputting results from the computer. One of the early means of communicating with minicomputers was a teletype which has a keyboard, printer, paper tape reader and paper tape punch. A teletype is a slow, noisy device and both quieter and faster operation is achieved by combining a keyboard with a dot-matrix printer where the characters are made from a series of dots so that the print head is simply composed of a series of pins, each with its own individual solenoid driver. However, characters composed from a dot-matrix, although quite presentable (see Fig. 5) are not letter quality and alternative printers use wheels or balls which have all the characters on them and can be rotated to select the required character. High speed printers use characters on a continuous chain with a hammer which strikes the chain to print the required character at the required position.

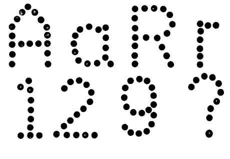

Fig. 5 Dot matrix representation of characters.

When a hard copy output is not required, a VDU (visual display unit) can be used. A standard television monitor may be used and the information to control the video scan is stored in a section of memory which is sequentially examined to produce the display. Thus, whatever is stored in the display memory, which may be either part of a micro-computer or a memory inside the terminal, is displayed and can be updated as required. A VDU display can often be used in one of two modes: alphanumeric or graphic. In the alphanumeric mode, characters are stored in the display memory and as it is examined, the characters are built up by a decoder unit using the dot matrix approach. In the graphics mode, either individual points or blocks can be made to appear on the screen and hence drawings can be built up. It is also possible to provide colour information within the words in the display store so that colour

(Continued on page 116)

Learned Society or Professional Institution

1. INTRODUCTION

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At the 1981 Annual General Meeting of the Acoustical Society a motion was defeated which would have completed the transition of the Society from its beginnings as a Learned Society into a Professional Association. The reason why the motion to remove clause 16 (d) (the so-called "grandfather" clause) from the "Memorandum and Articles of Association of the Australian Acoustical Society" was defeated, I suspect, was ignorance: ignorance of the direction the Society was going; ignorance of the educational qualification and examinations that the Society would require for membership; ignorance of what would happen to non-corporate members of the Society of a number of years standing and ignorance of what a Professional Society is. In such circumstances I am not surprised that members voted for the devil they knew.

When members are satisfactorily informed on these matters they will, I am sure, end up like the young lady of Kent:

There was a young lady of Kent
Who said that she knew what it meant
When men asked her to dine
Gave her cocktails and wine
She knew what it meant — but she went.

There are some drawbacks associated with being a Professional Society and some members will inevitably feel that these disadvantages outweigh the advantages. If other similar societies are anything to go by, though, it is also inevitable that the Australian Acoustical Society will become a fully-fledged Professional Institution.

Once members know what it means to be members of a Professional Institution most will not yell "rape" as they did at the last Annual General Meeting but will sit back and enjoy the status and respect that will be given them as members of the Professional class, . . . or will they? Actually I am inclined to think there is little substance in the arguments for or against the Australian Acoustical Society becoming a Professional Institution *provided* the Council responds to the needs and desires of its members (and potential members) and responds compassionately to them.

My greatest fear concerning the professionalization of the Society is that the Society will become cliquy, dull and pompose; that it will assume the monied pretensions of the AMA. One of the strengths of the present Society is the diversity of its members. A legally recognized professional society will have to set educational and entry standards which will inevitably be biased towards the engineering side of acoustics as the engineers form a large proportion of the Society's membership and because it is the engineers who have most to gain from legal recognition. The diversity of the Society will then be in danger.

Before I go too far off the deep end I should like to briefly remind you what the difference between a "Learned Society" and a "Professional Society" is and then give you a little history of professions and what people have thought of them and what makes a profession.

2. LEARNED SOCIETY/PROFESSIONAL SOCIETY/PROFESSIONAL PERSON

My understanding of a "Learned Society" is that it has a purely educational function. Membership of a "Learned Society" may or may not be restricted. Membership of the Royal Society of N.S.W. is unrestricted whereas membership of the Royal Society is a little bit more restricted and yet both are "Learned Societies". A "Professional Society" or "Professional Institution" must have restricted entry because the Professional Society guarantees the competence of its members to undertake certain tasks . . . and guarantees that its members won't try to undertake tasks they are not competent to undertake. A "Professional Society" combines some of the elements of a club, a union and an educational establishment for professional people with similar backgrounds and interests. To understand many peoples' attitudes to professional societies it is worth looking at some of the history of the professions.

The professions appear to have started as sinecures. In aristocratic families where there was more than one son and the title and inheritance passed to the eldest son the younger sons maintained their status by obtaining positions in one of three professions; the Church, the army or medicine. The qualifications for entry to these professions was that the candidate was a gentleman.

In the 18th century the Church of England's requirements were for, "a man of virtuous conversation and without crime". The more rigorous requirements that a man should have knowledge of Latin and the Scriptures could be waived if the candidate was known to be a gentleman. The medical skills and learning of a physician at this time were limited mainly to the art of writing complicated prescriptions.

A physician might have extensive learning in classic literature and culture, but he depended on his gentlemanly manner, impressive behaviour and his clients' ignorance to develop his medical practice. Even as recently as the 1960's the Dean of a British Medical School went on record as saying that students entering the Medical Faculty should come from the right socio-economic background.

Despite these "entry qualifications" the professions have provided one of the few means of gentrification; upward social mobility. Social status remains an important aspect of professional life. The relationship between social status and work (the less a person did the more status he had) also remains important. Professionals do not produce or distribute any goods and the further removed they are from production and distribution the greater their status, e.g., doctors and lawyers. Artisans (the workers) and farmers on the other hand have low socio-economic status and yet the goods they produce and distribute are essential for the survival of our society.

It is little wonder then that the professions have been identified as the drones of our society. The criticisms of the professions are well summarized by the following two quotations:

> "All professions are conspiracies: they make their subjects obscure in order to gain a living making it clearer."
>
> *Sir Hugh Casson, Architects Journal 9th December, 1981*

"At first, new knowledge is applied to the solution of a clearly stated problem and scientific measuring sticks are applied to account for the new efficiency. But at a second point, the process demonstrated in a previous achievement is used as a rationale for the exploitation of society by one of its self-certifying professional elites."

Ivan Illich, New Society
13th September 1973

While it is apparent, from what I have said, that a professional person does nothing, in these days of high unemployment, the converse is not true, i.e., that a person who does nothing is a professional. In order to find out what distinguishes a professional person from an artist or artisan I referred to some work by Sociologists. There are differences in knowledge, tasks, decision making, authority, identity, work, career, education and role. Two factors distinguishing professionals from non-professional are worth considering further because they appear to define the essence of a professional and they are of considerable importance in determining whether we are professionals and if so, what problems we will encounter if we form a professional institution for acousticians. The two areas are:

1. Education/knowledge/qualification.
2. Ethics/socialization/traditional codes of conduct.

3. EDUCATION/KNOWLEDGE/QUALIFICATIONS

In most, if not all, cultures manual work is considered inferior to "desk" jobs. This is particularly pronounced in Islamic societies but even in our own society the dislike of manual work is manifested in a dislike of manual workers when they aspire to higher status through higher wages and better conditions. Despite protestations, from the middle class, about the excessive wages of the working class, the headlong rush of the underpaid middle class, to undertake occupations traditionally filled by the working class is not so great as to cause any great concern about a localized "brain-drain". Financial reward then does not help define the difference between professionals and non-professionals.

Nor can the difference between professionals and non-professionals be based on the use or non-use of manual skills. Surgeons can be thought of as people plumbers and airline pilots as air-bus drivers and yet the surgeons and airline pilots are considered as professionals and plumbers and bus drivers are non-professionals. Besides the difference in class backgrounds between dentists and dental technicians, the main distinguishing feature between them is their education.

Although most professionals use very little of their formal training and although it has been shown that people who have not had formal professional training are capable of successfully providing services which are normally provided by, or inadequately provided by, professionals (e.g., Chiropractors and Herbalists) it seems that a formal recognized education is one of the few distinguishing features of a professional. His education is, in comparison with non-professionals, broad, and has a predominantly theoretical base.

When this broad theoretical knowledge has been mastered and a qualification is issued, the student joins the profession. Professional societies have, in the past, assessed the competence of people seeking admission to the profession. That function has been taken over by universities although some professional societies retain the vestiges of professional competence assessments.

As there is only one course in Australia that could be considered as acoustical training and as that course would be unsuitable as training for many branches of acoustics*, a professional Acoustical Society would be faced with either accepting many different courses (over which it has no control) as a basis for membership, or reverting to the outmoded concept of Society-set professional examinations. Both these possibilities are fraught with difficulties unless a very liberal attitude to entry requirements is taken. If a liberal attitude is taken then the "respectability" and "recognition" of membership of the Acoustical Society will suffer.

* Entry requirements and geographical considerations for the MSc (Acoustics) degree at the University of N.S.W. also limit the course's appeal.

4. ETHICS/SOCIALIZATION/TRADITIONAL CODES OF CONDUCT

A formal education is probably more important in forming common attitudes and an esprit de corps than it is in disseminating information which will be of use in professional practice. This "Socializaton" process which is the basis of initiation ceremonies is considered essential by the armed forces and is also well recognized in other professions. Attitudes to work and clients are formed in this way, as are standards of dress, customs and codes of conduct. An ethic is established which, although modified by individual differences in morality, can be relied on to produce a recognizable uniformity of behaviour. In the medical profession the "socialization" process is formalized by the taking of the Hippocratic Oath. In other professions members undertake to adhere to a Code of Ethics.

Members of the Acoustical Society come from a wide variety of backgrounds and with different socializing influences. It will be very difficult to establish a common code of conduct and yet without this code there is unlikely to be much cohesion and sense of belonging amongst the Society's members, or public recognition that the profession is acting in that meaningless term, "the public interest". Also the traditional antagonism between Architects and Engineers may, for instance, manifest itself in the Society if one or other group's values tend to dominate.

The educational and socialization issues should, I think, be paramount in deciding the future of the Society. The other deciding factor should be the wishes of the Society's members. The Australian Association of Acoustical Consultants and some members of the Public Service have very good reasons for wanting the Society to be a traditional professional institution, but many other members apparently do not want this.

If the history of societies was not such as to suggest that it is almost inevitable that the AAS becomes a professional institution I would suggest the AAAC and the Public Service Board seek to solve their problems in other ways. Perhaps they still should as the tide seems to be turning against the professions. No longer do many people consider that professional associations, "are stabilizing elements in society. They engender modes of life, habits of thought and standards of judgment which render them centres of resistance to crude forces which threaten steady and peaceful evolution—they stand like rocks against which the waves raised by these forces beat in vain". (Carr-Saunders and Wilson 1933.) More and more professional associations are criticised for their resistance to change and obsessive concern with financial and social status. There is a growing sympathy for the ideas of people like Illich who maintain that—"the time has come to take the syringe out of the hand of the doctor, as the pen was taken out of the hand of the scribe during the reformation in Europe".

There are also people who consider today's professionals, who are not self-employed, to be part of an intellectual slave trade. They are expected to work when required, for no extra reward, and carry their problems with them 24 hours a day, seven days a week. If Funeral Directors and Real Estate Agents see themselves as professionals perhaps we would be better off as non-professionals.

We have the opportunity to put sound level meters in the hands of other professionals, and the public, or to keep those sound level meters for ourselves. I advocate the distribution of sound level meters but if this is not done let us move to professional status slowly. Let us allow any of the present non-corporate members to become corporate members, if they wish. Let us also work out what we are to do about the issues of education, socialization, entry qualifications (e.g., a technical meeting presentation) and map the future of the Society before we change the Articles of Association. Above all else let us not become a dull, conservative, uncritical, status seeking professional association.

And let us not have stories told about us similar to that of two Macquarie Street Specialists:

First Specialist:	"I did a marvellous operation on a man yesterday."
Second Specialist:	"What for?"
First Specialist:	"10,000 dollars."
Second Specialist:	"No, No. What did he have?"
First Specialist:	"10,000 dollars."

because otherwise we may find ourselves with red faces and a large ARS (Acoustical Reform Society).

DIGITAL TECHNIQUES (Continued from Page 113)

displays can be produced. A VDU is a refresh display in that the information in the display store is continually scanned to maintain the output. An alternative means of display is to use a storage screen to hold the output so that a storage display need only be written once, but the entire display needs to be cleared before fresh information is received.

Data can be output to a plotter which can be driven either from X and Y analog voltages produced by digital to analog converters (DAC) or by decoding digital instructions.

Another way of inputting data is via digitising tablets where the X and Y co-ordinates of a point on the tablet can be sent to the computer. Elementary voice input units are available and voice output now can be readily achieved.

7. CONCLUSIONS

Modern technology allows data to be sampled and stored in a computer for subsequent computations for a modest expenditure. The computer can then operate on this data to provide information on the input signals and the results displayed on a variety of devices ranging from printers, plotters, voice output and colour graphics.

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Experimental Building for Facade Attenuation Measurements

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1. INTRODUCTION

A temporary experimental building for facade attenuation measurements has been constructed adjacent to a main road in Alexandria, a mainly industrial area of Sydney. The land, which had been resumed by the New South Wales Department of Main Roads for a future freeway, was leased to the University for this project at nominal cost. Research grants awarded by the New South Wales Pollution Control Commission and the Australian Research Grants Committee have been used to construct the experimental building and for the employment of some research staff to assist with the measurements.

The main aim of the project is to determine the effectiveness of the road traffic noise attenuation of facades, including doors and windows. In addition, an assessment of the appropriate measurement procedures involves comparisons between the results obtained using filtered white noise radiated by a loudspeaker, as used in laboratory tests, and traffic noise which varies in space and time.

2. THE EXPERIMENTAL BUILDING

The building contains two rooms of normal domestic proportions, one 4 x 5 x 2.4 m high and the other 3 x 5 x 2.4 m high (e.g., similar to a living room and a bedroom) and has a control/storage room at the rear. The walls of the building, except for the experimental facade, are of concrete block masonry and all dividing walls are carried up to the underside of the pitched roof tiles, to minimise flanking transmission via the suspended plaster board ceiling.

A concrete slab floor is provided for all three rooms. The two test rooms have additional suspended timber floors, independently supported on masonry piers, again to minimise flanking transmission. At a later stage in the project the timber floors will be removed so that the concrete slab will be the basic floor and the construction will represent one level of typical multistorey domestic buildings.

The first experimental facade comprised asbestos cement sheeting on timber framing. One room had no internal lining and the other was lined with 13 mm plasterboard. After the first series of tests an internal lining of 13 mm plasterboard was installed in the second room. Openings were made in both facades and a series of aluminium framed windows having double and single glazing arrangements were installed. These windows were donated by the manufacturers and were tested in the closed and open condition. A second layer of 16 mm plasterboard was added to the internal lining of one of the rooms in conjunction with the tests on the windows.

The second main stage of the project involved the construction of a masonry skin outside the timber frame to represent brick-veneer construction. The same series of windows and some doors will be installed in this facade. The third stage will involve the removal of both the timber floor and the stud wall and the installation of a second masonry skin, representative of full brick construction.

3. MEASUREMENT PROCEDURES

The assessment of various measurement procedures will lead to recommendations to the Standards Association of Australia on the most appropriate method(s) for field measurement of the transmission loss and noise reduction of facades. Both traffic noise from the adjacent road and loudspeaker generated noise have been used as the sound sources. The noise from road traffic was analysed in terms of dB(A) or one-third octave bands to allow for comparison with the results using the constant noise from the loudspeaker.

The microphone locations have been in a plane 1 m or 2 m from the facade or within a few mm of the facade. Inside the room the microphone has been either located centrally or at up to five independent positions which were subsequently averaged. The tests have been carried out with the rooms either bare or furnished with carpet, upholstered chairs, curtains and cupboards. The furniture reduces the reverberation time and provides some dispersion of the sound field, and the rooms therefore become more representative of a typical living room or bedroom.

4. CONCLUSION

The full series of tests with the asbestos cement and gypsum board lined stud wall as the facade have been completed, and the Experimental Building has been found to be an excellent facility for field studies of building facade attenuation. The results so far have indicated the limitations of laboratory type sound transmission loss/noise reduction measurements using a constant sound source to predict the attenuation of building facades and facade elements against road traffic noise. The poor performance of the asbestos cement/plasterboard wall limited the overall noise reduction of the facade so little benefit was obtained using a double window arrangement rather than a single glazed window. (An air gap of up to 100 mm between the two window leaves was tested.) It is anticipated that the performance of the various glazing arrangements will differ when the main facade has a higher sound reduction and greater spacings between the two leaves will then be tested. However, the tests have indicated that when opened a little for ventilation double windows with 100 mm spacing have a performance of the order of 4 dB(A) better than single glazing having the same opening area. The performance is further improved if the opening sashes are staggered (i.e., the outer left hand pane and the inner right hand pane are open).

Seeking the Songs of the Humpback Whale

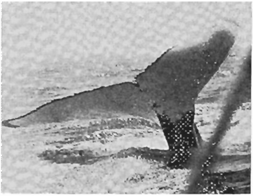
Douglas H. Cato
RAN Research Laboratory
P.O. Box 706, Darlinghurst, N.S.W. 2010

Of all the strange sounds to be heard in the ocean, probably the most spectacular are those of humpback whales during their migration to and from their tropical breeding grounds. They emit a wide variety of sounds at frequencies of tens of Hertz to tens of kilo Hertz, from deep throaty growls to high pitched squeaks and whistles, as well as moans, squeals, and sounds like trumpets, violins and engines. Their high source levels (in excess of 180 dB re 1 μPa = 154 dB re 20 μPa at 1 m) and the very low absorption attenuation of sound in water mean that they are audible for tens of kilometres, in spite of the relatively high background noise in the ocean (of the order of 100 dB re 1 μPa broad band). The most intriguing aspect of their sounds however is that they are organised into a complex sequence or song which lasts 10-15 minutes and is repeated continually, always with the sounds in the same order, and all whales in a particular geographical region singing the same song.

There are a number of reasons for interest in the humpback sounds. Firstly they compete with our own use of sound in the ocean (sound is widely used instead of electromagnetic radiation because of its far greater penetration). Detailed knowledge of the characteristics of the whale sounds would help resolve any confusion with our own signals. Secondly, their sounds may be an effective way of monitoring the presence and movement of the whales. Whales are large on our scale of things but the ocean is vast. Whales spend a relatively small proportion of their time at the surface and may move a considerable distance before surfacing again. Thirdly there is the general interest in the song and its behavioural significance — why is it so complicated yet apparently so stereotyped? Work in the southern hemisphere should be particularly significant in this respect because most of what is known comes from studies on northern hemisphere stocks. The stocks in the two hemispheres never come into contact so their sounds may be expected to differ significantly.

Humpback whales are so called because of the arching of the back when they break the surface. Mature whales reach about 15 m. long and weigh 45 to 50 tonnes. They spend the summer months feeding on krill and other small animals in the Antarctic, building up reserves of blubber to sustain them on the long winter migration to and from the tropical breeding grounds. There is little feeding once they leave the cold waters. Their migration paths in this part of the world follow the Australian and New Zealand coastlines and they were once a common sight at the right time of year. However the whaling activities of the late fifties reduced numbers to the extent that sightings became rare and it is only in the last few years that they have been seen in any numbers.

I recently spent a week recording humpback sounds off Stradbroke Island (near Brisbane) during the peak of the southbound migration, as part of RANRL's general research interest in the noise of the ocean. Stradbroke Island is near the most easterly part of the coast where migration paths converge and most whales are to be seen. I was working with Dr. Robert Paterson, a Brisbane radiologist who has been carefully monitoring humpback whale migration through this area for some years, and with Dr. Bill Dawbin of the Australian Museum, a world authority on humpback whales. It was Bill's research that established the migratory pattern of these whales. The recordings were made from a small boat using a hydrophone suspended from a partially buoyant cable. This type of suspension and other measures are necessary to reduce the effect of non-acoustic pressure fluctuations from the movement of water about the hydrophone.



The fifteen-foot tail of a humpback photographed by Bill Dawbin from a small boat at close quarters some years ago. Note the blurred image of an oar on the right.

In seven days we saw 35 whales. From our recordings it is evident that the song pattern follows a form generally similar to those of the northern hemisphere although the basic sounds comprising the song are quite different. The song comprises 8 main phrases, which always occur in the same order. Each phrase consists of a group of sounds in a particular order, and a phrase may be repeated a number of times before moving on to the next phrase. The number of times a particular phrase is repeated varies from one cycle of the song to the next, but otherwise the song is remarkably stereotyped. For example, no other variation was found between songs recorded 3 months apart. There is evidence however, that the song gradually evolves over a time scale of years, with new sounds replacing the old until a completely new song has emerged.

The purpose of the song is a matter of speculation. Presumably it provides some form of communication, possibly a means of keeping the herd together during migrations. Although the song is complex, the amount of information it can convey is quite limited because there is little variation from one cycle of the song to the next. Why then is the song so complex and why is there a gradual evolution to a completely new song over a few years? It is hoped that detailed study of the songs and the associated behavioural observations, and comparison with northern hemisphere results will shed some light on these questions.

Aircraft Noise in Australia
A Survey of Community Reaction

Hede, A. J., and Bullen, R. B.
No. 88, February 1982. Australian Government Publishing Service, Canberra.

A report of a major socio-acoustic investigation has been issued which was undertaken to assess the impact of aircraft noise on residential communities in Australia. In a social survey, personal interviews were conducted with a random sample of 3,575 residents around the international airports of Sydney, Melbourne and Perth, the domestic airport of Adelaide, and the Air Force base of Richmond. These airports vary considerably in the numbers and types of aircraft and in the day/night distribution of air traffic. From the responses to the questionnaire, subjective reaction to aircraft noise was measured in terms of GR (General Reaction), a score on a 0-10 scale comprising a number of ratings of dissatisfaction, annoyance and fear as well as reports of activity disturbance and complaint disposition. A score of GR >= was used to define whether or not respondents were "seriously affected" by aircraft noise.

Noise measurements were made at several sites around each airport either by tape-recording overflights or by the unmanned logging of noise levels over periods of two weeks. The noise exposure at each of the dwellings in the social survey was estimated in terms of 20 different indices which can be grouped into three types. "Equal-energy" indices are based on the assumption that reaction to aircraft noise is determined by the total amount of noise energy experienced, regardless of the particular mix of number of aircraft and noise level. "Peak-level" indices assume that it is only the loudest aircraft that determine the extent of subjective reaction. "Frequency-independent" indices assume that reaction is determined by the loudness of the aircraft and is not influenced by their number. Analysis showed that equal-energy indices were more highly correlated with community reaction than the other types of index. However, it was found that the standard weighting given to night flights is too high, and that there should be a weighting applied to flights during evening hours. It is recommended that the NEF system currently used to measure aircraft noise in Australia, be revised so that the current night weighting of 12 dB be replaced by a weighting of 6 dB in both evening and night hours, the revised system to be known as ANEF (Australian Noise Exposure Forecast).

As in previous studies overseas, it was found that little more than 10 per cent of the variance in the reaction of individuals could be explained in terms of noise exposure. By contrast, psycho-social variables explained almost 60 per cent of the variance in reaction. Psycho-social variables such as attitude towards the aviation industry, personal sensitivity to noise and fear of aircraft crashing are postulated to influence reaction by *modifying* the extent to which different individuals are affected by a given amount of aircraft noise. Demographic variables such as age, sex, occupation and education were found to be of generally minor importance in explaining subjective reaction.

Estimates are given of the number of residents around each airport who are affected by aircraft noise. These estimates proved to be considerably higher than previously assumed. From the dose/response function derived in the NAL study it is suggested that an ANEF value of 20 can be regarded as indicating an "excessive" amount of aircraft noise. It is recommended that the contour for 20 ANEF be plotted on future planning maps showing noise exposure around Australian airports. There would appear to be a need for existing standards on aircraft noise to be revised in the light of the results of the NAL study. However, the report recognizes that questions relating to noise regulation and land-use planning can be answered only by translating scientific findings into socio-political context.

TECHNICAL NOTES

Acoustics of Barbershop Music

About the turn of the century, a song form was introduced based on a harmonic progression known as the cycle of fifths. The style was such that the singers could improvise the harmony, easily predicting forthcoming chords and inversions. There was a lead tenor with the tune, a top tenor harmonising above, a bass giving the music a harmonic foundation by singing the root or the fifth of each chord and a baritone completing the texture—and "barbershop" was born. With it came a characteristic ringing sound. In a paper in the IMA *Bulletin* (1981 *17* 137), J. M. H. Peters of the Department of Mathematics at Liverpool Polytechnic investigates the origin of this barbershop sound, analysing it in terms of the nonlinear theory of simple harmonic vibrations.

When two simple tones are sounded together, then a number of additional frequencies are heard corresponding to the sum, the difference and twice the original frequencies. If any of these combination tones are too close (roughly within a factor of $2^{1/6}$) to any of the others or to the two fundamentals, then unpleasant "beats" are heard. A sung note (or a note produced by some musical instrument, for that matter) is made up of a fundamental and a number of harmonics (or partials) of differing strengths. Thus the higher harmonics (in particular) of two notes sung simultaneously have quite a high probability of beating together. The secret of successful harmonising is in getting the relative amplitudes of the partials right — in essence, shaping the mouth (the vocal cavity which can be thought of as a Helmholtz resonator) so that the upper partials are almost inaudible. Each harmonic element is known as a formant and combinations give the timbre to the individual voice.

While beating is the result of a mismatch in frequency, ringing follows the reinforcement of common partials and the barbershop style is to go through a sequence of chords, the elements of which have fundamental frequencies that are in simple ratios with each other (which in general do not exist in diatonic and tempered scales because these have been slightly modified). It is not difficult to see that such notes do have a large number of common partials. The barbershop technique demands that the notes are sung without vibrato, the singers carefully tuning the chords to get perfect coincidence of the lower, stronger harmonics and paying close attention to the vowel sounds which, to a great extent, control the strengths of the partials. The sound blends together in such a way that it is impossible for anyone listening to say which part is sung by whom.

"Barbershop" flourished between about 1900 and 1925, after which song styles changed and it was difficult to harmonise the new tunes in the same way. There is a current revival of the technique but broadcasting the essential ringing sound is tantamount to impossible —microphone and amplifier systems inevitably distort the balance of the partials and the effect is spoilt. Modern electromechanical acoustic systems, used in concert halls to minimise reverberation, also destroy the barbershop sound. Evidently the best place for such music making is still in the woodshed!

(from Physics Bulletin, 32, No. 12, December, 1981)

Ruler with a Bounce

CSIRO scientists have developed an ultrasonic measuring device which could have wide ranging industrial applications.

The device provides continuous measurement of distance by bouncing sound off the surface to be measured.

It can measure the thickness of biscuits on a production line; the width of timber; the level of liquid in a vat or take measurements from a vantage point too difficult or dangerous for physical measurement to be used.

The device, known as Continuous Distance Measuring Equipment, has been developed at CSIRO's Division of Applied Physics in Sydney.

According to Dr. K. J. Taylor, a scientist involved with its development, the equipment is accurate to within 0.1 mm.

"It is a non-contact measuring device," he explained.

"The device looks at a surface and tells how far away it is by sending out an ultrasonic sound and measuring the time taken for the echo to come back.

"It can make 200 measurements per second from moving or static objects at a range between 50 mm and one metre."

"Potentially it is quite inexpensive."

Dr. Taylor said it will be developed further before a commercial collaborator is sought. However, he would welcome discussions with potential commercial collaborators.

(From CSIRO News File)

Syllabus for Detective Story as written by a Physics Professor

Chapter 1 Origins of Law in Babylon.
2 Constitution of United States.
3 Basic Organization of Police Department.
4 Elements of Courtroom Practice.
5 Theory of Fingerprints.
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30 (Last Page) The Corpse.
(Solution left to the student).

Sales: Zero.

(From Physics Today, November, 1981)

Loudspeakers Make Things Quieter

Active silencing — the replication in antiphase of unwanted noise so that it can oppose and thus reduce the severity of the disturbance — was first thought of in the 1930s. But except on a very small scale or where the problem was limited to discrete frequencies, the implementation of this idea met with severe practical difficulties. However, the advent of modern electronics and control techniques has also brought the first large-scale industrial active silencing system — installed and tested over the past year at the British Gas compressor station in Duxford, Cambridgeshire.

The project, which was supported by the NRDC (now part of the British Technology Group), was based on a technique originally proposed about eight years ago by Malcolm Swinbanks when he was a research student at Cambridge University. Some of his studies on the behaviour of active sound absorbers in ducts carrying air were evidently applicable to silencing gas turbines. So, in recent years, Dr. Swinbanks has been collaborating with Topexpress Ltd. (a company specialising in high technology research) on the development of the system for Duxford. The chief features of the design are four microphones mounted inside the compressor's exhaust stack to pick up the noise, programmable digital filtering and 72 loudspeakers encircling the top of the stack.

The stack itself deadens the sound quite effectively over most of the audible range but, particularly when the weather is calm, frequencies covering roughly an octave around 30 Hz can be heard or felt up to 1 km away. At the first trials of active silencing, these frequencies had been reduced in intensity by an average of 7.5 dB (13 dB around the peak in the spectrum) but further refinement has increased this mean reduction to about 11 dB. Moreover there is negligible enhancement anywhere else in the spectrum and the cancellation effect is not just limited to certain places around the plant. The improvement was brought about through the use of the latest (and fastest) microprocessors, together with the minimum of hardware and circuitry — the response time is now very short.

The main application of active silencing is in the deadening of low frequency noise. In this it has the advantage of compactness over equivalent passive silencers, the dimensions of which have to be of the same order as the wavelength. Besides being unobtrusive and potentially less expensive (certainly in materials), Dr. Swinbanks' system uses at most 1 kW and has so far worked without any serious hitch.

(From Physics Bulletin ***33****, No. 3, Mar. 1982)*

Computer Sport

A technique, which had its humble beginnings in a British public house, is now being used in the training programmes of American athletes.

The widest applications are being made by Dr. Gideon Ariel and Computerised Biomedical Analysis (CBA) of Amherst, Massachusetts. Far from withholding the probable benefits of his work from America's competitors in the sporting field, Dr. Ariel has been touring Europe recently, introducing interested parties to the scope of his analysis programme.

Over 100,000 hours of programme development have been devoted to a technique which treats the performance of the human body in the same way that an engineer considers a bridge. All it takes is multiple application of Newton's laws of motion to reveal the stresses and forces in the various joints, and, possessed of these data, it becomes possible to optimise movement and the transfer of energy between body segments. Hence the application to the athletes' training programmes. A Data General Nova computer works away at the calculation of the kinetic parameters. Sports equipment can be analysed similarly and, in fact, the design and testing of shoes, rackets, etc., form the chief business of CBA.

Motion is recorded at anywhere between 64 and 10,000 frames/s and then a light pen is used to digitise the position of key points on the body on each frame. It takes about 1½ hours to process 100 frames in this way. The computer uses this information to produce stick-like figures (see figure 1) known as performance profiles. The calculation of velocities, accelerations, angles, forces, etc., at these key points follows and "What if?" modifications to the data show the way to the ideal movement, ready to be practised. The changes may be very small (e.g., 4° is critical in tennis) but still produce dramatic effects—as with Mac Wilkins whose discus throw increased from 219 feet to 230 feet "just like that"!

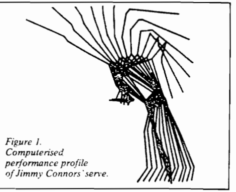


Figure 1. Computerised performance profile of Jimmy Connors' serve.

The first success for Dr. Ariel was in finding out why a prosthetic hip made a patient limp: once the distribution of mass in the new joint had been corrected, the problem was solved. Medical applications continue to feature in the work. An important research topic at present, the study of degenerative locomotor patterns, is another affliction that can be helped. The design of chairs, stairs, cars, etc., can all be improved. Dr. Ariel is currently planning a "2001 house" with every unit designed to optimise movement and energy conservation. Naturally enough, a computer would control all such items as heating. Industrial injury and rehabilitation also come under his wing: the system has been of great use to insurance companies in the former case and offers a change of approach in the latter. In any series of exercises, the patient can be continuously monitored and a halt called when a particular level of fatigue has set in.

So Gideon Ariel's work is not just good news for athletes. Everyone will benefit as everyday items really become designed for us.

(from Physics Bulletin, February, 1980)

Dyeing with less noise

Research carried out at the CSIRO Division of Textile Industry has led to the development of a simple and highly effective approach for reducing noise resulting from the injection of steam into dye vats.

The method has achieved reductions of 15-20 dBA in peak noise level under industrial conditions. Noise caused by the direct injection of steam into dye liquors can be as high as 108 dBA and is often over 100 dBA. Exposure to 108 dBA for only 8 minutes is equivalent to 90 dBA for 8 hours — the maximum legal noise dose for workers in Australia and many other countries.

The noise is generated by the steam condensing rapidly and producing a pressure pulse which causes the walls of the dyeing bath to vibrate.

It usually drops off when the liquor approaches boiling point, because the steam bubbles collapse more slowly as the rate of heat transfer is reduced.

The CSIRO method for reducing the noise entails feeding air into the steam before it is injected into the dye vats. The air slows and cushions the collapse of steam bubbles in the dye liquor and greatly reduces fluctuations in pressure.

Air is drawn into the vat's inlet steam line through a steam ejector fitted to the line. The type of ejector needed is commercially available.

A compressed-air supply is not required; the steam itself entrains atmospheric air — about one-tenth by volume of the amount of steam — via the ejector.

Besides reducing noise levels significantly, the presence of air in the steam promotes mixing of the dye liquor because the air bubbles keep the liquor moving after the steam has condensed. This improves temperature distribution within the bath and hence the rate of dyeing. The efficiency of colour use is enhanced too, with more dye being transferred from the bath to the textile fibres.

If steam injection is the only major source of noise in a dye plant, then the modification will reduce noise doses inflicted on the operator to a level comfortably below the legal limit.

From CSIRO Industrial Research News
May 1982

Jacki's in perfect voice, without any computers

After a two-year legal battle over criticism of the quality of her singing, the actress Jacki Weaver has won a public statement that she has perfect pitch.

Miss Weaver got a public apology from the magazine *Sydney City Monthly,* which had claimed she used a small computer to correct off-key notes in the hit show "They're Playing Our Song".

In the court Mr. John Riordan, for *Sydney City Monthly,* said the magazine and the writer of the piece apologised to Miss Weaver for the article, which appeared in September, 1980.

The article said that the promoters of "They're Playing Our Song" has a special microphone and a computer to change Miss Weaver's off-key notes to perfect pitch.

"No such device was used in the show", Mr. Riordan said.

"We acknowledge that no such device in fact exists. The perfect pitch the audience hears is Miss Weaver's own unaided performance", he said.

He said the magazine apologised for any embarrassment, hurt to feelings and harm to reputation suffered by Miss Weaver.

Outside the Supreme Court, Miss Weaver said that members of the audience and even co-workers thought it wasn't her true voice after the item appeared in the Asides column of the magazine.

"It's taken two years but maybe now people will believe that it is really me singing", she said. She had even heard people in the audience say during a performance, "that's not really her singing".

(from The Sydney Morning Herald, 7 August, 1982)

Nature and origin of Sydney's brown haze

The Division of Fossil Fuels has been carrying out an intensive investigation into the nature and origin of the unsightly brown haze experienced on calm winter mornings in Sydney. This winter haze is largely due to myriads of tiny particles emitted directly into the air and is quite different from photochemical smog, which occurs mainly in summer as a result of chemical reactions between gaseous hydrocarbons and nitrogen oxides occurring in sunlight.

Haze intensity was measured and many samples of the particles were collected at a number of locations in the Sydney area. Analyses showed that although the airborne material may contain 20 to 40 per cent by weight of sea salt, the haziness is almost entirely due to the finer particles emitted by combustion. This is reflected in the fact that carbon is the biggest single component (approximately 30 per cent). Motor vehicles and industrial and domestic incinerators account for the bulk (approximately 70 per cent) of the combustion-produced emissions.

From CSIRO Minerals & Energy Bulletin
July 1982

Rapid acoustic method for distinguishing ore veins

In certain types of ore deposit the valuable mineral is distributed erratically along particular quartz veins. When exploring such deposits with narrow diameter drill holes, it is difficult to distinguish apparently barren portions of mineralized veins from other vein systems, perhaps of a different age, that are totally unmineralized. Proximity to a valuable orebody may therefore escape notice.

The Division of Mineralogy has been investigating a method new to Australia that may solve this problem. This rests on the observation that heated vein minerals emit noise due to the cracking of submicroscopic fluid inclusions within them. The pattern of acoustic emission during progressive heating differs between mineralized and unmineralized vein systems, reflecting their different origin. In this way a vein can be recognized as part of a mineralized system even though it appears barren at the point of sampling. The Division is examining the theory and application of the method, especially in the exploration for tin and gold deposits, and is working in collaboration with Burlinson Geochemical Services of Darwin who have developed a new instrument for measuring acoustic emission.

From CSIRO Minerals & Energy Bulletin
October 1982

Sound paint

Conventional methods of **assessing paint failure** are often costly, time-consuming and give inconclusive results. Since acoustic emissions are indicative of structural failure in paint polymers, this technique has now been adapted by ICI into a quick and effective way of testing new paint formulations and paint that has failed in certain environments. At ICI, the acoustic emissions are produced by painting the product on to aluminium foil which is then continuously stretched at a slow rate. When sound waves emitted by the paint reach a sensor applied to the foil, these signals can be analysed and assessed. It is hoped that these acoustic emission tests will replace accelerated weathering tests which at the moment take up to three months to complete.

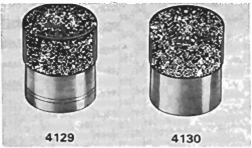
From Physics Bulletin
August 1982

NEW PRODUCTS

NEW B & K HALF-INCH MICROPHONES

Two half-inch condenser microphones, designed for use in measurement systems fulfilling IEC 651, Type 2, have been developed by Bruel & Kjaer.

Sensitivities for the Types 4129 and 4130 are 50 mV/Pa and 10 mV/Pa respectively, but in other respects they are acoustically equivalent. Type 4130 is used with a nominal polarization voltage of 28V. Type 4129 is prepolarized, utilizing a thin charge-carrying layer which is deposited on the microphone backplate. Both microphones are fitted with a non-removable protection grid which is finished in a wear-resistant black chrome. This grid has a fine gauze filter fitted internally for protection against dust and particle penetration to the diaphragm. In addition, the diaphragm itself is covered by an extremely thin polymer layer which affords excellent protection against corrosion. The microphones are supplied with a Random Incidence Corrector, allowing measurements to be made in accordance with ANSI S1.4—1971, Type 2 (and proposed revision).



½" CONDENSER MICROPHONE CARTRIDGES
TYPE 4129 AND 4130

SOUND SOURCE TYPE 4224

A Sound Source specifically designed for building acoustics measurements such as sound reduction index, facade insulation, reverberation time and absorption has been developed by Bruel & Kjaer.

The Type 4224 consists of a loudspeaker with built-in power amplifier and noise generator contained in a robust, moulded cabinet with an integral handle. It can deliver up to 115 dB sound power level from 100 Hz to 4 kHz when driven from its internal, rechargeable batteries or up to 118 dB sound power level when driven from a mains supply. In spite of its impressive performance the Type 4224 weighs only 18 kg (40 lbs).

The Sound Source is a portable and robust instrument capable of producing high noise levels. It is thus eminently suited for in situ building acoustics measurements.

When used in conjunction with the Building Acoustics Analyzer Type 4418 and a microphone, the 4224 constitutes a powerful and portable system for the automatic measurement and calculation of all the commonly used quantities in building acoustics according to both national and international standards.

The Type 4224 can be used with a wide variety of B. & K. instruments to form both simple easily portable set-ups as well as larger set-ups for automatic measurements. For sound insulation and reverberation measurements in octave bands a Sound Level Meter Type 2215 and a Level Recorder Type 2306 or 2307 would be enough. A more sophisticated system can be built up around a Digital Frequency Analyzer Type 2131 which gives the system the possibility of being connected to a computer.

A conical diffuser can be snap-locked onto the front of the cabinet to improve the reproductibility of sound insulation measurements and to render the measured results less dependent on the position and the angle of inclination of the cabinet. When not in use the diffuser can be stowed in the pocket of the instrument's protective cover.

NEW BRADFORD FIBERTEX ROCKWOOL

"The most significant improvements in rockwool for the past 40 years will make Bradford Fibertex Rockwool the preferred industrial insulation until well into the next century", said Mr. Colin Forster, Bradford Insulation's Industrial Product Manager, at a recent launch of the new Fibertex Rockwool range.

"As a result of major improvements in our technology, we have changed our method of rockwool manufacturing to produce significant improvements in its quality", Mr. Foster continued.

Extensive testing was conducted at CSR Building Materials' Research Laboratories. Thermal conductivity evaluation was done by CSR's new high technology Dynatech Model TCFGM, which enabled numerous and accurate thermal performance tests.

Major changes to Fibertex Rockwool which result from this $2 million investment are:

- A significant increase in fibre content at the expense of unfiberised material (known as shot). This fibre increase is in excess of 25 per cent at a given nominal density.
- A corresponding reduction in 'nominal' density of most products. The new product is lighter and performs better. Packs are easier to handle so application is faster.
- The reduction in 'shot' and changes in raw materials have resulted in a product with friendlier feel than previously associated with rockwool.
- A simplified product range will at least match and in some cases outperform the existing range. To distinguish this new range, there are new product names, with numbers referring to the product's maximum service temperature.
- With greater emphasis on performance, all products are now measured against a performance specification. This is similar to R values of home insulation as a replacement for thickness measurement.

Mr. Forster adds, "Bradford Insulation has produced detailed literature for the new product range. In addition to product application brochures, printed performance data is backed by test certificates including actual results, testing authorities and test methods used.

This ensures that customers can specify Fibertex Rockwool with the utmost confidence and that the selected product will perform under operating conditions".

NEW DUCTLINERS

To complement its range of superior black-faced fibreglass ductliners, Bradford Insulation have released two new lighter weight black-faced ductliners which offer high quality resistance to surface erosion. These new products, called LINACOUSTIC-MSB and BLACKSEAL-MSB, are designed specifically for internal duct applications where the prime requirements are for economical thermal performance and low light reflectance.

LINACOUSTIC-BSB is a light weight fibreglass board faced with a glass fibre surface tissue and sprayed with a black resin binder. The smooth surface minimises resistance to air flow and has a high resistance to surface erosion by ducted air. LINACOUSTIC-MSB provides economical thermal performance and has low light reflectance.

BLACKSEAL-MSB is a lightweight fibreglass board sprayed on one face with a black resinous surface binder. This product provides resistance to surface erosion by air flow at low to medium velocities as well as economical thermal performance and low light reflectance.

LINACOUSTIC-MSB and BLACKSEAL-MSB have been tested for Early Fire Hazard to ASTC 1530 Part 3 and the following Indices resulted from both:

Ignitability	0
Spread of Flame	0
Heat Evolved	0
Smoke Developed	3

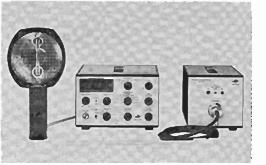
Enquiries: H. Anderson—237 5682.

BRUEL & KJAER STROBOSCOPES FOR MOTION ANALYSIS

Two new instruments for stroboscopic motion analysis have been developed by Bruel and Kjaer.

The Digital Stroboscope Type 4913 is especially engineered with the combined function of stroboscopic motion analyzer/tachometer and includes a built-in digital display. Using its high intensity, hand-held flash source, a stationary or slow moving image of all kinds of rapid repetitive motion can be obtained, making it extremely easy to observe the precise behaviour of vibration test components, engines, machines, etc. whilst actually in motion. The Type 4913 may be synchronized with motion frequencies as high as 10 kHz (600,000 r.p.m.) and can be both quickly and easily triggered from an int. generator, power line or ext. source such as a contact-free tachometer probe. Separate modes with adjustable time and phase delay permit precise measurement and observation at any required point in the motion cycle and a "Slow Motion" mode enables subjects to be viewed with an apparent motion frequency of 0.05 to 5 Hz.

Using the 4-digit display of the 4913 direct reading of motion frequency or speed, time or phase delay is possible. Additional features are choice of local or remote control, plus single flash operation for photographic purposes. As an optional light source Type 4913 can be coupled with the Fibre-Optic Stroboscope Source Type 4915, which outputs a convenient point source of illumination that is ideal for examination of small mechanical components, intricate mechanisms and microscope speciments, etc.



STROBOSCOPE
TYPE 4913
FIBRE-OPTIC STROBOSCOPE SOURCE
TYPE 4915

* * *

The material included in NEW PRODUCTS is supplied by manufacturers or agents and is printed free of charge. Information regarding new materials or instruments is welcome and should be sent to the Chief Editor.

BOOK REVIEWS

The Physics of Sound

by Richard E. Berg and David G. Stork,
Prentice-Hall (1982), 370 pages. $33.95 (Aust.)

The Science of Sound

by Thomas D. Rossing,
Addison-Wesley (1982), 637 pages, $24.95 (Aust.)

Study of the acoustics of musical instruments is a useful approach to the whole subject of sound, and has been adopted, we might argue, since the time of Pythagoras. Present day publishers seem convinced, at any rate, that this is a good way to proceed, and the two books under review are the most recent in an increasing flow, of which the best known have hitherto been by Backus (The Acoustical Foundations of Music, Norton 1969) and by Benade (Fundamentals of Musical Acoustics, Oxford 1976).

Both books cover essentially the same ground at not too far from the same level. Both are essentially nonmathematical, though Rossing quotes simple algebraic formulae (without trigonometric functions) while Berg and Stork generally keep to numerical examples. Rossing has a significantly briefer introduction on waves (56 pages or 10 per cent of the book) than Berg and Stork (a slightly tedious 115 pages or 30 per cent), so on both these grounds is slightly more advanced. Both cover hearing, perception and speech (135 and 30 pages respectively), electroacoustics (180 and 40 pages) and architectural acoustics (30 and 20 pages), in addition to their major concern with traditional musical instruments (120 and 130 pages). Rossing's book includes also a section on noise (40 pages) and a short illustrated discussion of acoustical instrumentation (10 pages). Both books have useful reference lists (Rossing's being more extensive), discussion topics and problems at the end of each chapter. Berg and Stork also list a few recordings.

The coincidence of content and treatment goes even further than this. Each book tries to be completely self-contained, beginning the "waves" section with a definition of distance and the "electronics" section with Ohm's law. Rossing's book then gets through filters, amplifiers, oscillators and distortion in 20 pages (with formulae and numerical examples)! Both books discuss auditory masking, vocal formants and FM stereo broadcasting, among other things, and both treat nearly the complete range of musical instruments.

Each book is well written, though Rossing's style is a little easier and more polished. Rossing's illustrations are better and more numerous, my only criticism being that the type style used for the captions is too similar to that of the main text. Both books are well designed, indexed and bound.

In the matter of accuracy, my only criticism of Rossing's book is the misleadingly scaled photograph of woodwind instruments on page 214, while Berg and Stork have let pass a few statements that would leave the reader with some entirely mistaken ideas. Thus, page 105 states that "wind instruments with a conical or tapered bore . . . may have nonintegral harmonics", page 264 shows and discusses an incorrect version of the flute head joint, pages 249-50 leave a wrong impression of the mechanism of sound production in flutes and organ pipes, and page 173 (after too much preoccupation with impedance matching in electronic equipment) says "typical power levels into speakers are between 10 and 100 watts . . . It requires typically less than 1 watt of acustic power to obtain a comfortable listening level in a normal listening room".

Despite these few reservations about Berg and Stork, both books are good and up-to-date general reading for anyone interested in the subject, though my own clear preference is for Rossing's book on the basis of price, style and detailed contents. Each could serve usefully as the text for a course in acoustics for music students at tertiary level, or as background reading for more scientifically oriented acoustics courses. Psychology students and those concerned with speech and hearing would find Rossing's book useful and both books should provide a wealth of material for teachers of the new "physics and music" options in senior high schools.

On the wider stage, Rossing may well join Backus as standard texts at this level; while Benade's very individual book still stands on its own.

NEVILLE FLETCHER.

Handbook of Noise Control Second Edition

Edited by Cyril M. Harris
Published by McGraw-Hill Book Company, 1979. $82.05 (Aust.)

This work is described as the Second Edition of the Handbook of Noise Control, first published in 1957. The First Edition was an authoritative and useful text, welcomed in an era delightfully free from the current crushing load of new books, journals and magazines.

As for the earlier publication, this volume brings together as contributors to its various chapters some 53 leading experts in their respective fields. In the main this edition introduces a totally new group of authors and their contributions, edited by Cyril M. Harris, provide a multidisciplinary approach well suited to the aims of the Handbook.

The Preface describes the Second Edition as being written not primarily for those specialists working in acoustics (as was the First Edition), but for the many nonspecialists in widely diverse fields whose work requires some knowledge of noise control and who need access to authoritative material written in terms they can understand, without diminishing the value of its technical information to the specialist.

In light of these facts it has not been possible to meaningfully review the Handbook without particular reference to the content and coverage of the earlier First Edition.

First impressions are that the book generally follows the established content and pattern of the earlier volume, updated with the latest technical information and developments. There are many familiar diagrams amongst interesting new tables and graphs. Octave band centre frequency values are updated in accordance with current usage. The latest terminology, symbols and units are used throughout.

Subject matters covered include properties and sources of sound, noise measurement and instrumentation, hearing, effects of noise, noise and vibration control, equipment noise, transportation noise, community response to noise, regulations and legislation.

As would be expected in an updated 1979 Edition of the Handbook, there are new facts and information on such widely diverse topics as the propagation and reverberation of noise in city streets, permissible talker-listener communication distances for various S.I.L. levels in noisy work environments and a significant update on aircraft noise rating scales and prediction indices.

However, on closer reading it soon becomes apparent this Second Edition is in fact a completely new book, with a marked change in emphasis and technical content towards statutory regulations and associated noise control aspects, written to accommodate both the nonspecialist and specialist reader.

Perhaps the most obvious feature is the addition of some eight completely new chapter topics covering U.S. Regulations for aircraft noise, occupational noise exposure, new product noise emission, surface carrier noise, highway planning and design, HUD policy and environmental impact statements. Although these chapters make interesting and informative reading, they are of somewhat restricted use to the Australian reader.

The series of chapters in the First Edition which provided a comprehensive coverage of vibration control, isolation, damping and measurement has been condensed and summarised into a broader but significantly less informative format. Completely removed from the Second Edition are chapters on acoustic filters and mufflers, gear noise, bearing noise and compressor noise.

Conversely, the single chapter on the effects of noise on behaviour from the First Edition has been expanded into three chapters, respectively covering in some detail the subjects of the short and long term physiological reactions of the human body to noise from infrasound to ultrasound to sonic boom, the effects of noise on efficiency and performance, and annoyance and noise to the individual and the community.

One has to ultimately conclude that the title of this new version of the Handbook is misleading. The use of the title "Second Volume" rather than "Second Edition" would be a more correct and far more meaningful description of a work which in the main is a completely new book.

What the Second Edition has gained in a deliberate broad appeal to the nonspecialist, it has lost in the depth of its technical content and information coverage for the specialist. However the volume should be viewed in terms of its actual content, which is that of a new book. As such the Second Edition of the Handbook of Noise Control would when placed alongside the original First Edition make a useful addition to a reference library.

JAMES MADDEN.

CSIRO RESEARCH GUIDE

A comprehensive guide to CSIRO's research activities throughout Australia is now available.

The guide contains descriptions of CSIRO's more than 700 research programmes and sub-programmes, and will be a valuable source of information for industry, Government and research and educational institutions.

In clear, non-technical language, it outlines research programmes being tackled by CSIRO and the implications of research findings.

The latest edition of the research guide contains programmes arranged under subject matter headings within four main sections covering rural industries, mineral, energy and water resources, manufacturing industries and community interests.

The names, addresses and telephone numbers of the people to contact for further information about any research topic are also included.

Three index listings are included: one which lists programmes and sub-programmes, one listing personal names and one listing subjects.

Copies of the publication, titled Directory of CSIRO Research Programmes, are available for $15 (postage included) from the CSIRO Editorial and Publications Service, P.O. Box 89, East Melbourne 3002. Cheques accompanying orders should be made out to "Collector of Moneys, CSIRO".

HUMAN BODY VIBRATION EXPOSURE AND ITS MEASUREMENT

G. Rasmussen.
B & K Technical Review, No. 1, 1982.

ABSTRACT

Experimental data collected over the years, for defining limits of vibration exposure to human beings, have resulted in a set of vibration criteria specified in ISO Standard 2631. In this article, instrumentation requirements for evaluation of the responses of humans to vibration according to these criteria are described, as well as some of the pitfalls to be avoided during these measurements.

Exposure limits for vibration transmitted to the hands and arms of operators of vibrating tools have been suggested in Draft Standard ISO/DIS 5349. A special hand adaptor developed for the measurement of hand-arm vibration transmitted from the handle of such tools is described in the article, and measurement results obtained with it on a chip hammer are illustrated .

THERMAL COMFORT

B. W. Olesen, Ph.D.
B & K Technical Review, No. 2, 1982.

ABSTRACT

The theory and research behind the thermal comfort of a human being is described in this article. The parameters influencing the thermal comfort of an individual are incorporated in the comfort equation introduced by Professor P. O. Fanger. Practical use of this equation is illustrated through the use of examples. The PMV and PPD indices are described, which quantify the degree of discomfort when the optimal thermal environment cannot be achieved. For practical measurements a Thermal Comfort Meter has been developed on which some of the parameters are dialled in, while the instrument measures the remaining parameters and computes in usable form a quantitative measure of comfort.

AUTOMATIC ANALYSIS AND RECOGNITION OF SPEECH PROCEEDINGS OF NATO ADVANCED STUDY INSTITUTE

Editor: J. P. Haton.
332 pp., 1982, $A41.80 plus $A1.00 postage.
Available from D.A. Book Depot, 11-13 Station St., Mitcham, Vic. 3132.

SPRINGER INTERNATIONAL STUDENT EDITION ULTRASONIC TESTING OF MATERIALS

J. & H. Krautkramer.
Special price for 10 copies: $A10.30.
Available from D.A. Book Depot, 11-13 Station St., Mitcham, Vic. 3132.

RECENT DEVELOPMENTS IN SIDE SCAN SONAR TECHNIQUES

Editor: W. G. A. Russell-Cargill.
1982, $US16.00 including postage.
Available from Central Acoustics Laboratory, University of Cape Town, Rondebosch 7700, South Africa.

Recent Titles from Plenum Publishing Corporation 233 Spring Street, New York, N.Y. 10013:

ULTRASONIC SPECTRAL ANALYSIS FOR NONDESTRUCTIVE EVALUATION

D. W. Fitting & L. Adler.
634 pp., 1981, $US54.00.

The volume features the results of a survey of over 100 leading scientists and engineers, reporting their views on the current state of the art of ultrasonic spectroscopy.

ACOUSTICAL IMAGING, Vol. 10

Editors: P. Alais & A. F. Metherell.

Proceedings of the Tenth International Symposium on Acoustical Imaging.
850 pp., 1981, $US102.00.

MECHANICS OF NONDESTRUCTIVE TESTING

Editor: W. W. Stinchcomb.
416 pp., 1980, $US57.00.

CONTENTS: Mechanics of NDT: overview. Material property determination. Defect and flaw characterisation. Material damage — initiation and growth: life prediction.

THESES

STRUCTURE BORNE NOISES IN BUILDINGS

J. T. Gressieux,
M.Sc. (Acoustics), University of New South Wales.

SUMMARY

An experiment to study the flow of sound radiation through a rod to a plate was designed. The set up is not unlike the kind of situation occurring in buildings, where sounds may be transmitted along beams or pillars into other parts of the building far removed from the noise source.

Using Skudrzyk's theory on plates (normal mode theory), the plate attached to the end of a rod can be approximated to a simple, inertial mass loading, and based upon this approximation, an expression for the transfer impedance between the rod and plate was developed.

In the experiment described below, the frequencies at which resonance occurred were noted, in the case of each rod-plate system under test and also for the rod on its own. These results were then compared with the resonant frequencies obtained from the expression for the transfer impedance obtained from the theory. These results are discussed and reconciled with the available theory.

ALTERNATIVE MODELS OF THE SOUND FIELD IN A REVERBERANT ROOM

G. J. Munroe,
M.Eng.Sci., University of Adelaide.

SUMMARY

The thesis examines various prediction models which have been developed to determine the variations in S.P.L. in a reverberent room at low frequencies and finds that none of these models fully explains the experimental results.

PUBLICATIONS by AUSTRALIANS

We are indebted to Marion Burgess of U.NSW for making regular journal checks and to Toni Benton of U.NSW for arranging the references for publication.

The **National Acoustic Laboratories** have issued a complete list of research papers and reports published during 1981 and the first part of 1982. Copies are available on request.

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Direct Measurement of Acoustic Energy Radiated by a Punch Press
R. J. Alfredson,
Dept. Mechanical Engineering, Monash University, Victoria.
Internoise 80, Miami, **2**, 1059-1062 (Dec. 1980).

Acoustical Laboratory Accreditation — Problems and Solutions
L. A. Challis,
Sydney, N.S.W.
Internoise 80, Miami, **2**, 1051-1054 (Dec. 1980).

1981

Evidence for Dislocation Damping Increases During Gamma Ray Irradiation of Sodium Chloride and Potassium Chloride Single Crystals
G. A. Bielig,
Physics Department, James Cook University, Qld.
J. Appl. Phys. **52** (9), 5584-5591 (1981).

Saw Blade Idling Noise Generation and Control
D. A. Bies,
Dept. Mechanical Engineering, University of Adelaide, S.A.
Noise Con. 81 Proceedings, Raleigh, U.S.A., June 1981.

Effects of Peaks in Hearing Aid Frequency Response Curves on Comfortable Listening Levels of Normal Hearing Subjects
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J. Acoust. Soc. Am., **70** (3), 707-711 (1981).

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Lincoln Institute Health Sciences, Carlton, Vic.
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Speculations in Science and Technology, **4** (5), 501-508 (1981).

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Dept. Elec. Eng. and Computer Eng., University of Newcastle, N.S.W.
J. Acoust. Soc. Am., **70** (2), 467-475 (1981).

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Acoustic Emission in Non-Destructive Testing
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KK & S Instruments, Sydney, N.S.W.
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An Improved Version of the High-Cut Cavity Vent
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NAL, Sydney, N.S.W.
Aust. J. Audiology, **3** (2), 49-57 (1981).

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CSIRO Applied Physics, Sydney, N.S.W.
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On Coincidence in Relation to Prediction of Pipe Wall Vibration and Noise Radiation Due to Turbulent Pipe Flow Distributed by Pipe Fittings
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M. P. Norton,
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International Conference on Flow Induced Vibrations in Fluid Engineering Reading, U.K., B.H.R.A. Fluid Engineering, Cranfield, Bedford, U.K., Paper H2, 347-368, 14-16 Sept. 1982.

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The Importance of Vocal Tract Resonance in Clarinet and Saxophone Performance, A Preliminary Account
P. G. Clinch, Dept. of Music, Melbourne State College.
G. J. Troup, Physics Dept., Monash University.
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Non Linear Vibrations of Elastic Plates Subjected to Transient Pressure Loading
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Dept. of Physics, Univ. of New England, Armidale, N.S.W.
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An Exploratory Study into the Prediction of Low Frequency Traffic Noise
G. H. Hollingworth,
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Applied Acoustics, **15**, 79 (1982).

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Dept. Mechanical Engineering, Monash University, Vic.
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Acustica **51**, 44-49 (1982).

Psychophysical Studies for Two Multiple Channel Cochlear Implant Patients
Y. Tong, G. Clark, P. Blamey, P. Busby, R. Dowell,
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Forthcoming closing dates for the receipt of these articles are as follows:

Vol. 11, No. 1 — Long articles: January 14
Short articles: January 31

Vol. 11, No. 2 — Long articles: May 13
Short articles: May 31

Contributions should be sent directly to the Chief Editor.

Articles should include a title, author's name, address and organisation (if applicable), and, in the case of long articles, be accompanied by an abstract of approximately 200 words.

The *body of the text* should be divided into numbered sections and preferably contain frequent subheadings, which greatly assist the reader in following the development of the paper. Any standard system of referencing is acceptable. Equations, tables and figures should be numbered sequentially. A list of captions for figures should be supplied on a separate sheet. It is recommended that captions give a complete explanation for each figure thus obviating the need to refer to the text for identifying details.

Drawings and **photographs** may be prepared to any convenient size and will normally be reduced proportionally by the printer to column width. Authors are requested to plan the proportions of diagrams accordingly. Original drawings should be supplied complete with lettering, with due allowance for the amount of reduction required.

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