The Bulletin

AUSTRALIAN ACOUSTICAL SOCIETY

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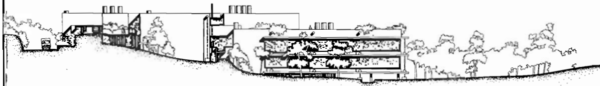
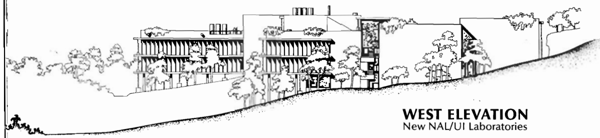


EAST ELEVATION



WEST ELEVATION
New NAL/UI Laboratories

Acoustics of a Tamtam
Thomas D. Rossing
Neville H. Fletcher

Comparison of Sound Absorption using Reverberation and Decay methods
Ross A. Wills

New Acoustic Facilities for Acoustic Research
Leigh Kenna
Jack Rose
David Robinson

WESTERN PACIFIC ACOUSTICAL CONFERENCE
SINGAPORE – 1-3 SEPTEMBER 1982

Background of Conference

The above meeting is the first to be held in this region apart from the International Congress on Acoustics in 1980 which by attracting more than 30 delegates from developing countries in this area showed that acoustics was sufficiently established to warrant the organisation of a special regional conference. It was felt that the aim should be to promote the application of acoustical research, techniques and materials to the solution of problems in the region and to investigate the possibility of forming a regional acoustical society.

The International Commission on Acoustics has encouraged this idea and has asked the Acoustical Society of Japan and the Australian Acoustical Society which have both organised large international meetings and are represented on the Commission itself to lend their support to the venture.

After early consideration of possible venues, Singapore was selected as the most central location and an approach was made to well-known members of the University of Singapore to see if they were prepared to accept the major responsibility for the planning and the running of the meeting. Fortunately, they were and a committee consisting of representatives of the ASJ, AAS and Singapore University was set up to handle the preliminary arrangements.

Most members of the AAS have by now received the first circular which lists the major topics of the conference and gives details of the organisation, venue, costs etc.

Contributed Papers

One aspect which needs clarification is that, due to postal delays, the circulars were not received in time to permit the forwarding of one page abstracts from those wishing to contribute a paper to the Singaporean central committee by the listed closing date.

A later closing date has been found necessary and, to permit this, the arrangement is that the AAS will continue to receive abstracts, grade them according to their relevance to the needs of the conference and then select sufficient to fill a quota allocated by the committee.

A major consideration will be the author's ability to attend and deliver the paper, so please indicate your plans for this when forwarding your abstract. In case of equality first received gets preference.

Authors so selected will be notified directly when the details are finalised.

The early response from possible delegates and authors is encouraging but more are welcome.

If further information is required at any stage please contact:

The AAS/WPRAC Sub-Committee
C/o N.A.L., 5 Hickson Road,
MILLERS POINT, N.S.W. 2000

Telephone contact can be made through

02/662/2236 (John Dunlop) or 02/20537 (Ray Piesse or Jack Rose)

The Singapore conference presents a unique opportunity for Australian educators, research workers and others associated with the application of acoustics to make contact with confreres in the region in a way which can only be beneficial to all.

It is hoped that from this small beginning something of a permanent nature will arise, perhaps with regular conferences every three years, at other interesting venues which abound in the region.

Jack Rose
AAS/WPRAC Committee Member

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Editorial

With this issue of the Bulletin a new editorial committee takes over its production. Although some changes will be made the overall style of the Bulletin will be preserved. Since its inception a number of committees have contributed to its evolution as a journal reflecting primarily the interests and activities of Australian acousticians. To the Victorian committee who have just relinquished the editorial reins we send our sincere congratulations for their sustained activity in producing the Bulletin and for their help during the transition period.

It is our wish to cater for all interests displayed by the varied membership of the Australian Acoustical Society. The surprising spread of interest was dramatically revealed by the papers submitted to the 10th ICA. The response to the recent questionnaire circulated to members shows clearly the major areas of interest: *Noise 58%, Architectural and Building Acoustics 44%, Measurements and Instrumentation 33%, Shock and Vibration 29% (Keen mathematical buffs will have noted that we have already exceeded 100%, a phenomenon that is a function of the multiple votes allowed to members).* Minor areas of interest include *physiological and psychological acoustics 18%, transduction 13%, speech communication 12%, physical acoustics 10%,* and less than *10%* support for *aeroacoustics, musical acoustics, bioacoustics, underwater sound* and *ultrasonics.*

While it is expected that papers submitted will to some extent follow these trends, we hope to be able to offer papers and articles covering the full range of interests of all members, including the (Australian) 'minority' areas. To facilitate the gathering of papers and information we have appointed a number of editors who will each be responsible for a specific area of acoustics (see back cover). In this way we hope to keep members in touch with new or growing areas of acoustics that may not necessarily be ones in which they specialise.

Following the lead of previous editorial committees, it is not our intention to convert the Bulletin into a standard technical journal. The Bulletin has a dual role to play. Firstly, it provides an outlet for information relating to local activities and members' peregrinations (contrary to rumour, 'Gossip' has not been pensioned off but will be included under the new heading *'People'.*). Secondly, the Bulletin is available for publishing both short and long technical articles. While original papers will be most welcome there is also room for informative review papers (especially in areas of interest in Australia), discussion and tutorial papers and short papers giving preliminary reports of investigation or research. With the active cooperation of those who feel the urge to write (or can be persuaded to do so) we hope to continue the process of producing an interesting and informative journal that will be primarily directed towards Australian acousticians and those with a general interest in acoustics, but hopefully will also present an active image to our many international subscribers.

We also wish to acknowledge the continuing support of our sustaining members and advertisers without whom it would not be possible to aim for high standards of production.

Howard Pollard

Overview of this Issue

Three technical papers are featured in this issue.

For those with an interest in Chinese percussion instruments, the first paper deals with the *'Acoustics of a Tamtam'*. The authors are Professor *Thomas Rossing* of *Northern Illinois University*, who has been on study leave at *New England University* and is an authority on percussion instruments and bells, and Professor *Neville Fletcher*, who is well-known for his theoretical and experimental work in musical acoustics and solid state physics. The tamtam is a non-linear system (if only the musicians were aware of this this!) which involves some characteristic changes of timbre with time in which there is a conversion of energy from low-frequency vibrational modes to those of higher frequency. If a small dose of mathematics is likely to cause intellectual indigestion, the paper still makes sense if section 2 is not read in detail.

Ross Wills of RMIT gives the results of research into the estimation of equivalent absorption area derived by two different methods: (1) by measurement of the steady state sound pressure level in a room using an ILG sound source, and (2) by measurement of the reverberation decay time followed by application of Sabine's formula. Measurements were made in four 'reverberant' rooms and five 'real' rooms.

The third paper is an account of the unique range of acoustic facilities being provided in the new building for the *National Acoustic Laboratories* and the *Ultrasonics Institute* at Chatswood, NSW. The authors, *Leigh Kenna, Jack Rose* and *David Robinson* describe the reasons for selecting the new site and the requirements to be met in providing special rooms for ultrasonic medical research, acoustic and audiological research.

We are grateful to *Graeme Harding* for agreeing to continue as columnist for the new feature *'People*, which has been expanded to include both 'gossip' items and news of new appointments, promotions, retirements, etc.; and to *Doug Cato* for his entertaining cartoons. Thanks are also due to the many contributors of items for Acoustical News and for Reports.

From the President

Since these notes are being written shortly after the publication of the December 1981 issue of the Bulletin I have not yet received any feedback regarding your views about the future directions AAS should take. Please contact myself or any of the Councillors and Committee members so that we can reflect the wishes of the membership as a whole. I am well aware that unless a member is actively involved in a Committee or Sub-Committee there does not seem to be a great deal going on; however, there is much to be done and volunteers are always welcome. One major task, for example is to gather information about all courses in acoustics offered by CAE's, Universities and TAFE institutions around Australia, one reason being that AAS is frequently asked for career guidance information.

Elsewhere in this issue you will find details of our first 'offshore' Conference, in Singapore in September. This is a joint venture with the Acoustical Society of Japan and it is being organised with the blessing of the International Commission on Acoustics. The Commission is anxious to encourage development in acoustics in the Western Pacific region and AAS has a key role to play in this area. I do hope that many AAS members will be able to take part in what promises to be a stimulating meeting.

On the subject of international meetings, I am sure that many of us have written "ICA, Paris, July '83" in the forward planning section of our diaries and again I hope that we will have a strong delegation from Australia to renew and strengthen the many international contacts made when we had the opportunity to hold the 10th ICA in Sydney in 1980.

Anita Lawrence

SUSTAINING MEMBERS

The Society values greatly the support given by the Sustaining Members listed below and invites enquiries regarding Sustaining Membership from other individuals or corporations who are interested in the welfare of the Society. Any person or corporation contributing $200.00 or more annually may be elected a Sustaining Member of the Society. Enquiries regarding membership may be made to The Secretary, Australian Acoustical Society, Science House, 35-43 Clarence Street, Sydney, N.S.W., 2000.

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ACOUSTICAL NEWS

1. Australian

1.1 Changes Affecting Acoustics at Lucas Heights

The Australian Atomic Energy Commission will accommodate, at Lucas Heights, a substantial part of an organisation for general energy research known as the Institute of Energy and Earth Resources (IEER) a newly formed unit of the Commonwealth Scientific and Industrial Research Organization.

Final arrangements are yet to be decided, but about 330 AAEC staff and at least two buildings at the Lucas Heights site will transfer to IEER. Support staff at Lucas Heights will service both AAEC and IEER.

The reorganisation will allow expansion of publicly sponsored non-nuclear energy research, without enlarging the public sector.

Discussions between the AAEC and CSIRO seeking agreement on details of the reorganisation are in progress.

First consideration for transfer was given to 13 AAEC staff who are researching applications of radioisotope tracing techniques in the mineral industry. They were seconded to the CSIRO IEER Division of Mineral Physics.

Announcing the formation of a new IEER Division of Energy Chemistry on the 26th August, the Minister for Science and Technology said that it would comprise 80 former AAEC staff under the leadership of Dr Peter Alfredson (former Chief of the AAEC's Chemical Technology Division) and would be responsible for research into extraction of oil from shale, conversion of coal to oil, exploitation of deep coal reserves, storage of energy, and conversion of the Sun's rays into usable energy. So far, 52 staff, specialising in analytical and physical chemistry research, have been seconded from the AAEC to this new CSIRO Division.

Programs remaining under the control of the AAEC include:

- operation of the nuclear reactor HIFAR;
- production and distribution of radioisotopes, including those used for medical diagnosis and therapy;
- research into fusion, nuclear waste management, and uranium enrichment; and
- support for regulatory and international obligations.

Another administrative change is the move of the AAEC Head Office from Coogee to Lucas Heights.

Extract from AAEC Nuclear News 9, September 1981

Acoustical Activities

The noise Analysis Laboratory and the group of workers concerned with the application of acoustic emission techniques has been transferred from the AAEC to the CSIRO Division of Mineral Physics. The facilities will remain at Lucas Heights and will be expanded under the leadership of Dr. Robert Ham's in accordance with CSIRO policy to encourage interaction with industry.

Much of the work of the Noise Analysis Laboratory is concerned with time-series analysis using a wide range of computer-linked equipment including real-time analysers, correlators, FM recorders, etc.

Some applications of this work follow:

Vibration in a rail wagon

In a freak incident, bags of cement burst on a rail journey between Sydney and Melbourne. This happened because the distribution of weight of the bags was such that a resonant vibration was established in the rail wagon.

Measurements from vibration-detecting devices (accelerometers) placed on a test wagon are being analysed by scientists from Railways of Australia and AAEC scientist Dr Robert Harris. Not surprisingly, the measurements vary irregularly with time as the wagon jolts along. Each record of a time-series of measurements is obtained for a known bogie loading and stretch of track.

Knowledge gained from the study will provide a basis for preventing the recurrence of resonance-vibration incidents, and for an improvement of safety and comfort on trains.

Nuclear reactor safety

AAEC scientists continually review safety and operational features of the Lucas Heights nuclear research reactor, HIFAR.

By analysing time-series of vibrations, measured outside the reactor, they are able to diagnose much about what is going on inside. So far, they have:

- ☐ predicted the failure of one of three parallel coolant circulating pumps (of the three, only two need be working at any time);
- ☐ demonstrated that they can check the integrity of a control mechanism inside the reactor core; this mechanism includes a movable arm that absorbs neutrons and so determines the rate of nuclear fission;
- ☐ demonstrate that they can reliably detect a loose uranium fuel plate in a fuel assembly.

Analysis of time series of neutron measurements in the reactor has yielded:

- the rate of oscillation of a control arm, and
- the averge time in which a neutron moves around the reactor before being absorbed, a time which influences the rate at which the reactor can be shut down.

Other projects using the AAEC service include:

- predicting, in a heat exchanging system, the power above which a cooling fluid will be no longer effective (due to vaporisation and flow instability);

- analysis of turbulence in a channel,
- measurement of the velocity of a flowing fluid, by comparing time series of measurements of a fluid property, such as temperature, taken at two positions, one a known distance downstream of the other;
- measuring the velocities of component phases of a two-phase mixture (for example, in a steam-water flow, measuring the differing velocities of steam and water);
- detecting yield stress in materials, and
- producing a "voice print" or diagram characterising and identifying a speaker.

In addition to the above types of investigations, sophisticated acoustic emission techniques have been developed by Dr. Ham's and Mr Brian Wood. These have been applied to a number of large-scale surveys to detect possible sources of fracture or fatigue in bridges, dams, pressure vessels, etc. Some of this work was described in the Symposium on Acoustic Emission conducted on 25 November, 1981 by the Department of Applied Physics, University of New South Wales in association with the Australian Acoustical Society.

1.2 Building and Construction Engineering Exhibition

The Building and Construction Engineering Industries have announced sponsorship of an International Exhibition and Conference to occur in Sydney in July, 1982.

The Building, Environment and Construction Engineering Exhibition and Conference '82 will occur from July 19 to 24 and is expected to involve more than 100 companies selling to Construction Contractors, Master Builders, Architects, Local Government, Statutory Authorities, State and Federal Governments, Surveyors, Civil and Mechanical Engineers, Mining companies and all trades, contractors and consultants operating in the industry.

Organised by Total Concept Exhibitions Pty. Ltd., the Building, Environment and Construction Engineering Exhibition is fully sponsored by the Master Builder's Federation of Australia, the Australian Federation of Construction Contractors, the Royal Australian Institute of Architects and the Housing Industry Association.

A further 13 Australian organisations are represented on an executive advisory committee which will assist the exhibition organisers to create a representative Conference and Exhibition for all sectors of the industry.

Mr. Roy Castle, Managing Director of Total Concept Exhibitions, says that overseas manufacturers and suppliers have already shown great interest in exhibiting and with the expected input from Australian manufacturers and suppliers, both the Exhibition and Conference are expected to be the largest of their kind seen in Australia.

Products and services to be exhibited to a national buyer audience include: construction and mining machinery and equipment, materials handling equipment, energy conservation systems, insulation, solar energy, air conditioning, heating and ventilation, fire protection and security systems, commercial, industrial and institutional building products and materials, housing products and materials, engineering products and systems, computer and communication systems, financial services and new technologies available to the industry.

Mr. Castle said the rapidly expanding mining and energy sectors of the Australian Resources industry had already shown interest in supporting the Exhibition and Conference which will investigate related issues and benefits for the Construction Industry.

"The reason for the solid support that we are experiencing, is that building and construction is quickly developing into one of Australia's highest growth areas," said Mr. Castle. "Within the next few years, it should account for 12% of Australia's gross domestic product. This could well be exceeded when the impact of resource development on the industry is registered."

Total Concept Exhibitions Pty. Ltd. is one of Australia's most experienced and successful Exhibition and Conference organisers and will stress the importance of this event by a publicity and promotion campaign to reach all sectors of the industry throughout Australia.

"We are backing the Exhibition with advertising in all leading trade journals and newspapers, 4000 direct mail invitations, around 200,000 season passes, and press advertisements in selected overseas publications", said Mr. Castle. "An on-going public relations campaign will continually point out the advantages of attending."

For further information contact Total Concept Exhibitions, 612 Pittwater Road, Brookvale, 2100. Telephone (02) 938-2033. Melbourne Telephone (03) 347-8373.

A brochure and provisional program for the conference is available for inspection by contacting the Chief Editor.

1.3 Acoustics at the University of New England

A pamphlet has been issued by the University of New England, Armidale, NSW giving details of acoustical activities and opportunities for research. At present well qualified students can be accepted to work towards higher degrees (M.Sc. or Ph.D) in most of the areas listed, and it is also possible for students who have qualified for a B.Sc. degree at a sufficiently high standard to complete the requirements for a B.Sc. (honours) degree by transferring to this University for their fourth year.

Musical Acoustics

Our research gained its initial impetus from an interest in the basic physics of musical instruments, not simply at the first-order level which is clearly set out in the text books but rather in order to gain a detailed understanding of the physical processes involved in sound production, harmonic generation, transient response, and those subtle features distinguishing a fine instrument from one of poor quality. Thus a study of the simple organ pipe has led to work on wave propagation on laminar and turbulent air jets, on the interaction of these jets with air columns and on the nonlinear coupling of inharmonic resonators. An investigation of clarinet reeds has similarly led to studies of the acoustic admittance of vibrating-reed generators of all types, and studies of gongs and cymbals have resulted in fundamental work on wave propagation and nonlinearity in various curved shells. Other instruments to which attention has been given include the flute, violin, guitar, harpsichord, clavichord and even the tam-tam and didjeridu, though some of these studies have been only preliminary. Finally some work has been done on performance technique, with parameters like blowing pressure and lip position being studied in relation to the acoustic requirements of the instrument.

Biological Acoustics

We have found that many of the techniques developed in our work on musical instruments can be applied quite directly to understand details of sound production and auditory sensitivity in insects and other small animals, thus giving information about frequency response, directionality and general system behaviour. We do not undertake any direct measurements ourselves on animals, but cooperate with neurobiologists in other universities in the design and interpretation of their experiments. Systems so far studied in some detail include the sensory hairs on caterpillars and some aquatic animals, the hearing mechanism in frogs, birds and crickets and the stridulation mechanism in ants. Further work is planned in these and related areas and in general system analysis. In addition we give general bio-physical advice in other quite remote areas of biology.

Theoretical Acoustics

Most of our work is an intimate blend of theory and experiment, with one guiding the development of the other. Some of the more nearly independent theoretical studies include those on mode locking in nonlinearly coupled inharmonic oscillators, wave propagation on conical shells, and optimization in biological acoustical systems to compare deliberate design with the results of evolution.

General Acoustics

Acoustics is a practical subject and we have carried on some research into motor vehicle noise as well as making occasional noise-level surveys and giving architectural advice. We have tentative plans for the production of a series of videotapes on Physics and Music for teaching purposes.

Equipment and Facilities

Major equipment items include a Hewlett Packard dual-channel Fast Fourier Transform signal analysis system, a General Radio narrowband analyzer system, and a Tektronix 4051 graphics-oriented computer system which can also serve as a terminal to the central University DEC 2060 computer. We also have good selection of precision microphones, probes, accelerometers, storage oscilloscopes, etc and a small anechoic and sound-isolating enclosure. Other items are constructed as the need arises, and we are at present developing a laser Doppler vibrometer system.

A list of publications in acoustics for the period 1974-1981 is included in the pamphlet.

Anyone requiring further information or copies of selected reprints is invited to write to the leader of the Acoustics Group

> Professor N.H. Fletcher,
> Department of Physics,
> University of New England,
> Armidale, N.S.W. 2351.

1.4 Telecommunications Inquiry Committee

The Minister for Communications, Mr Ian Sinclair, has announced the names of the Committee to inquire into telecommunications services in Australia, and the inquiry's terms of reference.

He said the wide-ranging inquiry would be chaired by Mr J.A. Davidson, of Sydney, Chairman of Commonwealth Industrial Gases and a Director of a number of companies.

The Committee members would be:

Professor A.E. Karbowiak, of Sydney, Professor of Electrical Engineering, University of New South Wales;

Mr. M.G. King, of Sydney, a retired senior executive of CSR Ltd., who is a Director of several companies;

Mr W.A. Dick, of Melbourne, a chartered accountant and Chairman of Pacific Carpets International, who also holds several directorships.

Mr Sinclair said the Government was fortunate in having been able to obtain the services of these four distinguished Australian to conduct the inquiry.

It would be held in public and was expected to begin soon. It would take about twelve months to complete.

The Minister said the terms of reference were:

Having regard to the continuing need to provide adequate telecommunications services throughout Australia as efficiently and economically as possible and the significant technological advances which are now occurring in the telecommunications field both in Australia and overseas, the Committe is required to examine the report to the Minister for Communications on:

(a) the extent to which the private sector could be more widely involved in the provision of existing or proposed telecommunications services in Australia either alone, in competition with or in conjunction with the Australian Telecommunications Commission;

(b) what consequential changes may be necessary in the statutory functions, duties, financial objectives and monopoly provisions of the Commission; and

(c) the effectiveness of the Commission's operational policies and organisational arrangements.

In carrying out the review, the Committee shall have regard to the effects and likely consequences of any changes that it might propose in respect to:

(i) revenues and the cost structure for telecommunications services in Australia;
(ii) the overall financial performance of the Commission;
(iii) the scope for and ability of Australian industries to compete and participate in the design, manufacture, supply and servicing of telecommunications equipment; and
(iv) the possible need for any revised regulatory arrangements in the telecommunications field.

The Committee is requested to submit its final report on a date twelve months after the establishment of the inquiry. It shall be open to the Committee to make progress reports or reports on particular aspects of the inquiry if the Committee determines it is appropriate.

An issue to be considered was the extent to which private enterprise involvement in those areas of Telecom's activities, now protected from competition, could result in a more efficient and economical service to the public.

1.5 Divisional Activities

South Australia
Technical Meetings:

September 1981 — Joint meeting with I E (Aust) 'Techniques Used For Predicting And Controlling Noise Emissions From A Chemical Plant'.

November 1981 — 'Underwater Ultrasonic Communication' Mr. Chris Flaherty SAIT School of Physics

Mr. Flaherty presented a paper on the development of an underwater communication system over a range of 300 metres. This is the basis of the research work he is doing for a Master of Science Degree. Present methods were discussed before a detailed outline of his work, followed by an inspection of an anechoic water tank developed for the project and a demonstration of his progress to date.

Greg Wild

New South Wales
The latter half of 1982 saw the N.S.W. Division involved in a variety of activities:

19th August, 1981 —
Technical meeting joint AAS/IEA
Dr. D.A. Bees, Statistical Energy Analysis

27th September-3 October 1981
Deaf Awareness Week

30th September, 1981
Technical Meeting
Prof. Ross Thorn – Office Design

25th November, 1981
1 Day Symposium
Acoustic Emission.

Each of these events was successfully conducted although the falling level of involvement by Division members in them is causing some concern to the Division committee. The highlight of this period was probably the Acoustic Emission Symposium held at The University of New South Wales. A distinguished panel of experts in the field (Prof. Svennson, Pollard, Dr. Harris, Wood) lectured on the theory and development of the technique during the afternoon, followed by a very successful general applications lecture by Brian Wood in the evening.

During this period the Division committee has met regularly and dealt with an increasing amount of business particularly membership applications.

John Dunlop

Victoria Division Report – February 1982

Just prior to the publication of the last edition of the Bulletin, Victorian members held a joint meeting with the Audiological Society. This meeting was held at "Taralye" which is the premises of the Advisory Council for Children with Impaired Hearing (Victoria). The topic for the meeting was acoustic treatment of classrooms for the hearing impaired child.

At the meeting, the members of both Society's were fortunate to hear from Mr. Grant Preston – Audiologist at the Victorian School for the Deaf and Mr. Graeme Moss – Director, Carr Acoustics Group, designer of the acoustic treatment at Taralye.

A joint meeting such as this is an extremely good way to bring people with related interests together and the Victorian Division members I feel sure enjoyed this opportunity to discuss an important area of common interest.

On 20 November 1981 the Victoria Division held its annual dinner at the Sciences Club. As always members had a most enjoyable time simply by having an opportunity to discuss an important area of common interest.

On 20 November 1981 the Victoria Division held its annual dinner at the Sciences Club. As always members had a most enjoyable time simply by having an opportunity of meeting socially other acousticians and their friends. Also, following on from the success of the previous years talk, the Victoria Division members were treated to a discussion of another family of musical instruments. Mr. Graeme Morat and his two sons gave an illustrated talk on the history and development of brass instruments. This proved to be an excellent finish to 1981 and was enjoyed by all members and their friends.

Before finishing the Victoria Division report I should add my thanks to the splendid work done by Gerald Riley and Duncan Gray who recently retired from active acoustical society committee work. A small dinner was held by the Victoria Division Committee as a token of their esteem for these two valued members.

John Lambert

1.6 Items from the AAS Council Meeting held in Adelaide: 27-28 February, 1982

Qualifications for the various grades of membership of the Society continued to be deliberated at considerable length. It was realised that a decision of the Council taken at its 27th Meeting in September 1981 had not been fully disseminated — that is, Council decided that the "formal education requirements, as approved by Council at its 26th Meeting be not implemented until available courses have been approved by Council". These requirements were published in the August 1981 issue of the Bulletin.

The issue of approval of courses in acoustics is being studied by an Education Sub-Committee of Council, under the convenorship of Dr. M. (Fred) Zockel. In addition, Council has appointed a new Sub-Committee to formulate guidelines for Divisional Membership Grading Committees when considering recommendations for admission of applicants to the various grades of member, under the convenorship of Anita Lawrence. It is hoped that these guidelines will be circulated to the Divisions for comment and agreement in time for ratification at the next Council Meeting in December.

The Society has been approached by the Bicentennial History of Science Committee of the Academy of Science regarding the proposed production of a book of essays dealing with the history of science and applied science in Australia over the last 200 years. If any of our members are interested in this project they should contact Bob Boyce or Anita Lawrence for further details.

The Society has also been asked for contributions to the Newsletter of the International Institute of Noise Control Engineering (INCE). If anyone has items of international interest – e.g. research projects, higher degree thesis, information regarding legislation etc. they should forward this directly to the Editor of the Newsletter (Dr. A. Cops, International INCE, Celestynenlaan 200D, 3030 Heverlee – Leuren. Belgium).

Another item of interest to members is the establishment of two standing committees of Council — one, mentioned elsewhere in this issue, under the convenorship of Richard Heggie is considering the issues of Professional Practice; the second, led by Cliff Winters, is concerned with Finance, and will be advising Council and Divisions on long term financial planning.

1.7 Future Events

South Australia Division

April 1982
'Ultrasonics In Medicine'

June 1982
A talk to be presented by Mr Adrian Jones on his recent trip to the USA covering work done at NASA.

July 1982
Mr Derrick Kendrick to present 'Anecdotes on Acoustic Space Design'.

New South Wales Division

April 28
Vibrations due to Blast
J. Goldberg, CSIRO

May/June
To be announced.

July 21
Solution of Acoustic Problems in Parliament House
L. Challis (joint meeting with I.E.A.)

August 18
Division AGM
Panel Discussion: A.A.S. – Professional Body or Learned Society?

September 2, 3, 4
Singapore Conference

October 27
Medical Ultrasonics
G. Kossoff, Ultrasonics Institute

December 10, 11
Public Forum – Aircraft Noise
A.A.S. AGM

52nd ANZAAS Congress

The 52nd Congress will be held in Sydney, May 10-14, 1982 at Macquarie University.

The Congress theme is *Australia's Industrial Future*.

Postal enquiries regarding enrolment, program, accommodation, and Congress tours should be addressed to: to

Hon. Organising Secretary, 52nd ANZAAS Congress, Macquarie University, North Ryde, NSW 2113.

Telephone enquiries to:

Congress Office (02) 88 9754 or Mr. D.M. Price (02) 88 9553 or Prof. L. Milthorpe (02) 88 9456.

Telegraphs and Telex: Macquni AA 22377.

1.8 Professional Practice Sub-Committee

A meeting of the Council of the AAS recently moved to form a Sub-committee on Professional Practice.

The role of this Sub-committee is "to examine the Society's role and obligations in Professional Practice and to advise whether the Society should concern itself with the conditions of engagement and practice of professional consultants and of salaried officers and to draft such proposals as may be required for submission to Council if the matter is deemed to be a Society function".

Some of the issues raised by the Sub-committee's brief are fundamental to the Society's future development: adoption of a Code of Ethics, qualifications and selection procedures for Member grade, and the role of the Society as an accreditation body.

Discussion at recent Federal and Divisional Annual General Meetings has highlighted the strong and sometimes conflicting opinions held by many members in relation to these matters.

To assist in developing fuller understanding of the various viewpoints, the Sub-committee will endeavour to stimulate wide ranging discussion and consideration of all the issues. Constructive comment will then be sought from Society members and from interested individuals and groups outside the Society.

It is hoped that a consensus of opinion will emerge to form a basis for the Sub-committee's recommendations to Federal Council.

The Council has invited Sydney Consulting Engineer, Mr. Richard Heggie, to convene the Sub-committee. Mr. Heggie is a past Federal Councillor and Treasurer of the Society, and served on the Aims and Objects Sub-committee in 1977/78.

As a basis for discussion and submission of comment, documents will be circulated shortly to members outline the issues and their implications. The address for correspondence to the Sub-committee is:

AAS Professional Practice Sub-Committee,
C/- Richard Heggie Acoustics Pty. Ltd.,
PO Box 204,
ROSEVILLE. NSW 2069

Telephone: (02) 411 7022

1.9 International Building and Construction Materials and Equipment Exhibition in conjunction with a National Symposium on the Economics of Skills Training. The Royal Exhibition Building, Melbourne, 19 May-22 May, 1982.

The Symposium–the first national forum for training and occupational skills, will have a speaking panel composed of prominent leaders of the building and construction industry, Government representaties, overseas guests and others associated with the industry. Discussion subjects range from "National Development and the Value of Skills" to "A Vision of the Future".

The Exhibition will feature displays by dozens of Australian and overseas companies, showing a wide range of equipment and services, and should be visited by everyone involved in the industry including tradesmen.

For invitations and for further information about the Exhibition and Symposium, contact Riddell Exhibition Promotions Pty. Ltd., 166 Albert Road, South Melbourne, Vic. 3205. Phone (03) 699 1066.

2. International

2.1 First International Conference on Industrial Pollution and Control

14-17 December 1982, Singapore.

Sponsored by World Health Organisation Western Pacific Region, Indonesian Society of Sanitary Engineers, Phillipine Society of Sanitary Engineers, Singapore Society of Environmental Engineers.

Aim

To bring together environmental specialists to discuss and examine environmental problems encountered due to rapid industrial development.

Scope

Papers will be considered on the following topics: *Air pollution and control, Water pollution, Noise pollution, Industrial Health, Industrial waste and treatment system.*

The conference sessions will include invited papers on the above topics.

The Conference will reflect the views of industry, government departments, water authorities and utilities, universities, national and international centres and agencies concerned with the industrial environment.

Details: The Conference Secretary, First International Conference on Industrial Pollution and Control, Dr Raymond B. W. Heng, Senior Lecturer, Dept of Mechanical and Production Engineering, National University of Singapore, Singapore 0511.

2.2 China Exchange Agreement

Applications are invited from scientists wishing to participate in the Australian Academy of Science – Academia Sinica scientific exchange program.

Intending applicants should have a specific project in mind, preferably one that has been developed in consultation with the institutes in China that they wish to visit. Documentary evidence of Chinese interest and support will greatly strengthen the application.

Applications may be made by individuals or by groups (up to a maximum of 6 members) and may be for short visits (3 to 4 weeks) or for a longer term to carry out research projects or field studies. Scientific Societies also are encouraged to submit proposals.

In making its selections, the Academy will be influenced by the following considerations:

a. the special features of the proposal which make it appropriate for inclusion inder this particular bilateral agreement, (what is there that is peculiar to China?);

b. its scientific merit and importance to science in Australia;

c. the potential for developing further collaboration;

d. the interest it is likely to arouse amongst scientists in similar fields of research in Australia, and

e. evidence of support for the proposal from within China.

Under the terms of the agreement travel expenses to China are our responsibility and expenses within China the responsibility of Academia Sinica. No additional stipends or allowances are paid.

Application forms and a list of the Institutes of Academia Sinica are available from the Australian Academy of Science, P.O. Box 783, Canberra City, ACT 2601.

It should be noted that Academia Sinica has difficulty in arranging visits to institutions not under its control and proposals should therefore be confined essentially to projects that can be organized through the Academy's Institutes.

2.3 17th General Assembly of the International Union of Pure and Applied Physics, 1-3 September 1981, Paris.

At this meeting, elections resulted in the following appointments:

The principal executive officers for 1981-1984 are:

K. Siegbahn (Sweden) – President
D.A. Bromley (USA) – First Vice President
L. Kerwin (Canada) and J.S. Nilsson (Sweden) – Secretary-General and Associate Secretary-General respectively.

The Australian and New Zealand representation on the Commission is now:

M.J. Buckingham (C3 – Statistical Mechanics and Thermodynamics)

A.G. Fenton (C4 – Cosmic Rays)
J.A. Rose (C7 – Acoustics)
A.P. Stamp (C12 – Nuclear) New Zealand.
E. Weigold (C15 – Atomic and Molecular Physics)
B.S. Liley (C16 – Plasma) New Zealand
D.F. Walls (C17 – Quantum Electronics) New Zealand
C.A. Hurst (C18 – Mathematical Physics).

2.4 11th ICA

The final selection of satellite symposia was recently announced by the organising committee of the Eleventh International Congress on Acoustics (Paris, 19-27 July 1983). Of the five originally suggested themes the following have been selected:

Active acoustical absorption and attenuation, 12-13 July 1983, Marseille
Acoustical radiation of mechanical structures and fluids, 15-16 July 1983, Lyon

Speech communication, 29-30 July 1983, Toulouse

The International Commission on Acoustics has accepted the Canadian invitation to hold the Twelfth International Congress on Acoustics (1986) in Toronto.

2.5 Technical Committees of the Acoustical Society of America and Their Chairmen

Architectural Acoustics – David Lubman
Hughes Aircraft, Ground Systems Group, Bldg. 618, MS P 415, Fullerton, CA 92631

Engineering Acoustics – Mauro Pierucci
Dept. of Aero. and Eng. Mechanics, San Diego State University, San Diego, CA 92182.

Musical Acoustics – William M. Hartmann
Physics Dept., Michigan State Univ., East Lansing, MI 48824.

Noise – Larry H. Royster
Mech. and Aerospace Eng. Dept., North Carolina State Univ., Raleigh, NC 29650.

Physical Acoustics – Walter G. Mayer
Dept. Of Physics, Georgetown University, Washington, DC 20057.

Psychological and Physiological Acoustics – Joseph E. Hind
Dept. of Neurophysiology, Univ. of Wisconsin Medical School, Madison, WI 53706.

Shock and Vibration – Wayne T. Reader
David W. Taylor Naval Ship R & D Center, Bethesda, MD 20084.

Speech Communication – Edward P. Neuburg
National Security Agency (R5), Fort Meade, MD 20755.

Underwater Acoustics – Harry A. DeFerrari
Rosensteil School of Marine and Atm. Sci., Miami, FL 33149.

2.7

J. F. Schouten (1910-1980)

Jan Frederik Schouten, son of the mathematician F. J. Schouten studied experimental physics under Ornstein. His Ph. D. thesis dealt with the psychophysics of adaption of the human eye.

In 1937 he joined the acoustics group of Philip's Physical Laboratory, Eindhoven. His first acoustical publication betrayed his optical breeding: employing the soundtrack of movie film as an optical grating, he obtained two dimensional diffraction patterns showing the Fourier components of the movie sound.

With another optico-acoustic artifice he constructed a sound synthesizer. He used a rotating slit to scan the mask of a time function. The light flux modulated in this way was converted into an electric current, driving a loudspeaker. This optical siren produced a periodic sound with the time function as wave form.

This apparatus enabled him to have a fresh look at the "case of the missing fundamental", i.e. the paradox that the pitch of a complex sound is isomorphous with its fundamental component, even when that fundamental is absent. In a series of experiments he refuted Helmholtz's suggestion that the pitch of such sounds is due to non-linear distortion in the ear. Two decades later, his reformulation of the problem of pitch perception would stimulate many physicists both in the Netherlands and abroad to study his corner of psychoacoustics.

After the war, as leader of the telecommunications group of the Physical Laboratory, he pioneered in digital signal transmission, the Delta Modulation being the best known result of this activity. He also tried his hand at machine recognition of speech.

In 1950 he was appointed assistant director of Philips' Telecommunication Industry. In 1957 he came back to science, founding the Institute for Perception Research in Eindhoven, guiding it until his retirement in 1972. He was nominated professor in the Technological University of Eindhoven, member of the Dutch Royal Academy of Sciences, and member or fellow of a number of scientific societies in the Netherlands and elsewhere. He knew that his heart was at risk. He was still active in many fields when a fatal failure occurred. For many of us he was a very good friend. He is survived by his wife and his three sons.

B. L. Cardozo
(Reprinted from Acustica)

2.6 French Scholarships

The French Government is offering a limited number of scholarships to enable Australians working in scientific and professional fields to visit France for three to six months in the period January to December 1983.

Further information and application forms are available from: The Secretary, Department of Education, (French Government Scientific and Professional Scholarships) P.O. Box 826, WODEN ACT 2606.
Closing date 28 May 1982.

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2.8 Future Events
1982

April 20-24 VIENNA 12th AICB Conference
'Results and Forecasts in Noise Abatement'
Details: Austrian Noise Abatement Society, Jägerstrasse 71, A-1200 Vienna.

April 26-30 CHICAGO Acoustical Society of America Meeting.

May 3-5 PARIS 1982 ICASSP
IEEE International Conference on Acoustics, Speech and Signal Processing
Registration: G. Charbonneau, I.E.F. Bâtiment 220, F-75230 Paris Cedex 05.

May 4-7 BUDAPEST, HUNGARY
8th Budapest Colloquium on Acoustics
(physical, physiological and subjective acoustics, electroacoustics, architectural acoustics, ultrasound, investigation of speech)
Details: Optikai, Akusztikai és Filmtechnikai Egyesület, Anker köz 1, H-1061 Budapest.

May 17-19 SAN FRANCISCO
INTER-NOISE 82
Details: INCE-Noise Control Foundation, P.O. Box 3469, Arlington Branch, Poughkeepsie, New York 12603.

May 23-27 HELSINKI, FINLAND
XVI International Congress of Audiology
Topics: Audiology past and future, Cochlear Mechanics, Evaluation and measurement of hearing handicap, Retrocohlear hearing disorders.
Information: XVI Intern. Congress of Audiology, Secr. General: Dr. Tapani Jauhiainen, Department of Otolaryngology, Helsinki University Central Hospital, Haartmaninkatu 4E, SF 00290 Helsinki 29.

May SHANGHAI, CHINA
The Third National Conference on Acoustics
Details: Acoustical Society of China, Prof. Wang Te-chao, President, Institute of Acoustics, Academia Sinica, Peking.

June 7-11 SUBOTICA, YUGOSLAVIA
XXVI ETAN Conference – all branches of acoustics.
Secretariat: Dr. P. Pravica, Electrotechnical Faculty, Bulevar Revolucije 73, YU-11000 Beograd.

July 6-8 SHEFFIELD, U.K.
Fourth British Conference on the Teaching of Vibration and Noise
Details: Mr. P.B. Round, Industrial Liaison Service, Sheffield City Polytechnic, Halfords House, 16 Fitzalan Square, Sheffield S1 2BG, U.K.

July 19-23 RIO DE JANEIRO, BRAZIL
30th Symposium on Acoustics in Brazil
Information: Brazilian Acoustical Association – ABRAC, Alberto Vieira de Azevedo, President, Avenida Ataulfo de Paiva, 1079, Grupo 603 Leblon – CEP – 22.440, Rio de Janeiro.

September 9-10 EDINBURGH, U.K.
Auditorium Acoustics
Details: Institute of Acoustics, Mrs C. Mackenzie, Secretary, 25 Chambers St., Edinburgh EH1 1HU, U.K.

September 13-17 GÖTTINGEN, GERMANY
3rd FASE Congress, jointly with *DAGA 82*
The Congress will cover: Speech research, Room and Building acoustics, Acoustic streaming, Nonlinear acoustics, Physical Acoustics. The DAGA '82 will cover: Electroacoustics, Psychological Acoustics, Measuring technics, Noise, etc.
Secretariat: Prof. M.R. Schroeder, III. Physikalisches Institut, Bürgerstr. 42, D-3400 Göttingen.

September 20-22 KRAKOW, POLAND
Noise Control 82
Conference theme is Practice of Noise Control.
Details: The Organising Committee, Noise Control 82, Institute of Mechanics and Vibroacoustics, Al. Mickiewicza 30, paw. B-2, 1p., 30-059 Krakow, Poland.

October 4-8 HIGH TATRA, CZECHOSLOVAKIA
21st Acoustical Conference on Noise and Environment
Secretariat: House of Technology, Ing. L. Goraliková, Škultétyho ul., 881 30 Bratislava, Czechoslovakia.

November 8-12 FLORIDA, U.S.A.
Meeting of the Acoustical Society of America
Chairman: Joseph E. Blue, Naval Research Laboratory, P.O. Box 8337, Orlando, Florida 32856.

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

May 9-13 CINCINNATI, U.S.A.
Meeting of the Acoustical Society of America
Chairman: Horst Hehmann, 1928 Fullerton Dr., Cincinnati, Ohio 45240.

July 19-27 PARIS
11th ICA – International Congress on Acoustics
Information: GALF, Ing. G. Minier c/o C.N.E.T., LAA-TSS-ATP, B.P. 40, 22301 Lannion.

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

July 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. Januška, Provaznická 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 Center, 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.

August 1-17 SANDEFJORD, NORWAY
FASE 84 – 4th Congress of the Federation of Acoustical Societies of Europe
Topic: Solving todays noise problems – technological and political aspects; Planning with respect to environmental noise; Acoustics in Condition Diagnosis.
Secretariat: FASE 84, Secr. Gen. J. Tro, ELAB, N-7034 Trondheim – NTH.

October 8-12 MINNEAPOLIS
Meeting of the Acoustical Society of America
Chairman: W. Dixon Ward, Hearing Research Laboratory, University of Minnesota, 2630 University Ave., S.E. Minneapolis, Minnesota 55414.

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WHAT! No gossip column; no, not a gossip column but a **People** column. Your old gossip columnist is involved, but not the sole writer.

In this column we hope to bring you news of the current and proposed activities of **People**, their new projects, appointments, promotions and similar.

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Before the news of people I have important revaluations regarding **Censorship** of The Bulletin. Inadvertent "Censorship" takes place when omissions are not picked up in proof-reading; another form occurs when editing is necessary to trim an article to integral page size.

The Complete List of A.A.S. conferences in last months copy of The Bulletin suffered from one inadvertant omission which was not picked up in proof-reading. Turn up last months issue and see if you can see which conference was omitted.

Editing was responsible also for the rather truncated ending to the column on page 7 of last issue. The information sent by **Len Koss** is rather long and what follows is, I hope, longer than that published in the last issue but probably edited a bit.

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Monash Reporter – A research project underway in the Department of Mechanical Engineering is examining methods of reducing the noise level of a widely-used piece of industrial equipment – the mechanically operated punch press.

The project, which is being carried out by Senior Lecturer Dr Leonard Koss, is being supported by the Australian Engineering Building Industries Research Assosiatin. AEBIRA representatives Mr. J. Van Der Molen and Mr. J. Cheeny last month gave the Department a cheque for $26,000 – the first instalment in a grant over three years which will amount to a minimum of $60,000 and possibly up to $87,500.

Dr. Koss estimates that there are three to four thousand mechanical punch presses being used chiefly for the manufacture of metal and plastic products in Australia.

At the moment, a typical machine when operating at full capacity would have a noise level of 100 dB(A). The aim of the project is, through machine modifications, to reduce the noise level to 90 dB(A). A reduction of the noise level by 10 dB(A) would mean that the loudness, subjectively, would be halved. More significantly, in terms of effect on hearing, the pressure level would be reduced three times.

Dr. Koss says that the work will be carried out in Mechanical Engineering's anechoic chamber and using the Department's computers. The project will also draw on the considerable expertise in the Department on noise control and acoustics problems. He says that the grant will enable a research fellow to be employed and the purchase of a processing computer.

The Australian Engineering Building Industries Research Association is a non-profit organisation which supports applied industrial research of a type which will have a benefits across an industry rather than, say, giving one manufacturer a competitive edge. AEBIRA stimulates funds for such research from among its 40 industrial members and other sources. The grant for the present project at Monash, for example, has attracted funds from the Federal Government.

AEBIRA has given support to another project in Mechanical Engineering – one on wind loading conducted by Professor Bill Melbourne."

It is with great sorrow that we record the death of GEORGE MURPHY M.A.A.S. George died suddenly from a heart attack whilst on a holiday in the U.K.

After graduating as a Bachelor of Science and Bachelor of Mechanical and Electrical Engineering at the University of Sydney, George began his career in the industry with Carrier Air Conditioning in 1934.

His career with Carrier was twice interrupted, first by a period spent on the island of Nauru working for the British Phosphate Commission, and, secondly, by Army service in World War II, during which he rose to the rank of major.

He terminated his long service with Carrier in the early 60s and after a year with Frigrite joined Gutteridge Haskins and Davey as an associate.

In later years George took a keen interest in computer-aided design, taught himself Fortran, and developed programmes for evaluating heat gains and losses to buildings, friction losses in pipes and ducts, and acoustic properties of duct systems.

George was undoubtedly one of our most intelligent and knowledgeable members who at the same time was most unpretentious and unassuming.

Early last year **Henrique d'Assumpcao** M.A.A.S., a senior scientist with the Defence Science and Technology Organisation was presented with the **1980 Award of Merit** of the Professional Officers' Association. The Award was made in recognition of Henrique's major contributions over many years to research on underwater acoustics and signal processing, and their application to defence projects. Henrique has taken a leading part in the development of the Barra sono-buoy.

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Vilhelm Lassen Jordan
Msc.Ph.D.

It is with regret that we record the passing of Dr. V.L. Jordan who died in the surf at Manly, N.S.W., in January, 1982.

His passing leaves a great vacuum in the field of acoustic research and consulting and particularly in the area of the design of concert halls and theatres.

Vilhelm Jordan studied acoustics in Denmark under the direction of P.O. Pedersen, Professor of Telecommunication, and subsequently Director of the Royal Technical University of Copenhagen. He also studied under Professor Erwin Meyer who was associated with the Heinrich Hertz Institute of Berlin and also the Institute of Physics of the University of Gottingen.

Vilhelm Jordan's initial entry into the field of practical acoustics was his involvement in the acoustical measurements of the Radiohuset in Copenhagen during the Second World War. The acoustic testing in the Danish Broadcasting Corporation Studios was considerably extended so that the hall would not be completed during the German occupation. The result was that Vilhelm Jordan was able to acquire a wealth of acoustical knowledge during the construction period of this building.

His work from that period included the Tivoli Concert Hall, in Copenhagen, the Aalborghallen and the Scala Theatre Aarhus, Denmark and University Hall of Reykjavik, Iceland.

In 1959, Jordan, together with Cyril M. Harris, became involved in the acoustical design of the new Metropolitan Opera House in New York. The great success of this hall led to a further commission for V. Jordan for the Ruben Darao Theatre of Nicaragua. During this period, Dr. Jordan was rapidly developing the technique of acoustic model testing at scale of approx. 1:10. However the work was hampered by the lack of adequate instrumentation. The refinement of the Bruel & Kjaer ⅛ inch microphone together with the use of high intensity spark sound source enabled model testing to be a practical reality.

His early two large scale ventures in model testing was for the Major Hall of the original Sydney Opera House design, and for the Metropolitan Opera House in New York. In applying criteria to the results from the model test, he was using the refinement of all the testing work that had been carried out in the Danish Studios during the Second World War. Dr. Jordan was particularly interested in the initial generation of the sound within an enclosure and considered that the build up of the sound field was as important as the overall decay. The early decay time was a very important concept in the development of his criteria.

His involvement in the Sydney Opera House resulted from the initial appointment of the Danish Architect Jorn Utzon. The services of Dr. Jordan were retained when a new firm of Architects was appointed in 1966. He initiated an exhaustive testing programme not only on the acoustic models for the Concert Hall and the Opera Theatre but also on components which were to be part of the building, including the glazing, the acoustic absorbency of seating and the lining materials of the Halls. His thoroughness and attention to detail was outstanding and it was obvious that Dr. Jordan's thirst for research was never ending.

The acoustic design of the Concert Hall of the Sydney Opera House represented the culmination of the experience of Dr. Jordan at that time. The resultant success of the Concert Hall has clearly illustrated Dr. Jordan's ability as an outstanding acoustician.

Since that date Dr. Jordan has been involved in the design of Concert Halls in Stockholm, Malmo, Dublin and Odens.

Those who were fortunate enough to be associated with Dr. Jordan knew him as a man of great ability and integrity, of tremendous personal charm with that wonderful quality of charisma. Vilhelm Jordan had the ability to communicate to people at all levels. All those that were fortunate to meet him went away much enriched by that experience. He is survived by his wife Ebba and his son Niels.

We extend to them our deepest sympathies on this occasion.

Peter Knowland
February 1982

Members of our Society have been active the Great Southern Ocean. I quote directly from a brief item in The Australian Physicist sent to me by **Michael Kateifides.** "Scientists from the RAN Research Laboratory, Sydney, have taken part in two civil-sponsored cruises in recent months in the course of their studies on the scattering of underwater sound by biological organisms. In one case, the opportunity arose to visit high latitudes on the *Nella Dan*, on a re-supply run t Macquarie Island. In the second case, berths were available aboard the *FRV Soela* on charter to theC.S.I.R.O. for a short cruise in the Tasman Sea. C.S.I.R.O. scientists trawled for the types of deep-sea fishes that are important sound scatterers while at the same time RANRL scientists made acoustic measurements. There was also a scientist from Materials Research Laboratories, Melbourne, on board, and he obtained a collection of fish on which he can make the detailed measurements that are needed for the prediction of their acoustic properties".

Acute observers will have noticed the bright red on the cover of our Bulletin. Surely the colour had some influence on the decision of **Centralnaja Nauchno-Techn** of **Leningrad, U.S.S.R.,** to place a subscription for The Bulletin.

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Harding's first law states "long letters requiring long replies are a long time being answered". From **Chris Day** in New Zealand we have received Day's amendment to that first law – "That the delay varies as the cube of the work x the social programme".

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The Australian Acoustical Society has been playing with the grading of Fellows for years. Whilst our Society has been playing, the Acoustical Society of America has conferred the grade of **Fellow** on one of our Members – **A. Harold Marshall M.A.A.S.** Perhaps this may prompt our Society to do something.

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Our next paragraph concerns that most often quoted person, **Anonymous,** who wrote a letter in **Green Ink** to the Victoria Divison complaining of the use of the Society's funds to subsidise not just the meal but drinks (alcoholic of course) at the Divisions Annual Dinner.

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Dr. Marshall Hall of RAN Research Laboratory is currently on an 18 month exchange posting at the Naval Ocean Systems Centre, San Diego. He is working with Dave Gordon of NOSC (who spent a year at RANRL in 1977) applying normal mode theory to sound propagation in the ocean. Marshall will be attending the Acoustical Society of America Meetings as well, no doubt, as seeing some of the U.S.A.

During Marshall's absence, **Dr. Martin Lawrence** is acting in his position (Senior Research Scientist). Martin's field of interest is the acoustics of the sea bed and he will now be acting manager of Project *Seamap* (see Technical Reports).

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It is with pleasure that we welcome the following new members of the Society approved at the 27th meeting of the Council, September 1981:

Member grade –
Dr. M.W. Lawrence of NSW
Mr. S.R. McLachlan of NSW

Subscriber grade –
Mr. R.J. Gaylor of S.A.

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Now some advance indication of news which we expect to report in the next issue. The people concerned is yours truly, your PEOPLE's columnist or rather his consulting business. Due to circumstances beyond our control (our lease has run out) we have to find new premises; and whilst we are changing address and 'phone number we will also be changing our name. Next issue we will tell you all about it.

Remember: Send news and photos of *People* to me, C/o. Knowland Harding Fitzell Pty. Ltd., 22a Liddiard Street, HAWTHORN, Vic. 3122.

Graeme E. Harding

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Council of the Australian Acoustical Society

A.B. Lawrence (President), R.A. Piesse (Vice President), R.W. Boyce (General Secretary), K.R. Cook (Treasurer), J.I. Dunlop, G.E. Harding, F.R. Jamieson, W.J. Kirkhope, T. Vass, M. Zockel (Councillors). Standing Committee on Membership: P. Dubout (Chairman).

Correspondence on NATIONAL matters should be addressed to: The General Secretary, Australian Acoustical Society, Science Centre, 35 Clarence St., Sydney, NSW 2000.

Correspondence on REGIONAL matters should be addressed to the appropriate Division Secretary.

Divisional Committees

NEW SOUTH WALES

(including Queensland and ACT)

J.I. Dunlop (Chairman), M. Kateifides (Vice Chairman), G.W. Patterson (Secretary), J.A. Whitlock (Treasurer & Registrar), A. Gale, L.R. Johnston, L.C. Kenna, A.B. Lawrence, M.E. Nelmes, R.A. Piesse (Members).

Address correspondence to: Mr G. Patterson, Science Centre, 35 Clarence St., Sydney, NSW 2000.

VICTORIA

(including Tasmania)

W.J. Kirkhope (Chairman), K.R. Cook (Vice Chairman), G.E. Harding (Secretary), G. Chenco (Treasurer & Registrar), G.A. Barnes, N. Broner, G.V. Coles, R.C. Lam, J.A. Lambert, J. Watson (Members).

Address correspondence to: Mr G.E. Harding, 22a Liddiard St., Hawthorn, VIC 3122.

SOUTH AUSTRALIA

(Including Northern Territory)

M. Zockel (Chairman), P.B. Swift (Vice Chairman), R.W. Boyce (Secretary), K.J. Martin (Treasurer & Registrar), D.A. Bies, H.S. Dean, A.D. Jones, M.A.P. Lane, R.P. Williamson, G.R. Wild (Members).

Address correspondence to: Mr R.W. Boyce, P.O. Box 87, Hindmarsh, SA 5007.

WESTERN AUSTRALIA

F.R. Jamieson (Chairman), V. Alder (Vice Chairman & Secretary), J. Spillman (Treasurer & Registrar), I.H. Bailey, D.D. Carruthers, N. Gabriels, P.A. Gunn, M.P. Norton, D. Robertson, T. Vass (Members).

Address correspondence to: Dr V. Alder, 10 Parkway, Nedlands, WA 6009.

INFORMATION FOR CONTRIBUTORS

Items for publication in the Bulletin may be of two types:

(a) *shorter articles* which will appear as News or as a Technical Note,

(b) *longer articles* which will be treated as refereed technical papers.

Forthcoming closing dates for the receipt of these articles are as follows:

Vol. 10 No. 2	Longer articles:	March 31
	Shorter articles:	April 30
Vol. 10 No. 3	Longer articles:	June 30
	Shorter articles:	July 30

Contributions may be sent directly to the Chief Editor or to the editor responsible for the particular subject area.

Longer articles should include a title, authors name, address and organisation (if applicable), and be accompanied by a summary 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 be reduced proportionally by the printer to column or page width. Preferably, original drawings should be supplied without lettering (or lettered with a soft pencil) and accompanied by a lettered copy since it is desirable for lettering to be added by the printer. (If diagrams are supplied with lettering, allowance should be made for the reduction process).

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Acoustics of a Tamtam

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Chinese tamtams are characterized by a delayed "shimmer" due to high frequency modes of vibration excited by nonlinear coupling to modes of lower frequency. Although the exact nature of this coupling is not known, it can be described by a semi-quantitative theory which is consistent with the experimental data. Coupling between modes of high and low axial symmetry appears to depend upon a ring of hammered bumps. Modes of low frequency have decay times as long as 18 seconds, whereas modes of higher frequency decay more rapidly.

1. INTRODUCTION: Among the many percussion instruments of Oriental origin that have been adopted into Western music, the tamtam is one of the most interesting acoustically. The sound of a large Chinese tamtam, which can be the loudest of any instrument in an orchestra, reaches full brilliance one or two seconds after being struck and may continue for up to one minute if the instrument is not damped. The tamtam is also widely used for creating special effects, such as the sound produced by the Herculean figure in the familiar screen trademark of the J. Arthur Rank Film Corporation.[1]

When the tamtam is struck somewhere near its center with a large padded mallet, the initial sound is one of very low pitch, but in a few seconds a louder sound of high pitch builds up, then slowly decays, leaving once again a lingering sound of a low pitch. The high-pitched sound fails to develop if the initial blow is not hard enough.

This paper describes the vibrational behaviour of the tamtam and attempts to analyze the conversion of energy from vibrational modes of low frequency to those of higher frequency. Due to the complexity of the vibrating system an exact theoretical description of the nonlinear mode conversion is not possible. Nevertheless, the semi-quantitative theory presented is consistent with the experimental measurements described.

2. THEORETICAL CONSIDERATIONS

2.1 The tamtam

Tamtams are of varying size up to about one meter in diameter. They are usually made of bronze (approximately 80% copper and 20% tin, with occasional traces of lead or iron). Although the center is usually raised slightly, they do not have a prominent central dome as do gongs and cymbals. They do, however, have one or more circles of hammered bumps and a fairly deep rim. They are considerably thinner than most large gongs. Our tamtam is shown in Fig. I.

2.2 Modes of vibration

Because of their large size, local variations in thickness, and numerous bumps and hammer marks, the modes of vibration of a tamtam show only faint resemblance to the normal modes of flat plate.[2,3] The low-frequency domain has several prominent axisymmetric modes, which absorb much of the energy of the initial blow.

Other families of modes of considerable interest are those that have numbers of radial nodes equal to the number (or an integer multiple) of hammered bumps in one of the circles. These modes would be favoured in the delayed sound if the bumps play a prominent role in the conversion of energy from axisymmetric to non-symmetric modes as suspected.

2.3 Nonlinear coupling

Any detailed analysis of the behaviour of the higher modes of the tamtam must, of course, await an understanding of the precise nature of the physical nonlinearities involved. It is possible, however, to write down some general results which are independent of the precise physics of the problem and which provide a framework against which the observed behaviour can be discussed.

In a linear system we can analyze the motion in terms of normal modes which are completely noninteracting. If $x_i(r,\theta)$ is the displacement associated with the i th normal mode then, after the initial strike, we can write

$$M_i\ddot{x}_i + R_i\dot{x}_i + K_ix_i = 0 \qquad (1)$$

where M_i, R_i and K_i are respectively a generalized mass, resistance and spring constant associated with this mode.

In the nonlinear system K_i is not a constant but has the form

$$K_i = K_i^0 + K_i'(x_1, x_2, \ldots) \qquad (2)$$

where K_i' is a general nonlinear function of all the mode amplitudes. For such a system we can no longer simply separate the modes as in (1) but rather we must write down a complete equation for the whole system, which then has a form like

$$\sum_j M_j\ddot{x}_j + \sum_j R_j\dot{x}_j + \sum_j K_j^0x_j + \sum_j K_j'(x_j, x_k, \ldots)\,x_j = 0 \qquad (3)$$

If the frequency of mode i is ω_i then (1) appears simply as the ω_i Fourier component of (3) when the nonlinear terms in K_i' are neglected. More generally, however, we must retain these terms and so arrive at an equation of the form

$$M_i \ddot{x}_i + R_i \dot{x}_i + K_i^0 x_i = F_i \ (x_j, x_k \ldots) \qquad (4)$$

where F_i is essentially the sum of those terms in $\Sigma K_j' x_j$ with frequencies close to ω_i. Any term in F_i with phase equal to that of x_i will simply modify the mode frequency ω_i while terms in F_i in quadrature with x_i will feed energy into or out of this i th mode. The first effect is important in understanding the pitch change behaviour of certain Chinese gongs, on which we have commented elsewhere,[4] while the second effect will concern us primarily here.

In the tamtam the initial strike with a large soft-headed mallet excites primarily the first mode of frequency ω_1 for which the mode shape x_1 (r) is close to $a_1 J_0(kr)$ where k is determined so that the Bessel function goes through its first zero near the edge of the gong. If we make the simplifying assumption that this is the only mode excited, then, by expanding $F(x_1)$ as a Taylor series without any explicit assumption about its form, and by noting that $\cos^n\theta$ has a leading term $\cos n\theta$, we see that the component in $F(x_1)$ with frequency $n\omega_1$ is proportional to $a_1{}^n$.

The normal modes of a tamtam are not harmonically related, but we can always define, for the i th mode, an integer n which is closest to the ratio ω_i/ω_1, and it is this n th component of $F(x_1)$ that is most important in driving x_i. (We return to more complicated possibilities later.) There will always be some fraction of this driving force in quadrature with x_i so that we can see immediately that the amplitude a_i of the i th mode grows like

$$da_i/dt = A_{1i}\, a_1{}^n \simeq A_{1i}\, a_1{}^{\omega_i/\omega_1} \qquad (5)$$

Here A_{1i}, to which we return presently, is a coupling coefficient between modes i and 1.

In the more general case in which several modes are excited by the initial strike we must consider them not only separately but also in interaction. Thus, if two modes ω_j and ω_k are excited with amplitudes a_j and a_k, we must consider all terms in $F(x_j,x_k)$ of the form $a_j^n a_k^m \cos(n\omega_j \pm m\omega_k)$ where $n\omega_j \pm m\omega_k \simeq \omega_i$.

Several such terms may combine to give a periodically-varying force amplitude near ω_i and a consequent complicated behaviour of a_i.

2.4 Time variation of the radiated spectrum

The lowest modes are probably damped largely by radiation, as we have said before. Their decay therefore follows a simple law like

$$a_1(t) = a_1(0)\ \exp\ (-t/\tau_1) \qquad (6)$$

The upper modes, in contrast, are pumped by the fundamental through the nonlinear coupling, the strength of which for an n th order coupling varies like $[a_1(t)]^n$. The i th mode has its own decay time τ_i, however and, if the pumping term were constant, its amplitude would grow like

$$a_1(t) = A_{1i} a_1{}^n \tau_i [1 - \exp\ (-t/\tau_i)] \qquad (7)$$

If it is being pumped by the n th harmonic of ω_1, however, its form should be like

$$a_i(t) = A_{1i} a_1{}^n \tau_i [1 - (n\tau_i/\tau_1)]^{-1} \times$$
$$[(\exp(-nt/\tau_1) - \exp(-t/\tau_i))] \qquad (8)$$

The behaviour suggested by (6) and (8) does seem to agree with experience.

2.5 Variation of radiated spectrum with strike force

The forms of (5) and (8) suggest a possibility for analysis of the radiated sound as a function of the force of the strike exciting the tamtam. Indeed, if τ_i and τ_1 remain unchanged by the force of the blow, which implies that the primary energy loss mechanisms for the fundamental mode remain radiation and internal losses rather than transfer to higher modes, we can conclude from (5) and (8) that

$$(a_i)_{max} \propto A_{1i}\, a_1{}^{\omega_i/\omega_1} \qquad (9)$$

This equation, however, ignores the fact that, in general, mode i will also be excited directly by the initial strike, in a manner which is linear and therefore exactly proportional to a_1. We therefore expect

$$(a_i)_{max} \propto B_i a_1 + A_{1i} a_1{}^{\omega_i/\omega_1} \qquad (10)$$

where B_i is another coupling coefficient. Such an equation is a worthwile basis for the analysis though it neglects the possibility of interactions in which two or more modes combine to excite x_i.

2.6 Coupling coefficients

The analysis above is quite general for any non-linear system and is specialized to the tamtam by defining on a physical basis the coupling coefficients A_i and B_i for the modes involved. In a plate with radial symmetry, like a cymbal, the normal modes are relatively simple in analytical form and can be written as

$$x_{nm} = R_{nm}(r)\ \cos m\theta \qquad (11)$$

It is then clear that an impact at the centre of the plate can excite only modes with circular symmetry $(m = 0)$ and also that these $m = 0$ modes can couple to other modes through the coefficients A_{ij} only if those other modes also have $m = 0$. If, however, the strike is at the edge, then modes with all m values are excited but again the A_{ij} are non-zero only for pairs of modes with the same m values.

The tamtam, however, does not have circular symmetry and the modes $x(r,\theta)$ cannot be written in separable form as in (11). This means that, in general, the initial excitation coefficients B_i and the coupling coefficients A_{jk} will be non-zero for all modes and pairs of modes. Considerations of symmetry and physical causes suggest, however, that for initial excitation at the centre, the B_i and A_{jk} will be large for all modes and pairs of modes having the same angular symmetry (or a multiple of it) as the tamtam itself. The B_i will, however, be generally large for modes resembling the $J_0(kr)$ modes of a flat circular plate and small for the modes resembling $J_n(kr) \cos n\theta$. Non-linearity in the nearly flat central part of the tamtam will give significant coupling between the J_0-like modes, while nonlinearity at the ring of bumps will couple the J_0 modes strongly to J_n-like modes with appropriate angular symmetry.

3. EXPERIMENTAL STUDIES

3.1 Description of the tamtam

The tamtam used in these experiments was 95.5 cm in diameter and approximately 2 mm thick, with a rim about 3 cm deep. Close to the rim is a circle of 101 hammered bumps, and less prominent bumps lie in circles roughly ½ and ¾ of the overall diameter. It was fabricated in Japan and is shown in Fig. 1.

3.2 Modes of vibration

A Bruel and Kjaer Type 8001 impedance head and Type 4810 vibration exciter were used to measure the mechanical admittance as a function of driving frequency. The driving point force was kept constant by use of a Gen Rad 1569 level controller, and the accelerometer output was amplified and integrated with a Bruel and Kjaer Type 2651 charge amplifier connected through the tracking filter of a Gen Rad 1900A analyzer to a Gen Rad 1521B chart recorder. Several driving points were used for each plate, including the center, near the edge, and at half the radius.

We attempted to determine the modal configuration for as many plate resonances as possible. Normally this was accomplished by moving a small microphone in the near field of the radiated sound. The plate-to-microphone spacing was kept as small as possible, and the nodal lines were mapped by noting the change in phase when a node was passed.

The principal modes excited with center drive had frequencies of 39, 162, 195, 318, 854, 979, and 1000 Hz. The lowest mode (39 Hz), which was the only one having complete axial symmetry, was about an octave below the corresponding fundamental mode in a large (36-inch diameter) Paiste tamtam previously studied.[5] The 318-Hz mode was nearly axially symmetric, having 3 concentric nodal circles but with two partial radial nodes near the outer edge.

With the drive point near the edge, the most prominent resonances occurred at 77, 148, 176, 199, 1000, 1223, and 1383 Hz. Mode shapes suggest standing flexural waves around the circumference. The frequences of these modes can be fitted to an empirical relationship $f = cm^k$ where m is the number of radial nodes, c = 29 Hz, and k = 1.17. This behaviour is somewhat similar to the modes of a large orchestral cymbal.[6]

3.3 Sound spectra

Peak sound spectra were determined by means of a Bruel and Kjaer Type 1623 filter set to a 23% (⅓-octave) bandwidth. The relative maximum sound pressure levels in several bands are given in Table 1. The tamtam was excited in three different ways: center strike with and without "priming" (i.e., with a soft roll before striking), and scraping on the edge with a wooden drum stick. The maximum sound levels occur in the bands centered at 1000, 2000 and 4000 Hz.

3.4 Determination of modal coupling

In order to attempt to determine some of the coupling coefficients in (3) and (4), the tamtam was driven in steady state at its center to a moderately large amplitude in one of its nearly axisymmetrical modes; the one selected was the one at 162 Hz. An accelerometer was attached to the tamtam at points lying near the edge, at half the radius, and at three quarters of the radius. Motion was detected at several frequencies including 252, 333, 490, 978 and 2890 Hz. The amplitude of the mode with f = 333 Hz was determined to be proportional to the square of the f = 162 Hz mode, which is fairly typical for a mode near the second harmonic of the driving force. No definite relationship could be established between the amplitudes of the other modes and that of the driving force due to our inability to drive the tamtam hard enough in the steady state.

Since the steady state experiment failed to establish a quantitative relationship between modes of low and high frequency, it was decided to use percussive excitation with a soft mallet instead. An accelerometer was attached to the tamtam at approximately half way between the center and edge, and a microphone was positioned about one meter distant. The outputs from the accelerometer and the microphone were recorded on two tracks of a tape loop, and the tamtam was struck near its center with blows of varying strength. The tapes were then played back through a tunable filter (Gen Rad 1900A) so that the vibration amplitude and sound radiation at various frequencies could be measured.

Fig. 2 shows the peak accelerometer voltage for vibrations at several frequencies vs that of the nearly axisymmetrical mode at 162 Hz. The accelerometer voltages can be divided by ω^2 and some constant scale factor to obtain the amplitudes in (10). Although the data points scatter considerably, it is possible to draw a family of curves having slopes of one for small amplitude, increasing in steepness at larger amplitude, as predicted by (10).

3.5 Sound buildup and decay

By coupling the filter output to a Gen Rad 1521B graphic level recorder, the sound buildup and decay times in various one-third octave bands could be recorded. Buildup and decay times (60 dB) are given in Table II. The maximum writing speed of the recorder is 200 dBs^{-1} which corresponds to a 0.3 s rise time for 60 dB. Hence buildup times below 0.4 s are not significant. Priming the tamtam before striking appears to lower the buildup times in the 4000, 8000, and (most likely) in the 16000 Hz bands, although the signal-to-noise ratio in the 16000 Hz band was most often insufficient to permit accurate measurements.

The buildup and decay of vibrations at various frequencies during the first 0.4 s is shown in Fig. 3. These waveforms were recorded with an accelerometer placed approximately half way between the center and edge.

Fig. 4 shows both the acceleration, as above, and the sound reaching a microphone about one meter from the tamtam. The slow buildup of the high-frequency modes is apparent in these figures.

4. DISCUSSION OF RESULTS

4.1 Modes of vibration and sound spectra

The tamtam has many modes of vibration. When it is excited near the edge, the modes appear to result from the excitation of standing flexural waves around the circumference. Excitation at the center emphasizes axisymmetric modes of low frequency which, however, couple to many other modes of higher frequency. Thus, when the tamtam is struck near the center with a hard blow, the initial sound spectrum is dominated by the low and middle-frequency bands. Modes of higher frequency build up in amplitude more slowly, so that a second or two after striking the sound spectrum is dominated by the bands centered around 1000 and 2000 Hz. The still-later developing modes of higher frequency contribute substantially to the timbre but not much to the total sound level.

Modes of high frequency not only build up more slowly but also decay more rapidly than modes of low frequency (see Table II). The persistence of the low-frequency modes, in fact, usually makes it necessary to damp the tamtam at the appropriate time after striking in a musical performance.

4.2 Modal coupling

We propose that the high-frequency modes are excited by two mechanisms: directly by the strike and indirectly by coupling to modes of lower frequency. It is very difficult to determine the respective coupling coefficients B_i and A_{li} in (10) by experiment, however.

When the tamtam is driven at 162 Hz (the frequency of a prominent axisymmetric mode) the amplitude of the nearly-harmonic mode at 333 Hz is observed to be nearly proportional to the square of the 162 Hz mode, which is consistent with (10). However, no definite relationship could be established between the amplitudes of the other modes.

When the tamtam is struck with a large mallet, a comparison of modal amplitudes shows fair resemblance to the behaviour predicted by (10). For soft to medium blows, the first term dominates, and the modal amplitudes increase in proportion to the amplitude of the axisymmetric mode at 162 Hz. The coefficient B_i decreases with frequency, and thus the curves of higher frequency are displaced downward in Fig. 2. For hard blows, the second term in (10) begins to take on increasing importance because of the exponent ω_i/ω_1 to which a_i is raised. This is demonstrated by the upward curvature in Fig. 2.

The variables in Fig. 2 are the peak voltages from the accelerometer attached to the tamtam after filtering through a narrow-band filter (10 Hz bandpass at 162 Hz, 50 Hz at other frequencies). No effort was made to determine actual modal amplitudes. If the axes in Fig. 2 were actual amplitudes, the vertical separation of the curves of different frequencies would be substantially greater, since the acceleration must be divided by ω^2 to obtain the amplitude. The shapes of the curves would remain as in Fig. 2, however.

The buildup and decay waveforms in Figs. 3 and 4 show considerable evidence of beats. These may be due, in part, to interference between two or more modes lying close together in frequency, but they are also suggestive of multiple or cascade excitation processes. During the transfer of energy from low-frequency modes to those of high frequency, modes of intermediate frequency would be expected to build up and decay intermittently, thus appearing as beats.

5. CONCLUSIONS

The distinctive timbre of a tamtam arises from the relatively slow buildup of modes of vibration having high frequencies. This slow buildup occurs because energy is fed to these modes from the modes of low frequency excited initially. The nature of the nonlinear coupling between modes is not well understood at present, but the large number of hammered bumps spaced around the tamtam appear to play a significant role in transferring energy from axisymmetric to radially symmetric and asymmetric modes. The harder the blow, the more significant the nonlinear coupling becomes.

ACKNOWLEDGEMENTS

We are grateful to the Department of Music for the loan of the tamtam and to Ron Silk for his assistance in the experimental studies. This research was supported by the National Science Foundation under the U.S.-Australia Cooperative Science Program and by the Australian Research Grants Committee.

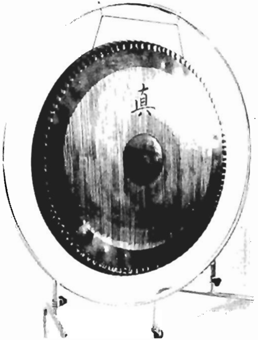

Fig. 1 The large tamtam used in these experiments.

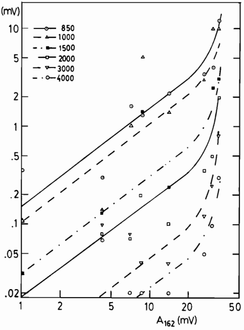

Fig. 2 Vibrational amplitudes, a_f, in six frequency bands as functions of the amplitude, a_{162}, of the axisymmetric mode at 162 Hz. The amplitudes given are the peak voltages recorded from an accelerometer attached to the tamtam. The bandwidth at 162 Hz was 10 Hz, and 50 Hz at all other frequencies.

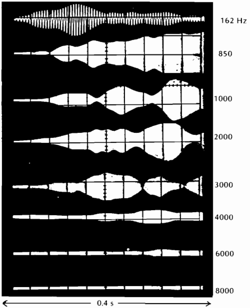

Fig. 3 Buildup and decay of vibrations in different frequency bands during the first 0.4 s.

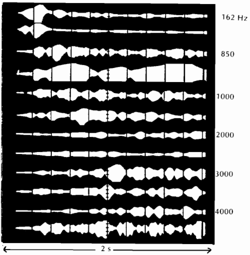

Fig. 4 Buildup and decay of radiated sound (upper curve at each frequency) and acceleration (lower curve at each frequency) in six different frequency bands.

Comparison of Sound Absorption in Rooms using an ILG Reference Sound Source and Reverberation Decay Methods

by

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This article is the result of research completed for the RMIT Applied Physics Industrial Elective PH979 at the CSIRO Division of Building Research, using the facilities of the Acoustics Group of the Division. The purpose of the research was to help provide data for the committee AK/4 of SAA.

The article compares the equivalent absorption area as found by two different methods, (1) by measuring the reverberation decay time of a room, and (2) by measuring the steady state sound level in a room due to a reference sound source. Only one sound source position was used in each of the 9 rooms measured.

The graphs compiled show that the Waterhouse corrected equivalent absorption area A_W (as found by method (2) above) is greater than the equivalent absorption area A_T (method (1)) in almost all cases. Also in the more reverberant rooms some frequency structure is seen.

1. INTRODUCTION: This work has been done for the RMIT Applied Physics Industrial Elective PH979. The topic of research was allotted by the CSIRO Acoustics Group of the Division of Building Research to help provide data for a working group of committee AK/4 of SAA.

The object of the research is to compare two different methods for determining the equivalent absorption area of a room. These methods are by the measurement of reverberation decay time and by a measurement of the steady state sound pressure level created in a room by an ILG reference sound source. ➧

TABLE I. Relative sound pressure levels in several ⅓-octave bands from a tamtam excited in different ways.

Excitation	125	250	500	1000	2000	4000	8000	16000	
	Band center frequency (Hz)								
Struck without priming	28	28	35	42	41	30	5	−3	dB
Struck after priming	25	28	35	40	45	31	10	0	dB
Scraped on rim	13	8	10	48	38	40	33	13	dB

Sound levels are the maximum levels in each band compared to arbitrary reference levels, which are the same for the first two excitations. Each level is the average of three or four measurements.

TABLE II. Buildup and decay times in several ⅓-octave bands for tamtam sound

	125	250	500	1000	2000	4000	8000	16000	
	Band center frequency (Hz)								
Buildup:									
Struck without priming	–	–	–	–	–	0.6	2.7	2.2	s
Struck after priming	–	–	–	–	–	–	2.2	?	s
Decay	12	14	18	11	7	5	6	?	s

Buildup times indicated by (–) are less than 0.4 s and thus are not accurately recorded by the level recorder.

Footnotes and references

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2. THE ROOMS

Measurements were taken in a total of 9 rooms, these have been divided into two groups.

The first group contains the 'Reverberant' rooms. These are the four reverberation rooms of the Acoustics Group of the CSIRO Division of Building Research.

The rooms are labelled, R, M-S, N and K. Room R is a 607 m^3, 5-sided room with a sloping roof. Room M-S is the sending and receiving rooms of the transmission chambers, without a partition, whose combined volume is 411 m^3. Room N is a 106 m^3, 5-sided room with a sloping floor and a level roof. Room K is a small 32 m^3, rectangular room with level floor and roof. All these rooms have some diffusers and smooth concrete surfaces.

The second group contains the 'Real' rooms. These have a reverberation time of approximately 0.5 seconds and unevenly distributed absorption. They represent rooms which would be realistically encountered by people every day, except for room LAB 2 which is more of a warehouse or factory room.

This group consists of the rooms Nabs, Kabs, LAB1, LOBBY and LAB2. Rooms Nabs and Kabs are the rooms N and K described above, but with enough absorbing material placed on their floors to cause them to have a reverberation time of approximately 0.5 seconds.

Room LAB2 is a large factory or warehouse type of room with a volume of 4502 m^3. Room LAB1 is an L-shaped laboratory room of volume 37.6 m^3. Room LOBBY is a small rectangular room of volume 34.8 m^3 between two other rooms. The last two rooms have windows in them.

3. METHOD

In the **first** method the equivalent absorption area was calculated by measuring the steady state sound pressure level in a room created by a reference ILG sound source. The reference sound source was first calibrated. The calibration was conducted in a semi-anechoic chamber above a reflecting steel floor. 20 microphone positions were used, as recommended by section 4.3 (a) at reference [3].

The sound power output of the ILG sound source was found using (see reference [1]).

$$L_W = \overline{L_p} + 10 \log_{10} (S_1/S_0) + C,$$

where

$$\overline{L_p} = 10 \log_{10} (1/N) \times \left[\sum_{i=1}^{N} 10^{0.1 L_{p_i}} \right]$$

$S_1 = 2\pi r^2$ area of test hemisphere,

$S_0 = 1\ m^2$

$C = -10 \log_{10} [Z_c/400]$.

For the conditions under which the measurements were performed it was found that C was approximately 0.1 dB and could be ignored. We used a test hemisphere of radius 1.3 m. Thus $10 \log_{10} [S_1/S_0] = 10.26$ dB.

In each room the reference sound source was placed at only one position, not too close to the walls and in a position without obvious symmetry with the walls. The microphone was mounted on a B and K rotating microphone boom and this was set orbiting with a period of 32 seconds with a radius from 0.9 m to 2.15 m to suit the room. The placement of the sound source and microphone boom depended on the room size and configuration. At least three, 32 second integrations of sound pressure squared were used to determine L_p for each room. This was done for third octave frequencies from 100 Hz to 5 kHz.

In calculating equivalent absorption area we used a relationship which can be derived by considering the energy density E in a diffuse sound field created by a source of power W (see reference [4]).

$$E = 4W/Ac,$$

$$\overline{p^2}/\rho c^2 = 4W/Ac,$$

and

$$A = 4W\, \rho c/\overline{p^2}.$$

Since

$$W_0 = 1\ \text{pW}$$

and

$$p_0 = 20\ \mu\text{Pa},$$

$$A = 4\, \rho c\, (W/W_0) \times 10^{-12} \times (p_0^2/\overline{p^2}) \times 1/4 \times 10^{10}.$$

Thus

$$10 \log_{10} A = 10 \log_{10} (W/W_0) - 10 \log_{10} (\overline{p^2}/p_0^2). + 10 \log_{10} (\rho c/100).$$

For $\rho c \simeq 400$ Rayls,

$$10 \log_{10} (4) \simeq 6.$$

Thus

$$10 \log_{10} A = L_W - L_p + 6,$$

and

$$A = 10^{0.1} (L_W - L_p + 6).$$

The L_p values can be corrected to allow for higher sound pressures close to the boundaries of the room. This correction is called the Waterhouse correction.

From section 8.22 of reference [2] the correction is:
$10 \log_{10} (1 + S\lambda/8V)$,
which is equivalent to
$10 \log_{10} (1 + Sc/8Vf)$,
where

S = total surface area of room in m^2,
V = volume of room in m^3,
f = center frequency of octave or third octave band,
c = speed of sound in m/sec.

This correction was incorporated into the determination of equivalent absorption area A (now denoted by A_W) by adding it to L_p in each third octave band.

The **second** method of determining the equivalent absorption area A that we used, is by measuring the reverberation decay time of a room and then using Sabine's formula. The equivalent absorption as determined this way was called A_T.

4. RESULTS

It is convenient to present the results of the comparison of A_W to A_T in decibel form, that is $10 \log_{10} (A_W/A_T)$, and this is shown for the 'Reverberant' and 'Real' rooms in Fig. 1 and 2 respectively.

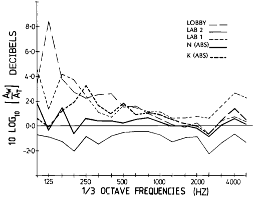

Fig. 1 Relative equivalent absorption areas (decibel units) as a function of frequency for the 'reverberant' rooms. A_W is the equivalent absorption area as measured by the first method. A_T is the equivalent absorption area measured by the second (Sabine) method.

5. DISCUSSION AND CONCLUSION

In both Fig. 1 and Fig. 2 we can see that there is a definite overall trend of A_W to overestimate A_T except in room LAB2 where this trend is negative. We are unable to explain this negative trend as experimental error.

In Fig. 1 the curves much more closely approximated 0.0 than in Fig. 2. This could be expected since Fig. 1 represents the 'Reverberant' rooms.

In Fig. 1 all the curves appear to follow the same frequency structure, having large variations at low frequencies, then curving above the 0.0 line to peak near 400 Hz and back to the line 0.0 at higher frequencies around 1.25 kHz where they oscillate about this line until around 3.0 kHz they again rise above the 0.0 line. In Fig. 2 it is not clear that the curves follow this frequency structure because the larger variations at low frequencies extend to higher frequencies than before. However it can be seen that there is a comparable high frequency structure present.

The results for N and K do not differ significantly from those of Nabs and Kabs. Perhaps this is because even though Nabs and Kabs contained a large amount of absorbing material it was placed on the floor and the rooms contained suspended diffusers.

All the results gathered have simulated a 'worst case' because we have only used one sound source position.

It is necessary here to note that measurements in the LOBBY were conducted under adverse weather conditions with intermittent bursts of high background noise from rain.

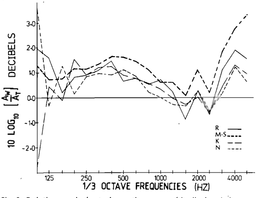

Fig. 2 Relative equivalent absorption areas (decibel units) as a function of frequency for the 'real' rooms.

ACKNOWLEDGEMENT

I wish to thank Paul Dubout and John Davy for their help and guidance during the time I was at the CSIRO Division of Building Research. I would also like to thank the Acoustics Group of the CSIRO Division of Building Research for allowing me to undertake the industrial elective at their laboratories.

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New Facilities for Acoustic Research at NAL/UI

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A new laboratory complex is under construction at Chatswood N.S.W. for the National Acoustic Laboratories (NAL) and the Ultrasonics Institute (UI).

After providing a brief background of the above organisations and the scope of their work the specialised acoustical facilities incorporated in the building are described in greater detail.

1. INTRODUCTION: The National Acoustic Laboratories and the Ultrasonics Institute were formerly part of the Commonwealth Acoustic Laboratories, which were set up to conduct research into hearing aids and the effects of noise on individuals.

The Ultrasonics Institute concentrates its efforts on the medical applications of ultra-sound while NAL researches the characteristics of hearing, including defective hearing, the effects of noise, rehabilitation of the deaf, hearing protective devices as well as the generation, propagation, reduction and measurement of sound.

The facilities to be built into the new complex reflect the scope of this research and may be regarded as those needed to cover the range of human hearing from infrasound to ultrasound and levels ranging from the threshold of hearing to upper limits of tolerance.

The facilities required for the Ultrasonics Institute are limited not by acoustic but by technical requirements. These include specialised clean-room facilities for transducer and integrated circuit fabrication, an animal house for biological research and patient examination facilities for clinical evaluation.

NAL also operates an audiological and hearing aid service to sectors of the Australian population and an advisory service to the other govérnmental authorities in relation to noise problems.

This association of research, development and service is relatively rare but a major factor in determining the kind of facilities incorporated in the building.

2. SITE SELECTION

Because much of the research to be conducted within the building requires very low background noise levels it was decided that the most economical way of achieving this was to start with a very quiet site.

Criteria laid down specified that it should be large enough to permit a buffer zone between the building and its neighbours, preferably surrounded by reserves or waterways, be outside the 30 NEF zone of aircraft noise, isolated from heavy industry and be within an already established area with no major new development planned in the vicinity. Another important factor limiting the selection was that the site preferably be on an earthy slope so that the most critical facilities could be built into the hill using it for shielding. At the same time, gravity drainage is enabled, thereby ensuring use of the complex unrestricted by the noise of sump-pumps which severely limits the usefulness of many similar test rooms overseas.

The main requirement was to avoid ground-borne vibration since the noise generated within test rooms from this source was a major limiting factor in many of the facilities investigated during the planning phase.

Further criteria related to the need for proximity to associated research organisations and for reasonable access by test subjects.

A total of twenty sites in the Sydney area were investigated, the final choice being a rocky hillside in Chatswood. It had the lowest ambient noise level over the normal working period (L_{50} 42.5 dBA) and also low ground vibration levels (total r.m.s. velocity below 10^{-6} metres per second).

3. FACILITIES FOR ULTRASONIC MEDICAL RESEARCH

Ultrasonic sound as applied in medicine is propagated entirely in liquids and soft tissues, rather than in air. Therefore no specialised acoustic rooms are required. Acoustic experiments are carried out in large tanks located in rooms with low floor vibration. The specialised facilities in the building allow work associated with ultrasound research to proceed which is not possible in the present quarters. The new building has a properly designed animal house to permit studies of the effect of ultrasound on tissue. Although diagnostic ultrasound is considered to be safe with the techniques at present in use, the margin of safety is not known. Newly developed techniques are tending to use ultrasonic irradiation pulses which may reduce this margin. Knowledge of quantitative data in this area will allow optimum diagnostic data to be obtained while retaining adequate safety.

Another area of specialised facilities is in transducer fabrication. New developments in transducers require clean rooms to ensure lack of contamination which could reduce reliability, and increasingly integrated circuit technology is being combined with transducer technology to provide array structures for new generation equipment.

The remainder of the Ultrasonic wing provides accommodation with less specialised requirements. Apart from more suitable office and laboratory accommodation for staff and visiting Scientists and Medical Consultants, specific arrangements have been made for a number of existing activities. These include photographic processing, audio-visual production and research interpretation, computer data processing, ultrasonic scanning and clinical examination.

4. ACOUSTIC AND AUDIOLOGICAL RESEARCH FACILITIES

Details of the various facilities needed to undertake NAL research are given below.

Since many of the facilities share a requirement for very low levels of vibration and background noise it was decided to enclose these within a structure referred to as a "sound-shell".

All hydraulic services and mechanical plant were removed from this area and the sound-shell, as a whole, isolated structurally from the remainder of the building.

Those services which must be brought into the sound-shell are provided through flexible connections to reduce structure-borne noise from equipment located in remote areas of the building.

Reduction of airborne sound was achieved by using multiple barriers, i.e. heavy concrete walls, or a series of rooms and hallways and, on the roof of the sound-shell, concrete plus soil in which plants could be grown. The idea of sinking the structure into the hillside and covering the roof with vegetation was to combine aesthetic aspects with functional efficiency.

The special audiological test rooms are not within the sound-shell and for obvious reasons the two high-intensity noise rooms (Animal and Human) are also external to it.

5. ANECHOIC CHAMBERS

There will be four anechoic chambers, classified as one large room, two medium rooms and one small room. In each case, the dimensions of the rooms have been chosen so that the clear working space within the room, on each axis, is not less than one wavelength at the room's specified cut-off frequency.

The internal dimensions of the large room will be 14 metres long by 12 metres wide by 10 metres high. The cut-off frequency is to be 50 Hz. The room is to be used for both subjective and objective testing. Objective tests will include measurement of polar patterns of transducers and noise-producing equipment, calibration of sound measurement equipment and modelling investigations.

The internal dimensions of the two medium anechoic rooms will be 7.72 metres long by 5.57 metres wide by 6.17 metres high. Cut-off frequency of both rooms will be 90 Hz. One room is to be used for subjective tests, and the other for testing and calibration of sound measurement instruments.

The small anechoic chamber will have internal dimensions of 3.4 metres long by 3 metres wide by 3.6 metres high. The cut-off frequency will be 180 Hz. The room will be used mainly for testing of hearing aids. The room is to be screened to protect it from radio-frequency interference.

Two distinct criteria for maximum background noise levels were set for each of the anechoic chambers. For normal testing, air-conditioning of the rooms is permissible, and the maximum specified background level of noise is NR10. For critical tests, such as measurement of hearing thresholds, the air-conditioning will be turned off and the maximum permissible background levels for the large and medium anechoic rooms are then to be approximately 20dB below the Minimum Audible Field: this margin is considered necessary so that ambient noise does not mask test signals during threshold tests. In the small anechoic room, maximum background sound level, with air-conditioning off, is not to exceed NR0.

The rooms are to be resiliently mounted, with mounts chosen so that transmissibility at all frequencies from 10 Hz upwards is less than unity.

The rooms are to be lined with sound absorbent material. The material and its configuration will be selected so that at all frequencies above the cut-off frequency the sound absorption co-efficient exceeds 0.99.

To minimise sound reflections, all rooms are to be fitted with tensioned, wire-mesh floors. However, in the large room, provision is also to be made to install, when required, a rigid reflective floor so that the chamber may be used for testing in a free-field above a reflecting plane.

6. REVERBERATION ROOMS

Two reverberation rooms are to be provided. The volume of each room is nominally 200 cubic metres. To enhance sound diffusion, the boundary surfaces of each room are non-parallel.

The adjacent walls of the two rooms and a third wall between the rooms, which is not structurally connected to either room, are penetrated by a 10 square metre aperture for use in sound transmission loss tests. This aperture will be sealed by rigid heavy doors in each reverberation room when not required.

In addition to being suitable for transmission loss tests, the rooms can be used for measurement of sound power levels of machinery and measurement of sound absorption co-efficients. However their main useage will be for subjective testing of communication in noise and tests involved with the development of hearing protection and noise measurement systems.

The maximum levels of background noise permissible in the rooms are the same as those for the large and medium anechoic rooms. The reverberation rooms are to be fitted with resilient suspensions also, as for the anechoic rooms.

Since it is anticipated that some of the machinery tested will include air-cooled internal combustion engines, of capacity up to about one litre, the air-conditioning supply to one room will be somewhat larger and require more silencing treatment than that to the other room.

One room will also be fitted with a total of 10 square metres of porous sound absorbent material, behind heavy hinged panels. The material can be uncovered, as required in particular experiments, to vary the reverberation time of the room.

7. PLANE-WAVE TUBES

Three plane-wave tubes, of differing sizes, will be available. All tubes will be of square cross-section. The two smaller tubes will be used for measurements of sound absorption co-efficients of acoustic materials, and will be 600 mm square and 300 mm square respectively. Both tubes are to be 12 metres in length. The useful frequency ranges for the two tubes will be from 25 Hz to 280 Hz for the 600 mm size tube, and from 25 Hz to 560 Hz for the smaller tube. For these tubes, the maximum level of background noise within the tubes should be NR10.

The largest of the three tubes will have internal dimensions of 2 metres square by 24.5 metres long. Its primary use will be for subjective testing over the frequency range from about 15 Hz to 50 Hz, where the frequency ranges of the plane-wave tube and the large anechoic room overlap. It will also be used for testing and calibration at low frequencies of microphones and sound level meters. The tube will be fitted with a termination which is anechoic for frequencies above 15 Hz.

In this tube, maximum permissible levels of background noise have been specified such that over the frequency range for which the tube is designed, the levels are substantially below the Minimum Audible Field.

8. LARGE QUIET ROOM

A large quiet room is to be provided, of dimensions 10 metres x 6 metres x 2.6 metres. This room will be used for testing involving simulated domestic or classroom environments. Such tests may involve erection of demountable partitions within the room to better simulate domestic-sized spaces. Maximum background noise levels in the room with air-conditioning on are not to exceed NR10, but over the speech frequency range (500 Hz to 4 kHz) the background level is not to exceed NR0. The reverberation time is to be less than 0.5 seconds for the frequency range from 125 Hz to 4 kHz.

9. CONTROL ROOMS

Associated with each test facility will be a control room, generally of an area about 12 square metres. The control rooms will include equipment benches and provision for connection of signal cabling, intercom and closed-circuit television to the corresponding test rooms.

The large anechoic rooms has dual control rooms to enable setting-up of a new experiment while another is in progress. Experience has shown that for large rooms the effective usage rate of the facility can be raised substantially by this means.

10. MAIN PREPARATION AREA

The central area of the sound-shell will be used as the main preparation area, being an open space from which access to all test rooms and control rooms is gained. The plane wave tubes will run horizontally along one side of this space. The area will be acoustically treated to keep the reverberation time low and the floor will be carpeted to reduce impact noise, both airborne and structure-borne.

11. HIGH-INTENSITY NOISE ROOMS

Two high-intensity noise rooms are to be constructed external to the sound-shell. The dimensions of the rooms will be 6 metres long x 5 metres wide x 3 metres high. The rooms are intended for exposure of human or animal subjects to noise for extended periods of time. To ensure, as far as possible, that the noise exposures are due only to the intended signals and not to extraneous noise, the maximum level of background, with air-conditioning on, is not to exceed NR10.

The rooms will be independently vibration-isolated, with suspensions chosen to provide a transmissibility of less than unity at all frequencies from 10 Hz upwards.

12. AUDIOLOGICAL TEST ROOMS

The size, shape and acoustical characteristics of the eleven audiological test rooms is determined by the special requirements of the research sections to which they are allocated. There are associated control rooms where experimental equipment can be set up on a more or less permanent basis.

Three of the rooms contain commercial audiometric booths within conventionally constructed partitioning while the remainder are of custom built, double-wall construction.

The rooms will be used for research into audiology, neuro-audiology, psycho-acoustics and hearing-aids.

One medium-sized room will be shielded to reduce the effects of stray electro-magnetic fields.

Since much of this research is aimed at development of systems which can be later applied in the field, i.e. hospitals, clinics or other situations where conditions are not ideal, these facilities are not designed to have highly advanced performance characteristics. However for areas of research which need these features the acoustical facilities described earlier may be used.

13. CONCLUSION

The new NAL/UI laboratory building at Chatswood will contain a concentration of acoustic facilities which will be unique in Australia, and possibly the world. Their construction will enable the range of acoustic research possible in Australia to be extended significantly.

REPORTS
1. Technical
1.1 Current Acoustical Activities at the RAN Research Laboratory, Rushcutters Bay, Sydney

Ocean Sciences Group activities

SEAMAP *RANRL* is undertaking a number of cruises along legs from major Australian ports to such places as Samoa (in the mid Pacific Ocean) and Kerguelen Islands (in the southern Indian Ocean). Various acoustic measurements will be made throughout these legs, as well as associated physical and biological measurements. These cruises will be made using the R.A.N.'s new oceanographic ship, *HMAS COOK.* Two **SEAMAP** cruises are scheduled each year, one in summer and one in winter, for the next five years. These cruises are designed to give values for various ocean acoustic properties along these tracks. The properties to be measured include many that **RAN RL** has been measuring in other investigations in the past, as well as including some new to **RANRL.**

Acoustic Modelling

RANRL uses a number of models of acoustic propagation which have been implemented on digital computers. For different situations models are used which are based on ray theory, normal mode theory and the parabolic approximation to the wave equation. Each type of model has its strengths and weaknesses. Propagation modelling performed at RANRL has investigated among other things:

(i) the effect of surface roughness,
(ii) the effect of ocean fronts and eddies,
(iii) propagation in the surface duct (formed by a layer of isothermal water).

Sonar and Surveillance Group activities

The factors influencing sound propagation in the first few metres below the sea surface are being studied in the frequency range 10-20 kHz.

Testing and calibration of hydrophones and transducers, together with related matters (e.g. the absorption of baffles), is being carried out on a regular basis. New techniques for hydrophone calibration are being evolved.

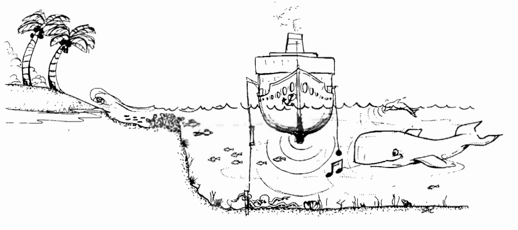
The ability of submarines to estimate target parameters through the medium of received sonar signals is being studied.

Volume reverberation

When a sound is made in the ocean, energy returns to the vicinity of the source due to reflection from the sea floor, the sea surface, and from various inhomogeneities within the sea. The latter is called volume reverberation. **RANRL** has made experimental measurements of this effect in different oceans, seasons and times of day. Integrated scattering strengths over hemispheres of defined radius are determined for various third octave frequency bands. These show strong diurnal variations, which are explained by attributing the bulk of volume scattering to reflections from fish, many of which vary their depth in the water on a daily cycle. Some fish have gas filled swimbladders which resonate with acoustic energy of a particular frequency. Marshall Hall has worked on the problem of relating fish density and characteristics to the observed volume scattering results. Mid-water net hauls are used to obtain fish samples.

Sea Noise

The various noises in the sea are being investigated by Doug Cato. Measurements have been made in many geographic locations around Australia. The observed noises are mainly caused by marine life, by wind and rain at the sea surface and by distant shipping. Various marine organisms, including snapping shrimp and whales, have been identified as the sources of some of the observed sounds; some others are still unidentified. Because of the relatively low shipping density in the southern hemisphere, the noise due to distant shipping (which is low frequency) is lower around Australia than in most waters that have been investiga-



ted. A new theory is being developed which relates wind generated noise levels to the wind strength (or wave height) and experiments are being carried out at Pittwater and Woronora Dam (both in Sydney) to provide the required experimental data to test the theory's predictions.

Bottom Interaction

An investigation has begun of the effect of the sea bottom on acoustic propagation in deep water. Martin Lawrence is to carry out sea experiments using *HMAS Cook.* Wide angle reflection measurements will be made using explosive charges as wideband acoustic sources. In one configuration of the experiment the charges are dropped from an aircraft at various ranges, while a hydrophone is deployed from *COOK.* Various geophysical and oceanographic measurements are made at the experiment site, in order to attempt understanding of the acoustic results. Oceanographic measurements are required in order to determine the acoustic propagation path through the water; geophysical measurements are required to determine the properties beneath the water-sediment interface. The acoustic energy enters into the sediments and is refracted upwards back into the water column, as well as being reflected at interfaces. Geophysical measurements which provide useful information include seismic profiling, taking and measurement of sediment cores, measurement of detailed bathymetry (using *HMAS COOK's* narrow beam echo sounder, which provides a contour map of the water-sediment interface).

1.2 Microphone "Round Robin"

N.A.T.A. registered laboratories in New South Wales and Victoria will be aware of the recently completed "Round Robin" in which two 1-inch B & K microphones and a pistonphone were circulated to assess the consistency of sound pressure measurement amongst the participating labs. Under the auspices of the Asia-Pacific Metrology programme the exercise is now being attempted internationally, with India, China, Indonesia and New Zealand taking part and Australia acting as the co-ordinating laboratory.

As may be imagined, the hazards and communication difficulties experienced in Australia are magnified many-fold on the international scene. On returning to Sydney after the first leg of its travels the diaphragm of one microphone was found to be torn, apparently during inspection by someone unaware of the fragility of such things. The pistonpone was also found not to be working, but this was a temporary state only. When the 6 alkaline cells were tested, one registered +.8 volts; the second +.6 volts; the remaining four averaged − 50 millivolts! The pistonphone switch was off.

1.3 NML Sound Calibrator

A useful sound calibrator has been developed at N.M.L. A Philips "dome tweeter" is fitted to one end of a cavity of about the dimensions of the I.E.C. 3 cc reciprocity coupler, the tweeter being energised from a B & K Heterodyne Analyser type 2010 with a compressor facility. The compressor drive voltage is obtained from a Knowles hearing-aid microphone which is built into the coupler wall and monitors the sound pressure in the cavity through a 2 mm hole.

If some care is taken with frequency equalisation, the h.a. microphone – compressor system will maintain the cavity sound pressure within ±0.5 dB over the frequency range 31.5 Hz to 4 kHz when the other end of the coupler is closed by the microphone under test.

By varying the compressor-loop gain the sound pressure may be raised or lowered. It will reach 124 dB at 1 kHz or below and 120 db over the full frequency range. The virtue of the monitored calibration is that is output, unlike that of the usual sound calibrator, is not sensitive to the volume of the unknown microphone, and widely varying microphones may be compared with reference microphones using this independence.

1.4 Acoustics and Proof Testing

by M. Arrington
(By courtesy of Acoustic Emission Trends)

Background

In many industries the design of a new component or the quality of a production item or structure is assessed by the imposition of a proof load. The successful application of such a loading perhaps to 20 percent or 50 percent above the working load both validates the design and confirms that the construction has been carried out completely. With some additional stress and fracture mechanics analysis, this proof loading approach can be extended to provide an estimate of safe life.

The Role of inspection

If a structure survives a proof load we can estimate the safe life in service before retesting is required. This assumes that the only deterioration is the result of fatigue under the known working conditions. Any additional deterioration such as corrosion or stress corrosion cracking requires additional safety factors to be incorporated.

What are the roles of NDT and Acoustic Emission in this situation? Obviously one wants the structure to survive the proof loading in order to be accepted for service. To this end, ultrasonic and X-ray techniques are often used to find and size the defects before proof testing. Both these inspection methods have inspection efficiences that fall off for small defects.

The difficulties of this approach are twofold:–

(a) The imposition of the proof load may itself cause defects to extend.
(b) Small cracks in highly stressed regions may be difficult to detect by ultrasonics and X-rays, especially if the geometry is complex.

Here, AE can make a significant contribution:

(I) AE gives a measure of the overall damage incurred.

(II) AE activity is a function both of crack size and local stress. Thus the AE indications are dependent on crack severity rather than just crack size.

(III) In newer materials such as composites there is not the same experience of design, production and use as there is for metals such as steel. This results in the requirement for higher safety factors in these materials until more experience is gained in their use. Improved inspection methods such as acoustic emission should be able to speed the reduction of these excess safety factors.

Some illustrations of the application of AE to proof testing

A large proportion of AE testing is used to monitor proof tests of both metallic and composite pressure vessels.

Perhaps the most famous example of the value of acoustic emission monitoring was the Polaris rocket motor case. These were GRP vessels with a 1 cycle fatigue life. They could be tested or used but not both, because the pressure test to working load caused so much damage. With AE it was possible to grade the vessels on a pressure test to some 60 percent of working load. Assuming a K^4 damage dependence, AE testing reduced the damage incurred by an order of magnitude and allowed good components to be selected and used.

We have done similar work on glass bottles used for carbonated beverages. Preliminary pressure proof testing showed no improvement in product quality because the bottles that survived one test could fail the second due to subcritical crack growth. With AE monitoring, however, it was possible to identify the bottles damaged on proof loading. Rejection of these bottles made a significant improvement in the failure strength distribution.

For example, when several identical vessels are being used in slightly varying environments we can select the best vessel for the most severe environment.

In some cases it is difficult to determine the proof test conditions required and some of the load limits may be set rather arbitrarily. In these circumstances, if the proof load is too high, even good specimens may be damaged by the proof testing procedure. Electrical connectors made from friction welded aluminium plate and copper bar are good examples of this. All connectors are proof loaded to check for brittle intermetallic layer that may form if the weld conditions are not exactly right at the aluminium-copper interface. For one particular item the proof load was 4½ KW. Using AE on this problem had two benefits:–

(i) It provided improved resolution of the brittle interfaces.

(ii) It showed that the 4½KW level was too high and that the good specimens were being damaged.

Stability during extended proof tests

In most cases the proof load is applied for a relatively short period and then released. In certain circumstances the load may be held for a longer period of time, as in the pre-yielding of a gas distribution line. A string of pipes are welded together and pressurized into the work hardening region. After 24 hours at pressure they are depressurized and cut up into sections. These sections are used in parts of the pipeline where especially good quality is required (for example, at road and railway crossings or for underwater sections).

This 24-hour test is the result of both metallurgical and practical experience. The fall-off of AE activity confirms the validity of the 24-hour test. If we saw no stabilization within the 24 hours this would indicate that the pipe was suffering from excessive creep. This slow decay of emission activity has also been observed in nonmetallic components such as concrete beams that will also 'talk' for many hours after the application of a proof load.

Proof testing has developed as a practical approach to safety.The incorporation of acoustic emission monitoring provides the bonus of additional information on product quality. No vessel is defect free; passing the proof test only screens out those with excessively large defects. With AE we can grade the survivors.

1.5 Non-returnable echoes

Controlling noise at its source is not feasible with many industrial processes.

However, the transmission of sound inside a plant building can be modified by lining the ceiling or walls with sound absorbent materials, This greatly reduces the amount of reflected sound, or "echo".

A recent project undertaken at the Engineering and Water Supply Department's Central Workshop in South Australia showed the effectiveness of this approach.

Approximately 2300 square metres of treatment was fixed to the underside of the roof and upper wall surfaces. As a result, reverberation times inside the building were significantly reduced by e.g. from approximately 9 seconds to 2.2 seconds at 125 Hz, and 3.5 seconds to 1.4 seconds at 4000 Hz.

The acoustic treatment had to be carefully designed to meet strict criteria: Weight was limited to 10kg per square metre.

Average absorption co-efficient of at least 0.6, from 125 to 4000 Hz.

Materials to be resistant to mechanical damage, welding fumes and moisture. A demountable system was specified.

The acoustic treatment consisted of Siddons Rockwool insulation wrapped in black polythene bags inside perforated galvabond trays, approximately 1 m by 2 m in size. The trays were supported on metal lugs, fixed by Ramset pins to the roof purlins.

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2. Standards

2.1 ASA publishes new bone vibrator standard

A new American National Standard, ANSI S3.26-1981, has been approved and published by the Society. ANSI S3.26-1981, American National Standard Reference Equivalent Threshold Force Levels for Audiometric Bone Vibrators, specifies reference equivalent threshold force levels for a combination of an artificial mastoid and a bone vibrator. The threshold force levels correspond to thresholds for normal hearing persons by air conduction as specified in ANSI S3.6-1969. Certain basic characteristics of bone vibrators and artificial mastoids to be used in audiometry are specified. Masking requirements are specified for the nontest ear. Appendices provide preferred mechanical impedance values for an artificial headbone, illustrate the construction of an artifial mastoid and bone vibrator, describe the preferred calibration apparatus, and point out a potential problem cause by radiated air-conducted sound from the bone vibrator.

The new standard is available from the Acoustical Society of America. Contact the Back Numbers Department, Dept. STD, American Institute of Physics, 335 E. 45th Street, New York, NY 10017. ANSI S3.26 (ASA Catalog No. 41-1981) is $15.00. Orders not accompanied by payment will be billed for a $2.00 handling charge.

2.2 New international hearing aid agreement is published

Just published by the IEC is a new international agreement that will prove of considerable interest to manufacturers and users of hearing aids. It standardizes methods of measurement of electro-acoustical characteristics of hearing aids. Designated IEC Publication 118-4, the agreement is specifically concerned with the magnetic field strength in audio-frequency induction loops for hearing aid purposes.

IEC Publication 118-4 gives recommendations for audio-frequency loop systems producing an alternating magnetic field and intended to provide an input signal for hearing aids operating with an induction pick-up coil.

Publication 118-4, Methods of measurement of electro-acoustical characteristics of hearing aids. Part 4: Magnetic field strength in audio-frequency induction loops for hearing aid purposes, is avalaible for SFr. 15.–. For more information contact the IEC, 1, rue de Varembe, 1211 Geneva 20, Switzerland.

2.3 New American National Standards

Precision Methods for the Determination of Sound Power Levels of Broad-Band Noise Sources in Reververation Rooms

(Counterpart to ISO 3741-1975)
S1.31-1980 (ASA Catalog No. 11)

This standard describes precision methods for determination of sound power levels of broad-band noise sources in reverberation rooms. The standard contains information on instrumentation, installation and operation of the source, procedures for determining the number of source locations and of microphone positions, methods for determination of average sound pressure level in the room, procedures for the calculation of sound power level, and procedures to qualify the test facility. *(US$27 each, shipped postpaid)*

SINGAPORE 1-3 SEPTEMBER 1982

Precision Method for the Determination of Sound Power Levels of Discrete-Frequency and Narrow-Band Noise Sources in Reverberation Rooms

(Counterpart to ISO 3742-1975) S1.32-1980 (ASA Catalog No. 12)

This standard specifies the additional requirements, above and beyond those of ANSI S1.31-1980, for the precision methods for determination of sound power levels of discrete-frequency and narrow-band components, for determining the required number of microphone positions and source locations, and for carrying out an alternative procedure for qualification of a given facility and test procedure. *(US$20)*

Procedure for the Computation of Loudness of Noise

S3.4-1980 (ASA Catalog No. 37)

This standard specifies a procedure for calculating the loudness of certain classes of noise. In applications of the procedure, it is assumed that the spectrum of sound has been measured in terms of sound pressure levels in ⅓-octave or 1/1-octave bands in either a diffuse or free field. The procedure is derived from three empirical relations: (1) A set of equal-loudness contours for bands of noise in a diffuse sound field. (2) A rule relating the total loudness of a sound to the loudness indexes of the frequency bands composing it. (3) A loudness function relating loudness in sones to loudness level in phons. This relation is such that loudness is a simple power function of sound pressure at 1000 hertz. *(US$20)*

Acoustical standards published by ASA are offered at a **20%** *discount to individual members of the Acoustical Society on single-copy orders with prepayment only.*

Order from: Back Numbers Department, American Institute of Physics, 335 East 45th Street, New York, New York 10017, Telephone; (516) 349-7800.

3. Theses

Following are summaries of recent successful theses and graduate projects submitted to Australian universities.

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C. H. Lim
PhD., University of Sydney

Some Aspects of Acoustical Privacy in Buildings

Summary

Effective design of sound isolation in buildings requires an understanding of the complex noise propagation behaviour in buildings. It also requires a simple method of assessing sound isolation in dwellings and information on how people react to noise coming from other parts of and outside of the buildings. At present, no simplified method for measuring sound insulation for building acceptance tests nor information on people's response on noise coming from either other parts of the buildings or outside of the buildings have been made available.

The present work involves:

i) development of a simplified method of testing sound isolation in buildings;
ii) obtaining information on how people react to noise coming from other parts of the buildings; and
iii) obtaining information on intersensory effects; i.e. the effect of the visual field on aural response to noise.

The results show acoustical privacy in buildings can only be obtained by a combination of technical know-how and an understanding of the response of occupants to noise, in their environment.

The regulations controlling acoustical requirements in buildings have been critically examined in the light of this work.

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E. Kruzins
M.Sc. (Arch), Unversity of Sydney

The Prediction of Sound Fields in Non-Diffuse Spaces

Summary

A Markov process, based upon the random walk of phonons, is applied in a statistical geometrical method to predict the high frequency sound pressure levels in internally complex spaces, excited by an omni-directional point source.

A theoretical solution is derived and experimentally verified.

The solution, which is extendable to any number, shape or directionality of sources, considers random incidence absorption and radiation from diffuse walls, as well as attenuation due to air.

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Sirisena Gunawardena
M.Arch., 1979, U. NSW

Sound-Absorbent Materials: Some solutions to environmental and maintenance problems encountered in building applications.

Summary

The most prevalent types of environments which may exist in modern buildings are investigated, and the environmental and maintenance problems encountered by common sound-absorbent materials in these environments are identified.

The physical properties of typical sound-absorbent materials are investigated to predict the behaviour of these materials as well as the behaviour of sound-absorbent systems based on these typical materials. Knowing these properties, materials which should behave favourably in various environments are then selected. Methods of improving various physical characteristics of certain absorbent materials are also examined in order to modify their behaviour.

Sound-absorbent systems are designed to suit various environments using these selected materials, giving special consideration to the type of absorption (low, medium or high frequency absorption) required in the particular environment.

As many sound-absorbent systems are not efficient sound absorbers, although they possess the basic absorption properties, their absorption properties have to be optimized. The techniques of optimization of absorption properties of sound-absorbent systems by trial and error using the reverberation room method, or with impedance charts using the impedance tube method are then investigated, and the advantages and disadvantages of these two techniques evaluated.

Although the impedance tube techniques cannot be used for most of the resonating absorbent systems and only a limited range of mounting systems can be simulated, the method is well known as a reproducible and economical technique of measuring absorption of porous materials and perforated panels backed by porous sound-absorbents.

Therefore the effects of changes in various parameters which influence the absorbent properties of sound-absorbent systems con-

sisting of porous materials as perforated panels backed by porous materials, are investigated by using the measurements carried out in an impedance tube, with the help of impedance curves plotted on impedance charts, in order to obtain useful information to design, to modify or to optimize the absorption properties of sound-absorbent systems consisting of porous materials or perforated panels with porous backings, which are especially designed to overcome environmental and maintenance problems in building applications.

The methods of overcoming various common maintenance problems encountered by sound-absorbent materials applied in buildings are also investigated.

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J. Cosentino
B.Arch., University of Sydney

Noise in Shopping Centres

Summary

This study examines the aural environment of enclosed mall shopping centres with reference to the Australian Standard, AS 2107. Other types of shopping centres are briefly investigated. Minimal published information regarding noise in such shopping centres is available. The study was undertaken to establish whether more attention should be paid to acoustic design and in order to determine satisfactory noise levels in such spaces. Objective measurements of the noise levels were made. To assess subjective responses, questionnaires were administered to shoppers and workers.

Measured noise levels in enclosed malls were typically in the range of 65 to 70 dB (A). These levels appear to be acceptable. The presence of promotional activities, which are the greatest source of annoyance in shopping centres to shoppers and workers alike, can cause the sound levels to rise by 7 dB (A) to 10 dB(A). Sound levels in individual shops were usually lower than those in the mall.

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D. Epstein
M.Blg.Science, University of Sydney

The Identification of Flanking Paths in Buildings.

Summary

In recent years there has been an increasing awareness of the need to regulate noise control in terms of acoustic isolation rather than the sound transmission loss of individual elements. If a partition whose attenuation characteristics seem satisfactory does not give adequate isolation then there would also be a need to identify the faulty areas. The present method as described in ASTM E336 is cumbersome and time consuming.

Various methods outlined in the literature have been reviewed and other methods have also been investigated.

i) The most simple method examined involves the use of a directional microphone to find out how the sound level varies as a room is surveyed. Best results are achieved when the source and the directional microphone are filtered at a high frequency.

ii) Two methods requiring the recognition of the path length difference between the direct signal from source to receiver and that via the flanking path were evaluated. One uses a cross-correlation technique and the other uses an impulse source.

ii) The use of an accelerometer was investigated for identifying structure-borne flanking transmission.

The cross-correlation and the impulse methods give accurate results but require quite sophisticated equipment. The accelerometer is useful for the identification of structure-borne flanking. The directional microphone method is very simple and gives reliable results with a minimum of equipment.

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R. Krishnaswamy
M.Blg.Sci., University of Sydney

Impulse Noise

Summary

An impulse noise is a very short duration noise such as a clap, a blow from a hammer, a gunshot or a cough. Such noises are particularly difficult to measure and specify because of the rapid rise times and short duration involved. They are also difficult to accurately record, reproduce and analyse. As a result of these factors and also because impulse sounds often do not sound very loud, even though they cause hearing damage, such noises have come in for comparatively little study.

This thesis is a review of impulse noise with particular reference to loudness perception, hearing damage, methods and limitations of objective measurement and analysis. This information is then applied (as far as is practicable with available instrumentation, to the measurement, analysis and control of noise from coughs in order to illustrate the techniques and problems involved.)

Coughs are a particularly annoying source of noise, if comments in newspapers or notes on concert programmes are anything to go by. It is now common practice for concert programmes to carry a message requesting patrons to refrain from coughing, or at least cover their mouths when they do cough, in order to reduce the noise.

How loud are coughs though and how much can the loudness be reduced by covering the mouth or other techniques? Such information is not available except in vague terms such as, "as loud as a trumpet playing fortissimo". The lack of information on the noise of coughs was the reason for taking coughs to illustrate the measurement and analysis of impulse noise in the present project though information on measurement analysis and perception of impulse noise is of immense importance in the study of noise in commercial, residential and industrial buildings. This is because many noise sources are impulsive, e.g. footsteps, banging doors and windows, typewriter and punch presses. This study is then a first step in a reassessment of the problems of impulse noise and its control in buildings.

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Lea Prasetio
M.Sc.(Acoustics), 1980, University of New South Wales

The Design and Construction of the Institut Teknologi Surabaya Campus With Respect to its Acoustic Aspects

Summary

This graduate project attempts to assess the new I.T.S. campus, especially the lecture rooms area with respect to its acoustics.

The acceptability of the site is investigated with regard to the road traffic noise in front of the campus and aircraft noise, since the airport is about 12 km from the site. The road traffic noise is

predicted by using Johnson & Saunders equation, while the acceptability due to aircraft noise is investigated in accordance with the Australian Standard, AS 2021-1977.

Levels due to the noise from the electric substation, pump-room, traffic within the campus, workshop and activities in adjacent lecture rooms are predicted using different formulae and some measurements. The noise levels from the sources are not only attenuated by distance, but also reduced by the envelope of the lecture rooms. Hence, the Sound Transmission Loss of walls comprising several elements are calculated.

It is important that a high degree of speech intelligibility exists in the lecture rooms. Hence, speech intelligibility tests are performed, using the Indonesian P.B. Word List and Indonesian people, to investigate the degree of intelligibility in the lecture rooms under the predicted noise level conditions.

Finally, suggestions are given with regard to the design and construction of the campus.

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Valerie E. Bray
M.Sc. (Acoustics), 1979, University of New South Wales

Control of Noise from Air-Cooled Induction Motors

Summary

Electric motors are in widespread use in today's industrial society and are frequently the cause of offensive noise.

This report discusses the sources of noise in the commonest type of electric motor, the air-cooled induction motor, and ways by which noise control may be achieved at the design stage.

Where additional control is required, this must be obtained by enclosure of the motor. Theory for the design of an enclosure suitable for a totally-enclosed fan-cooled motor is presented and tested by experiment.

Appendices give suggested methods of measurement for test and field situations and the collation of sound power levels for a range of commercially available motors.

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Ian J. Simpson
M.Sc. (Acoustics), 1979, U. NSW

Industrial Noise – legislation, levels and control, with particular reference to a case study.

Summary

This report investigates the noise problems facing New South Wales' industry in relation to present and proposed legislation. It covers the Noise Control Act, the Hearing Conservation Regulations introduced on June 1st, 1979 and briefly covers Common Law and the effects of compensation payments.

The effects of industrial noise are also investigated to gauge the adequacy of the legislation. The effects covered include auditory, non-auditory and the effects on other things such as social interaction and sleep.

As the legislated noise levels are above the medically recommended "safe" levels, the requirements for an effective hearing conservation program were also investigated. The coverage also includes examples of successful programs operating in industry with an analysis of their operation.

To determine how much effort will be required to meet the legislated levels, and the "safe" levels, a brief analysis of typical industry noise sources and levels was undertaken. The analysis covered the major industries, based on their hearing loss claims history, and a brief analysis of a case study factory's noise source and levels.

The evaluation of the severity of the noise problem then required the inclusion of a brief coverage of the possible noise control methods. Associated with this is a detailed analysis of a series of noise problems in the case study factory and possible solutions to them.

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Micheal Kateifides
M.Sc. (Acoustics), 1979, U. NSW

Application of Correlation Techniques to In Situ Measurements of Sound Transmission Loss.

Summary

The feasibility of using correlation techniques to determine in situ, the sound Transmission Loss of a building partition, was investigated both theoretically and by experiment. The experiment used a test panel subjected to a band limited random white noise emanating from a loudspeaker. The acoustic field was monitored by two microphones placed equidistant from, and on either side of the panel. The signals from the microphones were processed to give auto and cross-correlograms.

Fourier Transforms taken of segments of these correlograms chosen to examine only primary path correlation peaks, were used to compute the two frequency response estimates ie. via the ratio of the two auto-spectral densities and the ratio of the auto and cross-spectral densities. In order to correct for the spatial response of the test environment the experiment was repeated with the panel absent. The estimates based purely on the auto-correlations showed good agreement with the theoretical estimates for noise attenuation with distance in air whereas the estimates based on the cross-correlations showed poor agreement.

However, the estimates purely on auto-correlations of Transmission Loss were much lower than the estimates based on the cross-correlations which were again much lower than the Transmission Loss estimates determined by the standard Reverberation Room method. Although the lower Transmission Loss estimates were attributed to the influence of contaminating signals, especially the sound diffracted around the edge of the test panel, the discrepancy in noise attenuation with distance between the two estimates cannot be readily explained.

A failing of the experimental arrangement was that the Transmission Loss estimates obtained were for a range of angles of incidence (due to the sound source characteristics) rather than the discrete normal angle of incidence for which the experiment was designed.

It was concluded that if the separation between the primary and closest contaminating signal was increased the Transmission Loss estimates of much better agreement with standard measurements could be determined by using the correlation technique in practical situations. This could be achieved by using a larger panel size, choosing better source characteristics and also by making the measurements in the near field of the sound source and the retransmitted sound from the test panel.

4. Publications by Australians

A start has been made to compile regular lists of publications by Australian workers in acoustics. The following lists have been kindly supplied by Marshall Hall and Anne Quill of RANRL and by Marion Burgess of U.NSW. Authors of papers are requested to supply details either to the Chief Editor or their State liaison officer in order to minimise the likelihood of omission in future.

Key to Institutions

0 Non-Australian affiliation
1 University of Western Australia
2 University of New England
3 R.A.N. Research Laboratory
4 University of Melbourne
5 University of Adelaide
6 NSW Institute of Technology
7 University of NSW
8 Griffith University
9 WA Institute of Technology
10 University of Sydney
11 University of Newcastle
12 Monash University
13 CSIRO Division of Mechanical Engineering
14 Australian Atomic Energy Commission Research Establishment
15 Glenbrook, NSW
16 Royal Melbourne Institute of Technology
17 Caulfield Institute of Technology
18 Department of Defence Materials Research Laboratories, Vic.
19 Royal Military College, Duntroon
20 CSIRO Division of Forest Research, ACT
21 NSW Electricity Commission
22 National Acoustic Laboratories
23 University of Queensland
24 CSIRO Division of Textiles, Vic.

NOTE: Co-authors without a super-script have the same affiliation as the co-author preceding them.

Australian Papers on Acoustics 1979–1981

Journal of the Acoustical Society of America

1979

1. D.A. Bies[5] and C.H. Hansen
Measurements of the radiation impedance presented to a source in a reverberant room containing a rotating diffuser 65, 708-718.
2. J.I. Dunlop[7]
Light column display of sound pressure levels 65, 261-262 (L).
3. N.H. Fletcher[2] and S. Thwaites
Acoustical Analysis of the auditory system of the cricket Teleogryllus commodus (Walker) 66, 350-357.
4. H.P.W. Gottlieb[8]
Harmonic properties of the Annular Membrane 66, 647-650.
5. M. Hall[3]
The influence of submerged duct on sound propagation in a surface duct 66, 1102-1107.
6. J.R. Johnstone[1], V.A. Alder, B.M. Johnstone, D. Robertson, and G.K. Yates
Cochlear action potential threshold and single unit thresholds 65, 254-257 (L).
7. J.D. Penrose[9] and G.T. Kaye[0]
Acoustic target strengths of marine organisms 65, 374-380.
8. D. Robertson[1] and B.M. Johnstone
Aberrant tonotopic organization in the inner ear damaged by kanamycin 66, 466-469.

1980

1. R.C. Black[4] and G.M. Clark
Differential electrical excitation of the auditory nerve 67, 868-874.
2. P.W. Buchen[10] and R.A.W. Haddon
Diffraction of a plane pulse by thin arbitrarily shaped obstacles 68, 309-313.
3. A. Cantoni[11] and L.C. Godara
Resolving the directions of sources in a correlated field incident on an array 67, 1247-1255.
4. D.H. Cato[3]
Some unusual sounds of apparent biological origin responsible for sustained background noise in the Timor Sea 68, 1056-1060.
5. N.H. Fletcher[2] and L.M. Douglas
Harmonic generation in organ pipes, recorders, and flutes 68, 767-771.
6. M. Hall[3]
Surface-duct propagation: an evaluation of models of the effects of surface roughness 67, 803-811.
7. D. Robertson[1], A.R. Cody, G. Bredberg and B.M. Johnstone
Response properties of spiral ganglion neurons in cochleas damaged by direct mechanical trauma 67, 1295-1303.
8. M. MacPherson[15] and G. Frisk[0]
Contribution of normal modes in the bottom to the acoustic field in the ocean 68, 929-940.

Journal of Sound and Vibration

1979

1. D. Bucco[5], J. Mazumdar and G. Sved
Vibration Analysis of Plates of Arbitrary Shape–A New Approach 67, 253-262.
2. R. Bullen[10]
Statistical Evaluation of the Accuracy of External Sound Level Predictions Arising from Models 65(1) 11-28.
3. C.R. Fuller [5] and D.A. Bies
The effects of flow on the performance of a reactive acoustic attenuator 62(1), 73-92.
4. C.H. Hansen[5] and D.A. Bies
Nearfield Determination of the complex radiation efficiency and acoustic intensity distribution for a resonantly vibrating surface 62(1), 93-110.
5. L.L. Koss[12]
Mean square Pressure of a Transient Oscillator and applications to punch press noise 65(1), 137-144.
6. H.M. Nelson[10]
Transverse Vibration of A Moving Strip 65(3), 381-389.
7. T.M. Romberg[14] and R.W. Harris
Application of Vibration Signals to the Identification of Hydrodynamic Instabilities in a Heated Channel 65(3), 329-338.
8. K.K. Teh[1] and C.C. Huang
The vibrations of generally orthotropic beams, a finite element approach 62(2), 195-206.
9. R.F. Tonin[5] and D.A. Bies
Free vibration of circular cylinders of variable thickness 62, 165-180.
10. M.C. Welsh[13] and D.C. Gibson
Interaction of induced sound with flow past a square leading edged plate in a duct 67, 501-511.

1980

1. R.J. Alfredson[12]
The direct Measurement of Acoustic Energy in Transient Sound Fields 70(2), 181-186.
2. D.A. Bies[5] and S. Hamid
In situ determination of loss and coupling loss factors by the power injection method 70(2), 187-204.
3. M.K. Bull[5] and M.P. Norton
The proximity of coincidence and acoustic cut-off frequencies in relation to acoustic radiation from pipes with disturbed internal turbulent flow 69(1), 1-11.
4. K.P. Byrne[7]
On the growth rate of bending induced edge cracks in panels excited by convected random pressure fields 68(2), 161-171.
5. A. Cabelli[13]
The Acoustic Characteristics of Duct Bends 68(3), 369-388.
6. W.B. Fraser[10]
Separable equations for a cylindical anisotropic elastic waveguide 72(2), 151-157.
7. C.H. Hansen[5] and D.A. Bies
Near field measurements of the complex radiation impedance presented to a vibrating plate in a reverberant room containing a rotating diffuser 73(1), 79-102.
8. J. Mazumdar[5], D. Hill and D.L. Clements
Thermally induced vibrations of a viscoelastic plate 73(1), 31-40.
9. H.F. Pollard[7]
A joint Acceptance function for enclosed spaces 73(3), 429-446.
10. K.K. Teh[1] and C.C. Huang
The effects of fibre orientation on free vibration of composite beams 69(2), 327-337.
11. A.G. Thompson[5]
Auxillary mass throw in a tuned and damped vibration absorber 70(4), 481-486.

1981

1. H. Gottlieb[8]
Proper vibrations of rectangular and triangular cross-sections 75, 475-480.
2. J. Matthew[12] and R. Alfredson
The reflection of acoustical transients from fibrous absorptive surfaces 75, 459-473.

Applied Acoustics

1980

1. D.A. Bies[5] and C.H. Hansen
Flow resistance information for acoustical design 13, 357-392.
2. K.R. Cook[16]
Sound insulation of domestic roofing systems Part 1 13, 109-120; Part 2 13, 203-210; Part 3 13, 313-329.
3. A. Lawrence[7] and M. Burgess
Measurement of traffic noise shielding provided by buildings 13, 211-226.
4. N. Wang[11]
Distribution display attachment for a sound level meter 13, 145-150.
5. K.P. Byrne[7]
Calculation of the specific normal impedance of perforated facing-porous backing constructions 13, 43-56.

1981

1. J.G. Wegner[17] and C.G. Don
Attenuation of traffic noise indices L_{eq} *and* L_N 14, 147-156.

Miscellaneous

1979

1. R. Bullen[10] and F. Fricke
Traffic noise in urban areas Australian Road Research 9, 11-15.
2. I.C. Dunstan[18]
Underwater sound scattering by marine organisms–a review Dept. of Defence, Aust. Mat. Research Labs 1979, MRL-R-756, 25 pp.

1980

1. C.S. Chen[12]
Rapid development of acoustic trauma–induced audiogenic seizure risk in 3 strains of seizure–resistant mice Experientia 36, 1194-1196.
2. D.B. Stewart[19] and J.P. Baird
Laser interferometer probe for underwater pulse from electric arc Acoustics Letters 4, 58-64.
3. C.S. Keay[11]
Anomalous sounds from the entry of meteor fireballs Science 210, 11-15.
4. L.N. Binh[20] and J. Livingstone
Wide band acoustooptic TE-TM mode converter using a doubly confined structure IEEE J. of Quantum Electronics 16, 964-971.
5. A.G. Virgo[21]
An acoustic approach to standardising ultrasonic weld testing methods Non-Destructive Testing-Australia 17(3), 9-13, 16.
6. D.S. Blaser[14]
The reduction and display of ultrasonic data Non-Destructive Testing-Australia 17(5), 9-13.
7. D.G. Blair[1] and J. Ferreirinho
The effect of superconducting transition on the acoustic losses in audio frequency niobium resonators J. Low Temp. Physics 41, 267-274.
8. G.L. Plant[22]
Visual identification of Australian vowels and diphthongs Aust. J. Audiology 2, 83-91.
9. H. Dillon[22] and G. Walker
The perception by normal hearing persons of intensity fluctuations in narrow band stimuli and its implications for sound field calibration procedures Aust. J. Audiology 2, 72-82.
10. N. Lewis[23] and J. Jerger
Interaural differences in acoustic reflex thresholds Aust. J. Audiology 2, 45-47.
11. K. Atkinson[24] and P. Lamb
Time history analysis of multi-impact noise Noise Control Engineering 15(1), 6-10.
12. L.N. Binh[1] and J. Livingstone
Optimisation of a collinear acousto-optic TE_m*-*TE_n *mode converter* $LiNbO_3$ IEE Proc., Part H, 127, 323-329.

1981

1. I. Eddington[8] and N. Eddington
Attenuation of noise at the point of perception–a new look at a least preferred strategy Noise and Vibration Control Worldwide 12(1), 22-24.
2. E.M. Cherry[12]
Power amplifier 'Improver' J. Audio Eng. Soc. 29, 140-147.

5. Some Recent Abstracts of Interest

Measurements of Acoustic Volume Backscattering in the Indian and Southern Oceans

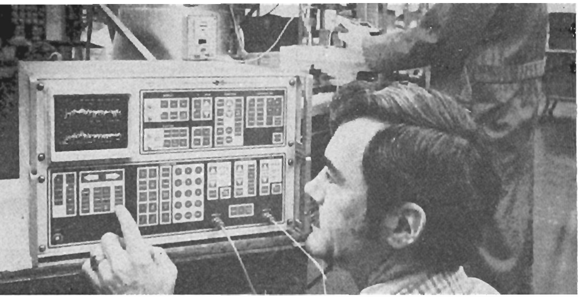
Marshall Hall, RAN Research Laboratory, P.O. Box 706, Darlinghurst, NSW 2010
Aust. J. of Marine and Freshwater Research, Dec. 1981 **32**, 857-879.

Volume backscattering strengths have been measured at several positions in the Indian Ocean and the Southern Ocean (across the Great Australian Bight). The positions in the Indian Ocean varied from the vicinity of the Equator to a station off the coast of Western Australia near Fremantle. The backscattering strengths have been analysed at frequencies in third-octave steps from 2.5 to 20 kHz. The average daytime scattering strengths at the Equator and in the Bight are similar and range from around −87 dB re m⁻¹ at 2.5 kHz to between −75 and −70 dB re m⁻¹ at 20 kHz. At night, the average scattering strengths in the Bight increase from about −75 dB re m⁻¹ at 2.5 kHz to about −70 dB at 20 kHz; whereas at the Equator, the results increase from about −82 dB re m⁻¹ at 2.5 kHz to −64 dB re m⁻¹ at 20 kHz. Deep scattering layers (DSL) were observed both in the Bight and at the Equator. The DSL in the Bight had a resonance frequency of 4 kHz and the average depth of the bottom of the layer was 950 m. From the acoustic scattering strength, it is inferred that the average population density of the fish in the layer is $10^{-5}m^{-3}$, and that the average mass of the fishes is around 40 g. The DSL at the Equator had a flat frequency response at frequencies above 10 kHz (there was no peak in the spectrum) and the average depth of the layer was about 500 m. The average abundance of the scatterers in the layer is inferred to be of the order of $5 \times 10^{-3}m^{-3}$. The backscattering strengths measured in the Great Australian Bight have been compared with predictions based on concurrent net hauls that were conducted to depths of 50 and 100 m. Good agreement occurs only at the higher frequencies and at night-time when most of the organisms are near the surface.

Comments on "Very low frequency (VLF) wind-generated noise produced by turbulent pressure fluctuations in the atmosphere near the ocean surface" [J. Acoust. Soc. Am. 66, 1499-1507 (1979)]

Douglas H. Cato, RAN Research Laboratory, P.O. Box 706, Darlinghurst, NSW 2010
J. Acoust. Soc. Am. **70**, *1783-1784, Dec. 1981.*

In a recent paper, Wilson claims to have corrected errors in the theory by Isakovich and Kur'yanov [Sov. Phys. Acoust. **16**, 49-58 (1970)] of underwater noise from wind turbulence and to have used improved models of the sea surface waves, resulting in substantially different predictions of noise level. In fact, Wilson's corrections appear to contain errors, mainly in the evaluation of an integral. While not commenting on the validity or otherwise of the assumptions used in the theories it is pointed out that a correct evaluation of the integral results in Wilson's method predicting noise levels about 20 dB higher than actually presented by Wilson. Over the frequency range for which the surface wave models apply, the corrected predictions



NEW PRODUCTS

1. INSTRUMENTS

DMX-1010 Computer Sound Processor

Digital Music Systems, Inc. P.O. Box 1632, Boston, MA02105 have announced a new powerful audio signal processor. It contains two computers – an LSI-11 microcomputer and a super-fast DMX-1000 digital audio signal processor. MUSIC-1000 software allows this system to be programmed easily in an intuitive way for almost every synthesis or processing task.

The DMX-1010 offers all the advantages of digital synthesis: freedom from noise and drift, precise control of tuning, repeatable and exact parameter settings, automated patching and programmable control. It also offers a degree of flexibility found, until now, only on analog synthesizers.

The DMX-1010 signal-processing units are not built directly in hardware but are programmed in software. MUSIC-1000 provides a library of these units (oscillators, filters, noise generators, envelope generators, delay units, etc.) and a way of programming them and patching them together.

The unit offers the same unlimited range of synthesis techniques found on an analog synthesizer or computer music system. Anything that can be programmed can be done on the DMX-1010. For example, it will do speech synthesis.

DMX-1010 Computer Sound Processor

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of Wilson are then much closer to those of Isakovich and Kur'yanov, and substantially higher than measurements presented by Wilson.

An ultrasonic pulse-echo system that makes use of interaural localization

Mitsuhiro Ueda, Research Laboratory of Precision Machinery and Electronics, Tokyo Institute of Technology, Nagatsuta, Midori-ku, Yokohama, 227 Japan

Koji Uda, Hokushin Electric Works, Ltd., Shimomaruko, Oota-ku, Tokyo, 144 Japan

J. Acoust. Soc. Am. **67**, *2099, June 1980*

A new type of ultrasonic pulse-echo method that makes use of interaural localization is described in this Letter. The basic idea of this method is to receive pulse echoes reflected from an object with two receiving transducers and to hear the echo signals stereophonically after they are converted to audible frequencies. The principles of the system and some results of preliminary experiments that make use of an ultrasonic pulse of 500 kHz are presented.

6. Journals Held in the National Acoustic Laboratories Library for The Australian Acoustical Society

Australian Acoustical Society, Bulletin Vol. 5 No. 3/4 September/October 1977. Vol. 6 Nos. 1/2 March/June 1978 (4 copies), Vol. 9 No. 3 December 1980, Vol. 8 No. 1.S. June 1980 (Directory issue, 8 copies).

Acta Acustica No. 4 1980, No. 1 1981

Background to Careers 1978

Ultrasonics Vol. 16 No. 3, May 1978

Search, Vol. 9 No. 10, October 1978

Acoustic design guidelines for S.A. Schools

Ocean Sciences Review 1977

The Convention Rostrum, May 1978

Calendar of National and International Scientific Meetings in Aust. June 1978. Productivity Australia, Aug. 1978.

CSIRO Research Program Objectives 1977/78, 1978/79

Acustica (Em FOCO) Vol. 5 No. 20, Dec. 1980

Journal of Technical Physics Vol. 19 Nos. 1-4 1978, Vol. 20 Nos. 1-4 1979, Vol. 21, No. 1 1980. (Quarterly)

International Institute of Noise Control Engineering, Newsletter No. 9 Jan. 1978. No. 10 May 1978, 4 copies of No. 11/12 October 1978

Acchuvum Akustyki Vol. 11 Nos. 1-4 1976 (in Polish)

Archives of Acoustics Vol. 1 No. 1 1976 - Vol. 5 No. 2 1980 inclusive

Acoustical Society of Japan Vol. 30 Nos. 2, 11, 12 1974, Vol. 31 Nos. 1-7, 9-12 1975, Vol. 32 Nos. 1-12 1976, Vol. 33 Nos. 1, 7-12 1979, Vol. 36 Nos. 1-12 1980, Vol. 37 No. 1 1981 §

Precision Sound Level Meter

A new slim-line Sound Level Meter with digital display has been released by Bruel & Kjaer. It combines portability and functional simplicity with the accuracy required for acoustic noise mesurements of Type 1 (precision) standards (including draft revision of AS1259).

The *Precision Sound Level Meter Type 2232* measures A-weighted sound pressure levels using either "Slow" or "Fast" time constants over a dynamic range of 34 to 130 dB (A) in two 60 dB measuring ranges. The level is displayed on a large digital display, making reading errors virtually impossible. Two modes of operation permit either the max. RMS level measured during the preceeding second to be automatically updated and displayed, or an RMS "max. hold" reading to be obtained by manual reset. An analogue DC output is provided for recording purposes.

Fitted with a high sensitivity prepolarized condenser microphone Type 4176, the Sound Level Meter offers up to 30 hours operation from one set of cells. In addition to displaying the measured level, the digital display indicates over-load, under-range and low battery conditions, and a visual check of all display segments when the instrument is first switched on.

Precision Sound Level Meter

General Purpose Vibration Pickup

Optimised to have good all-round specifications and a high Uni-Gain (Reg.) sensitivity of 10 pC/m^2 (100 pC/g), the new Bruel & Kjaer *Accelerometer Type 4381* is applicable to a wide variety of vibration measurements in industry, education, and in the laboratory.

With is titanium body the 4381 weighs in at 43 grams, which is very low considering its high sensitivity. The 4381 has a side-mounted connector and features the Delta-Shear (Reg.) design concept which results in a very low sensitivity to temperature transients and to strains transmitted from the measuring object through the base of the accelerometer. A similar accelerometer, Type 4370, is available with top-mounted connector.

Silentone 3000 Audiometric Room

Advanced Acoustics now have available a completely new audiometric testing room, that provides noise reduction of greater than 30 dB at 125 Hz. This room has been designed and tested to comply with the latest National Acoustics Laboratory K-2 Specification covering both noise reduction and testing method.

Rooms are manufactured to customer order and are fully demountable. Forced ventilation, equipment connecting panels, viewing window and fabric lining to the interior walls are standard.

For further information on this product, please contact:

Victoria	(03) 460 9055
NSW	(02) 522 4822
Queensland	(07) 52 7127
West Aust.	(09) 451 8811

New ACI Fibreglass Release

ACI Fibreglass recently announced the development of a new acoustic and thermal insulation product. *SONOMATT* is a lightweight, flexible pink fibreglass blanket adhered on one side with a black fibreglass tissue, which is available in 25mm and 50mm thicknesses and various lengths and widths.

It is an ideal acoustic (and thermal) overlay for metal pan, slatted metal and other modern linear ceilings. The black tissue facing ensures that *SONOMATT* has favourable sound characteristics and enables the product to be used for applications where minimising product visibility is a design consideration.

For further information on this product, please contact your local ACI Fibreglass office.

Perth	(09) 277 6444
Adelaide	(08) 268 1444
Melbourne	(03) 793 4333
Sydney	(02) 519 7351
Brisbane	(07) 268 5211

Human-Response Vibration Meter

An entirely new era of vibration measurement, concerned with the effects of vibration on the human body, is opened up by the latest instrument from Bruel & Kjaer.

The *Human-Response Vibration Meter Type 2512* is designed to carry out frequency-weighted measurements, in accordance with current standards, of both whole-body (including motion sickness) and hand-arm vibration. From these measurements, the equivalent continuous vibration level and the vibration exposure are calculated and compared with the appropriate criterion which is pre-selected from a number of recommended criteria stored within the instrument. The measurement's maximum peak value, its equivalent continuous vibration level, and the current exposure (in % of that allowed), as well as the elapsed time, are available on the digital display at any time.

The instrument is fully portable, being powered from internal batteries; and used with B & K Uni-Gain accelerometers or the special Triaxial Seat-Accelerometer Type 4322 (for measurements on seated subjects), the 2512 forms a compatible calibrated system which is easy to set up and straightforward to use in the field or in the laboratory. It is therefore especially suitable for measurements on all types of vehicles, and on hand-held power tools. Results can be output digitally via an IEC interface e.g. to an Alphanumeric Printer Type 2312 or in analogue form to a Level Recorder Type 2306, to obtain hard copy of results in the field.

Universal Balancing Machine — Type 3906

The B&K range of equipment for balancing rotating machine parts has been extended by the addition of a *Universal Balancing Machine, Type 3906,* for dynamic balancing of work pieces up to 50kg. It is suitable for balancing fans, armatures, automotive parts and all kinds of rotors down to balance quality grade G1.

The 3906, like the smaller Type 3905, is designed to be used with the all-electronic Balancing Machine Console Type 2504. The 3906 features soft-bearing suspension, and end-drive of the work piece by a two-speed 3-phase induction motor via a cardan shaft. The 3906/2504 system incorporates electronic compensators for ease of calibration, an angle reference generator for making corrections quickly and unambiguously, memory for holding the unbalance displays after the rotor has stopped turning, and a number of safety features to protect the operator.

½" Prepolaroized Condenser Microphone — Type 4176

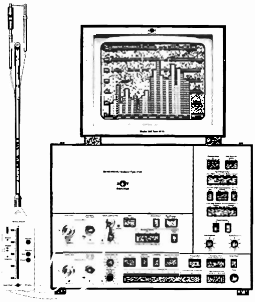
A ½" prepolarized condenser microphone cartridge, designed for use with the Bruel & Kjaer.

This is a high quality free-field microphone satisfying the requirements for sound measurements to IEC 651 Type 1 and with the Random Incidence Corrector DZ 9566 to ANSI S1.4 Type 1.

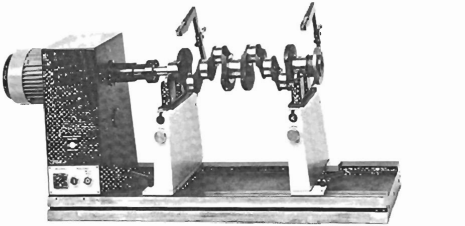
A charge bearing electret layer permanently polarizes the microphone, avoiding the need for an external polarizing voltage. Careful design and construction of the microphone has produced as good a stability and temperature coefficient as that of externally polarized Bruel & Kjaer microphones.

Real-Time Sound Intensity Analysis

The *Sound Intensity Analysing System* developed by Bruel & Kjaer opens new horizons in acoustical measurements. The system Type 3360 employs the finite difference approximation method to measure in real time, sound intensity levels in 1/1 and 1/3 octave bands. The results are displayed as a bar graph



Sound Intensity Analysing Systems — Type 3360



Universal Balancing Machine — Type 3906

of varying intensity which indicates the direction of the sound intensity. The frequency range for sound intensity measurements is from 3,2 Hz to 8 kHz and for sound pressure measurements from 1,6 Hz to 20 kHz (centre frequencies).

The special construction of the Probe permits easy calibration of the system with a B&K Pistonphone enabling sound intensity levels to be displayed in dB re 1 pW/m².

Applications of sound intensity measurements include location of noise source, mode studies and tracing of energy flow lines. As intensity measurements are little affected by background noise, many "classical" measurement techniques could be improved by using the 3360 System. For example, sound power can be measured in noisy environments and the use of an anechoic chamber becomes superfluous.

The 3360 System comprises four units: a digital frequency analyser; a portable display unit which may be used up to 5m from the analyser; a sound intensity probe supplied with two matched pairs of microphones and a set of 4 spacers and a remote indicating unit for observing a single channel, starting linear integration and initiating read-outs up to 15m from the analyser. This unit, which also gives an indication of the direction of the sound intensity, is very handy in confined spaces.

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Description of Ultrasonic Fields; Matthew O'Donnell, L.J. Busse, and J.G. Miller, *Piezoelectric Transducers;* M.A. Breazeale, John H. Cantrell, Jr., and Joseph S. Heyman, *Ultrasonic Wave Velocity and Attenuation Measurements;* Gilroy Harrison and A. John Barlow, *Dynamic Viscosity Measurement;* Leon J. Slutsky, *Ultrasonic Chemical Relaxation Spectroscopy;* Emanuel P. Papadakis, *Scattering in Polycrystalline Media;* James A. Rooney, *Nonlinear Phenomena;* Robert E. Apfel, *Acoustic Cavitation;* Joseph Heiserman, *Acoustic Measurements in Superfluid Helium;* G.I.A. Stegeman, *Acousto-Optic Phenomena;* Richard M. White, *Surface Elastic Waves;* B.P. Hildebrand, *Acoustic Holography;* James F. Greenleaf, *Computerized Transmission Tomography;*

Author Index
Subject Index

1981, 624 pp., U.S. $69.50/ Academic Press

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2. Books

Vibration and Sound
By Philip M. Morse, Ph.D. Professor Emeritus Massachusetts Institute of Technology

For forty-five years, this publication has remained the most widely used text on the science of acoustics. This reprinting will provide a new generation of students and professionals with a general introduction to the theory of vibration and sound, including wave motion, radiation problems, and transient phenomena.

488 pages paperback 1981
U.S. $15.00 per copy, prepaid
(U.S. $12.50 per copy, prepaid, for bulk orders of five or more to one address)

Available from: The Acoustical Society of America, 335 East 45 Street, New York, NY, 10017.

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Acoustical Designing in Architecture
By Vern O. Knudsen, Ph.D., Cyril M. Harris, Ph.D.
Completely Revised

This important volume, a comprehensive, non-mathematical treatment of architectural acoustics, is designed in handbook format for ease of use. The convenient paperback edition is divided into two parts. The first section addresses the general principles and procedures on which acoustical designing is based, and the second covers specific applications to the design of auditoriums, theaters, school buildings, homes, apartments and hotels, churches, and radio, television and sound-recording studios. This new edition has been updated to eliminate obsolete materials with new illustrations added. Other changes have been introduced by way of footnotes to the original text.

408 pages paperback Illustrated
U.S. $15.00 per copy, prepaid
(U.S. $12.50 per copy, prepaid for bulk orders of 5 copies or more.)

Available from: The Acoustical Society of America, 335 East 45 Street, New York, NY, 10017.

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Ultrasonics
Edited by P.D. Edmonds
Volume 19 in Methods of Experimental Physics

Contents: Peter D. Edmonds and F. Dunn, *Introduction: Physical*

Analytical Acoustics
By F.B. Stumpf, Professor of Physics, Ohio University, Athens.

An up-to-date text for a graduate or advanced undergraduate course in acoustics for physicists, engineers, and consultants. Surveys analytical vibration and sound for professionals working in applied acoustics (medical acoustics, hearing and speech, noise control, architectural acoustics, underwater sound).

Contents: *Transverse Waves in a String; Longitudinal and Transverse Vibrations of Rods or Bars; The Vibration of Membranes and Plates; Plane Sound Waves; Reflection and Transmission of Plane Sound Waves at Plane Boundaries; Spherical Waves and Radiation from a Piston; Architectural Acoustics; Noise–Its Measurement and Control; Underwater Sound; Ultrasonics in Liquids and Solids.*

1980. 290 pp. 104 fig. 12 tab. 145 ref. ISBN 0-250-40302-1.

Order from: Butterworths Pty. Ltd., 271 Lane Cove Road, NORTH RYDE, NSW 2113.

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Industrial Noise Control Handbook
By Paul N. Cheremisinoff, P.E., Associate Professor of Environmental Engineering, New Jersey Institute of Technology and Peter P. Cheremisinoff, PNC Engineering Co.

This comprehensive book emphasizes noise control applications in manufacturing and industrial operations.

This work takes a practical rather than a theoretical viewpoint, and case histories are used frequently.

Contents: *Introduction; Noise and Effects on Man; Noise Legislation; Acoustics and the Sound Field; Engineering Controls and Systems Design; Personal Safety Devices; Enclosures, Shields and Barriers–Designing with Lead; Noise Reduction with Glass; Additional Sound Control Materials; Silencers and Suppressor Systems; Fundamentals of Vibration; Vibration Control Applications; Abatement and Measurement of Control Valve Noise; Hydrodynamic Control of Valve Noise; Ventilating System Noise Control; Instrumentation for Noise Analysis; Audiometric Testing and Dosimeters; Noise Level Interpolation and Mapping; Glossary.*

1977,78. 361 pp. 255 fig. 32 tab. 42 ref. ISBN 0-250-40144-4.

Order from: Butterworths Pty. Ltd., 271 Lane Cove Road, NORTH RYDE, NSW 2113.

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Psychophysical Physiological and Behavioural Studies in Hearing
Edited by G. van den Brink and F.A. Bilsen

Proceedings of the 5th International Symposium on Hearing Noordwijkerhout, The Netherlands, April 8-12, 1980.

The symposium was the fifth in a series of international symposia devoted to the study of the auditory system of man and animals. The new experimental facts and models presented in this volume constitute an important source of information for researchers, teachers and postgraduate students in the different fields of hearing research. The contributions are grouped and introduced in such a way that the book will serve as an accessible file of information for the non-specialized readers as well.

Contents: *I. Cochlear functioning; II. Frequency- and time-resolution; III. Lateral suppression and distortion products, IV. Intensity coding and dynamic range; V. Pitch perception, VI. Binaural hearing; VII. Psychoacoustical and phonetical interrelations.*

Published by Sythoff and Noordhoff
1980, 480 pp., cloth, Dfl. 85.00/ °A$37.00. ISBN 90 286 0780 3.

Available from: D.A. Book Depot Pty. Ltd., 11-13 Station St., MITCHAM, VIC 3132. A$37.00 + 50¢ postage.

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Physical Acoustics
Principles and Methods
Volume 15 Edited by Warren P. Mason and Robert N. Thurston

Contents: Karl F. Graff, *A History of Ultrasonics;* W. Richard Smith, *Circuit-Model Analysis and Design of Interdigital Transducers for Surface Acoustic Wave Devices;* Lawrence Flax, Guillermo C. Gaunaurd, and Herbert Uberall,

Theory of Resonance Scattering; Arthur E. Lord, Jr., *Acoustic Emission – An Update.*
Each chapter contains references.
Author Index.
Subject Index.

May 1981, 384 pp., U.S.$45.00, Academic Press.

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Fundamental Aspects of Physical Acoustics
G.S. Verma, Banaras Hindu University, India.

Covers physical acoustics from its fundamentals to advanced level and also provides introductory material for those who are interested in research in acoustics.

Contents: *Kinematics of vibrations; Wave motion; Transverse waves in strings, rods and plates; Physical ultrasonics; Physics of reverberation phenomena; Physics of loudspeakers and microphones; Physics of resonators and filters.*

Order from: Pergamon Press (Aust.) Pty. Ltd., P.O. Box 544, Potts Point, NSW 2011.

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Reference Data for Acoustic Noise Control
W.L. Ghering, Research Specialist, Babcock & Wilcox Company, Alliance, Ohio, Editor.

This publication was designed to complement, rather than compete with the available noise control, noise and vibration, and acoustic literature. As a result, it consolidates much of the commonly required information on acoustic noise control, while providing numerous references to the literature where additional information may prove helpful.

Contents: *Description of Noise; Noise Level Estimators; Acoustic Information; Transmission Loss; Barriers, Enclosures, Partial Enclosures, Hoods; Standards; Noise Control Recommendations; Effects of Noise on People; Special Noise Sources; Structural Radiation and Response to Sound; Statistical Energy Analysis (SEA). Noise Literature. References. Appendix. Tables for Combining Decibels.*

1978,80. 152 pp. 59 fig. 37 tab. 57 ref. ISBN 0-250-40257-2.

Order from: Butterworths Pty. Ltd., 271 Lane Cove Road, NORTH RYDE, NSW 2113.

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3. Technical Publications

Acoustic Emmission Symposium

The proceedings of the symposium, jointly organised by the Department of Applied Physics, University of New South Wales and the Australian Acoustical Society, which was held on 25 November 1981 are available at a cost of $10 per copy from: Unisearch Ltd., Unisearch House, University of New South Wales, P.O. Box 1, Kensington, NSW 2033.

Contents: *Engineering Design and Failure Prevention* by Professor N.L. Svensson; *Mechanics of Solids* by Dr R.W. Harris; *Physical Acoustics* by Dr H.F. Pollard; *Signal Analysis* by Dr R.W. Harris; *Some Aspects of Acoustic Emmission Instrumentation* by B.R.A. Wood; *Application of Acoustic Emission Techniques* by B.R.A. Wood.

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New AE Journal Announced

A new technical journal devoted solely to acoustic emission will be published soon by the Acoustic Emission Group at the University of California at Los Angeles. Professor Kanji Ono has been named editor of the quarterly publication, called *The Journal of Acoustic Emission*. Professor Ono hopes to establish the journal as the official publication of the three acoustic emission working groups in the United States, Europe, and Japan, as well as of special committees such as the Committee on Acoustic Emission from Reinforced Plastics (CARP).

Subscriptions will be U.S.$30.00 ($25.00 if prepaid) for one year in the U.S. and its possessions; Canadian and Mexican subscriptions will cost $34.00 ($29.00 if prepaid), and prepaid subscriptions for other areas will cost $40.00 for one-year surface delivery. Inquiries about advertising rates, subscriptions, and further information should be directed to: Acoustic Emission Group, 6532 Boelter Hall, Materials Science and Engineering, University of California, Los Angeles, CA 90024.

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Inter-Noise 80 Proceedings

More than 600 engineers concerned with noise control attended INTER-NOISE 80, the 1980 International Conference on Noise Control Engineering which was held in Miami, Florida on 08-10 December 1980. The meeting covered a very wide variety of topics, including machinery noise control, impact noise, land use planning around airports, instrument calibration and certification, rapid transit system noise control, building noise control, valve noise, active noise attenuators and many other subjects in noise control engineering.

The papers presented at the conference have been collected into a two-volume set of Conference Proceedings which contain a total of 1,296 pages. The book, edited by Dr George C. Maling, Jr., is a comprehensive summary of the state of the technology in noise control. Copies of the Proceedings are available for U.S.$49.50 from Noise Control Foundation, P.O. Box 3469, Arlington Branch, Poughkeepsie, NY 12603, U.S.A. The two-volume set is mailed within the United States and overseas by surface mail at no cost. For shipment of the set overseas by air, there is a U.S.$25.00 additional charge for air mail postage, packing and handling.

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Noise Control Papers Presented at NOISE-CON 81

More than 400 engineers and others attended NOISE-CON 81 on 8-10 June, 1981 and heard 88 papers on the technology of noise control. NOISE-CON 81 was sponsored jointly the Institute of Noise Control Engineering and North Carolina State University, and was held in Raleigh, North Carolina. The theme of the Conference was "Applied Noise Control Technology."

Most of the papers presented at NOISE-CON 81 dealt with machinery noise, noise source identification, noise reduction by barriers and enclosures and applications of damping material. Particular emphasis was placed on machinery noise in the metal

fabricating industry, punch press noise, noise control in the textile and fiber industries, woodworking industry noise control and noise control in the tobacco and packaging industries.

The papers are available in the form of a 488-page book of Conference Proceedings. The price of the volume is U.S.$42.00 with an additional charge of $12.50 if the volume is to be mailed overseas by Air Mail. The Proceedings book is available from Noise Control Foundation, P.O. Box 3469, Arlington Branch, Poughkeepsie, NY 126023 U.S.A.

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Noise Control Engineering

Noise Control Engineering, the technical publication of the Institute of Noise Control Engineering contains articles of wide interest to noise control engineers.

The following articles appear in the November-December issue (Vol. 17, No. 3): *Noise Characteristics of a Pulsed Jet* by R.J. Hooker and R.H. Rumble; *Acoustic Intensity Measurements of Transient Noise Sources* by F.J. Fahy and S.J. Elliot; *Noise Reduction Processes in Cutting with High-Speed Tools* by H.K. Toenshoff, A. cherger and R. Westphal; *Pressure Dependence of Jet Noise and Silencing of Blow-Offs* by Maa Dah-you and Li Pei-zi.

Noise Control Engineering is published bimonthly by Ince. the subscription rate is U.S.$35.00 per year for libraries and institutions. Individual subscribers become Associates of the Institute and receive the bimonthly publication *Noise/News* in addition to *Noise Control Engineering*. There is an extra charge for shipment overseas by airmail. Further information and specimen copies may be obtained from Ince, P.O. Box 3206, Arlington Branch, Poughkeepsie, NY 12603, U.S.A.

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Proceedings From IUPAP Conferences in 1980

10th International Congress on Acoustics Sydney, Australia July 9-16, 1980.
Proceedings: Tenth International Congress on Acoustics.
Publisher: Australian Acoustical Society.
Publ. date: May, 1980.
Price: Australian $50.–(incl. airmail postage)

Address for orders: Australian Acoustical Society, c/o Science Centre, 35-43 Clarence Street, Sydney, N.S.W. 2000 Australia.

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Institute of Acoustics Publications on U.K. Meetings Available

The Institute of Acoustics (U.K.) has available proceedings of the following meetings which had taken place between 1979 and 1981: IOA Spring Conferences 1980 and 1981; Autumn Conferences 1979 and 1980; Low Frequency Noise, January 1979; Acoustic Test Facilities, May 1979; Room Acoustics, August 1979; Non-physical Aspects of Noise Criteria, October 1979; People, Noise and Buildings, March 1980; Microprocessor Applications in Acoustics, July 1980; Diesel Engine Noise Research, September 1980; Standardisation in Building Acoustics, 1980; Diesel Engine Noise Research, September 1980; Standardisation in Acoustics, October 1980; Recent Advances in Standardisation in Building Acoustics, November 1980; Active Control of Noise and Vibration, February 1981. Some older proceedings are also available. Prices range from £2.00 to £8.50. Inquiries should be sent to IOA, 25 Chambers Street, Edinburgh EH1 1HU, U.K.

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Australian Academy of Science
(P.O. Box 783, Canberra city 2601)

Science and Industry Forum Reports

Regular meetings between leading scientists and industrialists are held under the aegis of the Academy's Science and Industry Forum. These Forums study areas of mutual interest that effect public attitudes. The results of the studies are then published to promote a wider understanding of scientific advancement and its impact on the public, industry and technology.

Report No. 7
PhD Education in Australia—The Making of Professional Scientists. ISBN 0 85847 017 9. 1974. 240 pages. $5.95.

Report No. 8
The Future Education of Scientists. ISBN 0 85847 018 7. 1973. 53 pages. $5.95.

Report No. 9
National Goals and Research Needs. ISBN 0 85847 028 4. 1975. 63 pages. $5.95.

Report No. 10
From Stump Jump Plough to Interscan: A Review of Invention and Innovation in Australia. ISBN 0 85847 039 X. 1977. 112 pages. $5.95.

Report No. 11
Australia's Offshore Resources: Implications of the 200-mile Zone. ISBN 0 85847 047 0. 1978. 144 pages. $5.95.

Report No. 12
Transport in Australia. ISBN 0 85847 048 9. 1978. 160 pages. $5.95.

Report No. 13
Scientific Advances and Community Risk. ISBN 0 85847 054 3. 1979. 156 pages. $5.95.

Report No. 14
Materials for the Future. ISBN 0 85847 088 8. 1981. 132 pages. $5.95.

Report No. 15
Irrigation and Water Use in Australia. ISBN 0 85847 075 6. 1980. 96 pages. $5.95.

Report No. 16
The Impact of Microprocessors on Industry, Education and Society. ISBN 0 85847 065 9. 1980. 112 pages. $5.95.

Report No. 17
Liquid Fuels: What Can Australia Do? ISBN 0 85847 087 X. 1981. 109 pages. $5.95.

Report No. 18
Australia's Forests: Their Role in our Future. ISBN 0 85847 096 9. 88 pages. $5.95.

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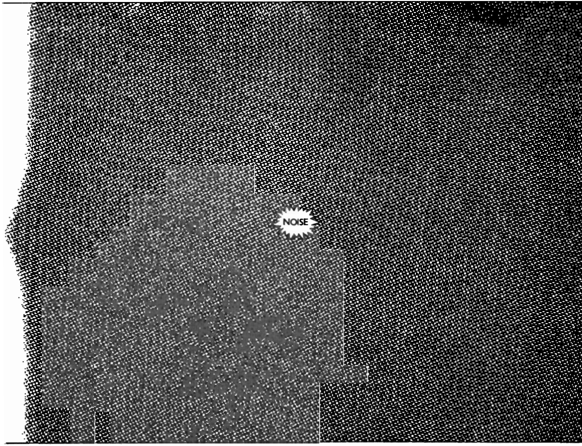
NOISE