Acoustics Australia

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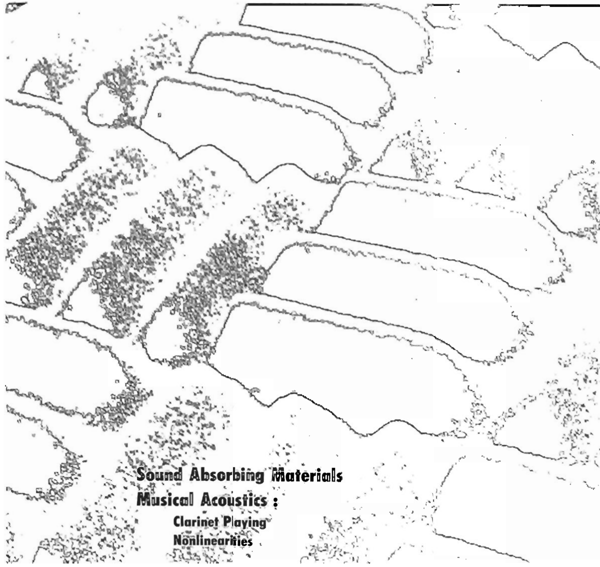

Sound Absorbing Materials

Musical Acoustics :

Clarinet Playing

Nonlinearities

Chief Editor:
Dr. Howard F. Pollard
Tel.: 697 4575

Associate Editor:
Marion Burgess
Tel.: 697 4797

Consulting Editors:
Dr. John I. Dunlop
Sound Propagation in Air and Matter, Acoustic Non-Destructive Testing

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Musical Acoustics, Bioacoustics

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Advertising Manager:
Jane Raines
Tel.: (02) 523 8661

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Address all correspondence to:
The Chief Editor
C/- School of Physics
The University of New South Wales
P.O. Box 1, Kensington, N.S.W. 2033

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Acoustics Australia

Vol. 14 No. 3 December 1986

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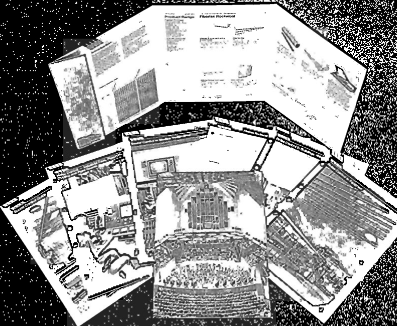
New Acoustic Literature available!



Bradford Insulation have produced a comprehensive range of acoustic literature

It includes a cover which details the Bradford acoustic product range, the specification of each product and their various applications.

In addition, five more detailed application brochures have been produced covering: General principles of sound (noise) control; noise control in factories; noise control in buildings; sound control in studios; noise control in plant rooms — including pipework, ducting and fans.

Also offered by Bradford is a range of technical data sheets dealing with the technical specifications of Bradford's products.

A binder of test data is also available which substantiates the product claims and defines the source and method of testing.

The brochures are available from any state office of Bradford Insulation or from their head office at 7 Percy St, Auburn, NSW 2144. Phone (02) 646 9111

BRADFORD INSULATION

AUSTRALIAN NEWS —

QUEENSLAND

September Technical Meeting

On Wednesday, 10th September, 1986 **Pat Closkey** from the Department of Employment and Industrial Relations and **Warner Johansson** from James Hardie & Co. spoke on "Noise Control and Hearing Conservation".

A review was given by the first speaker, of State Legislation around Australia on hearing conservation. Acceptable daily noise dose values together with restrictions on maximum permissible levels (if any) were presented. Brief information regarding the status and administration of hearing conservation regulations around Australia was included.

Warner Johansson then described the corporate policy which James Hardie & Co. Pty. Ltd. has adopted with regard to Noise Control and Hearing Protection. A description was given of noise measurement procedures and equipment in use; of the types of noise control measures undertaken (including abatement at the source, use of enclosures, etc.); of the hearing protection programmes developed and of company practice with regard to audiometry. Some of the legal implications of innovating a hearing conservation programme were discussed.

* * *

AAS Conference

The Community Noise Conference conducted jointly by the Society and the Queensland Division of Noise Abatement held in Toowoomba during October 1-3 was attended by more than 120 delegates. **Graham Cleary,** the Director of the Division of Noise Abatement and Air Pollution was the Chairman of the Organising Committee.

Topics covered at the Conference ranged from the legal aspects of noise control and land use planning for noise control to rock festival noise pollution and the use of an optical analogue for road traffic noise. The Conference was split into two parallel streams; one dealing primarily with policy and the other with technical matters. Four plenary sessions were accommodated, one for each key note speaker and one for **Judge K. F. Row** dealing with judicial supervision of noise control. All plenary papers presented by the keynote speakers, **Louis Sutherland, Arline Bronzaft** and **John Walma van der Molen** were considered to be quite complementary to the theme of the Conference and were well received by the delegates. Arline Bronzaft's paper dealing with the health hazards of noise was especially appreciated judging by the number of phone calls received afterwards by the Conference organisers. Extracts from Dr. Bronzaft's paper were featured in the Toowoomba "Chronicle" on October 4.

The workshops were also considered to be highlights of the Conference. Ron Rumble acted as moderator for the workshop on "Annoyance" by fielding questions put to a panel consisting of Arline Bronzaft (Psychologist), Graeme Harding (Consultant), Ian Badham (Enforcer) and Warren Middleton (Academic). Discussion centred around "What Constitutes Annoyance" and "How Do We Measure It". These great unquantifiables remained largely unresolved; there being probably as many solutions as delegates present. Ron Rumble also chaired the Planning Workshop on the Friday which featured Norma Parris, Peter Kotulski and Leanne Reichelt and saw some lively debate on "Buffer Zones" and "Who Was There First". The "Education" workshop was conducted by Lex Brown and centred on two main topics — the training of Health Surveyors and noise level assessment by measurement vs. subjective assessment. Peter Kotulski, Lex Brown, Dave Southgate and Louise Bryant featured in the discussion of these topics.

Concurrent with the Conference, a trade display was presented. Manufacturers of noise control products, sound measurement and analysis equipment and sound analysis software were represented.

The weather aside, most delegates seemed to enjoy the social events organised for the Conference. Sandy Thorne presented readings and the Brolga Bush Band provided music at the Jondaryan Woolshed on Wednesday evening. The timing of Sandy Thorne's presentation dealing with the construction of the Woolshed, which had remained intact for a century, was quite ironic — the Woolshed lost its roof (imported as a continuous roll from England last century) during storms a few days later.

The Queensland spring weather proved a great leveller for even the most thoroughly organised. Greg Lee-Manwar escorting a busload of delegates and spouses from Toowoomba city to the Conference venue became the victim of the highland mist and was talked back via two-way radio to the institute by the kitchen staff. You can't beat local knowledge!

This report would not be complete without a special mention to **Noela Eddington, Bob Hooker** and **Ron Windebank** for their great effort and perserverance in making the Conference the success that it was.

This report provided by Rus Brown.

SOUTH AUSTRALIA

July Technical Meeting

On 30th July, **Pan Jie,** a postgraduate student from the Department of Mechanical Engineering at the University of Adelaide spoke on "A New Look at the Description of a Reverberant Space".

The traditional description of the sound field in an enclosure assumes that the walls are locally reactive and that this interrelated with their sound absorption co-efficients can adequately predict the acoustic response of the enclosure. This concept has been applied to architectural acoustics, apparently without question, for several decades. However, it is known that this method is useless when applied to enclosures such as the interiors of aircraft and motor vehicles.

Experimental work carried out in a reverberation room indicates that the walls are not locally reactive and that the coupling between wall structural modes and room acoustic modes controls the reverberation time. This talk reviewed theoretical and experimental evidence related to this concept.

AGM and September Meeting

The Annual General Meeting of the SA Division was held on 17th September. Following the re-election of **Peter Swift, Ken Martin** and **Bob Boyce** and the election of four new members — **R. E. Bogner, T. R. Klar, R. P. Williamson** and **G. R. Wild** the Divisional Committee is now back to full strength. At the following committee meeting Peter Swift was elected Chairman of the Division with Bob Boyce as Vice-Chairman.

The speaker at the technical meeting following the AGM was the retiring chairman, **Dr. David Bies** who presented a talk entitled "The Ear, an Engineer's Point of View".

The ear was described as needing to act as a frequency analyser and direction finding device. The talk was aimed at analysing the electro-mechanics of the ear and a thesis was presented on how it might work to cater for both of these functions over the audible frequency range.

This talk was extremely well received by the audience and showed one more facet of David's wide interest in all matters acoustic.

WESTERN AUSTRALIA

August Technical Meeting

On 21st August **Alec Duncan** from the Centre for Marine Science and Technology at W.A.I.T. spoke on Depth Measuring Sidescan Sonar.

Conventional hydrographic surveying techniques rely on the use of an echo-sounder to measure the depth of water underneath the survey vessel. As a conventional echo-sounder only provides information about the depth of water directly beneath the vessel, it is necessary for that vessel to pass over every point for which a depth measurement is required. In a detailed or in a large area survey this can be very time consuming.

This talk described a system, developed initially at the University of Bath, England, and subsequently by a commercial company, which makes it possible to measure the depth of water in a wide swath either side of the survey vessel. The system is a modification of sidescan sonar, a surveying tool which has been used for many years to locate objects on the sea floor.

Satisfies All Industrial Hygiene, Safety and Community Needs.

The db-308 Sound Analyzer combines and expands upon the capabilities of the accepted industry standard Metrosonics db-301 Noise-Profiling Dosimeter and db-307 Integrating/Averaging Sound Level Meter. This unique microprocessor-based dosimeter provides a large LCD display, as well as digital output of all survey and exposure data required for industrial hygiene, safety and community noise measurements.

Selectable excxhange rate, criterion level, and cutoffs enable the db-308 to monitor in accordance with all noise exposure criteria currently in use, including OSHA, DOD, and ISO.

The db-308 operates simultaneously as a noise dosimeter, integrating/averaging and true-peak sound level meter, and time history monitor. A unique plant-survey mode allows separate time history plots for individual measurement sites.

Universal Noise Dosimeter

The user can select two different cut-off levels for both hearing conservation and compliance measurements. Current dose values can be read on the display during testing, along with the projected dose for a full workshift.

Remarkable flexibility allows the db-308 to accommodate workshifts or duty times other than the standard 8 hours, or to average over several workshifts. The system computes noise dose for the monitoring period defined for individual tests, and no corrections are required.

The db-308 also displays the total time that the noise level exceeds a preset ceiling limit, typically 115 dBA. Additional exposure data is also provided on output reports.

Integrating/Averaging And True Peak Sound Level Meter

Unsurpassed, the db-308 is a multi-function sound level meter for general noise surveys and for monitoring area noise prior to dosimeter measurements. Readouts include current sound level, average level, L_{max} and its time of occurrence, and Sound Exposure Level (SEL). Sound Level can be either A or C weighted. Detector response can be Slow or Fast. Instantaneous peak sound pressure (L_{pk}) and its time of occurrence can also be measured.

Time History Monitor

An exceptional feature of the db-308 is its ability to break up a test period into a series of equal-duration intervals and produce a valuable time history profile. Users define the duration of the intervals (1 second to 24 hours). The db-308 has the capability to save any or all of the following: L_{max}, L_{pk}, average level, and up to two L_n values, for each interval. A large memory capacity allows storage of more than 800 intervals, even when all statistics are saved.

During or after testing, data collected in previous intervals can be reviewed on the LCD display to give users essential information for verifying data integrity. A full graphic report may be printed for detailed examination.

When surveying noise at different locations, the db-308 can automatically time each measurement, separate the data, and identify each location by a tag number in the printout. This distinctive feature is extremely useful for periodic plant and community surveys.

Time history is invaluable for verifying dose measurements, providing valuable inputs for noise control engineering, administrative noise control, and for documenting plant boundary noise.

Report Generation

Fully formatted reports, ready for use in test documentation can be produced on the Metrosonics dp-421 Portable Printer, or any other RS-232C compatible printer or terminal.

Each report includes a header that completely identifies the test and the equipment used. A four-line headline allows the engineer or industrial hygienist to fully describe each test. The header also identifies the db-308's serial number and software version, the date and time of the report and the last acoustical calibration, measurement range, and the exchange rate, frequency response, and averaging response used for the test. This information is included in the Amplitude Distribution and Time History reports or may be printed separately as an overall Test Statistics report.

Amplitude Distribution, Average Level, And L_n

The db-308 logs the number of noise samples that occur within each 1-dB amplitude increment. This data enables the software to compute statistics for different noise exposure criteria.

The report includes a table of L_{eq}, L_{dod}, and L_{osha} levels, calculated for two user-defined cutoffs and for no cutoffs. Thus, users can accurately compare exposures viewed by different criteria, without the uncertainties otherwise introduced by separate tests. In addition, four L_n values can be requested on each printout.

Amplitude distribution analysis provided in the report can be used in the future to calculate exposure based upon new criteria.

Time History

The time history report contains a numeric and graphic printout of average level, L_{max}, L_{pk}, and up to 2 L_n's for each measurement interval.

In addition to formatted reports, the db-308 can transmit memory dumps to computers for processing, storage and readout. An exciting feature is an output that enables users to store test data on analog tape, allowing for review and analysis at the users convenience.

Real Time Computer Interface

A computer can control the START/STOP operation of the db-308 and can request output reports at any time. The computer can also request real-time sound level. This offers many opportunities for on-line monitoring, and for generating warning or shutdown signals in critical areas.

Easy To Set Up And Operate

Although it performs sophisticated measurements, the db-308 Sound Analyzer is extremely easy to set up and operate, by responding to prompts and menus, users can quickly program measurement parameters, display data, or request output reports. A high-speed computer chip operates all processing functions with sufficient speed that real-time readout does not disrupt the acquisition of current data.

Once programmed, measurement parameters remain in memory even when power is off. As a result, re-selection for each test is unnecessary.

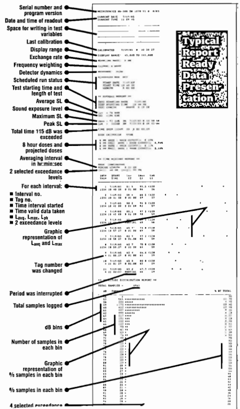
For the convenience of users who dispense more than one dosimeter at a time, or who cannot dispense them at the work station, the SCHEDULED RUN mode allows the db-308's start time and duration to be pre-programmed for automatic operation. Consequently, the work load of administrative personnel is greatly reduced.

Users can secure the db-308 against tampering or readout, by inhibiting all functions or only the programming function. The access code is designated at the time of use, to ensure that it is known only by authorized personnel.

Go Anywhere Use

The db-308 is housed in a rugged, lightweight aluminum extrusion and is completely gasketed to provide watertight protection. It can withstand harsh environmental conditions including rough handling or splashing liquids.

The aluminum case and special circuit design ensure data integrity by protecting against RFI and EMI. Low-current CMOS components permit at least 40 hours of operation from an internal battery.



AUSTRALIAN METROSONICS Pty. Ltd.

37 Benwerrin Dr., BURWOOD EAST, VIC. 3151

Ph. (03) 233 5744. Tlx. 152333.

1986 CONFERENCE PROCEEDINGS

Proceedings of the Community Noise Conference held in Toowoomba, 1-3 October, 1986 are available for sale.

The theme of the Conference was the achievement of community quietness through effective noise management. It served as a meeting point for the many disciplines associated with the control of community noise: acousticians, engineers, planners, legislators, administrators, academics.

Fifty-two papers were presented at the Conference and are presented in the 428-page Proceedings. Papers cover a broad range of topics, including policy and law, community levels, vehicle/aircraft/railway noise, education, specific applications, control guidelines, prediction techniques and the effects of noise on people.

Copies of the Proceedings are available for $35 (Aust.) from:

The Secretary,
Australian Acoustical Society
(Queensland Division),
P.O. Box 333
Toowong, Qld. 4066.

NSW

AGM and August Meeting

On 27th August, members and friends were invited to inspect the new facilities for the National Acoustics Laboratory and the Ultrasonics Institute at Chatswood. About 40 people were shown over the anechoic chambers, the reverberation chambers, the plane wave tube and the audiological facilities.

The AGM was held after the tour. Following the various reports from the Divisional Committee the elections for the five retiring Committee members were held. **Serg Hlistunov, Tony Hewett** and **Ray Piesse** were re-elected and **Bruce Cremin** was elected as a new member for the Committee. At the first Committee meeting following the AGM the renewal of **Peter Knowland's** term was endorsed.

October Meeting

This meeting was held on 7th October and was entitled "Community Noise Control, Amsterdam Style".

The responsibility for Noise Control in the Netherlands is decentralised and the speaker was the Director of the Department of Environmental Control for the Municipality of Amsterdam, **Mr. G. Walma van der Molen.** He was one of the Keynote Speakers at the Annual Conference in Queensland. His talk to the members of the N.S.W. Division gave more people the opportunity to hear and discuss how Europe deals with these problems.

VICTORIA

AGM and September Meeting

The Annual General Meeting of the Victoria Division was held on Thursday, 18th September at RMIT. One of the main items of business at the meeting was the election for the Divisional Committee. Three members of the Committee were unwilling to accept renomination and only one new member, **Joseph Matthew,** was elected. It is hoped that two new members can be co-opted onto the Committee to bring it back to full strength.

Following the AGM two students presented talks on their current research. **Ng Say Teong** from Monash University spoke on "Coupled Laser Resonance in Acoustics" and **Bruce Rouse** from RMIT spoke on "Sound Absorption Properties of Porous Materials".

It had originally been proposed that the award of the H. Vivian Taylor Prize would take place at this meeting. In view of the small number of student applicants for this prize, the Divisional Committee had decided to defer the award for 1986. It is hoped that changes to the awarding of the prize may encourage more applicants in 1987.

STANDARDS

HB4 Standards in Legislation — 3rd Edition

Considering that there are currently in excess of 3000 published Australian standards, and bearing in mind this country's Federal system of government with Commonwealth, State and Territory governments each promulgating large numbers of items of legislation, it would be a daunting task for anyone to ascertain compliance requirements. Recognising this need, the Standards Association of Australia publishes a handbook, HB4 - Register of Australian Standards Referenced in State and Commonwealth Legislation, which identifies the 1200 or so standards which are referred to in legislation and also identifies the relevant legislation title.

HB9 Manual of Industrial Personal Protection

This handbook is intended as a guide to industrial personal protection for people such as safety officers, members of occupational health and safety committees, and students in occupational health and safety courses. It has been prepared by the Standards Association of Australia in collaboration with a consultant in protective equipment and comprises extracts from Australian Standards on the selection, use, and maintenance of personal protective equipment, and extracts from Australian Standards which specify such equipment.

New Telephone Number

From 14th July, 1986 the telephone number for SAA's Head Office at 80 Arthur Street, North Sydney has been (02) 963 4111.

Master of Science (Acoustics)

Applications are invited from suitably qualified candidates for admission to the Master of Science (Acoustics) degree course at the University of New South Wales in 1987. The course is offered by the Graduate School of the Built Environment and it is directed by Associate Professor Anita Lawrence. It is normally taken over two years part-time study and it is suitable for graduates in engineering, architecture, building, science, or similar disciplines. Anyone interested should contact Anita Lawrence or the School Secretary, Mrs. Jan Chauncy, (02) 697 4848 as soon as possible.

AAS CONFERENCE November 12-13, 1987

The theme for this Conference is **"Acoustics in the Eighties".** It will cover all aspects of acoustics and will cater for both specialist and general interests. This will allow consideration of many issues, particularly those which have been topical during the 1980s. Papers will be streamed where appropriate to enable delegates to take full advantage of the technical programme.

The Hon. **Peter Hodgeman,** Tasmanian Minister for the Environment will officially open the Conference and deliver an Opening Address. Keynote Speaker for the Conference is to be Mr. **Trevor Brown,** Director of Environmental Control, Tasmanian Department of the Environment.

All sessions will be held on the campus of the University of Tasmania. This is located some 5 km from downtown Hobart and is adjacent to the Wrest Point Casino/Hotel complex. An interesting social programme has been arranged and includes the Conference Dinner on Thursday night at the Wrest Point Cabaret. For accompanying delegates, a full day tour of historic Port Arthur will be held on Thursday.

Abstracts for contributed papers are invited and should be submitted no later than 1 March 1987. They should not exceed 200 words but should provide sufficient information for selection of papers.

Details: Stephen Samuels, Australian Road Research Board, P.O. Box 156 (Bag 4), Nunawading, Victoria 3131. Phone: (03) 235 1555.

Australian News . . .

Opening of NAL and UI

On Friday, 15th August, 1986 the Hon. Neal Blewett, Federal Minister for Health, officially opened the new building for the National Acoustic Laboratories and Ultrasonic Institute at Chatswood, Sydney.

The site, in a wooded valley, was selected to meet stringent criteria for ambient noise and vibration levels. The unique combination of research, development and services within NAL and UI has determined the nature of the facilities provided in the new building.

The special acoustic facilities are mainly intended for research and reflect the wide scope of the work carried out at NAL. These include four anechoic chambers (the largest with a volume of 1680 cubic metres), a plane wave tube for frequencies between 15-50 Hz, two diffuse field rooms, two high intensity noise rooms, two quiet rooms and ten audiometric test rooms. Since many of the special facilities shared a requirement for very low levels of noise and vibration, special design concepts were developed and incorporated into the structure. These facilities are resiliently mounted in a "sound shell" which is itself isolated structurally from the remainder of the building and remote from all hydraulic services and mechanical plant.

The special facilities for UI consist of computing equipment for signal and image processing and examination rooms for patient examinations using prototype ultrasonic scanners. Also provided are a transducer/integrated circuit area with appropriate environmental conditions, and a biology laboratory with provisions for chemistry, histology and animals.

In support of the special facilities, an infrastructure of mechanical and electronics laboratories, test rooms, research laboratories, and administrative areas is provided. Where appropriate these are linked by data links and coaxial cables.

As befits a world class research establishment, there is provision for library services, training activities and the conduct of scientific meetings and conferences.

The Department of Housing and Construction undertook the architectural design and project management of the building which was constructed by White Industries Limited, North Sydney.

The National Acoustic Laboratories

The National Acoustic Laboratories (NAL) grew out of a research group established by the National Health and Medical Research Council (NH & MRC) during World War II to investigate the effect of noise on servicemen.

Today NAL is responsible for scientific investigations into hearing, hearing aids and the effects of noise on people as well as the provision of services including hearing aids to children, pensioners and ex-servicemen.

NAL maintains 33 Hearing Centres around Australia and its audiologists fitted about 68,000 hearing aids in 1985-86. Approximately 50 per cent of the population is eligible to receive this service.

NAL supplies more than 65 per cent of all hearing aids in Australia and is in the unusual position of being the designer of aids and the co-ordinator of manufacture, as well as the researcher, which decides the performance requirements, and fitting methods and the assessor of results and trends.

The Ultrasonics Institute

Ultrasonic research commenced in March 1959 and the Ultrasonics Institute (U.I.) was set up as a branch in its own right in 1975. The institute has made a number of pioneering advances in medical ultrasonics, with its work first appearing internationally in 1962. Ultrasound is now well accepted in clinical practice with applications in obstetrics, gynaecology, cardiology, opthalmology and radiology. Its transition from the development stage to routine clinical use was accelerated by the development at the Ultrasonics Institute of the grey-scale imaging technique.

The institute continues to make scientific and technical advances in the field. The non-invasive measurement of blood flow in deep-lying vessels using the Doppler effect and the measurement of sound-speed within tissue are two current research techniques which were pioneered at the UI. These techniques are being developed using two new ultrasonic scanners.

The institute works in close co-operation with five teaching hospitals in Sydney, and in particular with the Royal Hospital for Women and the Royal North Shore Hospital. It also undertakes joint projects with the universities and CSIRO.

Technological advances made at the institute are released for commercial manufacture in Australia for sale in Australia and overseas. The UI Octoson, a multi-transducer echoscope of novel design, was manufactured under a licensing agreement in Sydney.

B & K MOVE

On 1st November, 1986 Bruel and Kjaer Australia moved their N.S.W. office from Concord to their new headquarters at:

24 Tepko Road,
Terry Hills,
N.S.W. 2084

Their new telephone number is (02) 450 2373.

WOODTEX DISTRIBUTORS

August has seen the formalising of a Distribution Agreement for Woodtex products signed with Chadwick Holdings for the state of New South Wales and the Australian Capital Territory.

Chadwicks have a long association — over twenty years of selling Woodtex products throughout Australia — and K. H. Stramit welcomes their marketing and sales assistance to their products.

NEW SOUND RANGE

Clough Systems Limited has been awarded a contract for design and installation of a Shallow Water Sound Range at Jervis Bay for the Department of Defence (Navy).

Clough Systems (a joint venture between Clough Engineering Limited and Trippett Allan and Associates) has teamed with **Vipac Pty. Ltd.** and **Mari-Pro** of the U.S.A. to win this project from international competition. The project involves design of an array of hydrophones on the sea bottom, transmission of acoustic signals to shore over two 2500m buried cables, and subsequent data analysis and real time display of measured data, and computed-aided preparation of ranging reports.

Australian News . . .

Mini-Editorial

Our recent introduction of issues devoted to one selected topic has produced more articles than we can print in one issue. It has happened again with musical acoustics. Although a 'minor' professional interest according to the recent Society questionnaire, we hope there is enough general interest to sustain two further contributions in the current issue. The editors are indebted to Dr. Neville Fletcher for his assistance in organising the articles for this topic. His own article was originally provided as a 'back stop' in case we did not receive enough contributions! Our next special will feature some vibration problems.

We have a good supply of back issues. If any member has missed an issue for some reason (of course, beyond our control, as the ABC is wont to say) please drop us a line and we will post one to you. If there is a company, library or other institution that you think might like to have a sample copy, please supply the necessary name and address.

We are particularly keen to receive interesting survey articles (4-5 pp printed) in your field of interest, addressed not only to an audience of fellow acousticians but also to the substantial number of Society members who are not specialists, claiming to have a 'general interest' in acoustics.

—Howard Pollard.

Proposed Western Pacific Commission for Acoustics

Delegates to the 2nd Western Pacific Regional Acoustics Conference (WESTPAC II) held in December 1985 proposed the formation of a Commission for Acoustics for the development of acoustics in the region, promotion of co-operation in research and the organization of further WESTPAC conferences. The Chairman pro tem Professor Ken'iti Kido of Japan has developed a set of bylaws which are now being considered by the Society. Member organizations are expected to include the acoustical societies of China, India, Japan, Korea, New Zealand and Australia, Hong Kong Branch of the Institute of Acoustics, Institute of Noise Control Engineering of Japan and the Noise Section, Environmental Engineering Section of Singapore, National University of Singapore.

Change of Address

Australian Metrosonics Pty. Ltd. announce a change of address and main telephone number to the following:

37 Benwerrin Drive,
BURWOOD EAST, VIC. 3151.
Tel.: (03) 233 5744. Telex: 152333.

56th ANZAAS Congress

A circular entitled "ANZAAS Update — Science Programme Highlights" is available in connection with the forthcoming meeting in New Zealand. For a copy and any other information please contact Dr. M. Baxter, Massey University, Palmerston North, New Zealand. Tel.: (063) 69-099.

Software for hard problems

Siromath Pty. Ltd., the mathematical and statistical consultancy, offers customers a range of software packages designed for local needs as well as some overseas packages that are applicable in Australia.

- GENSTAT (General Statistical) programme — covering regression, cluster, multivariate and time-series analysis, as well as analysis of designed experiments;
- TSA (Time Series Analysis) — a package featuring Box-Jenkins modelling, spectral analysis, comprehensive mathematical operations on series, and versatile graphics readily interfaced to most output devices;
- MLP (Maximum Likelihood Programme) — provides a simple means of fitting a wide range of standard models to data and features curve fitting, multiple regression, and quantal response;
- Finite Element Library — a collection of programmes and subroutines for the developer of finite element techniques, it is aimed at addressing steady-state and time-dependent problems in up to three dimensions;
- S (Statistical Graphics Package) — an interactive language and system for analytical computing, data analysis, graphics and data management, it provides powerful graphical facilities for display of results in colour and three dimensions;
- MINITAB — a general purpose data management and analysis system with emphasis on ease of use;
- FINCASH (Financial Management) — providing a quantitative model of the forward financial requirements of a single building project. (This programme was developed by the CSIRO Division of Building Research.)

For more information:

SIROMATH Pty. Ltd.
Level 5, 156 Pacific Highway,
St. Leonards, N.S.W. 2065.
Tel.: (02) 436 0500

PEOPLE —

New Members

• Admissions

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

South Australia
Mr P. J. Maddern

• Graded

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

Subscriber

South Australia: Mr M. Fensham
Western Australia: Mr C. McCann
Christmas Island: Mrs J. M. McDonald, Mr E. S. McDonald

Member

New South Wales: Mr P. J. Griffiths
Victoria: Mr A. Ligthart

RONALD JOHN CARR

As many members will know, the Society lost one of its founder members when Ron Carr died last June.

During the formative years of the Society Ron was a very active member, organising many of the Victoria Division's dinners and technical meetings. In the Federal sphere, Ron made a significant contribution to the preparation of the constitution of the Society.

Being one of the first in the field of acoustical consulting in Australia, Ron was very well-known. In the early years he worked as Acoustics Australia, then from 1964 as Carr and Wilkinson and in the last ten years as Ron Carr & Co. Pty. Ltd. During the twenty-six years or so that Ron practised as a consultant, many hundreds of tests were made in his laboratories at Hawthorn (Melbourne) and many thousands of problems in building acoustics were solved.

Ron is survived by his wife, Jill, and three daughters to whom the Society extends its condolences. His contributions to both acoustics and the Society will be greatly missed.

Dr. Peter Swift has been appointed an Associate Director of the Adelaide Consulting Engineering firm of Pryce Goodale & Duncan Pty. Ltd. Dr. Swift Ph.D., M.I.E. Aust. did research for his doctorate in the field of vibration energy analysis.

He brings to this new post many years of experience in a wide range of acoustics, while specialising in the fields of industrial noise control, environmental acoustics and auditorium and studio design.

Nicolas Prescott has been appointed marketing manager for the Vipac Group, consisting of Vipac Pty. Ltd., consulting engineers and scientists; Contract Research and Development and Vipac Instruments Pty. Ltd., scientific instruments and software.

Mr. Prescott was formerly marketing manager for Companion Trading. Prior to this he has worked as a marketing advisor for several government departments and as a research scientist for the Environment Protection Authority (Victoria).

As Vipac's principal marketing executive, he will be responsible for the development of local and overseas marketing strategies for the Group.

Mr. David Pentecost has joined Vipac Instruments as Sales and Marketing Manager. David who comes from a long background in instrumentation sales has previously worked with Rion, Bruel & Kjaer and Warburton & Franki. Vipac Instruments specialise in vibration monitoring and acoustical equipment, representing Larson & Davis Laboratories, Spectral Dynamics, Ono Sokki and Entek in Australia.

INTERNATIONAL NEWS

12-ICA, JULY 1986

Rather more than ten Australians — I haven't counted the precise number — were able to attend the 12th International Congress on Acoustics in Toronto. For any one of us to attempt to give a detailed account of the Congress is impossible, since there were many simultaneous sessions, and each major interest group attracted enough papers to continue throughout most of the week. So here is my own individual view.

The Congress was well attended, with around 1000 participants, and there were rather more than 600 papers presented. The innovation of requiring registration fees to be paid before a paper was set down for the programme worked very well and there were very few missing authors. Plenary sessions at the rate of one or two per day gave a useful overview of the subject, ranging from acoustic nonlinearity to the bioacoustics of bats, and there was a very good equipment exhibition. The range of session titles was extensive and there was something for everybody in the programme.

Ted Schulz gave a fine lecture-demonstration on the variable acoustics of the new Roy Thomson Hall, achieved with adjustable convex reflectors over the stage area and absorbent rods and curtains high in the dome of the auditorium. As demonstrated by a string quartet, the organ, and later during the course of an orchestral concert, the adjustments produce quite marked changes, and the overall effect is very satisfactory.

Those interested in music were also able to hear a lunchtime organ concert, a demonstration of the eight instruments of **Carleen Hutchins'** new violin family, and two concerts of electronic music in which the Australian Fairlight CMI featured prominently, albeit in recorded form. Indeed the programme offered so many choices of activity that there was scarcely a spare moment.

Social arrangements were excellent and our Canadian hosts are to be congratulated on the pleasant atmosphere and the highly efficient organisation of the Congress. The weekend tour to Niagara Falls was a tourist "must" and was well patronised, while a smaller group visited the boundary-layer wind tunnel at the University of Western Ontario and then went on to a fine performance of Shakespeare's "Pericles" at Stratford. No-one wanted to visit the local nuclear power station and that tour had to be cancelled — I hear that the same happened to the 6.30 a.m. breakfast at the top of the CNR Tower, but under the flood of hospitality I was not one who rose early to find out!

The 13th ICA will be held in Belgrade in 1989 and the Yugoslavian hosts are already in the midst of detailed planning. Belgrade has a new Congress Centre, rather similar to the one in which the Toronto Congress was held, and such a facility certainly contributes greatly to the smoothness of Congress logistics from the viewpoint of participants — no doubt for the Organising Committee too! Being a European Congress the attendance is expected to be large. A decision on the location of the 1992 Congress will be made when the Commission meets in Rome next April.

Report prepared by Neville Fletcher.

INTER-NOISE 86

Inter-Noise 86 was sponsored by the International Institute of Noise Control Engineering (I-INCE) and was organised by INCE/USA and MIT in co-operation with the Acoustical Society of America. The Australian Acoustical Society is a member of I-INCE and Anita Lawrence represented the Society at the 12th General Assembly meeting held during the Conference.

The theme of Inter-Noise 86 was "Progress in Noise Control" and over 500 delegates from 37 countries attended. In the Distinguished Lecture Series papers were presented by **Jens Blauert, George Maling** and **Frank Fahey.** Of approximately 250 contributed papers, the majority addressed subjects in the following four areas:

Analysis (instrumentation, measurement methods, signal processing, modelling) — 27 per cent.

Emission (noise sources) — 16 per cent.

Immission (effects of noise) — 14 per cent.

Noise Control Elements — 10 per cent.

On the last afternoon of the Conference a series of five papers dealing with "Manpower Usage in Noise Control" included four papers from Australia. This session was chaired by **Ian Eddington** from the Darling Downs Institute of Advanced Education.

A three day INCE seminar on "Advanced Techniques for Noise Control" was held at the Sonesta Hotel in Cambridge immediately preceeding the Conference. This seminar was attended by 20 delegates and was led by **Malcolm Crocker.**

Some well-known Australian faces were seen on the MIT campus, many of them taking advantage of the sunshine from the northern summer. One social event of the Conference was a clam-bake which was followed by a dance. During free time, many delegates took the opportunity to follow the Freedom Trail and visit such historical sites as the Boston Tea Party Centre. Other popular sites were Faneuil Hall and the Union Oyster House, Boston's oldest restaurant, which is famous for its clam chowder.

Report prepared by Warren Renew.

Acoustics Group

Public Works Department New South Wales

W. Brown

Supervising Engineer, Acoustics

The N.S.W. Public Works Department is one of the largest construction organisations in Australia. It is responsible for the majority of building construction and maintenance projects for the State Government.

Within the Government Architect's Branch of the Department is a group of acoustic engineers who provide "in-house" consultancy services which include; noise investigations, design assistance, and general trouble shooting for the many projects undertaken by the branch's four hundred architects and engineers.

The group has eight members and is a substantial force in the acoustics industry. Each member of the group has a particular area of specialist expertise but is also capable of handling projects in any high demand area such as speech privacy and control of road traffic noise.

History

The Acoustics Group was established eleven years ago and, some 3,000 projects later, the depth of knowledge has become considerable. It has satisfied clients' expectations by providing effective cost efficient solutions.

Design innovations by the branch's architects and engineers has often been enhanced by reference to the group's project and client histories which provide an excellent basis from which to predict problems that may occur in the arrangement of space. For example a survey of noise problems in hospitals revealed that most complaints were associated with patient care and services areas.

Another major benefit of "in-house" expertise is the ability to identify common problem areas and devise standard corrective measures. The group has also placed emphasis on the education of architects and engineers to increase their awareness of acoustics and to impart standard procedures so that they can successfully meet their briefs.

Activities

Major Projects

Major projects to which the group is currently contributing include:

- The N.S.W. Art Gallery extensions
- The N.S.W. Museum extensions
- The Mark Foys Courts which includes a suite of 12 courts in an environment which is affected by train induced vibration from the underground subway
- The Lidcombe Technical College
- Design for the Greater Newcastle Teaching Hospital has now been completed, and the project is expected to cost $150 million. The acoustic input was successfully completed in-house with the assistance of contract engineers and demonstrates the depth of the knowledge base in the group.

Private consultants are encouraged to participate in Public Works projects and are presently completing work on:

- N.S.W. State Library
- Sutherland Court House
- Newtown School of Performing Arts.

The major portion of the groups' work is "nuts and bolts" acoustics where urgent solutions are required, or alternatives have to be found for items specified in building contracts. The nature of these over-the-desk responses places a premium on the practical application of knowledge.

Education

The group has published a wide range of Design Guides on noise control which are targeted to specific areas, including:

- School design notes
- Tertiary Planning Guidelines
- Mechanical Services Design Guide
- Pumping Stations Design Guide
- Audio Visual Rooms Design Guide
- Rain Noise Control/Cost Benefit Study
- Speech Privacy Design Guide
- Dust Extraction Noise for School Workshops Design Guide
- Design note on the selection of axial fans for noise.

Many copies have been issued throughout Australia.

Development

The group has the benefit of an acoustic laboratory which consists of twin reverberation chambers and a ventilation testing system. This is a great value for project related problems, quick evaluation of material selections and as a tool in education. Some of the tests performed include:

- Evaluation of commercial typewriters for use in government offices.
- Light-air fittings for Newcastle Police Station (air diffusion and noise)
- Tests to maximise the acoustic benefits of curtains using various weights, spacing from wall, and liners
- Tests of sound absorption of a wide range of practical building materials.

Innovations

The group has been responsible for significant innovations in the design and development of:

- A low noise impact work bench which was constructed in conjunction with the Schools Furniture Factory to assist with hearing conservation in industrial arts areas
- The experimental evaluation of vibration isolation afforded by "floating floors" to impulses such as would be caused by children jumping. This was undertaken in association with a private consultant and the resulting information has had an important effect on the branch's design practice.

Information

Recently the group completed a performance cost/benefit analysis of ceiling materials for use in schools and a comprehensive evaluation of operable partitioning and accordian doors.

Future

There is need to develop cost effective solutions in new designs to most changing environmental conditions, e.g. occupational health and safety issues (especially safety) which will have a marked impact on noise control in mechanical services. Plant located in potentially dangerous positions will be relocated in future design. In addition, the importance of current information concerning practices, procedures, products and prices is critical if such a large client base is to be serviced efficiently.

(continued on p. 81)

The Role of Vocal Tract Resonance in Clarinet Playing

R. Johnston*, P. G. Clinch† and G. J. Troup*
***Physics Department, Monash University, Clayton 3168, Victoria, Australia**
†Music Department, Melbourne CAE, Carlton 3053, Victoria, Australia

ABSTRACT:
The results of a real-time computer simulation of a clarinet-like system are presented. The system comprises well-known models of the instrument tube and reed appropriately coupled to a single resonant system representing the effect of the vocal tract. The results agree with predictions which can be made from noting that the system is a series one, and include phenomena well known to instrumentalists, such as 'bending the note', register change without use of the register key, and pitch control by vocal tract shape in the 'glissando' technique.

INTRODUCTION

The woodwind and brass instrument pedagogical literature contains numerous references to the effect of the shape of the vocal tract of the player on the timbre and intonation of the sound emitted by the instrument (1), (2), (4), (5). The position of the tongue is generally recognised as the main control variable (2), and instructions for developing this vocal tract technique are often expressed in terms of the formation of various vowel shapes (3), (4), (5), or by the adoption of terms used in singing training (8). Vocal tract manipulations are also thought to be important in the production of clarinet multiphonics (6), and in effecting the change of register (7).

On the other hand, the scientific literature is divided on the reality of this effect. Backus (9) concluded that the size and shape of the oral tract should be of no importance in clarinet tone production when he found that the level of sound pressure fluctuations in the oral tract were 20-25 dB below those in the mouthpiece of the instrument. Smithers, Wogram and Bowsher contend that vocal tract resonances are important in timbre and pitch control on the baroque trumpet (13).

Workers using artificially blown clarinets have come to differing conclusions about the effect of the air chamber shape on tone. Backus' (10) report finds little effect, as does Coopenbarger (11), but Mooney (3), using an artificial tongue placed in the blowing chamber, came to the opposite conclusion.

Clinch (1), (12), who used real time X-ray fluoroscopy to determine the vocal tract shapes assumed by players of several instruments during performance came to the following conclusions:

* Large systematic oral tract shape changes, largely regulated by the position of the tongue, occurred for players of the clarinet and soprano saxophone when the scale was ascended.
* For a given note, the shapes were very similar for different players if they were players of high calibre, and were very similar for notes of the same pitch on the two instruments, despite the acoustically important differences in bore geometry.
* The change was from a rearward position of the tongue, which created a large mouth cavity and small larynx cavity, for low notes, to a forward tongue position creating the opposite volume distribution for high notes (essentially the same as for the baroque trumpet).
* Movement of the tongue from the "normal" position, if slight, was found to alter the spectral components in the radiated sound, and if large, to cause changes of pitch (again, similar to the baroque trumpet) or "multiphonic" notes.
* Similar, but smaller changes were found in players of the recorder and oboe.

Clinch (1) and co-authors (12), proposed the hypothesis that the players of these instruments were intuitively matching a resonance of the vocal tract to the pitch of the note that was being played. The resonance being matched was usually the lowest but could be a higher resonance when the very high instrument registers were being played.

This report summarises the results of an investigation into the interactions of the vocal tract, using a numerical model of a clarinet-like system, including a vocal tract.

CLARINET MODEL INCLUDING VOCAL TRACT

In the now standard model, (14), the clarinet consists of a highly non-linear reed generator, coupled to a linear distributed acoustic system representing the instrument. To include the effects of vocal tract resonance, we follow workers in the field of speech analysis (15), (16), by representing the vocal tract as a linear distributed acoustic system. The two linear systems are characterised by their acoustic impedance functions, Z_c and Z_v. The reed generator is driven by the difference in the oscillating part of the pressure on each side of the reed, $P_c - P_v$. Owing to the possibility of negative effective impedance for the reed system (17), (18), self-sustained oscillations are possible.

As a result of recent theoretical and computational developments (19), (14), (20), it is entirely feasible to make *ab initio* computer calculations of the pressure waveform in the mouthpiece, given the impedance of the two linear systems, and a detailed model of the reed behaviour. Such calculations have been performed, and the results will be discussed below.

However, significant predictions of the behaviour of the system can be made by noting that the situation described above is formally equivalent to a system consisting of the same reed generator coupled to a distributed linear system having impedance function $Z_c + Z_v$ (26), (21). This impedance function has peaks arising from both the clarinet tube, and the vocal tract. A great deal is known, both experimentally and theoretically, about the influence of the relative strength and relative frequency of the impedance peaks, on the behaviour of self-sustained musical oscillators. For instance the following deductions can be made:

(1.) It is known, for reed instruments with the reed geometry of the clarinet or oboe type, that the favoured regime of oscillation is one based on a frequency just below the frequency of an impedance peak of the linear distributed system. For a theoretical derivation of this result see ref. (17), and for experimental confirmation see ref. (22). It is also known that the regime of oscillation will generally be based on the peak of lowest frequency provided it is strong enough. We can thus make the prediction that the regime of oscillation can be based on the vocal tract resonance provided that the resonance is lower in frequency than the lowest competing instrument resonance, and that the resonance is strong enough. Thus it is predicted that the clarinettist can alter the pitch of the instrument flat of its normal playing frequency by using vocal tract resonances. This type of pitch control is known to musicians to be possible, and is used in Jazz technique where it is known as "bending the note".

(2.) It is known experimentally (23) that if one of the higher resonances of the distributed linear system becomes more prominent than the fundamental, a register change can take place whereby the regime of oscillation is re-established based on this higher frequency peak. However, we can predict that the register change could also be affected by vocal tract manipulation if the higher resonance peak is enhanced by making a vocal tract resonance coincide with it. It is known to be possible to change registers without the use of the register key and while retaining the low register fingering. The technique is known as "bugling" (8). In this way, regimes based on the first, third, fifth and seventh harmonics of the fundamental can be produced, corresponding to the frequencies of the prominent peaks in the impedance of a straight column of air open at one end and closed at the other.

(3.) It is known both experimentally (23), (24) and theoretically (14), that if the resonance peaks of the distributed linear system are poorly aligned with respect to the harmonic series, that "multiphonic" tones can be produced. Multiphonic tones are tones with a complex periodicity which generally sound like a superposition of two or more tones of different frequencies. It is thus predicted that certain alignments of the vocal tract manipulations may assist in their production, using altered fingering chosen to produce the effect (7).

(4.) If the instrument resonances are made weak compared to those of the vocal tract it would be possible for the regime of oscillation to be based on the vocal tract resonance frequency over a wide range of pitch. This may occur in one technique of performing the effect known as the "glissando". A note is fingered very loosely so that the covered tone holes leak. It is found that the pitch of the instrument can then be varied by the player, continuously over a wide pitch range, quite controllably.

All the effects predicted above are well known to clarinettists, and it is also well known that the timbre of the instrument can be greatly controlled by the player. However, instrumentalists disagree on what variables of embouchure they are controlling when they produce these effects.

COMPUTER SIMULATION

All these effects were found to occur in the computer simulations. Here we will concentrate on the operating frequency, since this is unambiguously related to the musical variable of pitch. The connection between the pressure waveform in the mouthpiece, and the musical variable of the timbre of the radiated sound is less clear.

For Z_c, the calculation used the impedance function of an open tube modified to include the well known high frequency cutoff. The reed generator was similar to that described in ref. (14), except that the reed resonance frequency was 2500 Hz (25), and for the reactive part of the reed opening impedance, the empirical form given by Backus was used (28). These changes yielded waveforms for the mouthpiece pressure and reed tip position, when the model was run without vocal tract, in good agreement with those measured by Backus (27), for an artificially blown clarinet. Z_v was a single resonance whose frequency and peak height could be varied. This approach to the vocal tract avoids using a specific model of the effect of the geometry of the tract on its resonances, and indeed avoids the question of where and how the vocal tract terminates. Since the player can only control one resonance (usually the lowest) at a time, and because the operating frequency of musical oscillators is known to be determined mainly by the resonances near the operating frequency, we expect useful results from this approach.

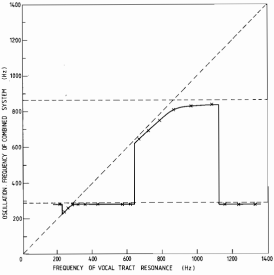


Figure 1. Frequency of oscillation of the model clarinet with vocal tract resonance included. Horizontal dotted lines are the resonance frequencies of the tube representing the clarinet. Diagonal dotted line represents the vocal tract resonance frequency. Horizontal axis represents frequency of vocal tract resonance. Vertical axis represents oscillation frequency of combined system. Peak height ratio is 0.7

Figures 1 and 2 show the calculated frequency for various vocal tract resonance frequencies. The fundamental resonance of the clarinet tube was 288.3 Hz. We see that for a limited range of frequencies for which the vocal tract resonance is lower in frequency than the nearby instrument resonance, the regime of oscillation is based on the vocal tract resonance. The frequency range over which the vocal tract can influence the behaviour of the clarinet is determined by the ratio of the heights of the peaks in the impedance function of the vocal tract to those of the clarinet. This ratio is determined partly by the relative losses of the two systems, but more importantly by the ratio of the areas of tract and clarinet tube at the reed. In Figures 1 and 2, the peak height ratios are 0.7 and 0.5 respectively. When this ratio is about 5.0, the regime of oscillation is based on the vocal tract resonance over the entire range. Below about 0.2 the oscillation is based on the first resonance of the clarinet. In between these extremes we see that the vocal tract resonances can be used to select which resonance of the clarinet the oscillation will be based on (bugling) and can also alter the pitch over a certain range (bending). Multiphonic waveforms were also found for certain values of the vocal tract resonance.

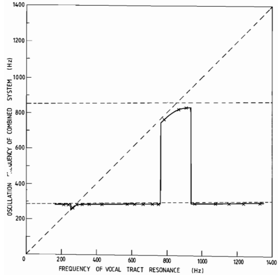


Figure 2. Similar to Figure 1 but with peak height ratio 0.5.

The question then arises whether the vocal tract resonances are ever large enough in practice to cause these effects. Backus (10) reports that the peak impedance of the vocal tract measured at the mouth is an order of magnitude less than that typical of the clarinet. However, these measurements were made with the vocal tract *terminating in a short length of tube with a cross sectional area of 11.4 square cm.* The typical height of the impedance peaks for a tube of variable cross sectional area, measured at one end, is mainly determined by the area of the tube at the plane of measurement, the influence of losses on peak height being similar for different tube shapes of the same average cross section and length. This statement has been verified for various tube shapes, by direct calculation, using the method of Plitnik and Strong (29). *Since the typical area of the vocal tract at the mouthpiece in clarinet playing is 1.5 — 2.0 square cm, the peak in the vocal tract impedance seen at the reed is at least 5 times greater than those measured by Backus.* A similar argument explains the failure to see the effects described above in an experiment (10) where a clarinet is artificially blown through a tube meant to represent the vocal tract. The model tract terminates at the reed in a large diameter section of tube, so the impedance seen at the reed will be much less than that of the real vocal tract.

CONCLUSIONS

Our computer simulations indicate that vocal tract resonance control is the main method used by the player to effect large pitch changes and to change registers without the use of the register key. Computer simulations using different reed parameters showed that the effect of changes to lip parameters was incapable of causing the large pitch variation possible on the instrument: see by comparison ref. (25). Thus it appears that the term "lipping the note", used for pitch bending, may be a misnomer.

A full account of the calculations and their results is being prepared for publication.

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Nonlinearities in Musical Acoustics

Neville H. Fletcher
Institute of Physical Sciences, CSIRO
Limestone Avenue
Canberra ACT 2602

ABSTRACT: The role of nonlinearity in the behaviour of musical instruments is discussed, with particular reference to the clarinet, the trumpet, the flute, the violin, and certain percussion instruments.

Nearly all the acoustical theory to which we have all been exposed over the years has been linear — twice the excitation gives twice the response — though we probably recall that at large amplitudes, as in shock waves, the situation is much more complex and nonlinear equations are involved. But this is too complicated for most of us to worry about, and surely shock waves are restricted to explosions and supersonic aircraft anyway!

Against this background it may come as something of a shock to realise that the behaviour of musical instruments such as the violin and the clarinet is dominated by nonlinearity and we have no hope of understanding their behaviour without considering it quite explicitly. In these few pages I would like to give a gentle introduction to nonlinearity and its importance in musical instruments. It is not a subject to which many people have given explicit attention, and I apologise in advance for the limited reference list, but a recognition of its importance is quite fundamental.

LINEAR AND NONLINEAR OSCILLATORS

All the instruments of music, and indeed almost all physical vibrating systems, behave as linear or harmonic oscillators if their amplitude of vibration is small enough. There are a few singular cases which we meet later, but this assertion really derives from the mathematical process of neglecting all but the most important terms or from the physical process of assuming all elastic forces to be reasonably described by Hooke's law provided the displacements are small.

Suppose that the coordinate x_n represents in a general way some oscillatory quantity. It could be the physical displacement, as a function of time, of a mass hanging from a spiral spring, or the displacement of a point on a vibrating string, or the velocity of air flow in a wind instrument. Whatever it is, the equation describing its behaviour can be written in the form

$$\ddot{x}_n + 2k_n\dot{x}_n + \omega_n^2 x_n = F(t) + G(x_n, \dot{x}_n) \qquad (1)$$

where a dot implies differentiation with respect to time, and on the right-hand side of (1) we have collected all the terms not explicitly accounted for on the left side. k_n and ω_n are constants chosen so that there are no terms linear in $\dot{x}_n$ or x_n on the right side. F(t) is a forcing function that represents the external force on the system while $G(x_n, \dot{x}_n)$ collects all the terms in x_n or $\dot{x}_n$ of higher than first power [1].

The linear approximation arises from the observation that, if x_n is small compared with some characteristic dimension of the system, then x^2_n is very small and we can neglect $G(x_n, \dot{x}_n)$. Further, if we are interested in the system only when it is not being acted upon by external forces other than steady ones, for example a piano string after the hammer impact or a trumpet playing a steady note, then we can neglect F(t) or incorporate it as a change of origin for x_n. As we all know, the solution to equation (1) then has the simple form

$$x_n = a_n \cos(\omega_n t + \phi_n) \exp(-k_n t) \qquad (2)$$

where the amplitude a_n and phase ϕ_n are determined from the way in which the motion was started.

For an "extended" system, like a bell or a violin string or the air column in a trumpet, which has several possible vibration modes, we have a set of equations like (1) and solutions like (2) for each mode x_n. The mode frequencies ω_n for a real system do not ever have exact integer ratios. The stiffness of real strings makes

$$\omega_n \cong n\omega_1(1 + \alpha n^2) \qquad (3)$$

for example in pianos, and there is a similar sharpening of upper mode frequencies in simple open pipes, while bells and gongs have mode frequencies distributed in a quite complex way. All this, however, is still quite linear. If we excite a bell with its clapper then each mode sounds out by itself and dies away according to an expression like (2).

The complication begins to arise, for simple systems like plucked strings or hammered gongs, when the initial amplitude a_n becomes so large that we can no longer neglect $G(x_n, \dot{x}_n)$ in (1). The simplest case is that of a plucked string. At large amplitude the tension T of the string is increased, in proportion to x_n^2, every time the string moves away from equilibrium. The restoring force is proportional to the product $T\nabla^2 x_n$ and so there is an extra term in G varying like x_n^3. Now x_n^3 involves $a_n^3\cos^3(\omega_n t + \phi_n)$, which can be expressed as terms in $a_n^3\cos(\omega_n t + \phi_n)$ and $a_n^3\cos 3(\omega_n t + \phi_n)$, and the first of these is at the correct frequency to influence the left-hand side of the equation. The resulting solution [1] for x_n has a frequency ω which varies like

$$\omega \cong \omega_n + \beta a_n^2 \exp(-2k_n t) \qquad (4)$$

so that the string emits a note with a descending "twang".

In gongs, particularly those used in China, the shape can be arranged so that the pitch glides either downward (for a flat-faced gong) or upward (for a slightly domed gong), the glide being as much as several semitones [2].

SELF-EXCITED OSCILLATORS

Of far more interest than the free oscillators discussed above, from both physical and musical points of view, are the self-excited oscillators which can produce a steady sound when supplied with a constant source of power. Such oscillators are, of course, common in the communications industry as well, but the design objectives in the two fields are completely different. The woodwind, brass and bowed-string instruments all belong to this category and for all of them nonlinearity is vital rather than merely incidental.

From a mathematical point of view F(t) in (1) is still constant, so can be neglected, but the physical system has been so arranged that $G(x_n, \dot{x}_n)$ now feeds back part of the acoustic output as a driving force, so that the system oscillates of its own accord. We examine a few typical systems in turn. In all of them we have a very nearly linear system — the air column or the string — coupled to a highly nonlinear feedback-controlled generator — a reed, an air jet, or a friction-regulated bow.

In (1) we can now suppose that the damping coefficient k_n is that which refers to the resonant system alone, without its generator, and that G may now contain terms in x_n and in $\dot{x}_n$ contributed by the generator. From (2), the condition for an oscillation to begin and build up is clearly that G should contain a term in-phase with $\dot{x}_n$ and larger than $2k_n\dot{x}_n$. Conversely if this term in G is smaller than $2k_n\dot{x}_n$, the oscillation will decay, while if equality prevails it will remain steady in amplitude.

THE CLARINET

One of the simplest systems to analyse is the clarinet [3, 4]. It has a light, responsive elastic reed closing one end of a cylindrical tube as shown in Figure 1(a). The player's mouth provides a blowing pressure p_o tending to close the reed, while the acoustic pressure p inside the mouthpiece (which we take as our variable x_n) tends to force it open. Since the resonant frequency of the reed is arranged to be much higher than the playing frequency ω_n the reed position responds like a simple spring valve and lets more or less air into the mouthpiece from the player's mouth. It is this flow of air, U, which drives the instrument oscillation.

The actual form of U(p), which is the same as that of $G(x_n)$ except for a phase shift of 90°, is shown in Figure 1(b). If the internal pressure p is equal to the blowing pressure p_o, which is typically about 3 kPa above atmospheric (i.e. 30 cm water gauge), then there is no air flow into the mouthpiece and we are at point D. As p is decreased the flow increases by Bernoulli's law as $(p_o - p)^{1/2}$ but soon this begins to be balanced by the fact that the pressure difference $p_o - p$ is forcing the reed closed. This closing effect dominates to the left of C and at B the reed is forced completely closed. The normal operating point is near A with the acoustic pressure swinging back and forth along the curve BC. This actually represents a negative resistance because the flow U is measured towards the driving pressure rather than away from it. In the region BC, $G(x_n)$ is in phase with $\dot{x}_n$ and the clarinet sounds.

It is clear that the very functioning of the clarinet and similar reed instruments depends upon the nonlinearity of the flow relation U(p) for the reed but this nonlinearity also has other effects. The curve in Figure 1(b) is invariant if we change the blowing pressure p_o — it simply slides along the axis — while the operating point always oscillates about atmospheric pressure. Clearly if p_o is too small then A will lie on the curve between C and D, and G will be dissipative rather than generating, while if p_o is too large A will be to the left of B and G will be zero.

If the operating pressure makes small excursions about A the coefficient of $\dot{x}$ that it contributes is essentially the slope of the curve at A. If this is greater than 2k the instrument will play — if not then we must remake the reed. As the pressure excursion increases, however, the curvature of the section BC begins to introduce harmonics of ω_n — precisely phase locked — into the flow U. These appear in drive terms not only for x_n but also for other modes x_m through equations like (1) and, since the cylindrical air column has nearly harmonic resonances at about $(2n-1)\omega_1$ the odd harmonics are preferentially reinforced. Quite generally, since the nonlinearity can be expanded as a power series in p, the amplitude of the sth harmonic of mode n will vary initially as $a_n{}^s$.

As the pressure amplitude grows larger and swings from X to Y say, the effective value of the coefficient of $\dot{x}$ in G decreases to roughly the slope of the line XZ, and growth stops when this is equal to the tube loss coefficient 2k. For a loudly blown reed — the amplitude is controlled by changing the geometry of the reed with the lips — the pressure excursion is typically like XY in the figure and the flow waveform is something like a square wave. This produces many harmonics, no longer with the simple $a_n{}^s$ amplitude relation, and the sound is rich and reedy.

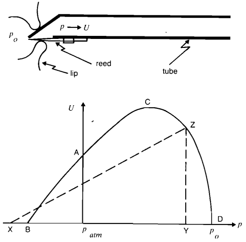

Figure 1: (a) Schematic diagram of a clarinet mouthpiece and tube. The reed is blown closed by the blowing pressure p_o in the player's mouth but this is resisted by the acoustic pressure p inside the instrument. The volume flow is U. (b) The static nonlinear relation between U and p. The normal operating point is close to A.

THE TRUMPET

In the case of lip-blown instruments such as the trumpet, the situation is rather different because the blowing pressure forces the lip valve open rather than closed [4-6]. This reversal in sign requires a compensating phase change of 180° somewhere else in the system, and this is introduced by adjusting muscle tension so that the resonant frequency for buzzing of the lips is just below the sounding frequency rather than well above as in the case of the clarinet reed. It turns out that the exact lip resonance frequency is critical to the operation of the system, so the player can (and must) adjust his lips to select just the pipe mode required. There is no blowing pressure limit for brass instruments as there is with reeds, and the dynamic nonlinearity is of the form shown in Figure 2. The limit to the sound power output is set only by the blowing pressure and volume flow that can be applied by the player.

FLUTES AND ORGAN PIPES

Among the gentler-toned instruments the flue organ pipe, flute and recorder are alike in that their sound generating mechanism relies upon a nearly plane jet of air emerging from a flue (or from the lips), traversing a mouth-hole cut in the pipe near one end, and then impinging on a more or less sharp

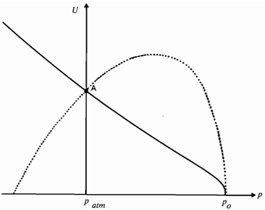

Figure 2: The static nonlinear relationship between airflow U and mouthpiece pressure p for a lip-excited (brass) instrument blown with pressure p_o. The dynamic flow relationship (dotted curve) is changed in sign because the operating frequency is above the lip resonance. The normal operating point is near A.

upper lip as shown in Figure 3(a). The jet can be deflected by the acoustic flow through the pipe mouth so that either more or less of it enters the pipe at the lip to drive increased pipe flow. The whole situation is complicated by the fact that the interaction between the mouth flow and the jet takes place at the flue where it induces transverse waves on the jet which take an appreciable time to reach the lip. Detailed study [7-9] shows that the phase relations are appropriate for regeneration when this wave transit time, which is close to twice the jet flow transit time, is very nearly half a period of the oscillation in the pipe.

Assuming now that this phase shift has been appropriately adjusted by varying blowing pressure and flue-to-lip distance, it is clear that the flow into the pipe at the lip, and hence the interaction function G, has the general form shown in Figure 3(b). Here U_m is the acoustic flow in the mouth and U_j is the jet flow into the pipe. The curve saturates for large positive or negative values of U_m when the jet is flowing entirely into or entirely out of the pipe. The operating point A is generally set asymmetrically so that the jet flows predominantly outside the pipe in its undeflected state. If the slope at A (allowing for other factors in G) is greater than 2k, then the oscillation will grow, to stabilise eventually (in fact after 20-40 cycles) to a sweep such as XY for which the slope of XZ is equal to 2k (again allowing for any deviation of the phase shift from the optimal value).

This nonlinearity both limits the amplitude and generates harmonics which can interact with the higher modes of the pipe. The relative strengths of even and odd harmonics depend critically upon the placing of the operating point A on the curve, and this is one of the operations carried out in pipe voicing, or one of the performance variables available to flute players [9, 10]. The relatively gentle nature of the nonlinearity gives a much smaller degree of harmonic development to the tone than is the case for reed pipes or lip-blown instruments.

STRINGS

As a quite different form of nonlinearity we consider now the bowed-string instruments. The string is itself a nearly linear vibrator and the interaction at the bow involves a stick-slip motion derived from the fact that static friction is greater than dynamic friction, which is itself velocity dependent. The speed v_o of the bow is constant and, if we take the oscillatory variable x to be the velocity v of the string at the bow position, then the curve relating the transverse force F on the string to

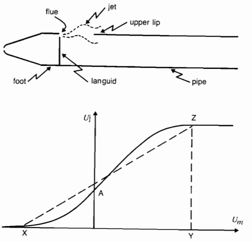

Figure 3: (a) Schematic diagram of an organ flue pipe. The air jet emerges from the flue, crosses the mouth, and strikes the upper lip. The jet has waves induced upon it by acoustic flow through the mouth and these deflect it into or out of the pipe at the lip. (b) The nonlinear relationship between jet flow U_j into the pipe at the upper lip and acoustic flow U_m through the mouth. The normal operating point is near A.

the velocity v has the form shown in Figure 4. The nonlinearity is obviously pathological, with a discontinuity at $v = v_o$.

The nonlinearity of the frictional characteristic implies that we could have self-sustained nearly sinusoidal vibrations about an operating point such as A, but in reality this can occur only for the case of a large oscillating mass driven by a small frictional force. The case of the bowed string is at the opposite extreme — the string mass is small and the rosined bow exerts a large frictional force. The motion then turns out to be one in which the string moves for a large part of each cycle in the sticking position B and then makes a switching transition for a small part of the cycle to the slipping position C. This stick-slip motion is so highly, and indeed essentially, nonlinear that it is quite inappropriate to attempt to analyse it by considering growth from the nearly linear situation. The string motion has however been analysed in detail, beginning with the studies of Helmholtz and Raman, and we now have a very good appreciation of most of the subtleties of its behaviour [11, 12].

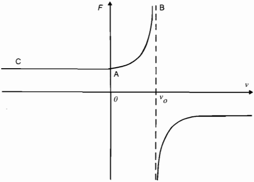

Figure 4: The relation between frictional force F and string velocity v for a bow drawn with velocity v_o across the string.

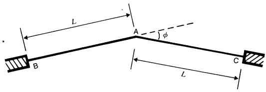

Figure 5: A thin bar (or plate) kinked (or creased) at a small angle ϕ.

EPILOGUE

As a final pathological nonlinearity let me return to consider a passive vibrating system consisting of either a very lightly creased thin plate or a slightly kinked thin bar held between clamps as shown in Figure 5. If the oscillation amplitude is very small, then simple analysis shows that the point A must remain fixed to first order so that the first and second modes will be respectively the antisymmetric and symmetric vibrations of the two half-bars of length L. However, as the vibration amplitude increases, nonlinear effects of the kind we have discussed before will move the point A downwards by an amount proportional to $a_n^2(1 + \cos 2\omega_n t)$ where ω_n is the frequency and a_n the amplitude of the mode involved. When a_n becomes large enough, the point A will approach the line BC and the bar will then be able to sustain an additional mode in which it vibrates as a whole as a bar of length 2L. The frequency of this mode is only about one quarter of that of the previous fundamental.

All this is not surprising when the angle ϕ is reasonably large. What does give cause for wonder is that this transition behaviour is confined to an amplitude range of order L sin ϕ, which clearly approaches zero as ϕ approaches zero, giving us another pathological or essential nonlinearity. This effect — a jump of nearly two octaves in the vibration pitch — can, in fact, be heard in the decaying vibrations of some dented flat-sided tin cans. It is saved from physical unreality as $\phi \to 0$ by the fact that thickness can no longer be neglected if it is comparable with L sin ϕ.

Nonlinearities are real, nonlinearities are often extremely important and, if we treat them right, they do not get out of hand.

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Terminal 4 — Heathrow

The opening of Terminal Four (T4) at Heathrow Airport in April 1986 will have been treated by regular air travellers with a great sigh of relief, as it will no doubt decrease the congestion experienced in the other terminals during the past few years. The prestigious new building on the south-eastern perimeter of the airport will cater for up to eight million passengers per annum right from the start, and will service all British Airways overseas flights as well as their Paris and Amsterdam routes, and all KLM and Air Malta flights. The opening of the terminal may, however, have been greeted with rather less enthusiasm by the residents in nearby Bedfont and Stanwell, except in so far as it meant the completion of several years major construction work.

During the Public Inquiry on the planning application for T4, held between May and December 1979, the most important single issue related to noise. There was concern firstly, about any increase in air traffic which might result, and secondly, about ground movements and activities around T4, which unlike the existing terminals was to be situated at the edge of the airport and close to a built-up area. The Inspector recognised the potential problem as presented to him in the evidence given by the GLC and other local authorities, and made a number of recommendations, most of which were accepted, some in a modified form, by the Secretary of State and included in the planning conditions.

Regarding total air traffic he recommended that annual Air Transport Movements (ATMS) should be limited to 260,000 once T4 was opened. The Secretary of State changed this to 275,000 but following the inquiry on **Terminal Five** the government decided in the White Paper on Airport Policy to scrap the limit altogether. The latest figures indicate over 285,000 ATMS per annum at Heathrow.

Many positive steps have however been taken to implement the Inspector's recommendations. These include the construction of 7m high concrete noise barriers, with a total length of 1.2km, covering the two aprons on the 'land' side of the airport, and some of the taxiways. Furthermore all maintenance work involving the running of aircraft engines at T4 throughout the day was prohibited. On the operational side conditions were set for T4 banning aircraft movements, the running of aircraft engines, and the use of APUs (auxiliary power units) between 23.30 and 6.30 hours. Subsequently however, following an appeal by the British Airports Authority and a further local inquiry, these conditions were relaxed to exclude aircraft on or taxing to and from the apron on the airport side of the terminal building. This relaxation was agreed on the basis of a three year experiment during which time the BAA and local authorities would monitor night time aircraft noise in the residential area. Continuous monitoring of aircraft noise is now taking place at sites in East and West Bedfont, and this is supported by occasional sampling at other locations in that area.

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A Practical Evaluation Method for the Stochastic Noise Reduction Effect of Sound Absorbing Materials

Mitsuo Ohta
Faculty of Engineering
Hiroshima University,
Shitami, Saijo-cho,
Higashi-hiroshima City, 724,
Japan

Yasuo Mitani
Faculty of Engineering,
Fukuyama University,
Sanzo, Higashimura-cho,
Fukuyama City, 729-02
Japan

ABSTRACT:
This paper describes a practical evaluation method for the stochastic noise reduction effect when a stationary random noise excitation of arbitrary non-Gaussian distribution type is attenuated by inserting a sound absorbing material into a room. By paying special attention to the change in the acoustic system due to the introduction of the sound absorbing material, it is possible to evaluate the 'improved' noise level probability distribution after inserting the sound absorbing material: this is very important for noise evaluation and regulation problems. The validity of the proposed method has been experimentally confirmed by applying it to actually observed data. The experimental results are in good agreement with the theoretically evaluated probability curves. Values of L_5, L_{10} and L_{50} *can be estimated within* ±1 dB.

1. INTRODUCTION

As was pointed out in previous work (1), it is very important to study the stochastic noise reduction effect of environmental random noise which one encounters in a daily life, because the statistics such as L_x sound levels (e.g., L_5, L_{10}, L_{50} and L_{90}) and an Leq evaluation index are used for evaluating such a random noise environment. From the methodological viewpoint, one can consider two approaches for the probabilistic evaluation of various noise reduction systems. As one approach, paying special attention to an acoustic system change, by reinforcement of the existing noise reduction system, a unified probabilistic evaluation method for various noise reduction systems can be constructed. On the other hand, another probabilistic evaluation method can be constructed based on considering the resultant probabilistic response of objective noise reduction systems, not from the viewpoint of the above acoustic system change. Based on the first way of thinking, by considering the reinforcement of the present sound insulation wall, a unified probabilistic evaluation method for predicting the improved noise level probability distribution (or noise intensity probability distribution) was proposed by use of a somewhat modified statistical energy analysis method (2). That is, in order to study systematically the mutual relationship between two probability distributions of the noise intensity fluctuations before and after improving the acoustic character of a wall based on the reinforcement of the present noise reduction system, a new trial for the stochastic noise reduction effect of the wall was proposed.

Based on the above unified theory due to the acoustic system change, this paper describes a practical method for evaluating the probabilistic response of another typical noise reduction system inside a room. More concretely, as one of the typical noise reduction systems inside a room, the probabilistic evaluation method of a sound absorbing material has been considered here, since no probabilistic evaluation of a sound absorbing material can be found despite many previous works (3-5).

Finally, the validity of the proposed evaluation method has been confirmed by use of actually observed noise data.

2. THEORETICAL CONSIDERATION

2.1 A General Theory on the Noise Intensity Probability Distribution

In order to evaluate the stochastic noise reduction effect for reducing the arbitrary L_x sound levels before and after the reinforcement of an acoustic system, it is first necessary to introduce a general theory on the improved noise level (or noise intensity) probability distribution function based on the original probability distribution form before its reinforcement. In this section, an objective explicit expression for the improved noise level (or noise intensity) probability distribution function after the reinforcement is briefly given based on the above-mentioned previous work (2). Let x and y denote respectively the noise intensity fluctuation before and after using a noise reduction system (i.e., before and after the reinforcement of acoustic system). The improved probability density function $P_y(y)$ after using the noise reduction system is expressed as (2):

$$P_y(y) = \sum_{r=0}^{\infty} (-1)^r \frac{A_r}{r!} \left(\frac{\partial}{\partial y}\right)^r P_x(y) \qquad (1)$$

with

$$A_r \overset{\Delta}{=} \frac{\partial^r}{\partial \theta^r} \left\{\exp\left(\sum_{n=1}^{\infty} \frac{\theta^n}{n!} (\kappa_{y,n} - \kappa_{x,n})\right)\right\}\Bigg|_{\theta=0}, \qquad (2)$$

where $P_x(.)$ is the probability density function before using the noise reduction system. Moreover, $\kappa_{x,n}$ and $\kappa_{y,n}$ denote respectively the nth order cumulants with respect to the random variables, x and y. From Eq.(1), the improved probability density function $P_y(y)$ after the reinforcement of acoustic system can be constructed by use of the original probability density function form $P_x(\cdot)$ before the reinforcement. At this time, the cumulative distribution form $Q_y(y)$, which is very important for the purpose of finding an arbitrary L_x sound level, can be derived as follows:

$$Q_y(y) = \int_0^y P_x(\xi)\, d\xi + \sum_{r=1}^{\infty} (-1)^r \frac{A_r}{r!} \left(\frac{\partial}{\partial y}\right)^{r-1} P_x(y) \qquad (3)$$

with

$$\left.\begin{aligned} &A_0 = 1, \quad A_1 = \kappa_{y,1} - \kappa_{x,1}, \\ &A_2 = \kappa_{y,2} - \kappa_{x,2} + (\kappa_{y,1} - \kappa_{x,1})^2, \ \dots \end{aligned}\right\} \qquad (4)$$

Needless to say, the above concrete form of the expansion coefficient, A_r, has been derived from its definition as shown in Eq. (2). In this case, it should be noted that one can reasonably employ the logarithmic normal distribution function as $P_x(y)$:

$$P_x(y) = [(2\pi)^{\frac{1}{2}} \sigma y]^{-1} \exp -[(\ln y - \mu)^2/2\sigma^2] \qquad (5)$$

with

$$\left.\begin{aligned} \mu &= \langle \ln x \rangle = \ln \langle x \rangle - \sigma^2/2, \\ \sigma^2 &= \langle (\ln x - \mu)^2 \rangle = \ln \{[\langle (x-\langle x \rangle)^2 \rangle / \langle x \rangle^2] + 1\}, \end{aligned}\right\} \qquad (6)$$

since a standard Gaussian distribution is very often employed as the approximate form of the probability density function for the noise level fluctuation (i.e., this function form is connected with the logarithmic normal distribution function for the noise intensity fluctuation under consideration). Therefore, the cumulative distribution function $Q_y(y)$ in Eq. (3) is concretely expressed as:

$$Q_y(y) = \int_0^y [(2\pi)^{\frac{1}{2}} \sigma \xi]^{-1} \exp -[(\ln \xi - \mu)^2/2\sigma^2] \, d\xi + \sum_{r=1}^{\infty} (-1)^r (A_r/r!) (\partial/\partial y)^{r-1} \cdot \{[(2\pi)^{\frac{1}{2}} \sigma y]^{-1} \exp -[(\ln y - \mu)^2/2\sigma^2]\}. \qquad (7)$$

Moreover, the cumulative noise level distribution, $Q_y(L)$, directly connected with the actual noise evaluation can be easily evaluated by use of the above explicit expression for $Q_y(y)$, as follows:

$$Q_y(L) = Q_y(y) \Big|_{y=y_0 \cdot 10^{L/10}}, \qquad (8)$$

where y_0 denotes a reference noise intensity usually taken as 10^{-12} (watt/m^2).

2.2 Relationship between Power Frequency Characteristic of Sound Absorbing Material and Distribution Parameters of Probability Expression

In order to determine the distribution parameters μ, σ^2 and A_r contained in the cumulative probability distribution expression, Eq. (7) it is first necessary to calculate the pth order cumulant (or the pth order moment with p=1,2, . . .) of the noise intensity fluctuation, y, at an observation point. Let X_i (i=1,2, . . .,N) be an input noise intensity fluctuation existing in the ith frequency band before using a sound absorbing material, and Y_i (i=1,2, . . .,N) be the output noise intensity fluctuation after using this sound absorbing material. Moreover, let the attenuation coefficient, α_i (i=1,2, . . .,N), denote the power frequency characteristic of the sound absorbing material at the center frequency, f_{ci}, of the ith octave band (or one-third-octave band). Based on the additive property of energy quantities, the output noise intensity fluctuation, y, at the observation point can be easily given by summing all of the noise intensity fluctuation in each frequency band:

$$y = \sum_{i=1}^{N} \alpha_i X_i. \qquad (9)$$

Originally, the power frequency characteristic, α_i (i=1,2, . . .,N), can be simply estimated by use of two moment data of X_i and Y_i, as follows:

$$\alpha_i = \frac{\langle Y_i \rangle}{\langle X_i \rangle}. \qquad (10)$$

Of course, it must be noticed that this parameter is a proper physical constant even in the arbitrary cases with a general random noise excitation. Therefore, the pth order moment, $\langle y^p \rangle$, for y can be estimated as: (11)

$$\langle y^p \rangle = \sum_{i+j+\ldots+n=p} \frac{P!}{i!\, j! \ldots n!} \alpha_1^i \alpha_2^j \ldots \alpha_N^n \langle X_1^i . X_2^j \ldots X_N^n \rangle,$$

by using the statistical property of the input noise intensity fluctuation, X_i (i=1,2, . . .,N), in each frequency band and the power frequency characteristic, α_i, of the sound absorbing material. Furthermore, from the mathematical viewpoint, it is a well-known fact that the pth order cumulant is given by the statistical information from the first order moment to the pth order moment, as follows (6):

$$\left.\begin{aligned} &\kappa_{y,1} = \langle y \rangle, \ \kappa_{y,2} = \langle y^2 \rangle - \langle y \rangle^2, \\ &\kappa_{y,3} = \langle y^3 \rangle - 3\langle y^2 \rangle \langle y \rangle + 2\langle y^3 \rangle, \ \ldots \,. \end{aligned}\right\} \qquad (12)$$

Hence, the distribution parameters μ, σ^2 and A_r in Eq. (7) can be determined by substituting Eq. (11) into Eqs. (4), (6) and (12).

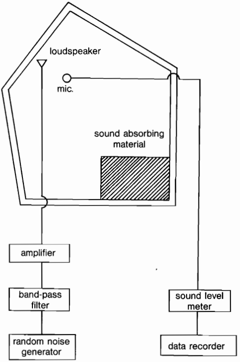
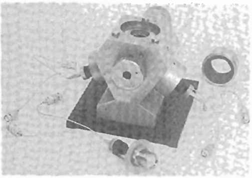


Figure 1 Block diagram of experimental arrangement after inserting the sound absorbing material into the reverberation room.



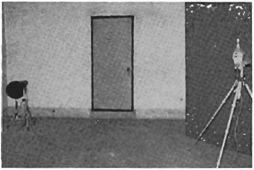


Figure 2 Actual scene of measuring the random noise fluctuation after inserting the sound absorbing material into the reverberation room.

3. EXPERIMENTAL CONSIDERATION

The experiment has been done in a reverberation room and the block diagram of the experimental arrangement is shown in Figure 1. Using a band-pass filter and an amplifier, white noise generated from a random noise generator was supplied to the loudspeaker. The received acoustic noise has been recorded by use of a data recorder. Figure 2 shows the actual scene of measuring the random noise fluctuation after inserting the sound absorbing material into the reverberation room. The observed values of the averaged noise intensity existing in the ith frequency band before and after inserting the sound absorbing material (porous material; 35.5 (width) x 15.5 (height) x 69.0 (length) cm) are shown in Table 1. Hereupon, the usual one-third-octave band analysis has been used. The power frequency characteristic, α_i (i=1,2,3), of the sound absorbing material is estimated by use of Eq. (10) and its value is shown in Table 2.

Figure 3 shows a comparison between the theoretically evaluated curves by use of the proposed method and the experimentally sampled points in the form of a cumulative noise level distribution (after inserting the sound absorbing material), together with the actual data observed before using this sound absorbing material. Hereupon, let us define the expansion expression from the first term to the term with expansion coefficient A_r $(r \geq 1)$ in Eq.(7), as the rth approximation of $Q_y(L)$. From this figure, it is obvious that the successive addition of higher expansion terms moves the theoretical probability curves closer to the experimentally sampled points. Moreover, according to the first and/or second approximations of $Q_y(L)$, the prediction errors of evaluation indices, L_5, L_{10} and L_{50}, usually used in the actual noise evaluation and/or regulation problems are almost all within ± 1 dB.

TABLE 1
The averaged noise intensity before and after inserting the sound absorbing material into the reverberation room.

1/3 octave band center frequency (Hz)	the averaged intensity before inserting the sound absorbing material (watt/m²)	the averaged intensity after inserting the sound absorbing material (watt/m²)
250	4.135×10^{-3}	2.528×10^{-3}
315	4.851×10^{-3}	3.711×10^{-3}
400	4.294×10^{-3}	2.860×10^{-3}

TABLE 2
Power frequency characteristics α_i of the sound absorbing material.

1/3 octave band center frequency (Hz)	power frequency characteristic α_i
250	0.6114
315	0.7650
400	0.6660

It should be noted that the proposed method is able to evaluate the stochastic response of an arbitrary sound reduction system once the power frequency characteristic of the system and the statistical information on the input noise intensity fluctuation are given experimentally or theoretically in advance.

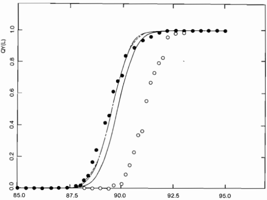


Figure 3 A comparison between the theoretically evaluated curves by use of the proposed method and the experimentally sampled points for the improved cumulative probability distribution after inserting the sound absorbing material, together with the experimentally sampled points before inserting this sound absorbing material. Experimentally sampled points are marked by ●, and the theoretically evaluated curves by use of Eq. (7) are respectively shown as _____, the first term of Eq.(7) ;— — — —, the first approximation ; — · —, the second approximation. Experimentally sampled points before inserting the sound absorbing material are marked by O.

4. CONCLUSION

A new method for evaluating the improved noise level probability distribution after inserting a sound absorbing material into a room has been proposed based on the original noise level probability distribution before reinforcement of the acoustic system. The effect of the statistical property of the input noise emitted from the sound source and the power frequency characteristic of the sound absorbing material on the improved noise level or noise intensity probability distribution is reflected in each distribution parameter of the cumulative probability distribution expression. The validity of the proposed evaluation method has been experimentally confirmed by applying it to measured noise data. The experimental results have been in good agreement with the theoretically evaluated probability curves.

Research on this kind of probability evaluation for various noise reduction systems is still in an early stage of study. And so, this paper has focussed only on its fundamental aspects. There still remain many problems when applied to other actual cases; this will be a future study.

ACKNOWLEDGEMENTS

The authors would like to express their grateful thanks to Prof. S. Yamaguchi, Dr. K. Hatakeyama and Mr. U. Yho for their helpful suggestions. The authors are also thankful for many constructive discussions in the annual meeting of the Acoustical Society of Japan.

(Received 4 February 1986)

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Roar of gas-fired furnaces tamed

Flames extending 2m or more from the nozzle of industrial gas burners are striking not merely because of their luminous quiver but also on account of their ear-splitting roar. For Alcoa of Australia Ltd. they presented a noise and operating problem until a CSIRO study showed how these effects could be alleviated.

Burners like these, of 1.5 MW capacity, are used to fire the reverberatory furnaces at Alcoa's Point Henry aluminium plant, south-west of Geelong.

The 100-plus decibel noise (with the furnace door open) bellowing from the burners corresponds to only one ten-millionth of the flame's energy being converted to sound, but it is well above the acceptable limit of 90 dBA for continuous exposure of unprotected workers.

The company sought the assistance of the CSIRO Division of Energy Technology. Dr. Andre Cabelli and colleagues Ian Pearson and Ian Shepherd then began an investigation of how gas flames generate sound in order to devise ways of reducing the noise levels of the burners.

Their work culminated in modifications being made to a production burner at Point Henry which, at maximum firing rate, produced a tolerable noise level of 85 dBA (with the furnace doors open). Alcoa plans to convert all burners in the plant during the next regular overhaul.

This was a pleasing result for Dr. Cabelli and his team who, at the outset of the study, were faced with a testing physics puzzle. How do you create conditions that would muffle the combustion roar while keeping all the other flame properties — length, colour, uniformity, stability, etc. — at their optimum?

The reverberatory furnaces at Point Henry use a nozzle that ejects air and gas from different orifices. Mixing of the gas and air takes place simultaneously with combustion, as opposed to the premixing of reactants before combustion in some commonly used domestic gas appliances. The former arrangement has two advantages: it is safer and the flame is easier to control. It is less noisy as well, but that is no compensation on the scale of the much larger industrial burner.

To study the effect of various nozzle arrangements and conditions, the researchers built a 30-kW scale-model burner composed of cylindrical aluminium modules (150mm long, 150mm diam.).

They tried different-sized components (contraction heads, burner tips, air distribution devices) and burner tiles with different expansion properties, and measured the various factors at work. These were taken and stored by microcomputer-controlled instruments. Conventional equipment was used to analyse sound.

To study factors affecting the flame, Dr. Cabelli turned to the ubiquitous laser to illuminate sections of the flame for short-exposure photographs to be taken. When the airstream was seeded with fine inert powder, the flow and mixing patterns within the flame were 'frozen' by the extremely brief light flash.

The experiments showed that the design of the nozzle and the relative velocities of the air and gas jets had a considerable influence on the noise produced by the burner.

By imparting swirl to the incoming air, the researchers found they could improve the stability of the flame, which in turn enabled them to make changes in the geometry of the nozzle to give a 5-10dBA drop in noise level.

Owing to the complexity of the processes involved, extrapolation of measurements made with the scale model to the full-size burner did not produce a figure that matched the actual reading — noise reductions were, in fact, significantly better than the model indicated.

Another plus was that the pressure of air feeding the burner could be reduced by about 90 per cent leading to a substantial saving in the power needed to drive the pressurising fan (and reduction in fan noise as well).

The researchers haven't found all the answers to the noise puzzle. They are now looking at the sound-generating mechanism more closely.

Alcoa of Australia Ltd. provided financial assistance for the study. The Division would be happy to discuss the possibility of working with other companies in a joint project of this kind.

For more information: Dr Andre Cabelli, CSIRO Division of Energy Technology, PO Box 26, Highett, Vic. 3190 — Phone (03) 555 0333.

(From CSIRO Industrial Research News ***178****, Sept. 1986)*

"Potty Doctor" tries to eavesdrop on history

His friends call him the "potty doctor", but Peter Lewin's novel theory of eavesdropping on history is based on perfect logic.

Dr. Lewin, a pathologist at the Toronto Hospital for Sick Children in Canada, believes ancient pots may have acted as natural gramophone records, recording snatches of gossip or even music in Egyptian or Roman potteries.

He believes it should be possible to "play back" the sounds with new optical technology of the sort used in compact discs. We might hear potters discussing the Nile floods or the latest on Cleopatra's love life.

While grooves were being etched in clay pots turned on a potter's wheel or glassware being engraved, the sound vibrations of nearby noises, including speech, would have caused the pot or the cutting tool to vibrate minutely.

This would have left an up-and-down trace in the bottom of the groove corresponding to the sound waves — a natural sound recording.

Attempts by Dr Lewin and others over several years to extract recorded sounds with a gramophone needle, used to "play" grooves in pots and glasses while they were rotated on a turntable, have been unsuccessful.

If any voices were recorded, they were lost in the meaningless sounds produced by scratches in the grooves.

Now he has another technique. First Dr. Lewin will have grooves engraved on glasses while loud recognisable sounds such as dialogue or music are played in the background. The newly made grooves then will be probed by a laser beam.

The effect of any irregularities on the beam, reflected back to a photo detector, will be translated back into sound through a loudspeaker via a computer programmed to screen out other irrelevant noises.

(John Newell in the Australian, 27 September 1986.)

Floor vibration
— CSIRO studies

Standing in a building where you can feel the floor vibrate when someone walks past can be disconcerting.

This is occurring more frequently in our medium-rise buildings as designers strive for greater floor spans. The longer-span floors tend to have lower fundamental frequencies (< 10Hz), and lower damping due to the stiffness required to meet deflection criteria. To test the dynamic performance of constructed floors, researchers at the CSIRO Division of Building Research have developed a portable instrumentation system.

The perception that people have of vibration is highly variable. This means that it is almost impossible to develop clear-cut design criteria. However, after testing suspended floors in a number of buildings, researcher **Barry Schafer** said that designers will have to consider the dynamic performance of long-span floors (> 10m) at the design stage.

A low level of damping was observed in the floors tested and indicated that for many long-span floors, additional damping needs to be built into the structure. The results showed that a relationship existed between static stiffness and observed frequency of vibration. This relationship could be used as a first check to see if the vibration of a floor system is likely to fall into the low-frequency area (< 5Hz) where excitation from foot traffic can be a problem.

(From: Rebuild, CSIRO Division of Building Research, Vol 11, No 3, 1986.)

Scientific terms made easy

Calculus of residues	How to clean up a bathtub ring
Catoptric	A feline eye
Coma	Italian: multi-toothed device for re-arranging one's hair
Commutator	A student who drives to school
Conic section	Funny paper
Corona	An officer who enquires into the manner of violent death
Cosine	The opposite of 'Stop sign'
Cusp	To use profane language
Exit pupil	A retiring student
Flux	Past particle of the verb 'to flex'
Gram	To review for examinations
Grand canonical ensemble	Ecumenical council
Graph	Principal item of a cow's diet
Ground state	Coffee, before brewing
Harmonic function	Concert
Hermitian operator	Recluse surgeon
Humbug	Noisy wiretap
Hypotenuse	Animal like rhinoceros but with no horn on nose
Len	Singular of lens, specifically a one-surface optical element
Marginal ray	A ray of doubtful origin
Millimetre	A bug like a centimetre but with more legs
Normal solution	The wrong answer
Orifice	Headquarters or place of business
Paradox	Two Ph D's
Polygon	A dead parrot
Poynting vector	A redundant term: all vectors point
Spectra	A female ghost
Sphere	A long, pointed weapon
Spin operator	Owner of a Ferris wheel
Statistical correlation	36-22-35
Torque	Conversation
Ultraviolet catastrophe	Bad sunburn
Vortex	Point of a mathematical figure opposite the base
Watt	Will you please repeat that remark?

(From: "A Random Walk in Science", Institute of Physics, London.)

(continued from p. 66)

The group already has some computing skills, however the potential for improvement of the group's technical ability and information retrieval using micro computers has yet to be fully realised. Our priority is to develop a computer programme for the modelling of acoustics in large spaces (utilising ray tracing techniques) in an effort to achieve optimum results. Presently, our software includes:

- Noise analysis of air conditioning ducts
- Calculation of reverberation of spaces
- Programmes for spectral analysis
- Computer automation of sound absorption testing in reverberation chambers.

New agreement on scientific journals

CSIRO has proposed a new agreement between its Bureau of Information and Public Communication and the Australian Academy of Science, involving a major marketing effort to put the Australian Journals of Scientific Research on a sound commercial footing.

The publications involved are the Australian Journals of Agricultural Research, Biological Sciences, Botany, Chemistry, Marine and Freshwater Research, Plant Physiology, Physics, Soil Research, Zoology and Australian Wildlife Research.

The journals, published jointly with the Australian Academy of Science, cost about $2m to produce in 1985-1986 and returned almost $500,000 in revenue. They are also used in an exchange programme in which CSIRO receives publications from institutions overseas.

Four major elements of the basis for agreement are that universities and other user groups contribute towards cost of publication; reduced typesetting and other costs; increased subscription revenue and **quotation of overseas subscriptions in US dollars;** and the preparation of a positive marketing plan involving more aggressive promotional support, a wider network of distributors, possible paid advertising and regular price reviews.

"The journals have established in their forty year history an important place in Australian science," Mr. Dunstan said. "They are distributed to more than 120 countries and are held in high regard by the international science community."

(Laboratory News, October, 1986.)

Data collection software

A "hand-held electronic notebook" has been developed for commercial sales by the CSIRO Division of Mineral Physics and Mineralogy, and Mining Research Associates, on behalf of the Australian Mineral Industries Research Association Ltd.

IDAS, which stands for Interactive Data Acquisition Software, is designed to allow interactive entry of numeric and alphabetic data into a portable, battery-powered computer. It can be used to record observations collected in the field and to have these verified at time of entry. The data base thus constructed can be transferred to a host computer for archiving or analysis without the need for extra key punching.

The IDAS software runs on the Husky Hunter, a small but very rugged lightweight portable computer. IDAS itself is marketed by Geodesy Pty. Ltd., of Victoria.

(From CSIRO Minerals & Energy Bulletin, October, 1986.)

NEW PRODUCTS —

CIRRUS

LEQ SOFTWARE

Cirrus Research announce a new software suite for their range of Leq and sound level meters, the 'S24' suite. The S24 suite can take input from up to 4 metres simultaneously, displaying the current levels and the global Leq on screen. The programme can store up to 48,000 separate sound level samples or Short Leqs on disc for later retrieval and analysis. The shortest Leq which can be taken is 1 second and about 24 hours can be stored on a disc with a 1 second resolution.

The data retrieval programmes can present the data in many different ways. The simple time history, that is the way the noise changes with time, can be displayed with full time zooming between any two times during the acquisition time. From this time history plot, specific noise events can be identified and separately analysed either visually or otherwise. The difference between any two of the sound level meters can be displayed to give, for example, the attenuation or transmission of a structure under dynamic conditions.

"WEAR EAR PROTECTORS WHEN THIS SIGN IS LIT"

While ear defenders can protect the worker against excessive noise, almost everyone dislikes wearing them as they can often cause discomfort and hinder communications. If, however, a factory is noisy, "excessive noise areas" have to be designated where ear defenders must be worn all the time.

In many factories, the noise level is only high part of the time, so the ideal solution would be a sign which lit up ONLY when the 90dB level was exceeded.

The Cirrus Research CRL 3.01HS Automatic Noise Alarm is such a sign which gives a visual warning of high noise levels. The display of the CRL 3.01HS has a blue and white logo to

BS 5378 which lights up when a preset noise level is exceeded. The "ON" level of the sign is normally 90dBA although any level between 40 and 110dB can be pre-set.

On reaching the pre-set level, after an integrated delay period, the CRL 3.01HS illuminates, informing employees that ear protection should be worn. Throughout this "on" phase the light will switch off only when the short term average noise level (Leq) is reduced to below pre-set level. Ear protection, therefore, need only be worn when necessary and not continually — this is appreciated by employees who generally dislike wearing ear defenders.

Further information: M. B. & K. J. Davidson Pty. Ltd., 17 Roberna Street, Moorabbin, Vic. 3189. (03) 555 7277.

BRADFORD INSULATION

ROMET

Bradford Insulation Group has announced its acquisition of the Romet pre-engineered insulation panel system from Bestobell, which will be manufactured at the company's factory at Clayton, Victoria.

The Bradford Romet insulation system is an advanced panel design which combines both the cladding and the insulation material during manufacture,

thereby gaining optimum mechanical, thermal and acoustic properties. This fully engineered, pre-planned system can be erected on the site as a fabricater unit. Panels are available in three widths of 350, 525 or 700 mm and in lengths to suit the application. Insulation levels may be as specified by a client or designed by Bradford Romet to suit the application and can be up to 200 mm in thickness.

The system is suitable for tanks, precipitators, stacks, silos for grain, roof and wall panels and facades. It was recently installed on the precipitators at Loy Yang Power Station, Victoria.
Further information: Bradford Insulation Office in your State.

ACADS

ACOUSTIC SOFTWARE

BAT, MOUSE, RACOON and LION is a suite of four, small, interactive acoustical analysis programmes available for installation on a mainframe or microcomputer. These programmes will assist designers in evaluating sound transmission in and around buildings and were developed by the Department of Housing and Construction and ACADS. They may be licensed through ACADS for mainframe or microcomputer installation or alternatively ACADS member organisations may access them through a number of bureaux where they are installed.

BAT determines the attenuation of a barrier wall at seven frequency bands within the range 63-4000 Hz.

MOUSE determines the total transmission loss of a wall made up of a number of different wall constructions, doors or windows. The transmission loss of a range of wall constructions is stored in the programme and can be referenced by the user.

RACOON is a room acoustics programme for determining the acoustic properties of a rectangular room. It has absorption co-efficients for a wide range of materials stored in the programme for reference by the user.

LION determines the attenuation of rectangular or circular internally lined air-conditioning ducts of any size. The effects of varying the density and thickness of insulation can also be investigated.

The four programmes in the Noise Suite are menu driven interactive programmes. The methodology on which they are based is described in the AIRAH/Department of Housing and Construction Design Aid-Noise Control Part 3, Sound Transmission In and Around Buildings. They are written in FORTRAN and the micro-versions are designed to run under MSDOS and supplied on floppy diskettes. It is planned to expand the Noise Suite with programmes contributed by ACADS member organisations and firms actively involved in evaluating sound transmission in and around buildings and enquiries are welcome in this area.

For further information: Murray Mason, ACADS, Building Services Group, 576 St. Kilda Road, Melbourne 3004. Telephone: (03) 51 9153.

ADVERTISER INDEX

New Products . . .

VIPAC

SOUND LEVEL METER

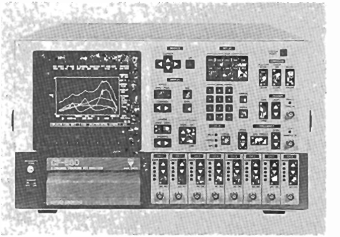
Vipac Instruments Pty. Ltd. have just established onto the Australian market the Larson-Davis 800B sound meter. This rugged lightweight instrument will measure the vast majority of acoustic parameters that are required in research and industry.

In addition, inexpensive computers can be used to make the 800B fully automatic with a choice of interface options. Features include frequency counter, 1/1 and 1/3 octave filters, total harmonic distortion, reverberation time, dose and projected dose, LEQ, LDOD, LOSHA and SEL. The meter comes with a two (2) year warranty.

FFT ANALYSER

The world's first portable-type 8 channel FFT analyser is now available on the Australian market. Manufactured by Ono Sokki and distributed by Vipac Instruments, it incorporates a disc drive and performs tracking analysis and a wide range of other applications which are facilitated by the eight channel input. It is a powerful tool for analysing the dynamic characteristics of rotating machines.

The system can measure up to 8 points at once, taking the labour right out of this process, and stores detailed analysis results on its internal micro floppy disc. The CF 880 is extremely versatile and can function as; an 8 channel tracking FFT analyser, a RPM-order ratio analyser, an 8 channel FFT analyser, an 8 channel oscilloscope and an 8 channel transient recorder/ signal analyser.



8 Channel FFT Analyser

DATA-TRAP

Data-Trap is an automated predictive maintenance system which records vibration data, process viables (temperatures, pressures, flow rates, etc.) and visual inspection data such as leaking seals, loose belts and dirty filters. These critical data are processed by the powerful Vipac software, generating reports within minutes to give instant visibility on developing problems. Later, the data can be further processed to produce early warning reports, trend analyses and vibration signatures. Effective action can be taken immediately. The portable (2.2 kg) DATA TRAP allows you to perform complete machinery inspections (more than 150 points/hour and over 100 machines/day can be covered) without specialised skills or reams of paper. Using this system you can slash maintenance costs up to 30%, reduce machine downtime and improve profitability for a very modest investment.

MAGFLOAT

The MAGFLOAT Stand utilises the repelling and attracting power of magnets to almost completely eliminate vibration. This is a new and exciting idea in isolation stands. In essence, it suspends precision apparatus in mid-air to protect them from vibration, and thus makes for more accurate measurement, and operation. Unlike rubber, spring, air spring vibration insulators of the past, its properties will not deteriorate with time. It will remain stable. This ensures an enduring and quality product, for your laboratory or plant.

MAGFLOAT has many applications including: microscopes, precision balances, electric micrometers, IC apparatus, laser instruments, rotation balance testers, microtome, analytical instruments and all other types of precision instruments/apparatus where minimising vibration is a must. The MAGFLOAT stand can operate in temperatures between —20°C to 50°C in humidities up to 85%.

Further information: Vipac Instruments Pty. Ltd., Mr. David Pentecost, Private Bag No. 16, Port Melbourne, Vic. 3207. (03) 647 9700 or (008) 33 8180.

ACL SPECIAL INSTRUMENTS

QUEST M-28 NOISE LOGGING DOSEMETER

The design objectives were to provide maximum readout information, maximum versatility and permanent hard copy printouts. The M-28 possesses exceptionally long battery life, long data storage and built-in protection against accidental loss of accumulated data. All data and time histories are printed out. A code key lets the user check parameter settings without removing the cover.

All data can be read at any time without disturbing dosemeter operation. Calibration is simple by merely checking and adjusting while reading sound level.

- A compact multi-function instrument with direct data readout, printer output and computer interface.
- Measures Dose, Leq, SEL, Sound Level, True Peak, Lmax, Run Time and Pause Time over a range of 35-146dB.
- Stores data for up to 16 separate events (measuring periods). Data for each event can be recalled. Up to 120 hours of information.
- Real Time Clock.
- Programmable Start/Stop Times; up to 16 separate events.
- Ldn will add 10dB between 2200 and 0700 if Ldn, 24 hour switch and clock are set.
- All stored data can be
  - —viewed directly on readout
  - —printed with serial or parallel printer
  - —sent to a computer via an RS-232 port.
- Printouts provide 10sec, 1-, 3-, 5-, and 10-minute histograms, 8-hour projected dose, percentage of time and percentage of dose statistical distributions. Printouts can be edited.
- Measurement parameters—exchange rates, ranges, overload levels, criteria levels, thresholds, A and C scale weightings, Fast and Slow time constants — are all user settable.
- Used as a personal dosimeter, area monitor, and survey instrument. Microphone is field-replaceable.
- Possible to change battery without losing data. Can run on external power.

"BARKS AND BELS"

An exciting new board game, for acousticians, their families, friends and students. Based on typical experiences of design, measurement, survey and problem solving, in the acoustics field, this game provides a light-hearted learning situation for both the experienced practitioner and those who have only a laymans experience of noise. "Barks and Bels" will provide a challenge to experienced acousticians to think laterally, and increase awareness in the uninitiated, of the complexity of issues involved in the field of acoustics.

Further details available from: ACL Special Instruments, 27 Rosella Street, East Doncaster 3109.

Phone (03) 842 8822. Fax (03) 842 5730. Telex AA35011.

AUDIO SYSTEMS: SPEAKERS, RECEIVERS, NON-AUDIO ELECTRONICS

Society of Automotive Engineers, 1986. Review copy from D. A. Book (Aust.) Pty. Ltd., 11-13 Station Street, Mitcham, Vic. 3132. Price: $51.50 (Aust.) (soft covers).

The papers in this publication are among those delivered at the 1986 International Congress and Exposition, Detroit, sponsored by the Society of Automotive Engineers.

Paper One gives a history of radio noise suppression in motor cars up to 1970. Why stop there? Papers Two and Four talk about measurement of magnetic fields in loudspeakers and the automatic testing of loudspeakers in a factory environment, respectively. The first appears to marginal on the main theme of the book, high quality stereo reproduction in motor cars.

The third paper describes an amplifier-speaker system to provide high quality stereo reproduction in a motor car. Stereo listening is a selfish pursuit even in the home (there is generally only a line of listening positions where good stereo is available). Here we have a system designed for the driver alone, and that only in a large motor car.

Dolby Labs provides a good explanatory paper on the Dolby C modification to cassette tape recorders to increase further the signal to noise ratio of reproduced sound. Philips provides a paper on a rotary head digital cassette audio tape recorder with a 96 dB signal to noise reproduction.

One paper deals with passively assisted loudspeakers. It describes methods to increase the frequency range of loudspeakers by adding external passive components. It goes on to report experiments on a 300 mm loudspeaker, hardly the size for a motor car installation.

Another Philips paper discusses digital maps on compact digital disc systems for car navigation. Columbia Broadcasting Company talks about its proposed FMX stereo broadcasting system to extend the effective range of an FM stereo transmitter. (The signal to noise ratio of a stereo transmitter is 20 dB worse than the same transmitter in mono operation.) The European Radio data system is given a paper. None of these systems will ever be used in Australia.

The final paper describes a four loudspeaker car audio system, each loudspeaker with its own 33 watt amplifier, the system capable of delivering 105 dB SPL with low distortion at the driver's ear.

I read these papers, then drive 140 kms. with the radio on tuned to Radio Helicon while I concentrated on safe driving. I heard some of the programme. I did not hear quiet music because of the masking of tyre and engine noise. The word "absurd" came to mind to describe the overall tenor of the book.

By the time I install the Philips CD navigation system, the 4 by 35 watt amplifier-loudspeakers together with the Dolby C cassette, the digital Philips tape recorder and the modified FM receiver in my small car there will be no room for me.

Perhaps the book describes what the trendy status-symbol-seeking car driver will be installing in his large car this year for his very own listening, as he sits stationary in the traffic jam or car-park, with the car engine off; annoying other car inhabitants and driving himself deaf. Certainly with his engine and/or car running he will not be able to appreciate his Dolby C, his 96 dB signal to noise digital tape recorder, his FM reception or have time to watch his navigation system while driving. (I assume no woman would be stupid enough to hanker over the above list. That is why I have used the masculine gender.)

Include me out!

Roy Caddy

2nd INTERNATIONAL CONGRESS ON ACOUSTIC INTENSITY

Noise Control Foundation, P.O. Box 3469, Arlington Branch, Poughkeepsie, N.Y., 12603; $80.00 U.S. (includes surface mail, extra $27.00 for air mail).

This extensive volume comprises the papers presented at the 2nd International Congress on Acoustic Intensity held at the French Centre Technique des Industries Mechaniques (CETIM) in Senlis, France in September, 1985. The first International Congress on the topic was held in 1981 and the growth in the use of acoustic intensity as a measurement tool in noise control engineering is reflected in the technical information presented in the papers.

The 580-page Proceedings contains 58 papers in English and 21 papers in French with English abstracts and figure captions. The papers are grouped into eight main sections:

Instrumentation — 9 papers
Vector Acoustics — 9 papers
Radiation of Sound — 5 papers
Intensity in the Presence of Flow — 5 papers
Intensity in Structures — 5 papers
Sound Power — 19 papers
Source Localisation — 14 papers
Impedance-Absorption-Transmission — 13 papers.

Acoustic Intensity is still a relatively new field and this volume provides an excellent overview of the variety of work being undertaken.

For those already using, and those about to commence using acoustic intensity measurements or analysis, these Proceedings contain the essential information on the approaches taken by others and therefore form a valuable reference.

Marion Burgess

INTER-NOISE 85 PROCEEDINGS

Noise Control Foundation, P.O. Box 3469, Arlington Branch, Poughkeepsie, N.Y,, 12603; 2 volumes, Price: $80.00 U.S. (includes surface mail, extra $30.00 for air mail).

Inter-Noise 85 was held in Munich, Federal Republic of Germany in September 1985. The 351 papers presented at the meeting comprise the two volumes of the Proceedings.

The three plenary papers indicate the very practical nature of the papers presented at Inter-Noise Conferences. One paper by A. O. Vogel is on "Regulations and Standards", the second by G. Jansen on "Noise Induced Health Disturbances" and the third by H. Peeken, C. Troeder, J. Schmidt and J. Rosenkranz on the "Principles of Machine Noise Reduction".

These are followed by eight very interesting survey papers on various aspects of noise and its reduction. As each of these papers are of the order of 10-12 pages they comprise a substantial amount of information and aptly satisfy their description as "survey papers".

The contributed papers are each approximately four pages long and arranged in order of INCE classification. It is difficult to obtain a good indication of the range of papers presented because there is no table of contents listing the titles of the papers and the authors. Thus, the reader must decide which sections of the Proceedings may include papers of interest, then go through each paper in those sections. There is an author index if you only wish to consult papers written by your favourite authors.

Inter-Noise has a reputation for attracting contributed papers which present practical solutions to noise problems and the papers in these Proceedings certainly indicate that reputation to be well founded. These volumes would be very worthwhile additions to technical and reference libraries.

Marion Burgess

* * *

THE SOFTWARE CATALOG: SCIENCE AND ENGINEERING

Elsevier Science Publishers, 2nd edition, 1985, pp. 540. Review copy from D.A. Book (Aust.), P.O. Box 163, Mitcham, Vic., 3132. Price: $A77.25 (soft cover).

This book is a most impressive catalogue of scientific software commercially available for workers in science and engineering. The comprehensive indexing is given in terms of subject and applications; computer types; and software suppliers. The subject and application index at the back gives the name of a programme; a very brief description of what it does; the computer systems for which the programme is available; the cost and an ISPN number. The ISPN number can be looked up in the main index where an expanded description of the capabilities of a programme is given together with the supplier for the programme and how it is distributed. There are, as one would expect, copious references to programmes that would be of use to an acoustician to carry out a wide range of statistical calculations including signal analysis, but interestingly, very few programmes are available for purely acoustical subjects apart from some relating to sound intensity calculations. Any individual or company who relies heavily on computing techniques and wishes to purchase propriety software rather than expend the large amount of effort required to develop computer programmes, will find this book an excellent resource reference.

R. W. Harris.

CONCERT HALL ACOUSTICS

Y. Ando

Springer-Verlag, Berlin, Heidelberg, 1985, pp. 151. Australian Distributor D.A. Book Ltd., P.O. Box 163, Vic., 3132. Price: $75.00.

In this remarkably concise book Professor Ando of Kobe University, Japan has condensed many years of fruitful research that he and his colleagues performed at the University of Gottingen. Professor Schroeder of that university has written an interesting foreword, some of which may sound familiar to readers of the April 1986 issue of Acoustics Australia. The book is essentially a very sophisticated exposition of the Fourier approach to room acoustics. Throughout, emphasis is placed on quantifying subjective preference judgments using techniques that have been pioneered at Gottingen. There is a fair amount of mathematics which the author uses in a most logical and convincing manner. It is the message, however, behind the equations that is the important part leading to a quite revolutionary way of designing a concert hall.

After a brief introductory chapter the next three chapters set the pace by establishing the Fourier approach to Sound Transmission Systems (emphasis on the autocorrelation function, transfer functions of sound fields and the characteristics of human hearing), Simulation of Sound Fields and Subjective Preference Judgments. The methodology allows for a natural distinction between the two important types of criteria; temporal-monaural and spatial-binaural. These three chapters cover an unusually wide viewpoint as they include both the purely physical aspects of sound source and sound field and psycho-acoustical assessment of the sound fields encountered in practice.

At first glance, chapter 5 (Prediction of Subjective Preference in Concert Halls) seems to be too ambitious to be true. However, the technique, based on a knowledge of the appropriate impulse responses and transfer functions, is very powerful and is capable of being applied to any signal transmission path, whether it is a physical path or a neurological path.

The crunch comes in chapter 6 where, in 13 succinct pages, the author shows how to design a concert hall for which listener preferences can be estimated for any seat in the hall. As Professor Ando writes: 'The remarkable convenience in designing auditoria is that the room shape is first determined by only the spatial criterion (interaural cross correlation) and then its dimensions and the absorption characteristics are taken into consideration according to the design range of the effective duration of the autocorrelation function of source signals to be performed'.

Despite the rather high price for such a slim volume and despite the high-powered theoretical basis, the book is worthy of serious study as few other books dealing with room acoustics have taken into account such a wide range of important criteria.

Howard Pollard.

THE NOISE HANDBOOK

W. Tempest (Editor)

Academic Press, London, 1985, pp. 407. Review copy from Academic Press Australia, P.O. Box 300, North Ryde, N.S.W. 2113. Price: $A203.10.

In the preface of the "Noise Handbook", the editor, W. Tempest states that the aim of the book is to give "a current picture of the effects of noise upon man, the incidence of noise in various environments and situations and the protection afforded by the law and by what is technically feasible in the way of noise control". One measure of the success of a book is a judgment of how well the aim has been achieved.

There are fifteen contributors to the fourteen chapters which form the four parts of the book:

Part I is on Noise Measurement (W. Tempest).

Part II comprises five chapters on the effects of noise on humans. These include Noise and Health (P. L. Pelmear), Noise and Hearing (W. Tempest), Noise and Communication (W. A. Ainsworth), Noise and Efficiency (D. R. Davies and D. M. Jones) and Noise Annoyances (F. J. Langdon).

Part III deals with four main sources of noise — Noise in Industry (W. Tempest), Noise Arising from Transportation (F. J. Langdon), Noise in Transportation (D. Williams) and Noise in the Home (G. M. Jackson and H. G. Leventhall).

Part IV deals with remedies for the noise problems — Noise Control (K. A. Mulholland), Noise and the Law in the United Kingdom (R. Grime), Noise and the Law in the United States (P. S. Edelman and A. J. Genna) and EEC Directives on Noise in the Environment (B. Hay).

Each chapter is written in the style of a Review/Tutorial Paper and has its own reference list. These lists are generally quite extensive, for example the list for the chapter on Noise and Efficiency includes more than 200 items. These references are essential as any book of around 400 pages can do no more than skim the surface of such a wide range of topics. It is a very readable book and this probably arises from the fact that it does not go into a lot of detail. For this reason it is unfortunate that the word "Handbook" is included in the title. It is immediately obvious that 15 pages on "Noise Arising from Transportation" of which only six pages are on "Road Traffic Noise" cannot deal with the problem in depth.

The fourth part — on remedies — is the largest part of the book with the three chapters on the legal aspects taking approximately 100 of the total 400 pages of the book. These three chapters appear to be comprehensive with extensive reference lists but are of limited value to those working in noise in Australia (perhaps the publishers should produce an Australian supplementary chapter!). The first chapter in this section is perhaps the least satisfactory chapter in the book, as it tries to cover all aspects of "Noise Control" in a mere 20 pages. The obvious restrictions produced by such a limitation have not been adequately compensated for by an extensive reference/bibliography list.

In summary, I consider that this book does provide a good overview of the effects of noise on man, the types of noises in our environment and the legal aspects associated with noise in the U.K., U.S.A., and EEC. As such, it is a valuable reference book but considering the very high price it is unlikely to find a place on many bookshelves.

Marion Burgess

NEW PUBLICATIONS —

Chinese Journal of Acoustics (in English) **V. 4 No. 3 July-Sept., 1985**
Contents include: **Ma Dayou,** Wide-band sound absorber based on microperforated panels.

ABSTRACT

It has been pointed out in a previous paper that a resonator formed by micro-perforated panels exhibits the property of high absorption in a very wide frequency band without using any porous material. This fact is further analysed quantitatively, using electrical equivalent circuits. The microperforated panel is characterised by its high acoustic resistance and low acoustic mass reactance, a property required for a wide-band absorber. And in a double resonator the reactance is further reduced in low and high frequency regions and remains low in several octaves. The double resonator absorber of micro-perforated panels will make a very efficient general-purpose absorber or special-purpose absorber for adverse circumstances in reverberation or noise control. Based on the analysis of the panel parameters, the situation suitable for the microperforated panels and guideline for choosing the design parameters are presented, with illustrating examples.

New Publications . . .

Wang Jiqing and Gu Qiangguo, The effects of the quantity of suspended diffusers and specimen area on the test results for sound absorption coefficient in a small reverberation chamber.

ABSTRACT

The diffusivity of the sound field in a reverberation chamber, which can be improved by diffusing elements hanging from the ceiling of the room, usually has a significant effect on the test results of sound absorption measurement. We have found that the diffusivity is sufficient when the total area of suspended diffusers reaches 60 - 70 per cent of the floor area in a small chamber, say about 100m². But for some acoustical materials such as perforated fiber tile, we have found the sound absorption coefficients are considerably independent on diffusivity. It can be concluded that the acoustical property of such material varies little for different angles of incident wave, hence they are not suitable in use for the determination of the diffusion improvement of sound field.

Test results of many commonly used acoustical materials show that when test specimen area changes from 10m² to 6m², provided that the ratio of length to width is controlled between 0.7 and 1.0, the deviation of the sound absorption coefficient obtained is rather small, say, less than 0.02 for common acoustical materials or less than 0.06 for certain highly absorbent materials. So a minimum test area of 6m² can be used with sufficient accuracy to meet the needs for engineering practice.

Tao Duchun, A study on ship-radiated noise rhythms, (I) - mathematical model and power spectrum density.

ABSTRACT

The sources of ship-radiated noise rhythms are analysed and the common types of rhythms are demonstrated in this paper. The noise modulation envelope is treated as a pulsatory random process with the same shape, equal iterative period, random amplitude and the group structure. Various types of modulation envelope power spectra are calculated. The theoretical results are in good agreement with the experimental results.

Chinese Journal of Acoustics V. 4 No. 4 Oct.-Dec. 1985

Contents include: **Wang Chenghao** and **Chen Dongpei,** Generalised Green's functions of surface excitation of elastic wave fields in a piezoelectric half-space; **J. Ranachowski** and **F. Rejmund,** Acoustics in investigation of ceramic materials; **Qian Menglu** and **Wei Mo'an,** a novel coupled resonant photoacoustic cell (T-type); **Qiang Panfu,** the frequency spectrum of coupled vibrations of finite circular piezaelectric ceramics disks; **Wu Shuoxian,** a computer model for predicting noise levels from a complex vehicle stream on a multi-lane road with some vehicle bunches.

ABSTRACT

In this article, a simple computer simulation method for synthetically predicting noise levels from a random complex traffic stream on a multi-lane road is presented. The probability distribution function, probability density function and the expectation of successive headways of a computer model (M_2 model) which can simulate complex traffic stream with some vehicle bunches are derived in details. The transformation formula producing the random numbers that obey this distribution is also derived. Then, the simulation flow chart is given. A comparison among some simulation results based on M_2 model and M_1 model (exponential distribution model) is made. Corresponding computer programme is worked out according to standard method of measurement regulation of road traffic noise in China. Provided that some parameters, such as traffic volume, traffic component and the distances between observer and equivalent lane and every lane are fed into computer, the noise levels L_{10}, L_{50} and $L_{A,eq}$ will be printed out. Calculations show that simulation data agree with measurements well.

Zhu Ye and **Chen Geng,** information principle of active sonar detection.

ABSTRACT

The relations between these factors: waveform, channel and receiver of active sonar is discussed in this paper. The models of active sonar channel, which includes marine reverberation, signal propagation and object scattering are described by the widesense scattering function and the widesense coherence function. Physical meaning of both functions are explained with the aid of channel output correlation function and matched filter output respectively, the fundamental principle for the design of the optimum waveform and the optimum receiver are presented.

Acta Acustica V. 11 No. 3 May 1986

Journal of the Catgut Society No. 45 May 1986

Contents include a number of articles relating to violin design and the properties of wood.

Applied Acoustics V. 19 No. 6 (1986).

Canadian Acoustics V. 14 No. 3 July 1986

Contents: **P. Zakarauskas,** Ambient noise in shallow water: a literature review; **M. Hodgson,** Factory sound fields — their characteristics and prediction; **C. Laroche, R. Hetu, M. Sawan, J. Nicholas,** Preliminary study of the effect of the spectral content of impulsive noises on the acquisition of auditory fatgue (in French).

Institute of Sound and Vibration Research, University of Southampton.

ISVR Technical Report No. 132: M. J. Griffin, R. W. McLeod, M. J. Moseley, C. H. Lewis, Whole-body vibration and aircrew performance, 63 pp.

ABSTRACT

A programme of experimental research concerned with the effects of aircraft vibration on vision and manual control performance has been completed. Twenty-eight experiments were conducted, 16 investigating effects on vision and 12 investigating effects on manual control performance. Short summaries of the objectives, methods and findings of all 28 experiments are presented. References to publications providing full reports of each experiment are also provided.

ISVR Technical Report No. 135: J. J. Tweed, R. J. Marchbanks, A. M. Martin, The effects of changes in cerebrospinal fluid pressure on the labyrinth in terms of tympanic membrane displacement, 53 pp.

PUBLICATIONS BY AUSTRALIANS

We are grateful to Richard Rosenberger, University of N.S.W., for this updating of publications by Australian authors. Within each year the listing is alphabetical by first author.

1984

An Acoustic Model of Multiple-Channel Cochlear Implant
P. J. BLAMEY, et al.
Dept. of Otolaringology, Univ. Melb., The Royal Vic. Eye and Ear Hospital, 32 Gisborne Street, Vic. 3002
J. Acoust. Soc. Am. **76** (1), 97-103 (1984).

Ultrasonic Waveform Acquisition and Processing
D. S. BLOSER
AAEC, Lucas Heights, NSW.
Non-Destr. Testing Aust. **21** (1), 6-9 (1984).

The Annoyance and Unacceptability of Lower Level Low Frequency Noise
(1) N. BRONER
(2) H. G. LEVENTHALL
(1) Vipac & Partners Pty. Ltd., 30-32 Claremont Street, South Yarra, Vic. 3142
(2) Atkins Res. & Dev., Epsom, Surrey KT18 5BW, UK
J. Low Freq. & Vib. **3** (4) (1984).

Measurement of Residual Stress
R. A. COYLE
Aeronautical Res. Laboratories, Melbourne, Vic.
Non-Destr. Testing Aust. **21** (1), 6-9 (1984).

Maximum Likelihood Estimation of the Frequencies of Multiple Tones in Noise
K. E. ENGLISH
Telecom Australia Res. Lab., Australia
ATR Aust. Telecom Rev. **18** (1), 47-57 (1984).

On-Line Ultrasonic Testing of Rails at Whyalla
R. A. FRANCIS
BHP Whyalla, SA 5600
Non-Destr. Testing Aust. **21** (4), 8-10 (1984).

Modelling the Exhaust Noise Radiated from Reciprocating Internal Combustion Engines — A Literature Review
A. D. JONES
Hills Ind. Ltd., PO Box 78, Clarence Gardens, SA 5039
Noise Control Eng. **23** (1), 12-31 (1984).

Diagnostic Imaging Systems
G. KOSSOFF
Ultrasonic Institute, 5 Hickson Road, Miller's Point, NSW 2000
J. Electrical Electronics Eng. Aust. **4** (2), 93-100 (1984).

Steam Injection Noise in Dye Vats
P. R. LAMB, et al.
CSIRO Div. of Textile Ind., Australia
Internat. Dyer & Textile Printer (6), 27-30 (1984).

Nonlinear Generation of Missing Modes on a Vibrating String
K. A. LEGGE, N. H. FLETCHER
Dept. of Physics, Univ. of New England, Armidale 2351
J. Acoust. Soc. Am. **76** (1), 9-11 (1984).

A Custom LSI CMOS Chip for a Cochlear Implant
H. McDERMOTT
Dept. of Otolaryngology, University of Melbourne, Parkville, Vic. 3152
J. Electrical Electronics Eng. Aust. **4** (4), 305-309 (1984).

Evaluation of Accuracies in Acoustic Emission Source Location
J. K. NANKIVELL
Aeronautical Res. Laboratories, Melbourne, Vic.
Non-Destr. Testing Aust. **21** (5), 9-11 (1984).

Admittance-Matched Structures for the Reduction of Noise in Tank Making Operations
M. G. PANDY, L. L. KOSS
Dept. Mech. Eng., Monash Univ., Clayton, Vic. 3168
J. Sound Vib. **95** (2), 261-279 (1984).

Ultrasonic Research in Australia
D. E. ROBINSON
Ultrasonics Insitute, 5 Hickson Road, Miller's Point, NSW 2000
J. Electrical Electronic Eng. Aust. **4** (2), 126-132 (1984).

Signal Processing Using Interaction of Laser Light and Surface Acoustic Waves
P. M. SHANKAR, T. W. COLE
School of El. Eng., University of Sydney, NSW 2006
J. Electrical Electronic Eng. Aust. **4** (1), 71-75 (1984).

The Effects of Multichannel Compression/Expansion Amplification on the Intelligibility of Nonsense Syllables in Noise
G. WALKER, D. BYRNE, H. DILLON
NAL, 5 Hickson Road, Sydney 2000
J. Acoust. Soc. Am. **76** (3), 746-757 (1984).

Flow-Resistant Sound Interaction in a Duct Containing a Plate, Part I: Semicircular Leading Edge
(1) M. C. WELSH
(2) A. N. STOKES, R. PARKER
(1) Div. Energy Technology, CSIRO, Melbourne, Vic.
J. Sound, Vib. **95** (3), 305-323 (1984).

Evaluation of Fibre Reinforced Plastic
B. R. A. WOOD, R. W. HARRIS
CSIRO Div. of Min. Phys., Lucas Heights, Australia
Non-Dest. Testing — Aust. **21** (6), 12-14 (1984).

Practical Realisation of Asynchronous Chirp Waveform Fourier Transformers
H. S. YAP, R. A. ZAKARIEVICIUS
School of Electrical Eng., The University of NSW, PO Box 1, Kensington, NSW 2033
IEEE 1984 Ultrasonics Symposium Proc. **1** 112-115 (1984).

A Chip Designed for Chinese Text-to-Speech Synthesis
K. C. ZHOU, T. COLE
Dept. of El. Eng., University of Sydney, NSW 2006
J. Electrical Electronic Eng. Aust. **4** (4), 314-318 (1984).

1985

A Wearable Multiple-electrode Electrotactile Speech Processor for the Profoundly Deaf
P. J. BLAMEY, G. M. CLARK
Dept. of Otolaryngology, Univ. of Melbourne, The Royal Victorian Eye and Ear Hospital, East Melb., Vic. 3002
J. Acoust. Soc. Am. **77** (4), 1619-21 (1985).

Resonator Effects in Window Frames
M. A. BURGESS
School of Architecture, The University of NSW, PO Box 1, Kensington 2033
J. Sound. Vib. **103** (3), 323-332 (1985).

Application of the Time Dependent Finite Difference Theory to the Study of Sound and Vibration Interactions in Ducts
A. CABELLI
Division of Energy Technology, CSIRO, Melbourne, Vic.
J. Sound. Vib. **103** (2), 13-23 (1985).

The Time Dependent Finite Difference Procedure for Propagation of Sound in a Non-Uniform Lined Duct — A Comparison with Experiments
A. CABELLI, R. F. LA FONTAINE, I. C. SHEPHERD
Division of Energy Technology, CSIRO, Melbourne, Vic.
J. Sound. Vib. **100** (1), 35-40 (1985).

A Review of the Problem of Relating Vocal-Tract State to Acoustic
D. A. CHALKER, D. MACKERRAS
El. Eng. Dept., University of Queensland, St. Lucia, Qld. 4067
J. Electrical Electronic Eng. Aust. **5** (1), 22-29 (1985).

Models for Representing the Acoustic Radiation Impedance of the Mouth
D. A. CHALKER, D. MACKERRAS
El. Eng. Dept., University of Queensland, St. Lucia, Qld. 4067
IEEE Transactions on Acoustics, Speech Signal Processing, **ASSP-33** (6), 1606-1609 (1985).

Impulse Propagation over Grassland in the Presence of Temperature and Wind Gradients
A. J. CRAMOND, C. G. DON
Dept. of Appl. Physics, Chisholm Inst. of Technology, 900 Dandenong Road, Caufield East, Vic. 3145
J. Acoust. Soc. Am. **78** (3), 1029-1037 (1985).

Demonstration of Wave Propagation in a Periodic Structure
R. C. CROSS
Wills Plasma Phys. Lab., School of Physics, University of Sydney NSW 2006
Am. J. Physics **53** (6), 563-567 (1985).

Road Traffic Sound Level Distributions
G. G. DON, I. G. REES
Dept. of Appl. Physics, Chisholm Inst. of Technology, Caufield East Vic. 3145
J. Sound. Vib. **100** (1), 41-53 (1985).

Acoustooptic Signal Processor Based on a Mach-Zehnder Interferometer
I. G. FUSS
Dept. of Defence, Defence Sci. & Technology Organisation, 2151 Adelaide SA 5001
Appl. Optics **24** (2), 3866-3871 (1985).

Drug Degeneration During Ultrasonic Nebulisation
A. E. GALE
PO Box 234, North Adelaide, SA 5006
J. Aerosol Science **16** (3), 265 (1985).

Exact Vibration Solutions for some Irregularly Shaped Membranes and Simply Supported Plates
H. P. W. GOTTLIEB
School of Science, Griffith University Nathan, Qld. 4111
J. Sound. Vib. **103** (3), 333-339 (1985).

Some Applications of Parametric and Non-Parametric Spectral Estimation Techniques to Passive Sonar Data
D. A. GRAY
Signal Processing and Classification Group, Weapons Syst. Res. Lab., Def. Research Centre Salisbury, GPO Box 2151, Adelaide, SA 5001
J. Electrical Electronic Eng. Aust. **5** (2), 112-119 (1985).

Demand Characteristics in Experimental Comparisons of the Effects of Noise and Vibration
R. F. S. JOB, R. B. BULLEN
National Acoustic Laboratories, Miller's Point, Sydney, NSW 2000
J. Sound. Vib. **101** (1), 127-129 (1985).

Punch Press Mechanical Clutch Engagement Noise and Noise Reduction
L. L. KOSS, W. KOWALCZYK
Dept. of Mech. Eng., Monash University, Clayton, Vic. 3168
J. Sound. Vib. **102** (4), 527-549 (1985).

A Bidirectional Microphone for the Measurement of Duct Noise
R. F. LA FONTAINE, I. C. SHEPHERD, A. CABELLI
Division of Energy Technology, CSIRO, Melbourne, Vic.
J. Sound. Vib. **101** (4), 565-573 (1985).

Three-Level Tone Test Signal For Setting Audio Level
A. N. THIELE
Australian Broadcasting Corporation, Sydney, NSW 2000
J. Audio Eng. Soc. **33** (12), 963-967 (1985).

1986

Deep Sound Channel Noise from High-Latitude Winds
R. W. BANNISTER
Weapons Syst. Res. Lab., Dept. of Defence, GPO Box 2151, Adelaide, SA 5001
J. Acoust. Soc. Am. **79** (1), 41-48 (1986).

Comparison of Frequency Estimators for Underwater Acoustic Data
R. F. BARRETT, D. R. A. McMAHON
Weapons Syst. Res. Lab., Dept. of Defence, GPO Box 2151, Adelaide, SA 5001
J. Acoust. Soc. Am. **79** (5), 1461-1471 (1986).

Transient Intermodulation Distortion — Part 2: Soft Nonlinearity
E. M. CHERRY, K. P. DABKE
Dept. of El. Eng., Monash University, Clayton, Vic. 3168
J. Audio Eng. Soc. **34** (1/2), 19-35 (1986).

Specific Acoustic Impedance Measurement by a Protruding Tube Method
J. I. DUNLOP
School of Physics, The University of NSW, PO Box 1, Kensington 2033
J. Acoust. Soc. Am. **79** (4), 1177-1180 (1986).

The Effect of Variations in Sound Speed on Coupling Coefficients Between Acoustic Normal Modes in Shallow Water Over a Sloping Bottom
M. HALL
RANRL, Defence Science and Technology Organisation, PO Box 706, Darlinghurst, NSW 2010
J. Acoust. Soc. Am. **79** (2), 332-337 (1986).

FUTURE EVENTS —

● Indicates an Australian Conference

1987

January 26-30, NEW ZEALAND
56th ANZAAS
"Science in a Changing Society".
Details: 56th ANZAAS, P.O. Box 5158, Palmerston North, New Zealand.

March 24-26, AACHEN
DAGA '87
Details: H. Kutruff, Inst. Technische Akustik der RWTH, Templergraben 55, D-5100 Aachen.

April 14-15, BIRMINGHAM
SONAR TRANSDUCERS — PAST, PRESENT and FUTURE
Details: Dr. B. V. Smith, Dept. Electronic & Electrical Engineering, University of Birmingham, P.O. Box 363, Birmingham, UK, B15 2TT.

May 11-15, INDIANAPOLIS
MEETING OF ACOUSTICAL SOCIETY OF AMERICA
Details: Mrs. B. Goodfriend, A.S.A., 335 East 45th St., New York, NY 10017, U.S.A.

● May 20-27, MELBOURNE
MAINTENANCE ENGINEERING CONFERENCE 1987
"Effective Maintenance: the road to profit"
Details: Institution of Engineers, 11 National Circuit, Barton, A.C.T. 2600.

May 19-21, POLAND
INTERNATIONAL CONFERENCE.
"How to teach Acoustics."
Details: Prof. Dr. A. Sliwinski, University of Gdansk, Institute of Experimental Physics, 80 952 Gdansk, Wita Stwosza 57.

June 1-4, YUGOSLAVIA
XXXI ETAN CONFERENCE
Details: Prof. P. Pravica, Electrotechnical Faculty, Bulevar Revolucije 73, Belgrade, Yugoslavia 11000.

June 8-10, PENNSYLVANIA
NOISE-CON 87
"High Technology for Noise Control".
Details: Conference Secretariat, NOISE-CON 87, The Graduate Programme in Acoustics, Applied Science Building, University Park, PA 16802.

June 9-11, UMEA, SWEDEN
4th INTERNATIONAL MEETING ON LOW FREQUENCY NOISE AND VIBRATION.
Details: Dr. W. Tempest, Multi-Science Publishing Co. Ltd., 107 High St., Brentwood, Essex, CM14 4RX, England.

● June 17-19, BRISBANE
COMPUTING SYSTEMS CONFERENCE 1987
Details: Institution of Engineers, 11 National Circuit, Barton, A.C.T. 2600.

June 19, MADRID
ACOUSTICS AND OCEAN BOTTOM
Details: SEA - FASE 87, Calle Serrano, 144, Madrid 6, Spain.

June 23-25, LISBON
5th FASE CONGRESS
Details: SPA - FASE 87, Lab. Nac Engenharia Civil, Av. Brasil, 1799 Lisboa Codex, Portugal.

July, ANTWERP, BELGIUM
15-25, SUMMER SCHOOL ON INTERNAL FRICTION PROCESSES.
27-30, CONFERENCE ON INTERNAL FRICTION AND ULTRASONIC ATTENUATION IN SOLIDS.
Details: R. de Batist, S.C.K. — C.E.N., Boeretang 200, 2400 MOL, Belgium.

August 24-28, U.S.S.R.
11th INTER. SYMPOSIUM ON NON-LINEAR ACOUSTICS
Details: V. K. Kedrinskii, Lavrentyev Institute of Hydrodynamics, Lavrentyev Prospekt 15, 630090 Novosibirsk.

September 15-17, CHINA
INTER-NOISE 87
"Noise Control in Industry".
Details: Inter-Noise 87, 5 Zhonggvancun St., P.O. Box 2712, Beijing, China.

September, BIRMINGHAM, U.K.
CONFERENCE OF BRITISH SOCIETY OF AUDIOLOGY
Details: Mr. N. Bland, 14 Bryony Road, Weoley Hill, Birmingham B29 4BU.

● November 12-13, HOBART
ACOUSTICS IN THE EIGHTIES.
Details: Stephen Samuels, A.A.R.B., P.O. Box 156 (Bag 4), Nunawading, Vic., 3131.

November 16-20, MIAMI
MEETING OF ACOUSTICAL SOCIETY OF AMERICA
Details: Mrs. B. Goodfrend, A.S.A., 335 East 45th St., New York, NY 10017, U.S.A.

● December 1-4, LAUNCESTON
8th AUSTRALASIAN CONFERENCE ON COASTAL AND OCEAN ENGINEERING.
Details: Conference Manager, Institution of Engineers, 11 National Circuit, Barton, ACT, 2600.

1988

May 16-20, SEATTLE
MEETING OF ACOUSTICAL SOCIETY OF AMERICA
Details: Mrs. B. Goodfriend, A.S.A., 335 East 45th St., New York, NY 10017, U.S.A.

August 21-25, STOCKHOLM
5th INTER. CONGRESS ON NOISE AS A PUBLIC HEALTH PROBLEM
Details: Noise '88, C/- Reso Congress Service, S-113 92 Stockholm.

August 29 - September 1, EDINBURGH
7th FASE SYMPOSIUM ON SPEECH
Details: Mrs. C. Mackenzie, I.O. Acoustics, 25 Chambers St., Edinburgh, EH1 1HU, Scotland.

August 29 - September 1, AVIGNON
INTER-NOISE 88.

1989

May 22-26, SYRACUSE
MEETING OF ACOUSTICAL SOCIETY OF AMERICA
Details: Mrs. B. Goodfriend, A.S.A., 335 East 45th St., New York, NY 10017, U.S.A.

November 6-10, ST LOUIS
MEETING OF ACOUSTICAL SOCIETY OF AMERICA
Details: Mrs. B. Goodfriend, A.S.A., 335 East 45th St., New York, NY 10017, U.S.A.

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