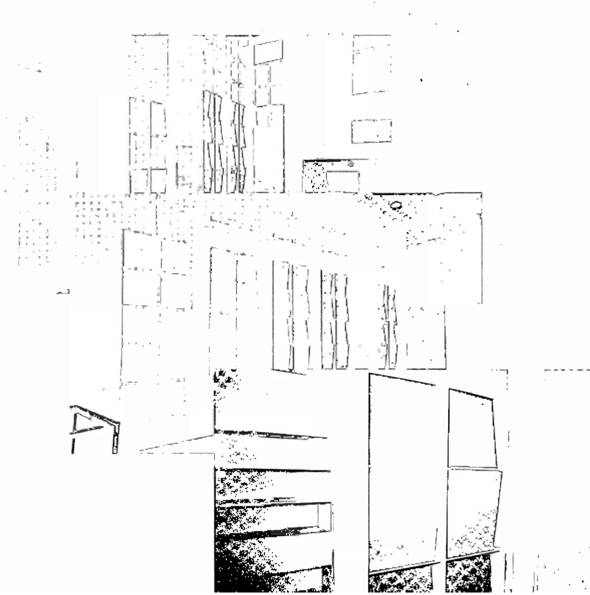
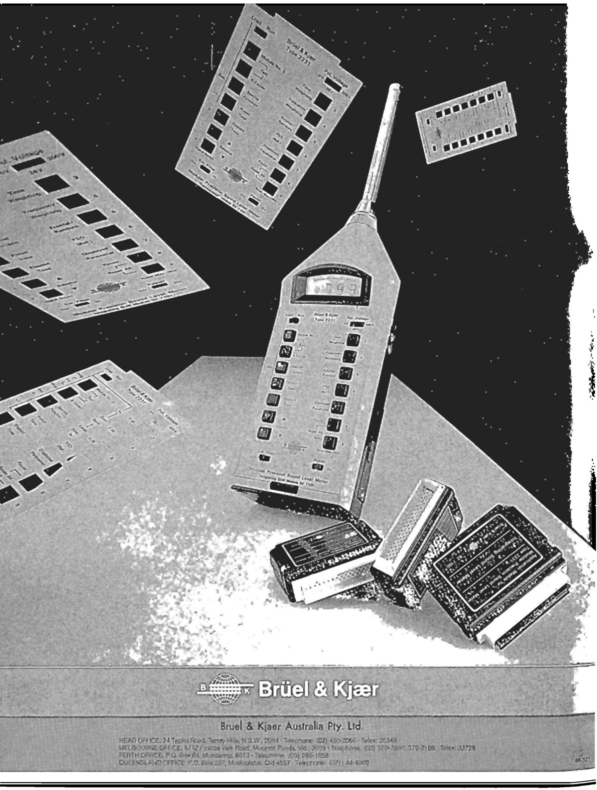
Acoustics Australia





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NEWS

ACT

July Meeting

The July meeting of the ACT Group was on Aircraft Noise Control and Prediction. **Leigh Kenna,** Manager of Environmental Engineering within the Advanced Systems Development Division of the Civil Aviation Authority, first outlined the main sources of aircraft noise. He showed that the ICAO regulations on aircraft noise limitations had led to the development of aeroplanes with greatly reduced noise levels and "noise footprints". **Mike Evenett** then described the ANEF system and explained that the Civil Aviation Authority produces ANEF Contour maps for all the major airports in Australia. He demonstrated the computer production of flight paths around an airport which are used in studies to minimise the noise impact on the community.

A lively discussion on the ANEF contours and the effects of individual planes not following flight paths, followed the main presentation. The discussion on aircraft and airship noise in the ACT region continued during an enjoyable dinner in a nearby restaurant.

October Meeting

The October meeting of the ACT Group was on "DICMA, DASI and SPRITE — Applications of Speech Recognition Technology". **Dr Mary O'Kane** from the School of Information Sciences & Engineering at the Canberra College of Advanced Education explained the background to the approach for speech recognition and demonstrated the DICMA system working on a problem of legal pleadings.

The DICMA project was the first in a set of projects to explore the development and applications of a technology that will provide speaker-independent recognition of continuous speech in offices where the vocabulary is naturally limited by the nature of the tasks specific to that office. The technology is based on the premise that in many situations a speech recognition task can be converted to a speech verification task if the vocabulary can be predicted. In the DICMA project the technology is applied to the transcription of dictated memos; in the DASI project it is applied to database query through speech input and in the SPRITE project it is used for automatic routing and summarising of phone messages.

After the main presentation, the discussion continued during the demonstration and during an enjoyable dinner in a nearby restaurant.

Marion Burgess

NSW

June Technical Meeting

On 21 June 1988 the guest speakers were **Joe Hayes** and **Quentin Goldfinch,** who gave an overview and demonstration of the operation of computerised musical instruments with particular attention to points of interest to acousticians.

In 1980 Fairlight Instruments released the world's first commercial Computer Musical Instrument based upon digital sampling technology, and the company still retains a leading position in the industry. The Series III Fairlight is still one of the very few fully integrated machines available which provide sound sampling, waveform analysis and manipulation, expressive live performances and graphics-based musical composition facilities in a single machine. Quentin Goldfinch was a hardware designer of the Series III and is now Manager of Research and Development at Fairlight Instruments. He provided a brief demonstration of the machine along with a technical discussion of its operation.

Joe Hayes was until recently a Founding Director of Passac and a designer of the Sentient Six Guitar-to-MIDI controller which provides an alternative musician interface, allowing a performer to play any MIDI-equipped synthesiser from a guitar instead of a music keyboard. The device was demonstrated controlling the Fairlight, and Joe discussed its technical operation and the psycho-acoustical aspects of translating the nuances of guitar performance to MIDI keyboard machines.

August Technical Meeting

On 11 August 1988 **Tim Marks,** General manager of NAP SILENTFLO, talked on the topic of "Industrial Silencers and Their Design", in particular on the design and application of absorptive and resonator silencers. Tim has a background in acoustical engineering extending over the last 15 years and is well known for his expertise in Australia and South-East Asia. Of special interest is Tim's involvement in the design and supply of silencers for the Loy Yang, Hazelwood, Tarong and Katherine Power Stations.

September Symposium

A symposium on the effects of music on the hearing of symphonic and rock musicians, audiences and other "listeners", and the response of other members of the public to amplified music, was held at NAL Chatswood on 21 September 1988. The discussion had particular reference to hearing conservation and current and proposed legislation bearing on the issues raised. The speakers and their topics were as follows:

Norm Carter (National Acoustic Laboratories): "The Effects of Rock Music on the Hearing of Audiences and Performers."

Don Woolford (Australian Broadcasting Corporation): "Hearing Loss in Orchestral Musicians. A dilemma."

Martin Foster (Sydney Symphony Orchestra): "Noise and Its Avoidence in Symphony Orchestras."

Marcel Sherman (Division of Occupational Health, LIRE, NSW): "Proposed NSW Hearing Conservation Regulations and Their Implications for the Music Industry."

Les Wicks (Musicians' Union): "Practical Problems in Applying General Industrial Restrictions on Noise Emission to the Music Industry."

Peter Kotulski (State Pollution Control Commission): "Amplified Music from Hotels and Clubs."

October Technical Meeting

On 17 October the guest speaker was **Dr Per V Bruel,** co-founder of Bruel & Kjaer A/S, of Naerum, Denmark. Dr Bruel has provided the following summary of his talk on "Progress Regarding the Influence of Short Duration Impulses on Hearing Damage".

ISO standards have recommended the use of the A-weighted continuous sound level as the basis for estimating the risk of noise-induced hearing loss in industry. L_{Aeq},T is used practically all over the world to estimate the maximum permissible noise levels in the legislation of various countries.

As early as 1974 several investigators had expressed doubts regarding the use of L_{Aeq},T as a suitable parameter for evaluating induced hearing damage in industry. L_{Aeq},T underestimates the short duration impulses with the result that impulsive noise is far more dangerous than continuous noise with the same L_{Aeq},T level.

This lecture illustrated the result of recent research in this field, and it showed that it is necessary to put far more emphasis on short duration impulses when evaluating the dangerous effects of noise on the human ear.

Victoria

May Visit

Thirty-five members of the Victorian Division toured the new **National Tennis Centre** in Melbourne on Thursday 12 May. Centre Manager **Peter Nicholson** presented a lively and informative description of the $86 million development. Completed in under two years, the Centre comprises seven indoor and 13 outdoor courts, as well as the centre court. The viability of a venture of this magnitude, undertaken by Tennis Australia with Victorian Government assistance, depends on its multi-purpose design that ensures year-round utilisation for a variety of events. To this end, the centre court stadium has been fitted with seating for 15,000 and topped with a retractable roof. Weighing 600 tonnes, the roof takes 28 minutes to open and close.

The Centre is used as an entertainment and function venue when not staging premier tennis events. Rock groups such as AC/DC and Pink Floyd have both recently performed concert seasons there successfully.

In order to meet the EPA (Victoria) Draft Music Noise Policy requirements, Acoustic Consultants Graeme Harding and Associates were engaged in the acoustical design of the interior spaces and the containment of noise emission from the Centre. **Graeme Harding** spoke, following on from Peter Nicholson, on the establishment of design criteria and achieving the design goals.

The various subtopics included community and rock band noise levels, envelope sound insulation, centre court acoustics, mechanical services noise control and the public address system.

The visit concluded with a brief tour of the centre court.

May Meeting

A technical meeting was organised at short notice by the Division, with **Mr Larry Elliot,** principal in the Audio Consulting firm of Larry Elliot Associates, speaking on sound system design. It was held in the Applied Physics Department, RMIT, on 17 May. The meeting was both informative and interesting and covered the following topics:

- Determination of room parameters;
- Determination of system performance requirements;
- Selection of likely loudspeakers;
- Testing of loudspeaker coverage;
- Selection of power amplifiers;
- Selection of signal processing equipment;
- Selection of programme sources.

July Meeting

On 13 July **Norm Parris,** the Assistant Director of the East Metropolitan Enforcement Section of the Victorian Environment Protection Authority, spoke on recent developments in the formulation and implementation of noise policies.

The talk covered the revision of SEPP No N-1 (Noise from Commercial, Industrial and Trade Premises) and the development of an Entertainment Noise Policy. The contents and concepts of these policies were discussed in some detail. Insights were also provided into the problems that a regulatory authority has in drafting and implementing noise policies.

The question period developed into a valuable exchange of ideas between acousticians working in the private and public fields, and included a discussion about the types of problems experienced by people using policies.

Joseph Mathew

AGM and September Meeting

The Annual General Meeting of the Victoria Division was held at Monash University on Thursday 8 September 1988. There were 14 people present. Two committee members, **Graham Harding** and **Joseph Mathew,** did not stand for re-election, but **John Upton, Glen Harries** and **Michael Snell** joined the committee.

The meeting was followed by a talk on "expert" computer systems by **Dr Joseph Mathew.**

In many problem areas theory must be tempered by practical experience to suit the real world. By pooling the knowledge of many practitioners it is hoped that a better problem-solving ability can be achieved than is normally available to any individual. This data bank of knowledge, in a "user friendly" computer system, can then make the expert knowledge readily available to the individual in the industry.

Some acoustic design problems such as duct and attenuator designs lend themselves to the development of such systems. Work is currently under way to incorporate industry expertise into a computer programme for the design of dissipative duct silencers.

Michael Snell

Graeme Harding Steps Down

At the annual general meeting of the Victoria Division in September **Graeme Harding** performed his last official function as chairman and finished his final term on the Victoria Division committee following **24 years** of active involvement in the Australian Acoustical Society.

The inaugural meeting of the Society in Victoria was held on 16 November 1964. Graeme was present at the meeting and from that day he has taken a great interest in the Society. Over the period he has served in many positions, including those of Divisional Chairman, Councillor and Federal President 1985-1987. He has been a regular attender at technical meetings.

Graeme has occupied a prominent role in acoustics for many years. In 1963, in association with Morry Jefferies, he established NONOYS Pty Ltd, producing acoustic doors and air duct attenuators. In 1976 NONOYS was sold to Sound Attenuators Pty Ltd but Graeme remained with the firm as Managing Director until 1979 when he formed the consultancy firm of Graeme Harding and Associates.

Graeme's most notable and visible achievement is his role as acoustic consultant for the National Tennis Centre in Melbourne. The task of containing the noise of pop concerts within the building, maintaining similar acoustic properties whether the roof is open or closed and minimising echoes is one of immense proportions.

By nature, Graeme is an extremely systematic, thorough person not willing to compromise his ideals. He is very keen to know how everything works, whether it be of a theoretical or technical nature.

We would like to thank Graeme for his magnificent contribution to the Society over so many years and wish him well for the future.

Thanks to Gerald Riley for his assistance in compiling this article.

Michael Snell

Noise and Vibration '89

The first International Conference on Noise and Vibration will be held in Singapore from Wednesday 16 August to Friday 18 August 1989. The conference is organised by the Nanyang Technological Institute. The programme will contain invited papers, contributed papers and technical exhibition. Proceedings containing all invited and contributed papers will be published.

Keynote papers and invited lectures will be given by: Prof David Erwins (Imperial College, London), Dr Jiri Tichy (Pen-State University, USA), Prof Z Maekawa (Kobe University, Japan), Mr Jean Tourret (CETIM, France) and Dr Heller (Institute for Design Aerodynamics, FRG).

Further information: Dr Lim Mong King, School of Mechanical & Production Engineering, Nanyang Technological Institute, Nanyang Avenue, Singapore 2263. Phone 265 1744 ext 578. Fax 264 1859.

Letters

In the August issue of Acoustics Australia *Campbell Steele stated that there were no pipe organs in Sydney "fit to play Bach". Printed below is a further letter from Mr Steele on this subject. Copies of the second letter were sent to Robert Ampt, Sydney City Organist, and David Rumsey, NSW State Conservatorium of Music, for comment. Robert Ampt replied in the form of a letter while David Rumsey was moved to write a complete article on the subject which appears in this issue.*

— Ed.

An Organ for Bach

In reply to the editor's aside on my letter ("Acoustics Australia", August 1988) I must say that I am aware of no Sydney church of the proportions of Thomas-Kirche in Leipzig which has an organ suitable for playing Bach. If I have overlooked any, I would be most grateful to have a list of them.

Since the Catholic and Anglican organ traditions are very different from the North European Protestant tradition, and since the early Presbyterian tradition is for not music, I must say I am not sanguine as to the outcome.

In any case, the absence of any organ suitable for playing Bach was as disgraceful in 1958 as it is in 1988.

Campbell Steele

25 August 1988

The City Organist's View

Campbell Steele's comment (above) that Sydney lacks pipe organs which are tonally satisfactory for playing Bach is both true and untrue. True, in that no baroque instruments exist in Australia; our late entry into European culture making this impossible. (And it must be remembered that no single organ is historically correct for all of Bach's music.) And untrue, in that new organs now exist which can deliver very clear and sympathetic performances of Bach's organ music, e.g., Mary Immaculate Church (Waverley), Great Hall and St Paul's College (Sydney University), German Lutheran (Sydney), Newington College (Stanmore), St Alban's (Epping).

Steele's subsequent reference to buildings with unsympathetic organ acoustics is quite another matter. Of the organs listed above, only two of them are in satisfactory acoustical environments — Waverley and Stanmore. While a natural and evenly decaying reverberation time of 3-5 seconds will not make a poor organ into a good one, it will transform a very good instrument into a beautiful one. Organs are at the mercy of their rooms, and for these rooms to offer natural and thrilling acoustics, they must have interior walls, ceiling and floor of natural materials. For all designers of churches and chapels, the new chapel at Newington College should be compulsory listening.

Robert Ampt

Sydney City Organist
(Robert Ampt was the organ consultant for Newington College)
19 September 1988

Conference Reports

Report 1

The 5th International Conference on **Noise as a Public Health Problem** was held in Stockholm on 21-25 August 1988. It was organised by the Karolinska Institute and the National Institute of Environmental Medicine on behalf of The International Commission on the Biological Effects of Noise and the Nordic Council of Ministers, with the co-sponsorship of the World Health Organisation.

The Conference is organised every five years primarily to enable the eight scientific teams of the Commission to report on research undertaken in the five-year period. This year's Conference also catered for contributed papers, most of which were presented in Free Communication format with a five-minute oral presentation. Prizes were awarded for the best presentations in this category.

The eight scientific teams comprise:
- Team 1: Noise Induced Hearing Loss.
- Team 2: Noise and Communication.
- Team 3: Non-Auditory Physiological Effects Induced by Noise.
- Team 4: Influence of Noise on Performance and Behaviour.
- Team 5: Effects of Noise on Sleep.
- Team 6: Community Response to Noise.
- Team 7: Noise and Animals.
- Team 8: Combined Agents.

The Conference was a very important forum for the dissemination of the most recent research on the health effects of noise. It was attended by eight Australians representing occupational and environmental aspects of acoustics in the areas of medicine, government, academia and consulting.

The City of Stockholm hosted a buffet dinner featuring many Swedish delicacies. The dinner was held in the courtyard of the historical Town Hall which is the venue for the Nobel Prize dinner.

Report 2

INTER-NOISE 88 was held in the Palais des Papes, Avignon, France, from 30 August to 1 September 1988. More than 450 papers were offered for the Conference, and of those the Scientific Committee selected 399 papers which fitted the theme "The Sources of Noise".

Three distinguished lectures were presented:
- Synthesis of the 5th International Congress on Noise as a Public Health Problem — Gerd Jansen.
- Active Control of "Noisy" Systems — J E Williams.
- Speed Related Noise in Land Transport — Claude Andre Lamure.

850 people attended the Conference, including nine Australians. The programme included a very popular Workshop on Labelling at which several invited papers provided an overview of the state-of-the-art of the labelling strategy. A number of participants expressed a desire for the forum to address implementation strategies but, unfortunately, much of the debate centred around test methods.

The Conference social event took the form of a dinner party in the Camargue, a national park located on the Mediterranean. Delegates were conveyed to the venue by bus passing through van Gogh country near Arles. The entertainment took place in a "manade" (breeding place for bulls and horses), where participants watched a centuries old rite in branding untamed bulls, and arena games where young people attempted to take a rosette from between the horns of a bull. Entertainment during the dinner was provided by an energetic band of gypsy musicians.

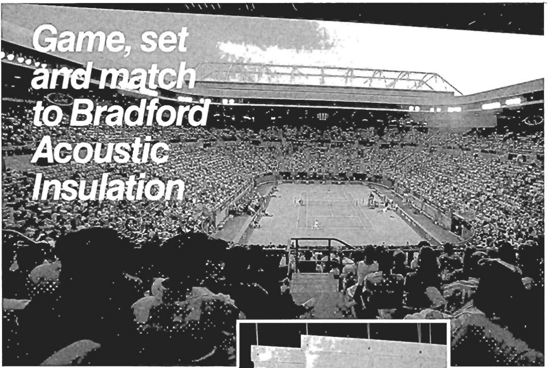
Noela Eddington

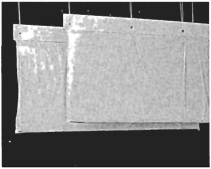
NATA News

The National Association of Testing Authorities has completed a Memorandum of Understanding (MOU) with the Commonwealth Government. This is a companion document to Memorandum between Standards Australia and the Commonwealth.

At the signing ceremony Senator Button stressed that the Commonwealth wishes to assist industry by strengthening the measurement and product and material testing system in Australia and to ensure that an appropriate level of accreditation is available. He added that accreditation is being internationally recognised as a means of eliminating technical barriers to trade, noting NATA's standing in this regard.

The essence of the MOU is very supportive of the NATA concept and gives formal recognition to NATA in a manner never before granted. In addition, it (with a similar clause in the SAA MOU) ensures that NATA and SAA will have even closer ties than in the past.





When selecting insulation for the retractable roof and ceiling of the new National Tennis Centre in Melbourne, Chadwick Industries chose Bradford Tuff-Skin Multi Service Board.

Tuff-Skin Multi Service Board suits a wide range of acoustic and thermal insulation applications, especially the control of reverberent noise on flat surfaces.

The Tennis Centre acoustic design called for fibreglass insulation of a particular thickness and density.

The flexibility of the Bradford manufacturing process meant that a special order of over 40,000 m^2 of 58 mm thickness and 18 kg/m^3 density fibreglass was easily manufactured.

Bradford Insulation, backed by Australia-wide service and a commitment to product development, manufactures Australia's most comprehensive range of sound control products.

The Bradford Acoustic Insulation range includes:

- Acoustic Baffles – designed to reduce reverberent noise where there is insufficient surface area, an economic form of sound insulation installed after construction.
- Semi Rigid – used where good compression resistance and resilience is required.
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Inter-Noise 89

INTER-NOISE 89, the 1989 International Conference on Noise Control Engineering, will be held in Newport Beach, which is a rapidly-growing business centre and resort community on the Pacific Coast south of Los Angeles. The conference will be held at the Newport Beach Marriott Hotel on 4-6 December 1989.

Inter-Noise 89 will be the 18th in a series of international conferences on noise control engineering that have been held in the United States and in other countries since 1972. The theme of Inter-Noise 89 is "Engineering for Environmental Noise Control". The conference is sponsored by the International Institute of Noise Control Engineering and is being organised by the Institute of Noise Control Engineering of the USA (INCE/USA).

Technical papers in all areas of noise control engineering will be considered for presentation at the conference. Abstracts must be submitted by 27 February 1989.

Further information: Inter-Noise 89 Conference Secretariat, PO Box 2469, Arlington Beach, Poughkeepsie, NY 12603, USA.

Standards Australia

The new trading name for the Standards Association of Australia is **Standards Australia.** The new logo is shown below.

A second development in the Standards area is the signing of the Memorandum of Understanding with the Commonwealth Government on 28 July 1988. Apart from the formal recognition it gives to the role of Standards Australia in the national sphere, the Memorandum will impose a greater commitment to ensure that Australia's industries are able to utilise the services of Standards Australia in competing in international markets. To achieve this, a better flow of information is required so that manufacturers in particular understand what is being done in relevant fields and have every opportunity to provide input where necessary.

STANDARDS AUSTRALIA

New CSIRO Division

The Minister for Science, Customs and Small Business, **The Honourable Barry Jones,** recently announced the formation of the new CSIRO Division of Building, Construction and Engineering, which merges the National Building Technology Centre (NBTC) and the former CSIRO Divisions of Building Research and Energy Technology. The Director of the Institute of Minerals Energy and Construction (within which the new Division has been formed, Dr A F Reid, stated that:

"As a consequence the skills and abilities of these three previous entities will now be brought to bear on a spectrum of activities across the building, construction and related engineering industries. This synthesis will provide a wider contribution than was previously available from any single group. The agreement between CSIRO and the Department of Industry, Technology and Commerce was arrived at in consultation with the former NBTC Advisory Board of Management and after consideration by the Board of CSIRO. The continued role within the new Division of the testing and accreditation function performed by NBTC, strengthened by inputs from the former Division of Building Research, was accepted, together with the conduct of strategic and applied research across the range of needs of the industries it serves. It is expected that the testing and accreditation of materials and systems will have a special importance in providing a window on industry's needs in areas of strategic research."

At present the Division is being led by **Dr Don Gibson** as Acting Chief. **Dr Don Close** has been moved from Melbourne to Sydney to manage the North Ryde site on a temporary basis pending appointment of the Chief and Deputy Chief.

The activities at the Highett site will include: Design for Durability, Life Cycle Performance, Safety and Risk, Shelter and Infrastructure and Engineering Technologies. The activities at the North Ryde site will include: Fire Technology, Building Performance, Building Services and Studies and Accreditation and the Building Code of Australia.

SPCC Re-organised

The regulatory and inspection functions of the NSW State Pollution Control Commission's Noise, Air and Water Branches have been amalgamated into a multi-disciplinary division, covering three extended Metropolitan Regions — South, North and Central Sydney, in addition to the existing Regional Offices in Wollongong, Albury and Newcastle. Policy matters will remain with the Noise, Air and Water Branches.

The previous Principal Engineers of the Noise, Air and Water Branches have been appointed Managers of the three Metropolitan Regions. Tony Hewett, MAAS, is Regional Manager for the Southern Region. Warren Hicks (ex Water Branch) and Alan Crapp (ex Air Branch) are the Regional Managers for the Northern and Central Sydney Regions respectively. Mike Mowle is the Manager of the Noise and Transportation Branch.

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.

Victoria
Dr A S Szczepanik.

• Graded

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

Student

New South Wales
Mr A J Madry, Mrs S H McLain.

Subscriber

New South Wales
Mr K Scannell (resident in England).

Member

ACT
Mr M L Evenett.
New South Wales
Mr J W Cotterill.

☆ ☆ ☆

Dr Andy Hede, formerly Director of the Public Policy Research Centre, North Sydney, has now been appointed as Principal Lecturer, Management, in the School of Business Studies, Darling Downs Institute of Advanced Education, Toowoomba, Queensland.

ACT Noise Control Ordinance

The ACT Noise Control Ordinance was passed through legislation in September 1988. The Ordinance provides the means for the control of both environmental noise and noise in the workplace. The details of the policies for different types of noises will be included in regulations and in the Manual. While the Ordinance will be implemented by the ACT Administration from November 1988, there is a 12-month period for review of the Ordinance, Regulations and Manual.

A seminar on the Noise Control Ordinance will be organised for May 1989 by the Acoustics and Vibration Centre, Dept of Mechanical Engineering, Australian Defence Force Academy.

Ecotech Move

Due to an excellent growth over the last few years and increases in Australian manufacturing, **Ecotech** is about to relocate to 12 Apollo Court in Blackburn. The new premises have been selected for a central location and the ability to allow further growth in the manufacturing of Ecotech's range of data acquisition systems, software packages, gas analysers, and gas calibration systems. The move is planned for early January 1989. The move follows soon on the opening of an office in Sydney and the establishments of representatives in each Australian State.

Further information available from: Ecotech Pty Ltd, 12 Apollo Court, Blackburn, Vic 3130. Tel: (03) 894 2399. Fax: 894 2445. Or Sydney Office: 2/73 Albert Avenue, Chatswood 2067. Tel: (02) 419 4395. Fax: 411 8183.

BOOK REVIEWS

INTER-NOISE 87 PROCEEDINGS

Acoustical Society of China,
P.O. Box 2712, Beijing,
Peoples Republic of China.
2 Volumes, 1,692 pp.
Price: $US80 (includes postage).

These proceedings contain the preprints of 412 papers which were presented at INTER-NOISE 87, the 16th International Conference on Noise Control Engineering and organised by the Acoustical Society of China and the Institute of Acoustics, Academia Sinica. The theme of the Conference was "Noise Control in Industry" and the distribution of the papers in the various categories was: General 1 per cent, Physical Phenomena 4 per cent, Vibration 7 per cent, Immission: Effects of Noise 17 per cent, Immission: Physical Aspects 12 per cent, Requirements 4 per cent, Emission: Noise Sources 17 per cent, Noise Control Elements 12 per cent and Analysis 26 per cent.

In the opening address, Fritz Ingerslev outlined the background to Inter-Noise and the relationships between the institutes and organisations for acoustics e.g. ICA, INCE, ICBEN, IEC Technical Committees, etc. The first plenary lecture was given by J. E. Ffowcs Williams from the University of Cambridge on "Active Control of Unsteady Flow". The second by R. H. Lyon from the Massachusetts Institute of Technology on "Conflict Resolution - Noise Reduction Style". The third was given by D. Y. Maa from Academic Sinica, Beijing on "General Laws and Reduction of Aerodynamic Noise".

These papers are then followed by the contributed papers which are included within each of the categories listed above. Each paper is only four pages long so only gives the main essential concepts. The value of proceedings of this nature is that there is enough data for the reader to assess if the information is of sufficient interest to warrant to following up with personal communications. The breadth of topics covered by the papers also give guidance to the current areas of research throughout the world. Inter-Noise has the reputation of encouraging papers dealing more with applications than with theoretical considerations and these proceedings would seem to justify this reputation. This practical approach is emphasised by the theme of the conference.

The proceedings would be of interest to anyone at all involved in noise control in industrial situations. They would be a valuable addition to any library and, at a cost of less than 5c (US) per page, represent excellent value.

Marion Burgess

Positions Vacant

ACOUSTICAL AND ENVIRONMENTAL CONSULTANT BRISBANE

THE FIRM: Winders, Barlow & Morrison Pty Ltd is a diversified and progressive firm of Consulting Engineers practising in acoustics, building services, mechanical design, mining machinery investigation, environmental studies and naval architecture.

The firm is based in Brisbane with a subsidiary in the United States and has Queensland, Interstate and International clientele. The Acoustics and Environmental section has been operating since the early 1970s. A wide range of instrumentation and in-house acoustic, hydraulic and air pollution computer programmes is maintained to assist in all aspects of the firm's Acoustical and Environmental consulting practice.

THE CONSULTANT: Typically B E or B Sc and preferably M Eng Sc or Ph D. Professional qualifications in Acoustics or extensive practical experience in Acoustics together with a related professional qualification. Some experience in preparation of EISs would be an advantage. The ability to prepare correspondence and reports of a high standard with minimal supervision is essential.

THE POSITION: The successful applicant will play a key role within the firm's existing Acoustics and Environmental section with an emphasis on promoting the firm's acoustical expertise as well as accepting significant responsibility for the firm's involvement in acoustic projects. Activities include such work as architectural acoustic design, acoustic evaluations of air conditioning duct systems, vibration investigations, and preparation of EISs.

Applicants should be enthusiastic, self starters, and should be prepared to travel.

SALARY: Commensurate with qualifications and experience.

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A brain the size of a planet would probably be a disadvantage, but the ability to apply a smaller one is mandatory.

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Fax: (03) 882 9298

As acoustics is such a serious business, we will treat all enquiries in strict confidence.

Merry Christmas.

Inter-Noise 91

The Australian Acoustical Society has been successful in its bid to hold INTER-NOISE 91 in Sydney. The venue will be the University of New South Wales and the conference will be held from 2 to 4 December. In addition to plenary lectures by distinguished acousticians there will be many contributed papers presented in parallel sessions, a technical exhibition, technical visits plus opportunities for social gatherings. Put these dates in your diary **now** so that you can participate in a once-in-a-decade international acoustics meeting (remember the 10th ICA 1980!).

For further information, contact Anita Lawrence on (02) 697 4850.

Microprocessor Controlled Variable Acoustics for the ABC's New Multi-purpose Radio Production Studio in Hobart

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ABSTRACT: This paper provides a brief description of the variable acoustic treatment installed in the Production Studio at the new Hobart Radio Studios of the ABC. A unique part of the design is the microprocessor control of the position and movement of the variable absorbers. This control system independently adjusts each of the 24 absorbers and allows repositioning of the absorbers to any one of up to 100 pre-set arrangements. The positions of the absorbers are depicted on a colour graphic display which shows a complete representation of all absorbers on a single screen. This display includes text entered by the user to identify each set-up.

In commissioning tests, reverberation times in the studio were able to be varied from 0.6 to 1.4 seconds over the range 250 to 4000 Hz whilst maintaining a uniform and high quality acoustic result. Reverberation time variation is essentially continuous, however five settings of reverberation time spaced at 0.2 second intervals were established for which the arrangement of absorbers deployed provides a result which is consistent throughout the studio.

Subjective appraisal with two groups of musicians confirmed the flexibility and acoustic appeal of the studio for a diverse range of recording requirements.

1. INTRODUCTION

The ABC began construction of the new Radio Broadcasting Centre in Hobart in September 1985. Initial design work for the project included two Production Studios, but cost cutting measures which had to be taken early in 1985 resulted in only one studio being constructed.

The necessity for a single production studio to satisfy the diverse needs of music, speech and drama created the need for acoustic finishes which could be readily adjusted to produce a range of reverberation times. Sandy Brown Associates, a U.K. firm of acoustic consultants, were approached to prepare a design which would allow the greatest possible range of acoustic conditions to be achieved with the minimum possible physical effort.

The major design objective was to construct a studio with a range of reverberation times; equally important was to achieve this whilst preserving conditions in the studio which would make it an acoustically comfortable and responsive performance space for musicians and actors.

Variable acoustics have been tried by most broadcasting organisations at one time or another. They usually fail in practice because they do not provide a worthwhile range of acoustic conditions or they take so much time and effort to change from one condition to another that the variation is seldom exploited. It was therefore with some trepidation that Sandy Brown Associates undertook this venture.

2. CONCEPT

The design objectives were to provide a studio with variable reverberation times with accompanying substantial evenness in acoustics throughout the studio, plus flexibility in the adjustment of these conditions to suit broadcasting, recording and performance requirements. They were approached using:—

1. A method of variable sound absorption researched by the West German Institut fur Rundfunktechnik;
2. A control system using current technology that would provide efficient adjustment of the variable absorbers to achieve and duplicate selected room acoustic conditions, within acceptable time limits.

The variable sound absorber system contemplated was to be similar to that in the West German design in the use of an acoustically resistive membrane or fabric continuously adjustable in coverage over cavities of various depths and efficient down to low frequencies. Adjustment of the coverage was to be made possible by running the fabric over rollers at the top and bottom of the absorber unit, with the top roller driven by an electric motor through an electrically operated clutch. The fabric would be sufficiently long to cover the fronts of the cavities when fully exposed at the front of the absorber. When moved from the fronts of the cavities, the fabric would travel behind the absorber units where it would no longer have an absorptive effect. Intermediate settings of the position of the fabric would also be possible. In the West German design the fabric is driven in one direction only. The Hobart installation has the capacity to drive the fabric in either direction.

The introduction of sensing techniques and computer control to such a concept suggested the attractive possibility of a considerable degree of remote control and pre-programming for various configurations. The maximum operational time for any configurational change was proposed as one minute.

Figure 3 and Figures 7, 8 and 9 show configurations of cavities and various positions of absorber fabrics in the final design. Appendix 1 provides a simplified description of the acoustic principles of operation of the absorber units.

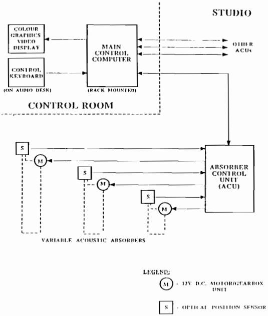

Figure 1: *Control System block diagram*

3. THE CONTROL SYSTEM (see Figure 1)

The control system as constructed comprises:—

- System software
- Colour graphics video display
- Control keyboard
- Main control computer
- Absorber control units
- Optical position sensors

At the outset it was clear that reasonable operating speed and ease of use would be the key factors in the continuing success of the variable absorber concept. Consequently emphasis was placed on these aspects of the design.

The controller allows the person operating the studio equipment to manipulate the absorbers from the control room, using the keyboard and visual display. The latter provides a bar chart representation of the studio walls, depicting the actual location of the membrane in each absorber unit.

The user may move any single absorber or any combination of absorbers any number of steps with a minimum number of keystrokes. Once a desired acoustic treatment has been achieved, the settings of the absorbers can be saved for later recall. To reset the studio to a previously saved setting requires four keystrokes. Alternatively, the user may browse through all settings to recall the required condition. Each library entry incorporates 20 characters of descriptive text.

System software

The processors used in the control system are Motorola 6801 and Zilog Z80 devices. All software was written using macro assemblers to achieve the highest level of performance possible with the selected devices, and care was taken with the user interface to facilitate easy operation. The main aspects of the software include:—

- Communications drivers for main computer and absorber control units (ACU)
- Colour video graphics driver
- Absorber positioning and optical sense algorithms
- Reversible braked variable speed DC motor driver
- Keyboard scanning and communnications

The software is divided into two main areas: the main control system based on the Z80 and the absorber controllers based on the 6801. The main control system software continually refreshes the video display and executes operator commands. Interrupt driven processes in the main control software handle timing and input/output (I/O) from the keyboard and communications circuits. The main control system communicates with the variable absorber controllers via a full duplex serial link.

Each variable absorber unit has its own processor which monitors and responds to data on the main communications interconnect, determines the shortest possible curtain movement to reach a destination location, drives the absorber motor units and senses the curtain location. The absorber software notifies the main control computer of the curtain location, allowing the video display to be updated.

The software includes a motor driver, driven by a mains frequency interrupt, which directly provides timing pulses to drive the SCR bridge connected motor control. The motors can be driven in either direction at variable speed and dynamically braked. Since one power supply drives three absorber units, motor starts are staggered to minimise maximum current requirements. The absorber software also notifies the main system controller of any error condition detected in the electronics.

The hardware and software approach selected for the project resulted in a system with minimum installation and interconnection cost, at the same time providing high reliability and ease of support.

Colour graphics video display

The display has been engineered to provide a complete representation of the entire system on a single screen. The relevant sections of the display are colour coded to match coloured keys on the keyboard. The display is a representation of all 24 absorbers showing the current location and indicating the next destination location.

Video display brightness is controlled via a VIDEO key on the keyboard and the display is muted by software after 30 minutes of inactivity. Pressing any key restores the display to its original brightness. The colour video monitor is recessed into the ceiling of the control room immediately above the studio window.

Control keyboard

The system keyboard contains 24 keys including a numeric keypad and specific function keys. The keyboard occupies a small section of the studio desk.

Main control computer

The control computer selected is an STD bus system based on the Z80 microprocessor. Components include a Z80 microcomputer with battery-backed CMOS memory and a colour video control card. The video card was modified to allow for programmable brightness control. The control computer has two serial data ports; RS232C to communicate with the keyboard and an RS422 link communicating with the absorber control units. This 19" rack mounted device is located in a section of the studio equipment bay.

Absorber control units

Each ACU controls three absorbers. These units are mounted at strategic locations in the studio ceiling.

The ACUs were fabricated using a double sided PCB designed for the purpose. All connectors and power supply components are sited on the PCB, resulting in minimum wiring. Active components include three programmable single chip microcomputers and silicon controlled rectifier (SCR) based reversible variable speed DC motor drivers capable of providing 8 amps drive current. The motor drivers also provide dynamic motor braking. The overall design usess the power of the microcomputer to achieve minimum component count. The ACU software allows for parameters associated with the control of the absorbers to be modified or down-loaded from the main control computer. Thus unknowns in the absorber transport can be corrected without removal or re-programming of the ACUs.

Optical position sensors

Adjustment of the absorbers requires that the position of the fabric membrane is known to within 20mm. This is achieved by the use of infrared optical sensors on each absorber to sense coded punched holes in the edge of the acoustic membranes. These devices use an array of 6 infrared light-emitting diodes and associated phototransistors. They were fabricated using two single sided PCBs mounted in custom designed housings machined from 1cm perspex stock sections. The units and associated mounting hardware provide three axis adjustment for alignment purposes.

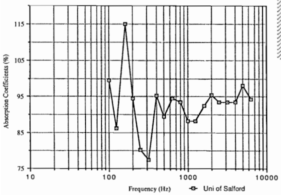

Figure 2: Absorption Coefficients Measured in Reverberation Room

4. ACOUSTIC AND MECHANICAL DESIGN AND CONSTRUCTION

A large number of fabrics were tested originally to determine their flow resistance. From the available range, six fabrics were selected and small samples were tested in an impedance tube to find their normal incidence absorption coefficient. Finally two fabrics, a cotton velvet and a cotton/viscose/flax (linen) combination with transversely corded surface, were tested in full scale measurements in a reverberation room. The individual test results were promising but an even more effective result was obtained by a combination of the two fabrics. When stretched over a 200mm airspace, a very strong peak of absorption resulted at 200 Hz, as would be expected from a membrane over such an airspace. With a combination of three different airspace depths the absorption could be spread over a much wider frequency range while the backing panels could also provide additional low frequency absorption from the panel vibration in combination with the closed airspace behind it.

The reverberation room test results for this combination are shown in Figure 2. It was predicted that using 24 variable absorbers covering a total surface of almost 140m², a variation of the reverberation time of 0.6 to 1.2 seconds would be achieved in this 600m³ production studio.

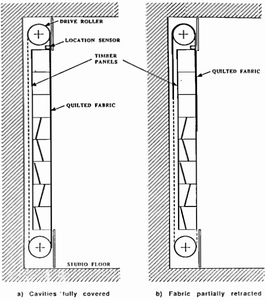

Figure 3: Variable Acoustic Absorber — Sections

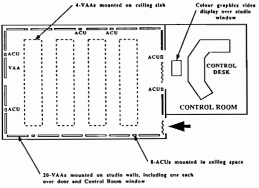

Figure 4: Production Studio Plan Layout of VAAs and ACUs

Considerable care was taken to ensure that the backing boxes would not cause flutter echoes in the studio even when very non-uniform combinations of absorbers were selected. The full depth boxes are positioned at high a level in the studio where the excitation of flutters is unlikely to occur. The lower level backing panels are all angled and distributed. A cross section of the variable acoustic absorber (VAA) is shown in Figure 3 and the disposition of VAAs and ACUs in Figure 4.

A small area of Quadratic Residue Diffusers [1], which are reflection phase gratings designed to scatter sound of many different wavelengths into a broad pattern, was incorporated into the room design to provide further diffusion of the sound field. Tuning procedures revealed the need for ceiling mounted low frequency absorption material, in addition to the variable absorbers. Extra absorption was not necessary on the walls, although provision was made to accommodate if required.

In order to determine final mechanical and acoustical requirements, a prototype variable absorber of half the full height was set up on site. The fabric mounting and drive were simplified by attaching the edge of the fabric to a corded webbing with the cord running in a guide track, as is done in sails. For reasons of stability and appearance the two fabrics forming the membrane were quilted together. Additional stiffening of the quilted fabric was by battens at 1200mm intervals; even so, it has proved difficult to ensure that the fabric is adequately stretched and runs with its leading edge truly horizontal.

The measured absorption characteristic of the absorbers differed little from proposals and design calculations. Thus experimentally selected fabrics were satisfactory, as were the various depths of airspace selected for the backing boxes. Samples of the absorbers were tested at Salford University the results being shown in Figure 2.

The design and development work was completed by December 1986 and installation subsequently arranged by the Commonwealth Department of Administrative Services, Construction Group, Hobart, Tasmania.

5. PERFORMANCE AND COMMISSIONING

The construction and installation of the absorbers and the decorative masking panels were completed in February 1988. Reverberation time measurements were first made with the absorbers fully exposed and fully retracted to define the limiting values of the system. The results plotted in Figure 5 show that the construction was as effective as predicted in the absorptive condition, and that the remanent absorption in the retracted condition had been very effectively minimised.

It was considered that the 1.7 second peak RT at 2 kHz was unnecessarily long for a studio of this volume, and that the characteristic would be improved if the curve could be flatter over a wider frequency range. This was achieved by using about 16m^2 of the double fabric hung over some of the areas of flat reflective panels.

Commissioning continued by selecting absorber configurations which adjusted the studio RT in 0.2 second steps with the most uniform distribution of absorption. The measurements confirmed that diffuse conditions had been provided in the studio because the reverberation times were satisfyingly uniform throughout the volume, both at floor level and at a number of high level microphone positions. In general, octave band measurements were used to calibrate the absorber arrangements but for each configuration a single one-third octave band of measurements was also made; this single position measurement is reproduced in Figure 6 for each reverberation time.

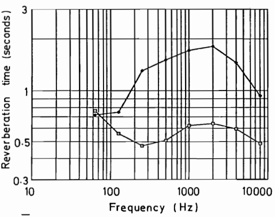

Figure 5: Reverberation times — maximum & minimum
Cavities —□— *fully exposed,*
—◆— *fully covered*

6. SUBJECTIVE EVALUATION AND CONCLUSION

Initial subjective evaluation of the studio and acoustics with various noise and impulsive sources confirmed that a consistent sound quality with an adequate degree of diffusion existed in the studio.

A string trio from the Tasmanian Symphony Orchestra played for a time in the studio. The reverberation time was set to 1.2 seconds initially and reduced to 1.0 second during the performance. For both settings the acoustic result was of high quality, the difference being a matter of recording preference to obtain the required result. It was notable that the players felt comfortable in both conditions and that microphones did not need to be moved to restore a suitable balance after the setting had been altered.

Test recordings were also made with a jazz quartet in the studio. In this instance tests were begun with a low reverberation time, 0.6 second, and the reverberation time was gradually raised. However, this performance requirement was found to be best served by the dead acoustic condition. As with the string trio, the players found the studio an acoustically comfortable performance space for all reverberation time settings.

In studios with a fixed reverberation time, excessive reverberation can only be reduced relative to the direct sound by placing the microphones closer to the sound source. Suitable artificial reverberation at the appropriate level can then be electronically introduced. This process is often time consuming, and frequently does not produce a suitable sound quality from the close microphone arrangement. The variable acoustic studio offers the advantage of the natural acoustic and balance of instruments and instrumental sound that are obtained from more normal microphone distances. In the limited tests conducted thus far, this was found to be the case.

The variable acoustic design and the associated control system exceeded our design expectations and will satisfy the requirements of the majority of the users. Drama may require some additional provision of acoustic isolation to achieve satisfactory live end/dead end operation.

The internal appearance of the studio is pleasing and it has the potential to be a very exciting performing environment.

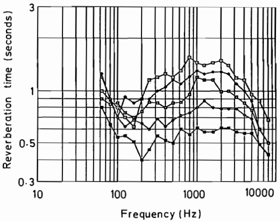

Figure 6: Reverberation times for five discrete absorber configurations.
—□— 1.4 seconds, —◆— 1.2 seconds,
—■— 1.0 seconds, —◇— 0.8 seconds,
—■— 0.6 seconds,

ACKNOWLEDGMENT

This paper is a slightly modified version of one presented at the Commonwealth Broadcasting Association General Conference, Nassau, Bahamas, September 4-11, 1988 and the Asia-Pacific Broadcasting Union Conference, Sydney, Australia, October 22-29, 1988.

(Received 31 May 1988)

APPENDIX:

VARIABLE ACOUSTIC ABSORBERS

Principles of Acoustic Operation

Refer Figures 2 and 3

The fabric or membrane described in the text is acoustically porous. When located in a free airspace, it provides a degree of sound absorption that is dependent upon its flow resistance. Higher frequencies only are absorbed in this configuration.

When this membrane is placed over an airspace such as the full-depth cavities depicted in upper Figure 3, there is marked increase in sound absorption at low frequencies. This is brought about by a Helmholtz resonator type interaction between the porous membrane and the airspace.

For the divided boxes, lower Figure 3, the same physical action occurs, but additional low frequency absorption results from interaction between the front panel vibrations and the air in the enclosed airspaces at the rear.

The combined absorption for all full-depth and divided cavities fully and simultaneously covered is shown in Figure 2.

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1. Manfred R. Schroeder, "Number Theory in Science and Communication, with Applications in Cytography, Physics, Biology, Digital Information and Computing". (Springer-Verlag, Berlin, Heidelberg, New York, 1984).

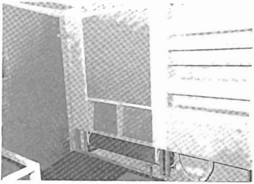

Figure 7: Corner of Production Studio

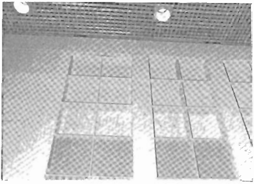

Figure 8: View showing acoustically transparent ceiling grille mounted below ceiling acoustic treatment: Several high level full depth cavities: and four lower level cavities with angled backing panels.

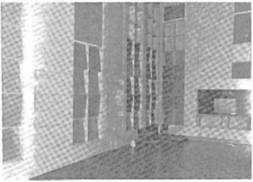

Figure 9: View showing acoustic fabric with corded webbing edge in guide track: Two open cavities: Lower roller: and quadratic residue diffuser on the right.

Acoustic Impulses as Probes

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ABSTRACT: A general comparison is made between continuous waves and impulses as probes for investigating a range of acoustic problems. The ability to time-isolate various components and to use changes to the pulse waveshape to deduce effects over a wide frequency range are two of the major features of impulses. These concepts are then applied to current investigations involving the diffraction, absorption and reflection of impulses. The experiments involve acoustic shielding by finite barriers, the properties of ground surfaces and the testing of ray models of sound in a real atmosphere.

1. INTRODUCTION

Loud bangs, such as gunfire or quarry blasts, are usually considered to be annoying sounds requiring attenuation or elimination. Indeed such acoustic impulses can be disturbing to a distant listener and are potentially damaging to the hearing of nearby listeners. For these reasons alone, knowledge of impulse noise and how it evolves as it propagates is worthwhile. However, short duration sounds can form a useful acoustic probe, revealing information which is often obscured when using more conventional continuous wave approaches. Some of the areas currently under investigation at Chisholm Institute of Technology include the acoustic behaviour of soils, especially when wet, the effect of finite barriers and the testing of theories of sound propagation. In the examples which follow, consideration will be limited to non-shock impulses, which obey linear acoustics and travel at the speed of sound.

2. WHY IMPULSES?

A major advantage when using impulses is the potential to time-isolate various signals arriving by different paths and so observe, say, the effect of reflecting sound from different types of soil. A comparison of the continuous wave situation and impulse results is presented in Figure 1 for this process, although the principles discussed are more general. The difference in path length means that the direct and reflected wave components are time-shifted when they reach the receiver. With a continuous wave the resultant is still a signal of the same frequency but with a different magnitude and shifted in phase relative to the input signal. It is difficult to accurately determine the magnitude and phase of the direct signal, without which it is impossible to deduce the reflected component.

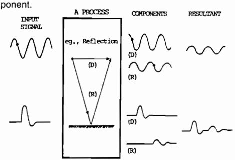

Fig. 1. Comparison of continuous wave and impulse behaviour in some process, such as the reflection of sound.

On the other hand, with impulses, the time separation occuring in the resultant signal often permits the components to be readily separated. Even when the pulses merge, if the shape of the direct impulse is known it can be subtracted off to reveal the reflected pulse, providing the leading edge is sufficiently well defined to act as the timing cue. If the process, in this case reflection, is frequency dependent then the final impulse waveform will differ from that of the incident pulse.

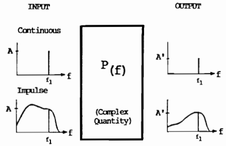

Fig. 2 Ratio of output to input frequency characteristics for both continuous wave and impulse signals.

Assuming that the required output signal has been obtained, another important aspect of impulse techniques is indicated in Figure 2. With a continuous wave signal, of frequency f_1, the effect of some process can be quantified by taking the ratio

$$P_{(f)} = A'/A \qquad (1)$$

where, simplistically, A and A' represent the amplitudes of the incident and required output wave. More correctly, there will be a phase shift involved and so A and A' are phasors with a magnitude and phase which gives rise to a complex coefficient $P_{(f)}$. An impulse contains a wide range of frequencies, corresponding to a continuous spectrum in the frequency domain. However, by Fourier analysing the initial and final waveforms into their frequency components, the values of $P_{(f)}$ can be deduced simultaneously over this frequency range. While the broad bandwidth is more demanding on both measurement and computational techniques, it is often a major advantage to be able to study how an external variable, such as wind or moisture content, effects the parameter being investigated at a given instant, over much of the frequency spectrum. In addition, it can be a more rigorous way of testing theories and a faster method of gathering data.

The concepts discussed above are quite general and are being utilized in three different types of measurements currently being undertaken at Chisholm Institute of Technology. As will be discussed shortly, with the appropriate experimental geometry, $P_{(f)}$ can be interpreted as a diffraction, an absorption or a reflection coefficient.

3. PULSE TECHNIQUES

For those not familiar with manipulating impulses, a resume of production, capture and analysis techniques may be appropriate. Initially, our impulses were produced by the discharge of loaded ammunition from a rifle, however, the projectile caused problems, The bullet, travelling at a speed greater than that of sound, produces shock waves which have non-linear effects and may, under certain geometries, coincide in time with the required acoustic blast caused by the explosion of hot gas from the gunpowder. Incidentally, the projectile is also lethal! Both problems are avoided by forming a "blank", where the gunpowder is sealed in the cartridge by rubber epoxy, which is ejected as fragments that travel, at best, a few metres. Typically this produces an impulse with a maximum level around 150dB, measured 2m from the source, and lasting perhaps 2ms, as indicated in Figure 3(a). If less intense levels, say 130dB, are sufficient, a similar waveform can be produced by detonating a shotshell primer, held in a suitable rig at one end of a long tube.

Our first waveforms were recorded by photographing the screen of an analogue storage oscilloscope. Fortunately, the advent of digital storage systems permits much more reliable recordings which can be directly manipulated by a computer.

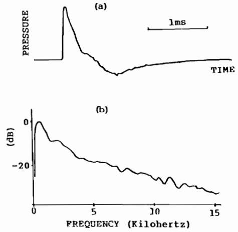

Fig. 3 (a) Typical impulse waveform, (b) The corresponding frequency spectrum.

Currently, we can capture up to ten simultaneous waveforms, with possible digitizing rates of 1MHz and 16 bit resolution. Upper frequency roll-off of the 1/4" microphones used to capture impulses, close to the source, limits the meaningful range to about 40kHz, although we rarely consider values above 10kHz. While the reference pulse energy is dominant around 1kHz, as is apparent in Figure 3(b), the higher frequencies are important as they influence the initial rise time and hence the peak pressure level. Under certain geometries, such as long distances from the source or when the microphone is placed on the ground, the higher frequencies are attenuated and so 1/2" microphones can be satisfactorily utilized.

Small fluctuations occur between consecutive impulse waveforms measured under similar conditions. These shot-to-shot variations are caused by differences in the loads and, for outside work, atmospheric turbulence. Both effects can be made negligible by ensemble averaging ten or more successive impulses.

In order to determine the change due to some process, it is necessary to know the input impulse waveshape. Tests indicate that although our sources are essentially a point, producing a spherical wavefront, the pulse magnitude and shape does depend on position relative to the axis formed by the barrel. However, they exhibit conical symmetry, so providing we stay on the same radial line, the direct impulse retains its waveshape and closely follows inverse square law predictions, although beyond a few tens of metres account must be taken of atmospheric absorption. To avoid making assumptions about the above approximations, whenever possible the input waveform is measured at the same distance and similar spacial geometry, relative to the source axis defined by the gun barrel, to that of the resultant impulse. Then by division of the corresponding Fourier components, $P_{(f)}$ can be determined from Eqn. (1). When testing a theoretical model, values of $P_{(f)}$ can be computed and used to modify the Fourier components of the input waveform, and an inverse transform applied to predict the resultant impulse waveshape. Often the resultant waveform must be generated from a number of individual impulses, each delayed by a time which depends on the relative path length difference.

4. DIFFRACTION BY A BARRIER

When an impulse is diffracted around a semi-infinite barrier, then the ratio $P_{(f)}$ corresponds to the frequency dependent diffraction factors. While there are a number of theories and approximations which permit such diffraction factors to be calculated, little work has been done to experimentally measure the properties of barriers using real impulses.

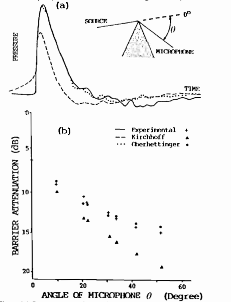

Fig. 4 (a) Comparison of experimental and theoretical impulse waveforms and (b) Attenuation of the peak level as function of angle behind a barrier.

Currently we are comparing theoretical predictions derived from both an approximate Kirchhoff-Fresnel integral [1] and a more exact diffraction model [2] with experimental impulse waveforms measured over a wide range of geometries. Figure 4(a) compares two calculated waveforms with a measured impulse while Figure 4(b) presents the variation in peak intensities deduced from the same two models with measured values, as a function of diffracted angle. It is apparent that the more sophisticated approach of Oberhettinger is a reasonable match, although it slightly underpredicts the peak attenuation at high angles.

Once we can satisfactorily calculate impulse waveforms for the semi-infinite, single edged barrier, a number of interesting possibilities arise. Experiments have already been performed on wide barriers and ones with "castellated tops", although predicting the resulting waveforms theoretically is still a challenge. Perhaps of greater interest is the effect of a crack, which can be observed in Figure 5. Because of the shorter path length, a small pulse precedes the main diffracted one, due to energy leaking through the crack. Knowing the expected diffracted waveform, this can

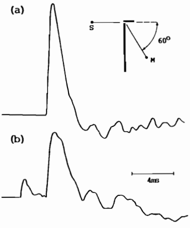

Fig. 5 Effect of a crack on a diffracted impulse: (a) received pulse with no crack, (b) pulse with 1mm crack near diffracting edge.

be subtracted from the resultant to reveal the leaked pulse shape, and hence the relative magnitude of the diffracted to leaked energy can be deduced. An interesting application is the typical Australian wood pailing fence, where a multitude of cracks permit portion of the energy to pass through the barrier. While continuous sound measurements would permit the overall level to be determined, pulses offer the potential to quantify the relative contributions.

5. ABSORPTION OF IMPULSES

When sound passes through a material it is partially attenuated and delayed due to a changed speed. By comparing waveshapes with and without a layer of material in the propagation path, the ratio $P_{(f)}$ can be interpreted as a measure of the absorption and phase delay at the particular frequency for the thickness of material under test.

A sketch of the test rig currently being used at Chisholm to take such measurements is shown in Figure 6(a) while microphone outputs are given in Figure 6(b) with and without the sample present. The thin wire mesh used to support the sample is transparent to the acoustic impulses while the distances to the edge of the sample, supporting framework and the ground are such that all reflections are sufficiently delayed. Pulse A recorded by the microphone above the sample is the direct impulse from the source and should be the same as that registered by microphone M_2 without the sample present, labeled Pulse B, after scaling for distance

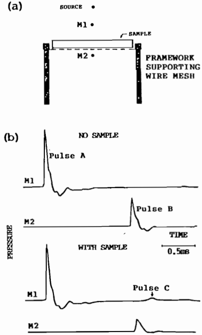

Fig. 6 (a) The test rig used for absorption measurements and (b) Impulses measured at the two microphone positions with and without a fibreglass specimen present.

effects. When the sample is introduced, there is a small pulse reflected at normal incidence from the top of the sample, Pulse C, while Pulse B has now changed shape and may have a slightly different delay relative to Pulse A. Providing the duration of the pulses are significantly less than the delay to unwanted reflections, then the appropriate pulses can be isolated and the waveshapes used to calculate both reflection and absorption properties of the sample.

Such measurements are currently being used to check existing data on partially absorbent fibrous materials and can be extended to layered systems. However, the main purpose is to investigate the properties of soils, in particular the effect that moisture has on their acoustic behaviour. Why are we concerned to obtain such data? Before discussing the reason, let us consider the third experiment described by Figures 1 and 2.

6. MEASUREMENT OF SURFACE IMPEDANCE

If a source and microphone are mounted, say, 4m apart and 1.4m above a partially reflecting surface, then the direct impulse reaching the receiver will precede the reflected waveform by 2.9ms and can be time isolated providing the impulse has a sufficiently short duration. As the reflected impulse will be modified by the surface impedance the latter can, in principle, be determined by calculating the reflection coefficients $R_p = P_{(f)}$ through Eqn. (1). However, to avoid corrections due to a non-spherical source and different path lengths, a two microphone technique is preferred [3], where one microphone captures the direct and the other the corresponding reflected component. The normalized acoustic impedance, Z, of the surface is then found from

$$Z = (R + jX) = (1 + R_p) / [1 - R_p) \sin\psi] \qquad (2)$$

where Ψ is the angle between the incident sound ray and the surface. Since R_p is complex, then Z is also complex, its magnitude being a measure of the attenuation while the argument relates to the phase delay experienced by the particular frequency on reflection.

Often, experimental measurements of the impedance of grassland can be closely approximated by a single parameter model, due to Delany and Bazley [4]:

$$R = 1 + 9.08\,(f/\sigma_E)^{-0.75}, \qquad (3)$$
$$X = 11.9\,(f/\sigma_E)^{-0.73}$$

where an effective flow resistivity, σ_E , is chosen to give the best fit. A σ_E of 300 cgs rayl is typical for grassland, although the particular value is site dependent. Figure 7(a) compares measurements with curves calculated by assuming σ_E = 250 cgs rayl. However, not all measurements conform to such curves, as is evident in Figure 7(b) and a multi-parameter model of the soil impedance is necessary to fit the data [5].

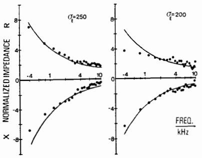

Fig. 7 Impedance measurements taken over two grassland sites and compared with curves derived from Eqn. (3).

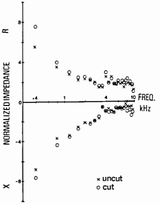

Fig. 8 The impedance of the same area of grassland before and after cutting 40cm long grass. The difference is generally within the experimental uncertainty.

As indicated earlier, one advantage of the impulse technique is that data, such as impedance values, are obtained over a wide frequency span in the one measurement. This permits changes to the impedance values to be readily monitored. For example, the effect of the height and thickness of grass cover above the soil can readily be observed by taking measurements in a region of long grass and, without moving either source or receiver, mowing the area before repeating the impedance measurement. One such set of data is shown in Figure 8 for the case of long spindly grass, about 40cm high, where it is apparent that the effect of the long grass is negligible. Over shorter, more densely packed vegetation a small pre-pulse can occure from sound reflected from the top of the grass, however, the ground remains the main reflector and the impedance is relatively unaltered.

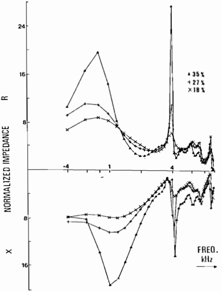

Fig. 9 "Resonances" which occur in the impedance of grassland as the moisture content of the site altered.

Perhaps a more important application is to monitor the effect of rainwater on soil impedance [6]. One approach is to set up the source and measuring microphones over a region of dry grassland and determine the impedance values. Without moving the measuring equipment, the ground is soaked and then left to dry out, during which time further impedance measurements and corresponding estimates of the moisture content are made. A typical set of data is presented in Figure 9. While there is an overall increase in the impedance values, the noteworthy feature is the pronounced "resonance" which occures, the magnitude of the resonance being dependent on the moisture content. The number of resonances and the frequency at which they occur is very position dependent. They also occur in barren earth and sand, indicating they are not a property of the root structure. What causes such sharp, well defined resonances? Almost certainly they are due to layering of the water in the soil but attempts to explain them by such modelling have failed. One of the reasons for measuring the transmission properties of soils, as discussed in the previous section, is to improve the reliability of the data used when modelling the resonances.

Apart from improving our understanding of the acoustic behaviour of real surfaces, ground impedance is an important parameter when studying the propagation of sound. The following section looks at some aspects which have been investiaged using impulses.

7. PROPAGATION OVER GRASSLAND

Similar to the reflection measurements, the microphone receives direct and reflected sound, except that in this work a known ground impedance is used to deduce the reflected component. This is then suitably delayed before adding to the direct component to produce a resultant pulse, which can be compared with experiment. However, there are several complications. A point source produces spherical wavefronts. When these interact with the flat ground plane they form a specularly reflected wave and an additional component which can be thought of as a diffuse reflection, usually called a ground wave [7]. Close to the source, with the geometry used in the previous impedance measurements, this latter component is negligible, however, at larger distances it becomes important. With a continuous wave signal the ground wave is just another component at the same frequency as the direct and specular reflection, and so can't be experimentally identified. As a pulse contains a range of frequencies and the ground wave effect is large at lower frequencies, the result is a pulse of quite a different shape to the originating impulse and so can be directly identified. This is evident in Figure 10, where the various components, including the ground wave, have been calculated and added together for the case of a source to receiver distance of 37m above grassland ($_E$ = 300 cgs rayl).

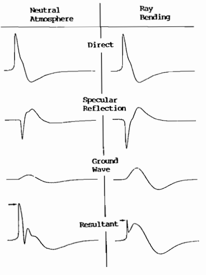

Fig. 10 A comparison of theoretical pulse shapes expected in a neutral atmosphere and when ray bending occurs in the presence of a linear sound speed gradient. Each resultant pulse is the sum of three components which have been calculated from the known source pulse shape.

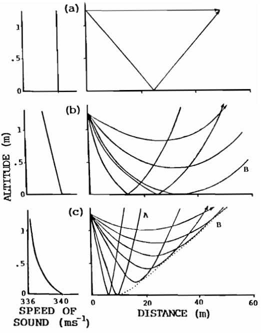

Fig. 11 Possible sound speed variations and the corresponding ray paths. (a) Constant, (b) Linearly decreasing and (c) Non-linear decrease with increasing altitude.

Figure 10 distinguishes two cases: a neutral atmosphere and one where ray bending occurs. To explain this difference consider the situations in Figure 11, where typical ray paths are indicated in the right-hand diagrams for different sound speed gradients, indicated on the left. Assuming the sound speed is constant with altitude, the sound rays follow straight line paths and this condition is called a neutral atmosphere. However, when a temperature or wind gradient occurs, the sound speed is no longer a constant with altitude and the atmosphere is refractive. Ray paths are indicated for the conditions where the sound speed decreases linearly and non-linearly with altitude. In both these situations a condition occurs such that there is a shadow boundary, indicated by B in Figure 11, beyond which no sound can penetrate according to these ray treatments. The passage of sound into the shadow zone by creeping waves has also been investigated by using impulses [8,9] but is beyond the scope of this discussion.

One of the effects of a refractive atmosphere is that it changes the path lengths and consequently the delay between the direct and reflected components. Indeed, quite close to the shadow boundary, in a linear gradient situation, the direct and reflected components follow almost identical paths, although the specularly reflected component is inverted due to R_p tending to -1. The result is that these two can almost completely cancel, leaving only the ground wave and a small residue of the direct impulse. This effect can be seen in Figure 10, the residue of the direct peak is arrowed and can be compared with the unaffected peak in a neutral atmosphere. The non-linear gradient case is more complex. Out to ray A of Figure 11, there is both a direct and reflected component which will at least partially cancel. However, between ray A and the boundary, the second ray approaches the ground but does not hit it and so is not inverted. In this region the resultant is essentially a pulse of the same shape as the direct component but of nearly twice the amplitude.

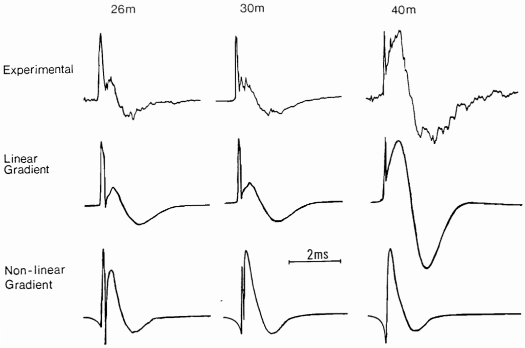

Fig. 12 Comparison of experimental waveforms with ones calculated assuming a linear and non-linear sound speed gradient.

Thus the different ray models predict quite different pulse shapes and amplitudes.

Figure 12 compares experimental waveforms with pulse shapes computed for both linear and non-linear sound speed gradients. In this diagram all pulses have been drawn so they have the same maximum value to permit ease of comparison of shape. It is apparent from Figure 12 that the linear gradient predictions of waveform are in reasonable agreement with experiement, even showing the significant ground wave term at the larger distances. Unfortunately, however, measurements also indicate that experimentally the sound speed gradient is non-linear close to the ground and so the other set of waveform predictions should apply. This, and other impulse measurements, have led us to conclude that ray treatments of sound are inappropriate close to a real boundary where wind and/or temperature gradients occur [10,11].

8. CONCLUSION

The above examples have illustrated that acoustic impulse techniques are capable of giving insight in situations where continuous wave treatments would be inappropriate. Because impulses involve a wide range of frequencies they form a more rigorous test of theories and also can produce data simultaneously over the acoustic spectrum. However, it is often the ability to time isolate components, or the effect which subtle changes to the paths cause on the resultant pulse shape, which leads to the most revealing applications of impulses as acoustic probes.

ACKNOWLEDGEMENT

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The Sounds of Bach

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ABSTRACT: The suitability of a particular organ for the performance of Bach's music is often debated. In this article consideration is given to relevant acoustical and musical qualities both of the instrument and the building. A set of criteria is proposed and applied to a number of Australian organs.

Acoustical Considerations

There can be no denying that organ music works in a kind of "chicken and egg" fashion with the medium on which it is played. This is perhaps one of the great achievements of the West, at first empirically, then later scientifically, to exploit all the natural acoustic phenomena and create a magnificent art form. The mixtures of an old German organ exploit the formant principles, perhaps more familiar in the harpsichord, where the plucking point effects higher harmonic development in the bass and lower in the treble, bringing all voices of a fugue into equal prominence on account of the human ear's frequency sensitivity. The trumpet stops of an old French organ with their increase in intensity towards the low frequency end of their range meant that French fugues tended to exploit the dynamic effects of the final voice-entry being in the bass. The music of Franck depends on long rise and decay times, the music of Vincent Lübeck much less so.

The acoustic phenomena on which organ music depends include the following:

(a) the coupling of the organ to the building;
(b) the range of frequencies available from the instrument (its compass in manuals and pedals);
(c) the pitch at which the notes are set, e.g., A = 440 Hz;
(d) the tempering used, i.e., how the octave is divided into 12 different notes, equally or unequally;
(e) the speech and tonal characteristics of the pipes (and conjunctly the ability of the action to affect these);
(f) the specification of the organ, i.e., acoustically the basic tonal materials out of which the organist, through stop-selection, can synthesize the necessary sounds to suit the music being played;
(g) the acoustic qualities of the building, rise and decay, dispersion, first reflections, etc.;
(h) the wind-system of the instrument, especially the effect on pipe speech and frequency stability when the normal disturbances through playing or use of tremulants are encouraged.

Obviously the subject is huge — but that is one of the great fascinations surrounding the organ! To return to our "chicken and egg" we must acknowledge that the capabilities of various organ types have responded to the demands made by composers by exploiting different balances of the above acoustical phenomena. It is very hard to know which came first, the organs or the repertoire! Certainly at least 15 totally different schools of organ playing/organ building are clearly identifiable over the past 500 years.

It is not easy to allocate J. S. Bach to any one of these schools. Nevertheless the circumstances of his life and the internal evidence of his music allow us to fairly clearly define the acoustic qualities required for it. Recent restorations and studies of organs which he gravitated towards, played, designed or commented on give us a fairly clear picture of his preferences and expectations.

For example we know he was strongly attracted to the North German organ type as it existed in the first part of his life (to ca. 1720). We know also that he had certain altercations with the organ-builder Silbermann about his tempering methods. We have some of the organs he played in middle-Germany later in his life (they are very different to their Northern cousins). We have specifications which he drew up for organ improvement (e.g., Mühlhausen) or for entirely new organs (e.g., Bad Berka).

Virtually every organ he ever played was directly coupled to the building in which it stood. Each division of the organ manifested the now-familiar German "Werkprinzip", which effected direct coupling of each division (pedals, manuals) down a main axis — nave or transept, and endowed these divisions with subtle differences in acoustic power and available tonal resources. The pipes of each division stood on their windchests and were enclosed on three sides and at the top, the sound emitting from the open side, unobstructed by other divisions, swell shutters, or anything else. This meant that whatever the rise and decay time of the building a direct acoustical path was virtually universally available to any listener enabling focusing and positioning of the sound (kind of "cocktail-party-effect"). The Silbermann organs of the Strasbourg/Basel region usually placed their pedal department behind the main division, thus only indirect/reflected sound was available to most listeners, restricting thereby the clarity of the pedal and encouraging its use to low-frequency support of manual activity rather than, say, contrapuntal independence. Contrary to popular opinion, therefore, they are less than ideal vehicles for Bach's highly contrapuntal music.

Compass, Pitch and Temperament

Bach's music rarely requires more than four octaves of manual compass and two octaves of pedal. We might say that where more is provided on a modern organ that this is no problem: we just use what we want. However some of the world's leading organ builders have pointed out in recent years the extremely sensitive interrelationships between windchest design and pipe speech and blend. The bigger the windchest the more, for example, cushioning effects of the mass of "dormant" air lying in them will affect the opening transients of pipe speech, yet also necessitate "bleeding" air off so that pipes will stop speaking immediately supply ceases. These may seem small points but many organ builders are seemingly proving this with the latest instruments they are building. Therefore compasses which significantly exceed those available to Bach may be said to reduce the suitability of an instrument for his music.

Musical pitch is another major factor: and on organs it has varied considerably over the centuries. A = 440 Hz may be standard today, but it was exceptionally uncommon 200 years ago! There is ample evidence that organists, especially of the North German school to which Bach was so attracted, used to actually transpose their pieces in order to bring them out at the right (absolute) pitch. One of Bach's early organ works exists in two keys and transpositions are evident between original chorale and chorale-prelude in such collections as his "Little Organ Book". Obviously this question of absolute pitch-level was important to Bach although clearly this became quickly of dramatic significance when singers were involved!

With the question of musical tempering we are on firmer ground. Whatever the arguments which raged around his harpsichord tuning the organs were clearly in something other than equal temperament. The temperings projected by Werckmeister were well-disseminated and used in early 18th century Germany, and Bach, in his earlier works (before his move to Leipzig around 1723), generally keeps very close to the "good" keys of the Werckmeister system. Later, towards the end of his life, there is clear evidence (from such collections as the "Clavierübung part III" and the "Schübler" chorales) that a slightly wider choice of key was available to him although there is equally a lot of evidence to support the notion that he was exploiting key colour, i.e., the increased dissonance of the remoter keys to symbolize and dramatize the texts he was portraying.

Organ and Room Tonal Qualities

The tonal qualities of the pipework, like the tempering, seem to have changed slightly throughout Bach's lifetime, partly through regional influences, partly through changing musical aesthetic. The North German organs were big and weighty in sound, with brilliant and full upper-work stacking its harmonic structures over healthy foundation stops. Fundamental-rich pedal-reeds could virtually support these choruses unaided. A fully-endowed North German organ offered an exceptionally diverse range of synthesizable tone-colours from highly individual reed-colours to mutations such as the "Nasat" or the "Sesquialtera" (third harmonic, or third and fifth harmonics predominating respectively). The Central German organ of Bach's Leipzig sojourn was thinner and keener in tone and included some string stops such as "Viola da Gamba" as well as a greater selection of foundational stops than the North German organs. It is on these organs that the "Neo-Classical" organs of the 20th Century are based to some extent. However towards the end of his life he was still designing specifications which have a strong Northern influence and few concessions to what was going on about him.

The actual room acoustic — confining ourselves to rise and decay characteristics — which Bach worked with seems to have been generally relatively "dry". This was consistent with many, although not all, of the Churches in which Bach worked and some of the North German Churches. Clearly in some works (the C major Prelude and Fugue, BWV 547) a longer rise and decay time (about 2-3 seconds?) is essential. Of course any piano or organ music will fare better with a healthy "acoustic", but for Bach we must be careful not to exceed certain limits. Since it is generally complex contrapuntal music which we are involved in with Bach we need the balance alluded to earlier whereby the listener's concentration on the articulate detail of the performance (cocktail-party effect) is not compromised by too many reflections of nearly-equal intensity getting in the way. In the absence of known data on this (at least to me) I would estimate anything over 3-4 seconds as bordering on the excessive for Bach, although there will clearly be other factors in the equation too.

Wind Systems

It has recently been recognised in the organ-building/organ-playing professions that a too-steady wind supply gives what is perceived as an "unmusical" or "dead-sounding" organ. Naturally an unsteady or inadequate supply can become a problem too, and Bach is known to have been acutely interested in this whenever (in his own words) he tried out the "lungs" of a new organ. Old wind-raising, storage and distribution systems were characterised by a certain flexibility, a modulation of pressure according to demands made in performance (equivalent perhaps to doppler effects of violinists who move whilst playing, to cello strings which are under marginally more tension when played with greater amplitude, or to singers who apply a natural "vibrato"). Modern wind systems often use far more efficient wind-steadying systems (e.g., the devices known as "Schwimmers") but thereby rob their instruments of the small modulatory effects on frequency and amplitude available with a sensitive pipe-voicing, chest design and winding system, which imitates these natural effects available on "musical" instruments. (This is really a case of what was once considered "unscientific/subjective" musicians' perceptions now being explained as real "objective musico-scientific" phenomena.) In any event the wind systems known by Bach were not of the modern variety and there are many instances in his music where, for example, long-held right-hand notes are subtly modulated by repeated left-hand chords rippling the wind-supply within the same chest. The almost universal endowment of organs with tremulants in this era leaves no doubt that wind-supply variation was regarded as a sine qua non for much of the music — a hypothesis which needs a lot more research but is certainly supported by many 17th and 18th Century theoretical treatises on organ registration.

Criteria for Bach's Music

If we now use these acoustic guidelines as a criterion for assessing the degree to which an organ is suitable for playing Bach's music some interesting results should be forthcoming. Naturally we must also note that some of his organ music pre-supposes the availability of a larger, say 3 manual, organ, while certain individual pieces require but a single stop. In brief we can say that a suitable organ for Bach will have the following:

(i) it will be built and placed in the building on the "Werkprinzip" practice;
(ii) it will have a minimum manual compass of four octaves, a minimum pedal compass of two octaves and one note; whilst some extension of these compasses is possible, even desirable, "significant" increases are to be eschewed;
(iii) tempering should be unequal, based on the Werckmeister schemes or somewhere between these and equal (but not equal);
(iv) it should be at least two, preferably three manuals, employing the construction schemes, pipe scaling and voicing schemes of turn-of-the-18th Century North Germany or early to mid-18th Century Middle Germany. The specification should be appropriate to these regions and eras and compromises or concessions to other eras must be recognised as detracting from the organ's suitability for playing Bach;
(v) the acoustic qualities of the building may be relatively "dry" to moderately "live";
(vi) the organ should have the kind of wind system now known as "flexible winding".

Of course there are many other desirable requirements — a beautifully architectural and appropriately decorated church, for example!

Applying these criteria to a number of Australian organs is an interesting exercise, and may have some significance. By that we must acknowledge that when an organist is engaged to do a recital of Bach's music on a particular instrument he should immediately acquaint himself with it and design a program selectively so that he matches up those works of Bach which will best suit the particular organ. Isolated works may well come off glowingly on an organ not generally regarded as suitable for Bach. A scale of 0-3 has been used to grade each aspect: 0 is low, 3 is high. Table 1 is only to be read as a sample and makes no pretence at completeness.

The columns correspond to the items listed above:

"Werk" (i) refers to the degree to which the instrument conforms to the "Werkprinzip" and may be read acoustically as the effectiveness of the instrument's coupling to the building (which for Bach should be exceptionally good).

"Comp" (ii) indicates manual and pedal compass. Where compass is less than that required by Bach a "0" is awarded, 5-octave compasses get "1", "near-perfect" Bach compasses get "3" etc.

"Temp" (iii) indicates tempering. Mean-tone, if it existed, would get "0", equal gets "1", other 18th Century temperings get "2" and Werckmeister or similar get "3".

"Size" (iv) refers to the number of manuals and stops available, a 1-manual organ is very limiting for Bach so gets "1", small 2-manual organs of around 20 stops score "2" and larger organs "3".

"Spec" (iv) means whether the stop-list of the organ includes stops needed for performance of Bach's music, the appropriate balance of primary and secondary "choruses" etc.

"Actn" (iv) indicates whether the organ's action is capable of the right touch control, repetition rate etc.; a point is deducted if actions are mixed (e.g., mechanical key action with electric couplers; different kinds of pneumatic actions etc.);

"Voic" (iv) indicates proximity or otherwise to the scaling and voicing practices evident in North or Middle Germany between 1700 and 1750 (approx.);

"Room" (v) refers to the acoustic environment's suitability. 2-4 seconds is considered optimum, for each second more or less than that a point is deducted;

"Wind" (vi) indicates that an organ has a traditional wind system with ideal flexibility ("3"), the same with "problems" ("2"), the same but no flexibility evident ("1"), and "Schwimmer" systems get "0".

Credibility may be assessed by checking each column vertically and comparing the marks given on an organ-by-organ basis. It may also be assessed by comparing the final "scores" and listing the organs in order of suitability for playing Bach. I leave it to the reader to decide whether the table does accurately reflect the situation or not.

Table 1

Rating of Some Australian Organs for Bach's Music

Organ	Werk	Comp	Temp	Size	Spec	Actn	Voic	Room	Wind	Score/27
Sydney Town Hall	0	1	1	3	1	-1	1	3	3	11
Monash University	3	3	3	3	2	3	3	2	3	25
Adelaide Festival	2	1	1	3	2	2	1	1	0	13
Sydney University	2	2	1	3	2	2	2	3	0	17
St. Alban's, Epping	2	3	3	2	1	3	2	2	3	21
Sydney Opera House	1	2	1	3	2	2	2	3	0	16
Epping Baptist	0	2	1	2	1	0	0	2	0	8
Newington College	3	3	1	2	1	3	2	3	0	18
Anglican, Hay, NSW	3	0	1	1	0	1	0	3	1	10
German Lutheran	2	3	1	2	1	3	2	1	0	15

Listing the organs in order, starting with the most suitable and ending with the least suitable Bach organ:

Monash University (Vic)
Organ by Ahrend (Germany).
St. Alban's, Epping (NSW)
Organ by Letourneau (Canada).
Newington College (Sydney, NSW)
Organ by Knud Smenge (Melbourne).
Sydney University, Great Hall
Organ by Beckerath (Germany)
Sydney Opera House
Organ by R. Sharp (Sydney).
German Lutheran Church, Sydney
Organ by Schuke (Germany).
Adelaide Festival Centre (SA)
Organ by Rieger (Austria).
Sydney Town Hall
Organ by Hill (UK).
Anglican Cathedral (Hay, NSW)
Organ by Walcker (Germany).
Baptist Church (Epping, NSW)
Theatre Organ by Christie (UK).

My own personal interpretation of this, having regard to the highest of standards, is that only one organ in the above listing is in any way ideally suited to Bach. The following three are good compromises but have their limitations, the next three are not unsuitable but have too many compromises of one kind or another, and the final three would not generally cope very well with Bach at all.

(Received 24 October 1988)

M.Sc. (Acoustics) Course

There will be a new intake of candidates in the Master of Science (Acoustics) course, Graduate School of the Built Environment, University of New South Wales, in 1989. The course is open to graduates holding minimum four-year degrees in engineering, science, architecture, building and related disciplines. Electives and a graduate project account for about 40 per cent of the credit. The course is normally taken over four part-time sessions, or two academic years (the final session being devoted to the graduate project). However, from 1989 it will be possible to complete the course over one year's full-time study.

Details and application forms: Associate Professor Anita Lawrence, GSBE, UNSW, PO Box 1, Kensington, NSW 2033. Phone 697 4850.

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International Symposium on Numerical Methods in Acoustic Radiation

The purpose of the symposium is to provide a forum for discussion of the most recent investigations of the application of numerical techniques to the prediction of acoustic radiation. Numerical predictions of acoustic radiation using finite difference methods, finite element methods, boundary element methods, Doubly Asymptotic Approximations, variational methods and other numerical formulations are solicited.

Prospective contributors are requested to submit three copies of an abstract (approx 100-150 words) by 15 January 1989 to: *Professor Robert J Bernhard, Ray W Herrick Laboratories, School of Mechanical Engineering, Purdue University, West Lafayette, IN 47907, USA.*

The Science of the Singing Voice

Although there are numerous books dealing with the science and acoustics of speech, there are relatively few that deal with the singing voice as distinct from the speaking voice. Now, John Sundberg's **The Science of the Singing Voice** — illustrated with over a hundred instructive and significant diagrams and drawings — thoroughly describes the structure and functions of the vocal organs in singing, from the aerodynamics of respiration through the dynamics of articulation.

Johan Sundberg is a professor of musical acoustics at the Royal Institute of Technology in Stockholm and one of the world's foremost voice researchers. He is also an active singer.

Further information: Northern University Press, Dekalb, Illinois, USA, 60115.2854. (Price US$35.)

A Violin Quality Assessment Method: Pilot Study

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ABSTRACT: An account is given of a pilot study for assessing violin quality in which an audience gave ratings for seven characteristics of two old and two new violins.

The unique appeal of the violin's musical tone is associated with the legendary and unsurpassed standards of violin making set by the 17th and 18th century Italian Masters of Cremona and Brescia, though several other European centres have hosted the growth of this great tradition. The assumption of Old Master violin superiority is virtually universal within the ranks of orchestral, chamber music and solo string players, for most of whom the ownership of an old "named" instrument (certified as the work of a maker of repute) is an important (and expensive) part of a musical career. Yet paradoxically, recognition of the coveted superior tone of old pedigree instruments is not as easy as the fabulous prices they command would suggest, and few, if any, purchases of valuable old instruments are made using blindfold playing and listening comparisons, where the make and value of the instruments being considered are unknown during playing trials, and comparisons with quality contemporary instruments are rarely even contemplated.

It is therefore not surprising that substantial research into the measurable behaviour of old and new violins has been pursued in many countries since the turn of this century in an attempt to identify the special ingredients of old violin sound, and to relate those ingredients to any unique features in the design, materials or ageing effects evident in the old master instruments. The quality assessment exercise reported here employs a method of individual and group rating of a played instrument which elicits meaningful measures of musical quality over a range of properties, and in the discipline of that exercise, sharpens the listeners' awareness of elements in violin tone quality.

METHOD

Students attending the 1988 Riverina Summer School for Strings at Wagga, NSW ranged in ages between 12 and mature years, and following a lecture on violin history and construction, on Wednesday, 6 January 1988, performed the violin quality rating exercise during the playing of four violins by Mary Nemet, principal lecturer in violin at the Victorian College of the Arts, and Vincent Edwards, lecturer in violin and viola at the Canberra School of Music.

The "Violin Rating Form" was distributed to the audience gathered in the Riverina College of Advanced Education Hall, a venue of good acoustic for string instruments, having a moderate reverberation time and an uncoloured reverberation tone.

The instructions on one side of the Rating Form were:

"If the violin you are hearing or playing impresses you with any of the properties set out below, write a +1, and if the impression is strong, write a +2. If the violin strikes you as deficient in any of the properties, write a −1 or a −2 according to the degree of deficiency. Write a 0 if you feel the violin is average or normal in a given property. Only write next to those properties you consider meaningful, and comments are helpful."

A rating table on the reverse side of the form (see Table 1 below with the results of the exercise) enabled the listeners to enter scores between +2 and −2 for each of 7 properties for each of the four violins. The seven properties chosen to be rated were those commonly arising in violin quality discussions which could also be related to the physical properties of violins identified in many scientific studies. Words like "sonorous, roundness etc", though often used, do not have agreed negatives and cannot be rated on the +2 to −2 scale. They are also hard to relate to the measured physical properties of violins.

Table 1— Rating Exercise on Four Violins

PROPERTY	Violin A avge, sd	Violin B avge, sd	Violin C avge, sd	Violin D avge, sd
(i) Power or loudness	.88, .68	.33, .96	.50, .88	.75, .79
(ii) Projection or carrying power	.78, .74	.75, .85	.48, .66	.96, .71
(iii) Tone quality or timbre Bright (dull or muted)	.63, 1.1	.36, 1.1	.74, .81	.58, .92
Full or rich (shallow)	.50, 1.2	.95, .76	.35, 1.2	1.00, .78
Open (closed or boxy)	.45, .91	.41, .96	0.00, .87	.66, .70
Clear (muffled)	1.0 , .91	.66, 1.0	.42, 1.1	.61, .94
(iv) Evenness	.30, .86	.42, .78	.33, .96	.67, .91
Total, asd (24 forms)	4.58, .91	3.88, .92	2.82, .93	5.23, .82
Total, asd (37 forms)	4.42, .87	3.91, .92	2.33, .92	5.24, .82

Violin A: G.F. Celoniato, Turin, 1720. Owned by Vincent Edwards, Lecturer in Violin and Viola, Canberra School of Music.
Violin B: C.F. Landolphi, Milan, 1742. Owned by Mary Nemet, Principal Lecturer in Violin, Victoria College of the Arts.
Violin C: "King William II" small model, Canberra, 1987. Made in King William Pine and Tasmanian Blackwood.
Violin D: Stradivari Pattern, Canberra, 1987. Made in European Spruce and European Maple.

The opening bars of the Bruch violin concerto were then played on each of the violins A, B, C, D by each of the violinists with the audience seated half way down the hall and facing away from the players so they could not know which of the violins was being played except by the designation A, B, C or D given verbally. After each violin had been played twice by each of the players, the audience was consulted about their progress in rating and requests for open string bowing, pizzicato and spicato were accommodated in a further round of playing, the audience again facing away from the players and proceeding to score.

Finally, the audience faced the players and part of the J.S. Bach Double Violin Concerto was played by two pairs of instruments, one old pair and one new pair, before the audience was informed of the identity of violins A, B, C and D, as in Table 1. After a brief discussion on the rating exercise, the forms were collected for the statistical analysis presented here.

AUDIENCE RESPONSE TO THE RATING PROCEDURE

(i) **Verbal.** The majority registered no difficulty in rating the four violins for the seven properties listed in the rating form. Some sought more time to complete the form, which was not available within the Summer School programme. This means that each of the majority were able to rate their reactions to the violins between +2 and −2 twenty-eight times (four violins across seven properties) during the 25-minute playing schedule. A positive response to the discipline of focusing on the different properties during playing cycles was expressed by many individuals later.

In the several violin quality rating studies reported in the references listed below [1,2,3,4,5], listeners are unable to distinguish between valuable old instruments and professionally made new ones (although new factory instruments are usually recognised as inferior), and many individuals in this case were surprised at their inability to identify the anticipated superior quality of the old violins used in this exercise. The two violinists, when questioned after the rating session on their response to the three violins they had played with no prior experience (one of the four being their own instrument), agreed that security with each other's old instrument was felt, although Mary Nemet remarked on her favourable playing response to the new unfamiliar violin D. It should be noted that the new violin C was designed to suit the Australian tonewoods from which it was made with marginally shorter body and string lengths than standard.

(ii) **Written responses.** Of the 39 rating forms returned, 37 were consistently and clearly rated (no property rated by less than 70% of the 37) and were used to find the average response between +2 and −2 to the four violins for the seven properties and the standard deviation around the average, a quantity which accounts for the variation of assessment amongst the listeners. Since 1 is the unit of our assessment, a standard deviation (sd) of less than 1 indicates a meaningful agreement in the audience assessment, while a sd of more than 1 indicates a wider spread of opinion.

Of the 37 forms, 24 were selected as most clearly and systematically rated (no property rated by less than 90% of the 24), and the detailed analysis of these 24 rating forms is presented in the table. The sum of the average ratings is shown at the bottom of each column A, B, C, D as a measure of the overall approval rating for each violin. The average sd (asd) indicates the variation of opinion averaged across all properties. The sum and the asd for the 37 forms is shown below the sum and asd for the selected 24 forms.

DISCUSSION

The high percentage usage of most of the properties listed and the sd's of mostly less than 1 support the validity of this rating procedure and suggest that the average ratings of these properties for the four violins may be regarded as meaningful measures of their quality as assessed by this audience of variable experience and background. Lower sd's may be expected from more uniform audiences, such as masterclasses, as further application of this method will test. It should be noted that the 40°C heat prevailing at the time did not assist the violinists, the audience or the violins in performing optimally for the exercise!

Scanning across the average ratings for A, B, C and D for each property, we find the averages all fall within a sd, indicating no unanimous agreement on superiority or inferiority for any of these violins, but when we sum the average ratings to find total approval rating, a fair consensus for this audience emerges, where the total ratings are separated by about one sd (except for the two old violins) and the highest score occurs together with the lowest sd, meaning the agreement is greatest when approval is highest, although the differences are not dramatic. This trend is also evident in the ratings and sd's for the seven properties listed. The properties "Power or loudness" and "Projection or carrying power" were rated with lower sd's than the "Tone quality" or "Evenness" properties, suggesting that some modification of the rating form should be made for ongoing applications.

It must be emphasised that certain individuals registered strong preferences or dislikes for one or two of the four violins. For example, total ratings (summed over the seven properties) for two individuals were, for A, B, C, D respectively, 13, 10, 2, 4; 8, 2, −7, 2, showing a strong approval of the old violins A and B (and a strong disapproval of violin C), while two others rated 0, −1, 8, 6; 2, 3, 6, 8, showing strong approval for the new violins C and D even though the violin C was rated lowest overall. Such results serve to caution us that preferences in violin tone may vary dramatically between individuals even within an audience consensus for the instruments assessed.

In other studies of violin tone, it is found that most listeners are unable to distinguish old violins from new in playing comparisons (see references) but that "a very few especially gifted and experienced listeners can distinguish an old violin of high quality, even over the radio." [1]. But without a rating procedure as we describe here, nothing can be said about the quality of the old or new violin identified; i.e. identification of violin type does not assess quality of tone. The individual examples above only show that within the variation around the average ratings, certain individuals in this audience preferred the tone of old violins and others preferred the tone of new violins. When the total ratings for the old violins A+B were compared with the total ratings for the new violins C+D in the 24 most consistently rated forms, 8 had approximately equal sums, 9 favoured A+B and 7 favoured C+D, again revealing no audience number consensus for or against old or new violins. We must also remember that the two new violins were totally unfamiliar to the players (one being of smaller scale) while each was intimately familiar with their own old violins A or B. If one subscribes also to the importance of the "playing in" process, we must allow for the fact that the new violins had hardly been played at all (being only a few months old) while the old violins had been played regularly for 200 years. In fact this author and others have measured some marginal increase in response levels of new violins in the 2-5 kilohertz region as they have been played, an increase which may improve the brightness and clarity of tone, but playing comparisons such as this one suggest "playing in" may be at least as much a player's familiarisation with a particular violin as a change in the instrument itself.

CONCLUSION

In conclusion we should address the recurring and puzzling issue of why old violins are so universally assumed to sound superior to new ones, when rating or identification exercises cannot affirm this assumption, even when the old violins are familiar to the players, have been adjusted by the most experienced violin dealers in the world and played by accomplished violinists for centuries. The assertion that old violins give a sense of security on the concert platform [3] conveys little about musical quality and may be a circular argument: old violins feel secure because they are old. Perhaps the assumption of old violin superiority is a consequence of the decline in making standards during European Industrialisation last century, when the flood of instruments clumsily crafted to feed the growing popularity of the violin characterised "new" violins as inferior against the recognised original master instruments used by famous soloists. During this century, publication of many works on the old master methods, and substantial research into the quality of old and new instruments has offered modern makers a comprehensive body of information on the great traditions of the old masters and scientific research has provided specific information on the optimal adjustment of the violin bellies and backs prior to assembly. Musicians are not generally aware of the regeneration of knowledge and skills in violin making and find it difficult to consider new instruments on their own merits within the prevailing fashion to play professionally on old instruments. It is encouraging to find musicians such as Mary Nemet and Vincent Edwards who are prepared to play old and new violins to the best of their professional ability in exercises such as this one to the great interest and education of a string-playing audience.

We may regard the above exercise as a pilot study in a proposed method of assessing violin quality from an audience consensus. It may offer a means of establishing quality ratings for an individual more comprehensive and reliable than the usual subjective impressions formed during trials of known volins. With modifications to the rating form based on this pilot study, we may move towards a better rating procedure in ongoing assessment exercises.

ACKNOWLEDGEMENTS

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Control of Handtool Noise NOHSC Funded R & D

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ABSTRACT: Vipac has recently completed a basic research and demonstration project, aimed to show the feasibility of handtool noise control. This work was funded by the National Occupational Health and Safety Commission.

INTRODUCTION

Claims for Workers' Compensation resulting from hearing loss form one of the most significant categories of Workers' Compensation claims throughout Australia [1, 2]. The hearing loss is directly attributed to exposure of the workers to Daily Noise Dose exceeding unity [3, 4]. This is equivalent to continuous exposure to a noise level of 90 dBA over an eight hour working day. From a study by Robinson [5], estimating the distribution and exposure of the Australian population, CSIRO [6] made initial calculations of aggregate hearing loss versus fraction of the population exposed to the noise. Associated noise control cost and compensation liability were estimated, as shown in reduced form in Table 1. If 1973 American data is applicable to present day Australia (ie. the technology base is the same), there are significant numbers of the working population exposed to above 90 dBA in the metals fabrication and construction industries. This data does not however, provide an insight to the causes of the excessive Daily Noise Dose, nor into the degree of exposure (or lack of protection) of individuals' ears and therefore their hearing.

Analysis of hearing conservation surveys in many industries around Australia over the last decade shows that the cause of high Daily Noise Dose for the great majority individual workers is likely *not* to be large machine sources such as presses and machine tools, but more likely to be the result of noise from small machines and hand tools. In general, industry experience is that, for many short time duration tasks, workers do not use any hearing protection, even if muffs or plugs are available. Similarly, for long term tasks, their use is often only partial. This severely reduces the usefulness of the protection achieved [7]. Further, the effectiveness of ear muffs in-situ is often far below that expected from muff laboratory test data [8].

To some extent the sources of high exposure are confirmed by U.S. experience: recent American data on noise dose surveys, attributes fractional noise dose incurred by various categories of operators to the various machines they used. One such survey report considered the steel plate fabricators industry [9]; from Table 2, one can see that it is the small hand held tools, in this case grinding and chipping tools, which caused some of the most significant noise dose in that industry. Vipac data [10] indicates that similar distributions of noise sources apply in Australia.

Thus we contend that, unless Noise Doses resulting from use of hand tools is controlled, no significant reductions of Daily Noise Dose in the metal manufacturing and construction industries will be achieved, in spite of any number of reductions applied to larger machine items.

Typical hand tools include carpentry tools — saws, planers, drills, sanders, routers; and metal working tools —grinders, nut runners, hammering (boilermaking), metal saws. Noise is generated both from the mechanism (tool) and from the product (workpiece). Hand tools are often small, fast running implements, held close to the body. They are characteristically used in small size or independent work places employing only a small number of persons. Their low unit costs make the relatively high cost of providing noise control designs unattractive for normal operations. Hand tool noise problems may be categorised as shown in Table 3. It has been proposed to develop and demonstrate practical retrofit and design noise controls for each in a longer-term phased program, making use of extensive 'industry' co-operation.

PRESENT DEMONSTRATIONS

Initially three typical sources (two tools and one workplace) were selected for consideration. This was done following broad field measurement programme and in co-operation with users/unions/health and employer bodies. The tools had the attributes of widespread usage, high noise levels and low capital cost. The demonstrations have taken the form of co-operational ventures to apply remedial treatments or basic reworking of the tools and process selected. For this project the required co-operation was established on reasonably small, short duration tasks and for this reason, the saw bench treatment was adopted for workpiece radiation control and one each of an electric rotary tool and a pneumatic rotary tool were selected.

R & D WORK PROGRAMME

In the present research effort, a carefully selected set of laboratory and field measurements was carried out to quantify the level of noise radiated from the various parts of selected tools and processes. Noise controls were then designed for each significant mechanism to enable the maximum practical noise reductions to be achieved; in general to 90 dBA at the operator's ear. The controls were reviewed and refined with regard to weight, size, durability, practicality and cost. Liaison and discussions were held with users and manufacturers. Resources available from industry were mobilised to provide the hardware modifications themselves.

Significant noise reductions have been produced on two hand tools and an extrusion work bench using methods believed both cost effective and acceptable to users and manufacturers.

TABLE 1: AGGREGATE NOISE CONTROL COSTS VS COMPENSATION IN AUSTRALIAN INDUSTRIES
(after GIBSON & NORTON [6 TABLE V])

Where are the High Noise Levels?

Industry	Number of Australian Employees June 75 (000's)	% Workers exposed above 90dBA	* Aver. $A per worker to control	* Total Industry Cost A$ million	* Comp. Liability A$ million
Food & Kindred Products	204.3	30	408	27	24
Tobacco Products	7.3	63	537	1.3	1.2
Textile Mill Products	44.1	85	1201	17	8
Clothing & Apparel	56.5				
Lumber & Wood Products	51.6	72	1246	21	9
Furniture & Fixtures	27.9	15	778		
Paper & Allied Products	28.9	37	331	3.1	8
Printing Publishing, etc.	70.9	15	597	17.5	3.5
Chemical & Allied Products	62.6	11	351	7	4
Petroleum Industries	5.2	20	1115	2	1
Rubber & Plastics Industry	56.9	20	166	3	3
Leather & Leather Goods	7.4	0	0	0	0.1
Stone, Clay, Glass & Concrete	54.0	25	1087	19	3
Primary Metal Industry	109.3	26	1168	41	19
Fabricated Metal Products	101.5	20	707	23	13
Machinery, except Electrical	93.4	20	691	21	11
Electrical & Electronic Equip.	104.0	20	137	5	5
Transportation Equipment	108.0	21	519	18	8
Electric & Gas Utilities	75.3	30	536	13	11

*Taken as 1975 costs

TABLE 2: FRACTIONAL AND DAILY NOISE DOSES BASED ON 90dBA THRESHOLD [9]

Operator Classification	No. of Operators	FRACTIONAL NOISE DOSE IN EACH JOB OPERATION									Daily Noise Dose	Rank Order	No. of Operators Over-exposed
		Arc Welding	Arc-Air Gouginig	Chipping	Grinding	Machine Operation	Gas Burning	Plasma Arc Burning	Hand Blasting	Background Other			
Press etc Operators	412	0.02			0.35	0.35				0.09	0.81	13	
Machinists	393	0.01				0.24				0.12	0.37	16	
Automatic Welders	244	0.12	2.42	0.23	0.35					0.19	3.31	10	244
Arc Welder A	956	0.59	3.64	0.46	0.44					0.13	5.26	7	956
Arc Welder B	275	0.51	3.33	0.99	0.87					0.12	5.82	6	275
Arc Welder C	152	0.40	3.33	1.37	1.05					0.15	6.30	5	152
Arc-Air Gouger	8	0.29	3.33	0.30	0.35		0.05			0.40	4.72	8	8
Gas Burners	259				0.17		0.34			0.08	0.59	15	
Plasma Arc Burners	42	0.08			0.35			6.16		0.09	6.68	3	42
Hand Grinders	202			0.38	5.67					0.28	6.33	4	202
Machine Grinders	26			0.08	6.55					0.23	6.86	2	26
Fitters	538	0.06	0.61	0.15	0.35		0.03			0.73	1.93	11	538
Helpers	432	0.06	0.61	0.76	2.44		0.02			0.34	4.23	9	432
Furnace Operators	80						0.66			0.06	0.72	14	
Hand Blasters	80				0.17				30.81	0.07	31.05	1	80
Machine Blasters	24			0.15	0.61				0.47	0.10	1.33 +	12	24
	4123												2979

Average Number of Personnel Overexposed = 2979 (72%)

\+ Daily Noise Dose Incomplete

Rotary electric hand saw

In particular, the operator noise levels associated with the use of an Australian-made, rotary electric hand saw were reduced by 7 dBA during cutting and by 13 dBA during free running. Noise controls involved changing gear profile, material and quality; improved design of cooling fan; and use of damping treatments on saw blades. Such noise reductions brought the noise exposure or Daily Noise Dose of an operator on a normal cycle of tool use from well above the allowable legislated limit of unity to well below this limit. Substantial co-operation with the saw manufacturer was arranged and some of the noise control treatments are currently being investigated for incorporation in this or similar products.

Vertical disc grinder

Operator noise levels developed during use of a hand held pneumatic 235mm vertical disc grinder have been reduced

TABLE 3: CATEGORISATION OF NOISE FOR HAND TOOL OPERATIONS

MACHINE/TOOL

Source of energy input — sometimes highest source of noise at operator ear

Electric Powered	
Rotary	drill sander grinder router planner saw
Impactive	drill jigsaw nibbler
Pneumatic Powered	
Rotary	drill grinders saws
Impactive	nutrunner rockdrill pavement breaker chipper needle gun scabbler
Other	
hammering/boilermaking	
explosive tools	
PRODUCT	
Passive object being worked on —	
Workpiece	regular, production irregular, "jobbing"
Workbench	surfaces isolators
Surroundings	walls screens

from 103 to 105 dBA by 5 to 7 dBA during grinding and from 88 dBA by 5 dBA during free running. The noise reductions during grinding were achieved by reducing the vibration response of the grinding disc and workpiece by means of a highly damped disc, a rather fundamental and, to our knowledge, unique result. This is considered highly significant and may provide strong directions for future research on control at source of cutting processes. Over a typical operator's work day, his Daily Noise Dose using this noise-reduced grinder should be marginally below the allowable legislated limit of unity. Good co-operation with the tool distributor and disc manufacturer was arranged during the project and this must be continued if new grinding discs are to be developed for production.

Aluminium extrusion cut-off saw

A highly-damped saw bench was designed for an aluminium extrusion cut-off saw. Typically overall radiated sound power from the cutting process is dominated by workpiece radiation. Noise reductions of 10 to 15 dBA in extrusion radiated sound power were produced in laboratory experiments. The noise control treatments designed in this report, when coupled to conventional noise controls of the saw, should produce an overall noise reduction in the range 10 to 15 dBA. The Daily control treatments designed in this report, when coupled to conventional noise controls of the saw, should produce an overall noise reduction in the range 10 to 15 dBA. The Daily Noise Dose of an operator would thereby reduce to below the acceptable, legislated limit of unity.

Preliminary testing on other hand tools was carried out. It is highly probable that similar noise reductions can be demonstrated successfully on other hand tools, for example on electric rotary routers and pneumatic nutrunners.

RESEARCH BENEFITS

The impact of such noise reductions, achievable by either retrofit or design, is to reduce users' Daily Noise Dose by factors of 4 to 10. Such reductions will, in many practical situations, reduce workers overall Daily Noise Dose to below unity and cause substantial reductions in noise-induced hearing loss and associated Workers Compensation claims.

The significance of the research carried out and outlined above is that it demonstrates the feasibility of hand tool noise control and will allow worthwhile noise reduction to be applied to hand tools. However, most of these tools are used in smaller workshops and work sites by small groups of employees having facilities of low capital value. No single user, local manufacturer nor importer can justify undertaking the engineering research required to achieve realistic noise controls for individual hand tools. However, once this research is proven, we believe that many will indeed be able to justify the investment on the cost of noise control.

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(Received 31 March 1988)

NEW PRODUCTS

Matrix Industries

Wall Ties for Vibration Isolation

The MB range of wall ties from Matrix Industries have been designed for applications where it is desirable to reduce the transfer of vibration between the leaves of double walls. They are most suitable for reduction of structure borne noise, but also will increase the airborne noise transmission loss of the walls. There are ties for double masonry walls and for masonry/plasterboard walls.

Other ties in the MB range are for fixing brick or block walls to solid walls and plasterboard walls to masonry walls.

Further information: Matrix Industries Pty Ltd, 1/48 Garema Circuit, Kingsgrove, NSW 2208. Phone (02) 758 2944.

Cirrus

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The new CRL 2.39B from Cirrus Research is basically a hand held Real Time Analyser, but while operating in a "real time" mode, the CRL 2.39B can store up to 16,000 separate octave spectra in its internal memory. As each spectrum contains the results of 11 separate sound level meters all operating together in parallel, this is a most impressive performance advance.

Three different acquisition rates are supported, corresponding to Impulse, Fast and Slow responses which allows the CRL 2.39B to record such transient data as reverberation time as well as simple environmental spectra. Data taken at these speeds can be replayed on the internal matrix display of the unit in true time or speeded up to show noise trends. Full auto-ranging and even auto-calibration is fitted to the new analyser which means that many of the problems associated with sound level meters have been designed out.

The internal memory of the analyser follows all range changes and even changes of speed and function. All these are faithfully recorded for replay.

The data in the CRL 2.39B can not only be played back on its own display, but the memory contents can also be copied to a desktop computer for analysis. Once in the computer, nearly any acoustic index can be calculated with Cirrus software or by other specialised packages specially written for the device.

Applications for the new unit are widespread. However, it is in the measurement of industrial noise that the CRL 2.39B shows most cost benefit. Traditionally to make a full noise survey of a large plant could take several days. With the CRL 2.39B, the operator simply walks round the factory stopping for a few seconds at designated places. It is only after returning to the office that the data is transferred to a computer which then performs all the octave calculations.

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

Vipac

CF-210 Field FFT Analyser

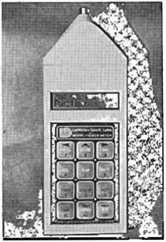
The CF-210 is an exciting development in portable acoustics and vibration measurements — analysis instrumentation developed by Ono Sokki Co. It weighs only 8 kg, incorporates a large LCD display, has inbuilt thermal printer and is a powerful stand alone analyser for dc to 20 KHz frequency applications.

Separate direct inputs are provided for microphones and accelerometers in addition to the BNC and trigger inputs. Three-way power supply allows flexible usage, G.P.I.B. is standard and RS-232 optional.

The CF-210 provides full complement of processing functions via menu selection. These include 1/3 octave band spectrum analysis and phase. A three-dimensional (waterfall) display is standard, as are numerically displayed lists of measured data. Cursors include to 20th Harmonic components search functions. Internal memory (unaffected by power interruption) allows storage of 64 frames of displayed data thus eliminating the need for tape recorders in many applications.

Dosimeter 1 Sound Level Meter

The Larson Davis LD700 is both a dosimeter and a Type 2 sound level meter. It features a 110 db dynamic range (35 to 145 db in one range); accurate RMS of a single 200 us pulse and a two-way computer interface through a RS-232 compatible port.



The LD700 is fully programmable, can hold four different types of data histories and has a 7,000 sample capacity. After a noise measurement is made, over 40,000 different combinations of threshold, criterion level and exchange rate selections are available for computing dose.

Further information: Vipac, 275-283 Normanby Road, Port Melbourne, Vic 3207. Phone (03) 647 9700.

Metrosonics

Calibrator

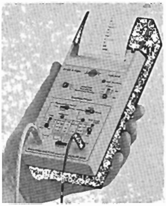
Metrosonics is proud to announce the addition of a rugged new acoustical calibrator to its sound measurement instruments. The cl-304 is a high performance single-amplitude calibrator for use in verifying the accuracy of sound level meters, dosimeters and sound level analysers. Coupling adapters are available for interfacing the cl-304 to a multitude of common microphones, including those used on the Metrosonics db-300 to a multitude of common microphones, including those used on the Metrosonics db-300 and 600 series instruments.

Further information: Australian Metrosonics Pty Ltd, PO Box 120, Mt Waverley, Victoria 3149. Phone (03) 233 5889.

Bruel & Kjaer

New Interface Modules

Graphics Printer Type 2318 — A small, handy, battery-operated printer — now has **two** interface modules: Serial Interface Module ZI0054, and the new Integration and Filter-control Module ZR0035. The Serial Interface Module is used for graphic and alphanumeric printouts from instruments with a serial interface, in particular Bruel & Kjaer's top-of-the-range Modular Precision Sound Level Meter Type 2231. The new module, however, also considerably enhances the measuring and documentation possibilities of most other Bruel & Kjaer sound level meters.



The Intergration and Filter-control Module can be used with all Bruel & Kjaer SLMs which have a DC output but not a serial interface. The module calculates L_{eq} over one-, five- or 15-minute periods from the DC output of the SLM and prints out the results in a table. Furthermore, for Types 2230/33/34/35, in conjunction with the Type 1625 Filter Set, it permits accurate measurement of the average level for each frequency band. With optimisation of the dwell-time per band, the serial frequency analysis is completed automatically; the results are printed in multi-component bar-chart form.

Publications by Australians

We are grateful to Dr Richard Rosenberger, University of NSW, for this updating of publications by Australian authors. Within each year the listing is aphabetical by first author.

1987

Urban Noise Surveys
(1) A. L. BROWN
(2) K.C. LAMM
(1) School of Australian Environmental Studies, Griffith University, Nathan, QLD. 4111
Appl. Ac. **20 (1),** 23-39 (1987).

Levels of Ambient Noise in Hong Kong
(1) A. L. BROWN
(2) K. C. LAMM
(1) School of Australian Environmental Studies, Griffith University, Nathan, QLD. 4111
Appl. Ac. **20 (2),** 75-100 (1987).

Responses to an Increase in Road Traffic Noise
A. L. BROWN
School of Australian Environmental Studies, Griffith University, Nathan, QLD. 4111
J. Sound Vib. **117 (1),** 69-79 (1987).

Kosters Prism Acousto-Optic Interferometer for Radio-Frequency Direction of Arrival Measurements
M. S. BROWN
Electronics Res. Laboratory, Defence Res. Centre, Salisbury, G.P.O. Box 215 Adelaide, S.A. 5001
J. Physics E: Scientific Instruments **20 (2),** 164-169 (1987).

Acoustic Parameters Measured by a Formant-Estimating Speech Processor for a Multiple-Channel Cochlear Implant
P. J. BLAMEY, R. C. DOWELL, G. M. CLARK, P. M. SELIGMAN
Dept. of Otolaryngology, University of Melbourne, The Royal Victorian Eye and Ear Hospital, 32 Gisborne St., East Melbourne, VIC. 3002
J. Acoust. Soc. Am. **82 (1),** 38-47 (1987).

Psychophysical Studies Relevant to the Design of a Digital Electrotactile Speech Processor
P. J. BLAMEY, G. M. CLARK, R. C. DOWELL
Dept. of Otolaryngology, University of Melbourne, The Royal Victorian Eye and Ear Hospital, 32 Gisborne St., East Melbourne, VIC. 3002
J. Acoust. Soc. Am. **82 (1),** 116-125 (1987).

Vowel and Consonant Recognition of a Cochlear Implant Patients using Formant-Estimating Speech Processors
P. J. BLAMEY, R. C. DOWELL, G. M. CLARK, P. M. SELIGMAN
Dept. of Otolaryngology, University of Melbourne, The Royal Victorian Eye and Ear Hospital, 32 Gisborne St., East Melbourne, VIC. 3002
J. Acoust. Soc. Am. **82 (1),** 48-57 (1987).

Development of a Rating Procedure for Impact Noise Transmission through Walls
S. J. BOWLES, E. GOLD
Appl. Physics Dept., RMIT, Melbourne, VIC.
Appl. Ac. **21 (1),** 53-14 (1987).

Effects of Moisture Content on Soil Impedance
A. J. CRAMOND, C. G. DON
Dept. of Appl. Physics, Chisholm Institute of Technology, 90 0Dandenong Rd., Caulfield East, VIC. 3145

Measurement of Low Frequency Absorption
W. A. DAVERN
Div. of Building Research, CSIRO, P.O. Box 56, Highett, VIC. 3190
Appl. Ac **21 (1),** 1-11 (1987).

Improvements to Formulate for the Ensemble Relative Variance of Random Noise in a Reverberation Room
J. L. DAVY
Division of Building Research, CSIRO, P.O. Box 56 Highett, VIC. 3190
J. Sound Vib. **115 (1),** 123-130 (1987).

The Statistical Bandwith of Butter-Worth Filters
J. L. DAVY, I. P. DUNN
Division of Building Research, CSIRO, P.O. Box 56 Highett, VIC. 3190
J. Sound Vib. **115 (3),** 539-549 (1987).

Impulse Propogation in a Neutral Atmosphere
C. G. DON, A. J. CRAMOND
Dept. of Appl. Physics, Chisholm Institute of Technology, 900 Dandenong Rd., Caulfield East, Vic. 3145
J. Acoust. Soc. Am. **81 (5),** 1341-1349 (1987).

Comparison of Observed and Theoretical Responses of a Horizontal Line Array to Wind-Induced Noise in the Deep Ocean
B. G. FERGUSON, D. V. WYLLIE
Defence Science and Technology Organisation, Weapons Systems Research Laboratory, RAN Research Laboratory, P.O. Box 706, Darlinghurst, N.S.W. 2010
J. Acoust. Soc. Am. **82 (2),** 601-605 (1987).

The Production of Ground Vibrations by Railway Trains
R. A. J. FORD
School of Mechanical and Industrial Engineering, The University of N.S.W., P.O. Box 1, Kensington, N.S.W. 2033
J. Sound Vib. **116 (3),** 585-589 (1987).

On the General Solution of the Vector Helmholtz Equation in Cylindrical Polar Coordinates
H. P. W. GOTTLIEB
School of Science, Griffith University, Nathan, QLD. 4111
J. Acoust. Soc. Am. **81 (5),** 1628-1629 (1987).

A Study of the Thermally Induced Large Amplitude Vibrations of Viscoelastic Plates and Shallow Shells
D. L. HILL, J. MAZUMDAR
Dept. of Appl. Mathematics, University of Adelaide, Adelaide, S.A. 5001
J. Sound Vib. **116 (2),** 323-337 (1987).

NEW PRODUCTS . . .

Head and Torso Simulator

The new Head and Torso Simulator (HATS) Type 4128 from Bruel & Kjaer provides a new dimension to electro-acoustic measurements. It has been developed for objective in-situ research and evaluation of a variety of electro-acoustic and acoustic devices, such as telephones, headsets, group audio terminals (GATs), microphones, headphones, hearing aids and hearing protectors. The Type 4128 also has applications in the evaluation of room acoustics, vehicle audio systems and noise control measures in vehicles.

The Head and Torso Simulator replicates the geometry of a median adult human head and torso and complies fully with the acoustic requirements of both ANSI S 3.36 and IEC 959. It is equipped with an ear simulator based on the industry standard Bruel & Kjaer Type 4157, and with a mouth simulator which produces a sound field which closely replicates that generated by the human mouth. An additional ear simulator is available as an accessory, enabling binaural measurements to be made.

Further information: Bruel & Kjaer (Aust), 24 Tepko Road, Terrey Hills, NSW 2084. Phone (02) 450 2066.

ADVERTISER INDEX

Readers are asked to mention this publication when replying to advertisements.

FUTURE EVENTS

● Indicates an Australian Conference

1989

March 7-10, HAMBURG
86th AES CONVENTION

Details: Herman Wilms, Exhibition Director, Zevenbunderslaan 142/9, Brussels, Belgium 1190.

March 20-22, NORTH CAROLINA
WORLD MEETING ON ACOUSTIC EMISSION

Details: Organising Committee: c/o Prof W Sachse, World Meeting on AE, T & AM, Thurston Hall, Cornell University, Ithaca, NY 14853, USA.

April 3-5, LIVERPOOL
MODERN PRACTICE IN STRESS AND VIBRATION ANALYSIS

Details: Meetings Officer, Institute of Physics, 47 Belgrave Square, London, SWIX 8QX, U.K.

● April 10-14, PERTH
1989 NATIONAL ENGINEERING CONFERENCE

Developing Australia's Resources

Details: Conference Manager, 1989 Nat. Eng. Conf., Institution of Engineers, 11 National Circuit, Barton, ACT 2600.

April 24-28, ZARAGOZA
8th FASE SYMPOSIUM

Environmental Acoustics

Details: Viajes el Corte Ingles, Dpto Congresos, Avda. Cesar Augusto, 14, 2a planta, 5000 4 Zaragoza, Spain.

April 25-29, GLASGOW
INTERNATIONAL CONFERENCE ON ACOUSTICS, SPEECH AND SIGNAL PROCESSING

Details: Inst. Elect. & Electronic Eng., Conference Co-ordinator, 345 E 47th St., New York, NY 10017, USA.

May 22-26, SYRACUSE
MEETING OF ACOUSTICAL SOCIETY OF AMERICA

Details: Murray Strasberg, ASA, 500 Sunnyside Blvd., Woodbury, New York 11797, USA.

May 23-27, GDANSK
4th SPRING SCHOOL ON ACOUTO-OPTICS

Details: Prof. A. Sliwinski, Inst. of Experimental Physics, University Gdansk, Wita Stwosza 57, 80 952 Gdansk, Poland.

June 7-10, PECS
6th SEMINAR ON NOISE CONTROL

Details: Optical, Acoustical & Filmtechnical Soc., FO u. 68, H-1027, Budapest II, Hungary.

July 3-7, MADRID
ULTRASONICS INTERNATIONAL 1989

Details: Conference Organiser, Ultrasonics International 89, Butterworth Scientific Ltd, PO Box 63, Westbury House, Bury Street, Guildford, Surrey GU2 5BH, UK.

● August 8-10, SYDNEY
COMPUTING SYSTEMS AND INFORMATION TECHNOLOGY 1989

Details: Conference Manager, Institution of Engineers, 11 National Circuit, Barton, ACT 2600.

August 16-18, SINGAPORE
INTERNATIONAL CONFERENCE NOISE & VIBRATION 89

Details: The Secretariat, International Conference Noise & Vibration 89, c/- School of Mechanical & Production Engineering, Nanyang Technological Institute, Nanyang Ave., Singapore 2263.

August 19-22, MITTENWALD
INTERNATIONAL SYMPOSIUM ON MUSICAL ACOUSTICS

Details: Sekretariat des ISMA 1989, c/- Muller-BBM, Robert-Koch-Str 11, 8033 Planegg, W. Germany.

August 24-31, BELGRADE
13th ICA

SYMPOSIA

September 1-3, ZAGREB
Electroacoustics

September 4-6, DUBROVNIK
Sea Acoustics

Details: 13 ICA Secretariat, Sava Centre, 11070 Belgrade, Yugoslavia.

October 4-6, MONTREAL
IEEE/UFFCS

Ultrasonics Symposium.

Details: Allied-Signal Inc., Atten.: H. van de Vaart, PO Box 10221R, Morristown, NJ 07960, USA.

October 18-19, BARCELONA
II WORLD CONGRESS OF CHRONICAL RONCOPATHY

"Snore and OSAS Syndrome."

Details: Prof. E. Perello, Facultat de Medicina, Universitat Autonoma de Barcelona, Passeig de la Vall D'Hebron, S/N 08035 Barcelona, Spain.

November 6-10, ST LOUIS
MEETING OF ACOUSTICAL SOCIETY OF AMERICA

Details: Murray Strasberg, ASA, 500 Sunnyside Blvd., Woodbury, New York 11797, USA.

● November 14-16, ADELAIDE
AUSTRALIAN INSTRUMENTATION AND MEASUREMENT CONFERENCE

Details: The Conference Manager, AIM 89, The Institution of Engineers, Australia, 11 National Circuit, Barton, ACT 2600.

December 4-6, NEWPORT BEACH
INTER-NOISE 89

ENGINEERING IN NOISE CONTROL

Details: Inter-noise 89, Inst. Noise Control Eng., PO Box 3206, Poughkeepsie, NY 12603, USA.

December 10-15, SAN FRANCISCO
INTERNATIONAL SYMPOSIUM ON NUMERICAL METHODS IN ACOUSTIC RADIATION

Details: Prof R J Bernhard, Ray W Herrick Labs, School of Mech Eng, Purdue University, West Lafayette, IN 47907.

1990

May 21-25, PENNSYLVANIA
MEETING OF ACOUSTICAL SOCIETY OF AMERICA

Details: Murray Strasberg, ASA, 500 Sunnyside Blvd., Woodbury, New York 11797, USA.

November 26-30, SAN DIEGO
MEETING OF ACOUSTICAL SOCIETY OF AMERICA

Details: Murray Strasberg, ASA, 500 Sunnyside Blvd., Woodbury, New York 11797, USA.

1991

May 5-9, BALTIMORE
MEETING OF ACOUSTICAL SOCIETY OF AMERICA

Details: Murray Strasberg, ASA, 500 Sunnyside Blvd., Woodbury, New York 11797, USA.

November 4-8, HOUSTON
MEETING OF ACOUSTICAL SOCIETY OF AMERICA

Details: Murray Strasberg, ASA, 500 Sunnyside Blvd., Woodbury, New York 11797, USA.

Vibration Monitoring at a Nuclear Power Plant

A new Application Note from Bruel & Kjaer, **Machine-condition Monitoring Using Vibration Analysis - A Case Study from a Nuclear Power Plant**, describes a machine-condition monitoring success story from an industry which is currently very much in the limelight. The article gives a thorough description of a vibration-monitoring system in use at Virginia Power's North Anna Power Station, U.S.A., and details a number of faults tracked down by the system. Savings in the region of $2-3 million a year are reported.

Although this article is based on experiences from a nuclear power plant, much of the monitored equipment described is also common to fossil-fuel plants. This Application Note therefore serves as an illustration of the benefits of vibration monitoring in all types of steam-powered generating plants.

Further information: Bruel & Kjaer Aust, 24 Tepko Road, Terrey Hills, NSW 2084.

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