Acoustics Australia

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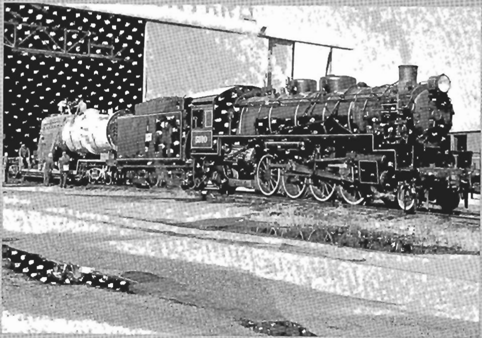
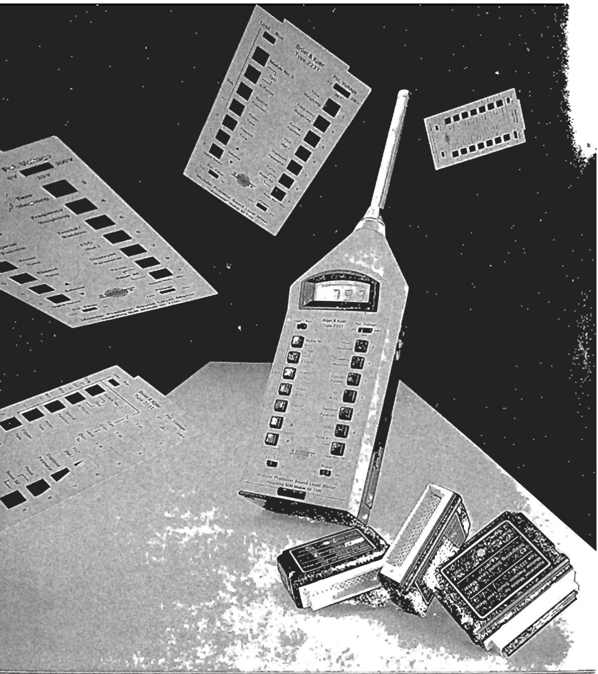


- Short Leg Method
- A. E. and Locomotives
- Harmonica Playing
- Hearing and Orchestras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CONTENTS

Front cover shows the proof testing of the boiler of locomotive 3801. Hot pressurised water was supplied by a 59 class locomotive (see report by Brian Wood).

NEWS

A.C.T.

August Technical Meeting

On Tuesday, 11 August, 1987, the third meeting of the A.C.T. Group took the form of a visit to the acoustics facilities in the Department of Mechanical Engineering of the University College, Australian Defence Force Academy. **Professor R. Duggins,** Head of the Department, welcomed the group and outlined the teaching and research activities of the Department and the link between the Academy and the University of New South Wales. **Dr Joseph Lai** then described the facilities and the research work being undertaken and being planned.

The Department has the first anechoic room in the A.C.T. and Dr Lai explained the construction and features of the room (see "Acoustics Australia", v. 15, n. 1, p. 14). He then described the range of sound measuring and analysing equipment which is available within the Department; this includes a sound intensity analysing system comprising a dual channel FFT analyser and dedicated micro-computer. The current research activities include studies of the different measurement procedures and the effect of background noise for determination of the sound power of sources, and investigations of the acoustic properties of samples of building materials. This talk was followed by a tour of the anechoic room and the acoustic laboratory. A demonstration of the measurement of the sound power of a source in the laboratory was made using the sound intensity system.

The meeting was attended by 24, which is an excellent attendance considering the number in the acoustics area in the A.C.T. Interstate representatives from the Chadwick Group (the contractors for the construction of the anechoic room) and Bruel & Kjaer also attended the meeting. Following the meeting most stayed for an enjoyable dinner in the Officers' Mess at the Academy. The pleasant surroundings led to a very congenial evening.

Marion Burgess

QUEENSLAND

August Technical Meeting

The technical meeting held on August 5, 1987, featured a presentation by **Prof. Gordon Spearritt** of the Department of Music at Queensland University. Prof. Spearritt presented a most interesting discussion on the problems associated with the aural and machine transcription of music of Papua New Guinea. His discussion dealt principally with the drum and flute music of the people of the village of Kandangai on the middle reaches of the Sepic River.

Using slides to illustrate his descriptions, Prof. Spearritt related the methods of playing of the most favoured ensembles amongst the Iatmul people of Kandangai, i.e., paired slit-drums and paired flutes. After recounting details of the ceremonies in which these ensembles are played and the various rhythms played during these occasions, Prof. Spearritt spoke of the means he has used to transcribe the music of the Iatmul. Firstly, he described his attempts to annotate by use of dots on squared paper; a painstaking process of playing and re-playing the same magnetic tape recordings until every individual drum beat or flute note was captured. Following this, he described the use of electro-mechanical instrumentation to produce a paper tape print out of the drum beats contained on the same magnetic tape recording.

The results of the two means of transcription were contrasted. And what does the Iatmul man think about it? Prof. Spearritt suggests that "he doesn't care, at least at the present time, because he does not need any form of transcription. He knows the music already, as it has been 'in his ears' since he was a child bouncing on his mother's back when she danced in time to the music."

September Technical Meeting

On September 8 a technical meeting dealing with "Sound Insulation" was attended by 40 members and friends which was quite a sizeable turn out for Queensland Division.

The topic was split into four sections:

- A brief introduction to the terms and measures used in relation to sound absorption and sound insulation as well as the difference between the two properties.
- A practical demonstration of sound transmission loss in the reverberation chambers of the Division of Noise Abatement.
- A presentation and description of products by four manufacturers of sound insulation products.
- A selection of case histories from the archives of a noise control equipment supplier.

Warren Middleton's presentation was well received, especially by the less technically minded of the audience who at last were able to get a grasp on the difference between transmission loss and sound absorption and between insertion loss and noise reduction.

Ron Rumble's demonstration featured a damped profiled sheet steel panel undergoing a sound transmission loss test. The material was one of several which were considered for roofing for Queensland power stations.

Manufacturers' representatives from Insulboard, Bradford, Stramit and Chadwick presented their products and discussed the features of each. Each rep. also presented a trade display featuring samples and performance data.

Finally, **Allan Monkhouse** discussed the installation of several of his company's noise control products in areas such as hotels and motor yachts.

Russ Brown

VICTORIA

May Technical Meeting

Approximately 15 members participated in the site visit to Vipac on 22 May. Vipac offers research, development and consulting services in mechanical engineering and the physical and information sciences. It also develops, markets and distributes scientific software and instrumentation systems. We were exposed to some aspects of their current work which included projects on the following:—

- fixed hydrophone arrays for vessel classification;
- vibration endurance testing of automotive wheel hub assemblies using a large electrodynamic shaker;
- structural proving and modification of structures based on modal testing;
- environmental testing in their large chamber which is capable of simulating a range of environmental conditions, including temperature, humidity, solar load, reflectivity and wind.

A.G.M., September Meeting

The Annual General Meeting of the Victorian Division was held at the Dragon Dance Restaurant, Surrey Hills, on the 30th of September. The meetiing was well supported. New faces on the Divisional Committee are Mike Hartley, Rob Burton and Simon Leverton.

The members and their spouses were subjected to a presentation of "Anecdotal Acoustics" by a number of speakers after the formalities. The speakers and relevant topics included John Upton (Panel Testing and ASIO); Stephen Samuels (Roads, Bumps and Signs); Robert Burton (Clients to Avoid); Keith Porter (Enclosures and Somewhat Neurotic Complainants); Graeme Harding (Detailing and Air Suspension); Geoff Barnes (Masking Things that Go Bump in the Night); David Watkin (Problems in Moving and Restructuring a Bureaucracy).

Joseph Mathew

Conferences

Westpac III

The third Western Pacific Regional Acoustics Conference will be held in Shanghai, China, in November 2-4, 1988. This conference is co-sponsored by the Acoustical Societies in the Western Pacific region. The theme is "Developments of Acoustics in the Western Pacific Region" and contributed papers in all areas are welcome. The deadline for submission of the theme of the paper is November 30, 1987, for the abstract is March 31, 1988, and for the manuscript is June 30, 1988.

Further information: Secretariat Westpac III, Institute of Acoustics, Academia Sinica, 17 Zhongguancun Street, Beijing, China.

Polmet 88

As with the first Polmet Conference, the main theme will be Pollution in the Metropolitan and Urban Environment, with emphasis on the issues of relevance to countries in Asia and the Pacific Region. One of the seven streams of the Conference will be "Noise Planning and Control". The Polmet conferences are designed to provide opportunities for experiences in tackling urban pollution problems to be shared so that those from different countries can learn from the successes and failures of others. The conference will be held in **Hong Kong** from November 28 to December 2, 1988, and the **deadline** for abstracts of 250-300 words is 1 December, 1987.

Further information: Polmet 88 Secretariat, c/o Hong Kong Institution of Engineers, 9/F., Island Centre, No. 1, Great George Street, Causeway Bay, Hong Kong.

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Noise-Con 88

The 1988 National Conference on Noise Control Engineering will be held at Purdue University from June 20 to 22. The conference will be the ninth in the series and the theme will be "Noise Control Design: Methods and Practice". Topics will include the design for quiet machinery and vehicles, design for quiet workspaces, design for a quiet environment and noise control design techniques. Technical exhibitions and tours will form part of the conference.

Further information: Conference Secretary, Ray W. Herrick Laboratories, Purdue University, West Lafayette, In 47907, U.S.A.

E.P.A. Moves

On July the 27th, Victoria's E.P.A. moved shop and took up residence in the Olderfleet Building in Collins Street in company with the remainder of the Ministry for Planning and Environment. The Authority underwent an organisational restructure at the same time as this bodily translocation took place.

The E.P.A. is now divided into multi-disciplinary groups instead of the former Air, Water, Noise and Waste Management Branches. The operational groups are composed of two metropolitan and three country regions, and the Motor Vehicles section. Officers of the former branches are being encouraged to acquire new skills and work in some or all of the four disciplines. As a result of these changes, investigations will deal more with the overall pollution problem of a particular company or premises than with the different types of pollution separately.

Such a radical re-organisation has naturally produced some teething problems and the odd breakdown (nervous and otherwise). It is, however, expected that the changes will in future enable the Authority to provide clients with a more effective and efficient service.

Inter-Noise 87

Over 630 delegates from 32 countries participated in Inter-Noise 87, which was held in the recently opened Kun Lun Hotel, Beijing, China, from 15-17 September. Well over half of the delegates were from overseas countries and there were more than 100 accompanying persons — reflecting the great international interest in Chinese acoustical developments and in China itself. There were nearly 20 delegates and accompanying persons from Australia.

Three plenary lectures formed the major part of the first morning's opening session. **Professor J. E. Flowcs-Williams** discussed the extension of steady-state active noise control techniques to the stabilisation of potentially unsteady flows ("Active control of unsteady flows"). **Professor Lyon's** "Conflict resolution — noise reduction style" referred to the conflicts between noise control requirements and structural rigidity, machine performance and cooling that may occur in product design. Noise control should be part of the design process, not simply applied to the end product.

Professor Maa developed a theory of turbulent jet noise based on sound pressure rather than on Lighthill's eighth-power velocity law. ("General laws and reduction of aerodynamic noise.") He described the use of diffusion to reduce intermediate and low pressure aerodynamic noise and the use of micropores to shift the emitted frequency spectrum to the high, inaudible range in the case of high, intermediate and low pressures.

Nearly 400 technical papers were presented in sixty-four two-hour sessions, in eight parallel streams. As usual, it was difficult to choose which sessions to attend and the two-minute changeover period between papers demanded nimble footwork if mid-session changes were desired. Most of the papers were in the following categories: Emission-noise sources (64); Physical phenomena (16); Noise control elements (45); Vibration-generation, transmission, isolation and reduction (30); Immission-physical aspects of environmental noise (49); Immission-effects of noise (68); Analysis (102) and Requirements (15). They have been published as a two-volume set of approximately 1,700 pages.

Unfortunately, the considerable range in the usefulness and quality of the papers presented, as usually occurs in such conferences,. was evident. There are still some authors who ignore advice regarding legibility of visual aids. However, the quality of the audio and visual presentation facilities provided by our Chinese hosts was excellent, and their radio-controlled automatic timing system outwitted all but the most aggressive free-formatting chairmen!

The non-technical part of the program was also very pleasant. A reception in the hotel garden on the first evening enabled old and new friends to mingle informally. An exciting acrobatic program performed by men and women of the Chinese Army was enjoyed by many of the visiting participants and the final Chinese Banquet in the grand banqueting hall of the Beijing Hotel was a memorable occasion.

Many delegates and accompanying persons took part in pre- and post-conference tours of varying length and some will remember vividly being drenched in a brief, ill-timed thunderstorm on the Great Wall!

Anita Lawrence

Outdoor Sound Conference

A one-day conference on Outdoor Sound Propagation was held on September 14th, 1987, in London by the Institute of Acoustics. Organised by Dr K. Attenborough of the Open University, delegates came from the U.S.A., Japan, various European countries and two from Australia. The latter, **Dr Charles Don** and **Andrew Cramond,** both from Chisholm Institute of Technology in Melbourne, delivered two of the eleven papers: one on the effects of water on ground impedance and the other on meteorological effects on impulse sound propagation. Other topics included methods of measuring acoustic impedance and how to define the boundary of a rough surface. Problems of defining a standard grass surface for EEC lawn-mower noise specifications, the effect of strips of differing impedance, of snow and forest coverings on sound propagation were also discussed. A number of the afternoon papers were concerned with predicting sound levels in fluctuating wind and temperature gradients. All papers will be published in the Proceedings of the Institute of Acoustics.

Charles Don

Australian Acoustical Society

Conference on Seismic and Underwater Acoustics

Thursday, 28 January, 1988

University of New South Wales Sydney

A Bicentenary Congress of Physicists will be conducted in Sydney during January 1988 to coincide with Australia's Bicentenary Celebration. As part of the Bicentenary Congress the Australian Acoustical Society is organising a one-day conference on Seismic and Underwater Acoustics.

An associated conference and workshop on ambient sea noise being held at the RAN Research Laboratory may also be of interest. Attendees are invited to participate in other activities of the Congress.

Registration forms and other details from:
Conference Organiser

Dr. John I. Dunlop

University of New South Wales
PO Box 1, Kensington 2033
(02) 697 4575

People

Noela Eddington and **Lex Brown** are off to Kuala Lumpur on 4 November for a month to act as consultants to the World Health Organisation. They have been engaged together with a representative from the United States EPA to run the PEPAS Regional Workshop on Noise Abatement and Control.

* * *

The Victorian Department of Labour has recognised the need for a systematic and comprehensive guide for noise control and hearing conservation programs in the metal trades industries. Recently Vipac was awarded a study to research, develop and produce an effective training and information package to assist in the development of these programs. Vipac's **Dr Norm Broner** said that "the training program together with the printed literature that we will be preparing will aim to provide managers with the information necessary to enable them to identify and understand the problems, familiarise themselves with examples of practical solutions to noise problems and also assist them in actioning the processes".

* * *

Richard Heggie Associates Pty. Ltd. have moved into spacious new offices in the Konica Building, 22 Giffnock Ave., North Ryde 2113. Business address is P.O. Box 148; telephone (02) 805 0144, Fax (02) 805 0356.

New Guitar Family

The premier public performance of an innovative guitar family was presented by the Canberra Guitar Ensemble on 18 October. The guitars were designed and made by Canberra luthier **Graham Caldersmith.**

The Classical Guitar Family project, supported by the Australia Council and using acoustic research facilities funded by the Australian Research Grants Scheme, involves the translation of the standard classical guitar into three new pitch and tonal ranges: the bass, one octave below standard; the baritone, seven semitones below standard; and the treble, five semitones above standard. The treble and baritone guitars are one octave apart in pitch. While treble and bass guitars have been made in various designs during the history of the guitar, these new instruments have been designed and made in the classical tradition using advanced research in classical guitar behaviour, resulting in a true family of instruments tonally integrated and pitched for effective arrangement and composition in various combinations.

The performance by the Guitar Ensemble of specially arranged works by Praetorius, Bach, Brahms, Joplin and others was well received by the appreciative audience.

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.

New South Wales

Mr G. W. Caldersmith, Mr J. D. Macpherson, Mr F. J. Weatherall.

Queensland

Mr Cardnell.

• Graded

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

Student

Victoria

Mr G. R. Campbell.

Subscriber

Queensland

Mr R. H. Greentree.

South Australia

Mr G. W. Cayzer.

Member

Victoria

Mr Ng Say Teong.

Inter-Noise 87

The proceedings of this conference, entitled "Noise Control in Industry", are now available for purchase. The two volume set costs $U.S.80 and may be ordered from: *Acoustical Society of China, P.O. Box 2712, Beijing, China.*

Science and Music

From 26 July to 19 August, **Professor Charles Taylor** visited all the States of Australia and gave a series of demonstration lectures based on "Science and the Sounds of Music". Professor Taylor is Emeritus Professor of Physics at University College, Cardiff, as well as Professor of Experimental Physics at the Royal Institution in London, and his visit to Australia was arranged by the National Science and Technology Centre with the assistance of the Institute of Physics and sponsorship from Qantas.

Some of the lectures were for schoolchildren and others were for the general public. Professor Taylor is very skilled at presenting scientific concepts in an entertaining and understandable manner. At one of his public lectures in Canberra he used very simple demonstrations to describe several families of instruments; for example, a plastic straw which produced a different note as it was reduced in length, a saw which produced different notes depending on the nature of the bend and the type of bowing and a coiled hose pipe fitted with a reed. He described sound pressure as "squash" of the air, frequency as "wobble" and then led on to fundamentals, harmonics, starting and stopping variations, attack transients and plate vibrations. He concluded his lecture with some "aural illusions" which included a sound which was apparently decreasing in pitch but was everlasting and the perception of information within noise.

The enthusiasm and interest of Professor Taylor were passed on to his audience, who showed their appreciation. At the completion of the lecture many stayed to ask questions and discuss some of the concepts he had explained. It was a thoroughly entertaining and informative evening.

Marion Burgess

Standards

The following Standards have been recently published by the Standards Association of Australia.

AS 2972. "Isolators - procedure for specifying characteristics." This standard contains the subject matter and format to be specified for describing isolators (resilient moments), the equipment to be isolated, supporting structure and environment. It should provide the means for a clear understanding by both the user and the supplier.

AS 2973. "Human Response — Measuring Instrumentation." This standard specifies the characteristics with which instrument systems and components of systems must comply when they are used for measuring whole-body or hand/arm transmitted vibration.

AS 2991. "Method for determination of airborne noise emitted by household and similar electrical appliances, Part 1 — General requirements." The potential users of the methods specified in this standard will be manufacturers of household appliances, testing laboratories, labelling organisations, and consumers' unions. The measuring methods are based on those described in AS 1217.4 and AS 1217.5

AS 2993. "Dynamic characteristics of the human being." This standard draws together available information on the input mechanical characteristics of the human body when subjected to vertical mechanical vibration. It is expected that the impedance information contained in this standard will be used in the analytical design of isolation systems such as platforms, seats and vehicle suspensions.

Environmental Noise Model Launched

The Minister for Planning and Environment, **Mr Bob Carr,** introduced in September the Environmental Noise Model, a computer program developed by **RTA Software Pty Ltd,** a division of Renzo Tonin & Associates Pty Ltd, consulting engineers, and endorsed by the Australian Environment Council.

The model calculates noise levels using algorithms which mathematically express factors which affect the loss of sound energy along its propagation paths. It caters for attenuation due to noise source enclosures and other noise control measures, for distance from the source to the receiver, for the noise source radiation patterns, for barriers and natural topographical features and for sound absorption in the air. It also takes into account differences in sound propagation from noise sources of various shapes and sizes.

Excess attenuation due to barriers such as natural topography and from manmade features, such as earth mounds, as well as ground absorption effects such as those due to vegetation, bare ground or hard surfaces are derived using the most recently available scientific theories. Weather conditions such as wind speed and direction

ENM Launch, Sydney: Hands-on demonstration to personnel from environmental authorities from all states in Australia.

and the vertical temperature gradient of the atmosphere are also accounted for as these can dramatically attenuate or amplify sound.

Program ENM gives two main outputs: a detailed quantitative analysis of the overall sound level in dB (A) together with the frequency spectrum analysis of noise levels at any chosen point, and a qualitative noise contour, which is a noise level map predicted for the area of concern.

Tony Hewitt, chief engineer with the State Pollution Control Commission in NSW, initially conceived the project and has supported it throughout its develoipment over a period of three years. This support was essential to ensure wide acceptance throughout Australia and as a result ENM is now expected to provide a consistent and scientific base for evaluation of environmental noise throughout Australia.

A two-day seminar for representatives of the Australian Environment Council followed the launch. Technical representatives from most States in Australia attended and were given a fast-track introduction to ENM from preparation of simple source-section-receiver examples to map digitising and calculation of ground cross-sections.

The seminar culminated in the evening in a technical presentation given by **Renzo Tonin** at the Annual General Meeting of the NSW Division of the Australian Acoustical Society.

ENM was launched in Adelaide by **John Lambert,** Chairman of the ENCC, AEC and Manager of the Noise Abatement Branch of the Department of Environment and Planning. This launch attracted a diverse range of acoustics professionals, including representatives from government authorities, universities and consultants.

Technical meetings are currently being planned for Melbourne and Canberra.

AAS 1987 Conference Report

The 1987 Annual Conference of the Society was held in Hobart at the Physics Department, University of Tasmania, on November 12 and 13. A wide range of topics was covered by some 33 papers under the general banner of **"Acoustics in the Eighties".** Sessions covered community noise, hearing, sound propagation, music, theatre acoustics, acoustic properties, measurement technology, noise control and transportation noise. A special feature of the Conference was a Workshop on Scenarios for Australian Acoustics in the 1990s. In this interesting forum the ASTEC Committee's findings on acoustics research and development in Australia were discussed and debated.

Delegates wined and dined at Wrest Point on the Thursday evening of the Conference and then proceeded to explore the Casino. Interestingly, Friday revealed very little about the extent of the fortunes won or lost. Most acousticians obviously know the right time for quiet. Social tours of Port Arthur and Battery Point were well received as were the technical inspection tours of the ABC studios and the CSIRO marine laboratories.

In summary, the 1987 Conference was both technically and socially a success. It was the first Society Conference ever held in Tasmania. As the practice of rotating the Conference around the country is now established, the possibility of returning to Tasmania at a future date is anticipated with interest.

Stephen Samuels,
Conference Convenor

Ray Piesse

His Contributions to the Society and NAL

An Interview by Ted Weston

Ray, who retired around a year ago, started out in the country in the south-west of Western Australia. He attended primary school in the town of Wigan, from where he won entrance to Albany High School. From high school Ray was awarded a scholarship to the University of Western Australia, where he enrolled in the Faculty of Science and, in due course, majored in physics and mathematics. In his honours year that followed he undertook a project in ultrasonics — a pointer to the career he was later to take up. The opportunity for that came after a few months when the Commonwealth Acoustic Laboratories required a scientist for its expanding functions. In 1949 he found himself in Sydney CAL at their current location in Erskine House.

Early Days at CAL

CAL had its origins in an organisation set up at the Kanematsu Institute at Sydney Hospital. It had studied the effects of gunfire on hearing and on communication in noisy conditions. The former work had led to the development of ear plugs for troops firing mortars in the New Guinea campaign of World War II. The temporary deafness experienced put the soldiers at great risk because of the inability to hear faint noises in the jungle. Norman Murray was one of those involved in investigation of the effects of gunfire on hearing, and it was he who was later to head CAL. Possibly because his own hearing had been affected by his experiments, he became interested in the provision of hearing aids for ex-service personnel and also for deaf children. Attention was focused on the latter because of the effects of German measles, a severe outbreak of which had occurred in Sydney during the war years, afflicting many children, and the work of Dr Eccles, who established a causal relationship between the disease and deafness. These functions had been taken up by the Medical Health and Research Council but were transferred to the Department of Health, so that the budding Commonwealth Acoustic Laboratories were up and running when Ray joined them.

Initially resources were scarce — scarcer in fact in Erskine House than before when the association with Sydney University gave access to the new medical school's anechoic room. In lieu of that there was what Ray described as an "anechoic box", which was used for tests on hearing aids and microphones. However, they made up an artificial ear, set up reciprocity calibration for condenser microphones, and soon had good standards for measurement of sound pressure levels and for the calibration of audiometers. The laboratories provided a service almost certainly unique in Australia at that time and one whose value was recognised by the use made of it by doctors.

Ray was involved in an important extension of the work of the young organisation. Early in 1950 some 500 subjects from the Chullora railway workshops were given hearing tests, with Norman Murray, Dr Roly Farrant, then chief audiologist, Dr Kahn and Ray all participating. The considerable extent of hearing impairment that the survey revealed contributed to setting a course that CAL (and NAL as it became) was to follow. Ray pays a high tribute to Norman Murray for his initiative and drive in the efforts to conserve hearing, the need for which had shown up so dramatically in the early survey in industry. By the early sixties good hearing conservation programs had been put in place, and much credit for this, Ray considers, must go to Norman Murray and to the enthusiasm and efforts of Jack Rose with whom Ray collaborated in many ways.

During the period, the Laboratories had changed their location to Customs House overlooking Circular Quay, and in the mid-sixties it changed again to Hickson Road on Millers Point. Here improved facilities were available although there were still some problems, notably because the buildings were old and there was noise from the Harbour Bridge. Nevertheless, some very good research work was undertaken. The staff had built up from about 20 in the days of Erskine House to some 140 at Hickson Road. A number of research sections were formed — one for psycho-acoustics research, another for acoustics and electro-acoustics (which Ray headed), and another for audiology. The ultrasonics section had already been established and the fruits of its research were rapidly gaining recognition.

Ray becomes Director

Ray succeeded Norman Murray as Director of the Laboratories in 1968. Early in the period of his appointment planning began on new facilities — the present premises that were not to reach fruition until well into the eighties. Hardly, as Ray says, an ill-considered crash program although the gestation period was not one of the staff's making. The hearing conservation programs continued during that time to provide great satisfaction, and the work made for a firm basis for the National Health and Medical Research Council and others to develop regulations to protect hearing. Another project of the period that gave considerable satisfaction concerned the effect of aircraft noise on the community. It had humble beginnings in the late fifties. Ray recalls how he, Jack Rose and others spent bitter winter nights sitting on a sewer pipe near Kingsford-Smith Airport waiting to measure the sound of late take-offs of the noisy propeller aircraft then in service. The project developed from that through the sixties and seventies and into the eighties to the present highly refined form that exists today, including the ANEF classification.

The hearing aid services for children are yet another project which Ray regards as a notable NAL contribution. The unique Australian system — credit for which concept Ray also attributes to Norman Murray — was to bring in psychologists to train as audiologists to provide advice and to fit hearing aids, and to combine their skills with those of engineers and physicists to make an interdisciplinary team. The outcome, he believes, is superior to that provided elsewhere when specialists tend to operate separately. A feature of the approach is the emphasis the scientists place on good measurement and calibration techniques for instruments involved in hearing testing, thereby providing assurance of more reliable results than from practitioners apt to be less well versed in these vital aspects and therefore liable to make undetected errors. Ultrasonics was, of course, a notable achievement for the Laboratories, to such an extent that it was hived off in the mid-seventies to function as a separate independent entity.

Throughout the long period of his directorship Ray felt he had been well supported by his team. He and the team had experienced about as many frustrations as he thought could be heaped upon them, but, despite these, numerous contributions had been made. Many members of the staff have moved out to contribute in other areas of acoustics, but always it seems the Laboratories have been able to provide a good technical basis to enable them to do this. A vision Ray always had for NAL was for there to be an even closer association of the disciplines of engineering, science and audiology. To do this involved organisational changes with interdisciplinary teams being formed rather than ones based on different skills. He sees that type of organisation continuing to take shape since he left, although naturally he expects that changes will take place, and in fact he hopes they will as the organisation confronts changing circumstances and new challenges.

Standards Activities

Ray recalls that he drafted the original proposal that was prepared by CAL for the Standards Association of Australia in regard to the formation of technical committees for the preparation of Australian standards in acoustics. He became chairman of committee AK/2 (now AV/2) from its inception, and remained so until about two years ago. Staff of NAL were encouraged to contribute to the work on standards and to carry out investigations that could assist technical committees in the preparation of documents. Interest in standards and in measurement and calibration of acoustical instruments led Ray naturally into close association with NATA, the National Association of Testing Authorities. Assurance of good measurement technique with reliably calibrated instruments is clearly a matter that is not to be trifled with in Ray's opinion. Hence it is that he expresses concern about the difficulty of checking some of the highly sophisticated measuring equipment presently coming into increasing use in all areas of acoustics.

Ray and the Society

Ray has, of course, had a long and close association with the Acoustical Society since its inception, and his active involvement still continues. He has been Treasurer, Vice-President and President of the Society, Chairman of the NSW Division, and is currently the Society's General Secretary. He sees the Society as a positive force, bringing about a greater awareness of acoustics and a better understanding between those with quite different interests because of its many aspects. As to its future, Ray would like to see the Society encompass vibration to a greater extent than it now does. The move to bring acoustics and vibration together in the area of standards could, he feels, be emulated to advantage. The Society has brought together architects, engineers, scientists, psychologists and many others to focus on problems in acoustics, yet interest in vibration has tended to develop separately. He sees scope for the Society to take a more active role in environmental issues by creating awareness of noise from traffic and other sources that degrades community living and of the means to reduce it. He discounts the proposition that to counter difficult economic conditions should necessarily mean that efforts to provide for quality of life should have to be ignored. It is for informed people to point the way by which such conflict may be resolved, and in this the Society can be a contributor. Ray hopes that the future will see the Society's journal, "Acoustics Australia", which he regards as having developed to a high standard, continue to provide a vital communication link for members.

And what of the future for Ray? He sees no dramatic change in his present activities which enable him to maintain association with the acoustics community, including the Society and NAL. Therese, his wife, who is well known to many Society members, talks of other interesting possibilities, but for the present that is all they are. The marriage of Ray and Therese is a classic example of the boy and girl who lived next door. When Ray came to Sydney he happened "by chance" to board in the house next to the one where Therese was living. They lived in another suburb for several years after they married, but then returned to live in one of the houses where they first met. The four members of their family live nearby: Ray contends they must fear he might slip into inactivity because they manage to present him with so many tasks and handyman jobs. They may have reduced his time to embark on his own gardening, and on his silver crafting for which he recently purchased a kiln, but he won't allow interference with his tennis, which game he plays with enthusiasm.

Good wishes abound for Ray and Therese in their present lifestyle, as do hopes for an active and healthy "retirement".

Anti-noise: two approaches

(1)

The Australian Mineral Industries Research Association (AMIRA) is co-ordinating a joint project between a CSIRO team and mining and industrial companies to take noise reduction work further toward commercialisation.

The CSIRO work will quieten all types of fans and will potentially work for pumps, jet engines and rocket chambers.

Dr. Martin Welsh, principal research scientist at the Division of Energy Technology, says the group is going to try to cancel the noise at its source.

He says the group's fundamental research has allowed it to identify what causes noise in fans, meaning that it should be possible to make some of those noise sources cancel other noise sources.

"In other words you alter the phase between them so that when one is generating noise, another is absorbing it and vice versa. The advantage is you don't need silencers," he says.

Dr. Welsh says the method is the same in principle as the one already tried in which people have recorded noise, and seeded it through speakers where they have changed the phase relationship with a micro computer.

But unlike this active attenuation, the CSIRO's method is passive attenuation, using the flow itself to cancel its own noise-generating mechanism.

The group has done successful laboratory tests using idealised test rigs, and now will use a water tank in which fans will be run so the vortices can be observed.

They are aiming at a 10 dB noise reduction.

(2)

A small research and development company in Great Neck, New York, called **Noise Cancellation Technologies** (NCT) has, as its name implies, staked its future on the role anti-noise could play in making the world a quieter place.

The noise they can handle is repetitive noise — noise and vibration caused, for example, by the repeated explosion of gases in a cylinder or the crunching of gears in a turbine are repetitive and fairly regular.

The silencer using noise-cancellation technology consists of several parts.

First, an intelligent microphone near the front of the silencer picks up the repetitive sound waves generated by the engine and sends this information to a microprocessor.

The microprocessor then determines how often the engine makes the sound, either with a second sensor or by monitoring the engine's electronic ignition system.

Continued on page 77

"Short Leq": A New Acoustic Measuring Technique

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ABSTRACT: The use of computer technology has given a new lease of life to the old 'outbox' processing technique of recording the acoustic signal and analysing it on replay. Using "Short Leq" the raw data can be stored and used to re-create any acoustic situation, where the actual peak value of the signal is not involved.

Introduction

The relatively new technique of "Short Leq" has its origins in one of the oldest methods of acoustic measuring, 'outbox' processing. For many years, if a measurement was required to be taken for a legal dispute or when the form of the noise was unknown, a tape recorder was used to record the actual noise itself for replay in the laboratory. The disadvantages of this method are well known and include the limited time span that was possible, the low accuracy of the overall system and the very swift deterioration of the raw data as the tape was constantly replayed; together with the general inconvenience of the system.

In 1979, in a report to the EEC, Komorn and Luquet [1] proposed a method of storing data on a computer disk. This method, called "Short Leq", was devised as a method of compressing the data, ensuring its integrity and yet storing a true representation of the original noise.

The method suggested was to integrate the sound level over a short period, typically under 1 second, and produce a non-time weighted Leq for this short period. This "Short Leq" would be stored and a further Leq taken, with no gap between them, continuing with successive Leq's for the duration of the whole measuring period. The advantage of the method is that the Leq is a true integral of the energy and thus accurately describes it for all statistical purposes. A memory store of 86400 locations, therefore the same number of bytes, would allow 24-hour operation with 1-second Leq values being stored. To store 125-millisecond Leq values over a full working day would require 230,400 bytes. This assumes an 8-bit word as was common at the time.

In 1979, the idea of putting even 86 kilobytes of memory in a hand-held meter was held to be a dream, as current desktop computers had a memory of only about 64K. Also, even if it could be done, a high-current source would be needed to drive it, which would somewhat limit its portability. Naturally, if a 16-bit data length was used for each word, the size of memory would double to 460K; even more of a dream.

In 1983 at the ICA in Paris, a group of engineers met and discussed a series of prototype units made by the French company Integra, who had managed to pack 44 kilobytes of 8-bit memory into a rather large, but just handheld, box. This unit, which acquired ⅛th-, 1- and 2-second Short Leq, had a Basic programme on an HP85 computer to process the data after downloading. While far from ideal, it was the first Short Leq meter intended for production and thus deserves its place in history. As a result of the meeting at the ICA, Integra, together with Cirrus Research in the UK and Quest Electronics in the USA, decided to work together to make the concept of acoustic data storage a reality.

At this time, the International Electrotechnical Commission specification, IEC804, for Leq meters, or as correctly described "Integrating averaging sound level meters", was published and it was felt by all the three companies that any new concept or unit must fully meet this standard in the smallest detail if it was to be commercially and academically successful. Also, any unit produced must be a useful addition to the technology which demands all the conventional functions of current units.

The Short Leq Concept

While the original reasoning behind the concept was to store data in a compressed form, by 1983 it was obvious that having stored the data on an external computer, the computer should also make the actual measurements. That is to say, the Leq meter can be relegated to the status of a simple "dumb" acquisition unit. If this acquisition unit has adequate dynamic range, the whole of the measuring task during acquisition is to place the Leq meter in the correct place, to keep it secure and to ensure an adequate power supply. This is not to say the Leq meter cannot perform other background tasks, such as giving perfectly conventional Leq or sound level readings etc., but these tasks are considered incidental to the main function of integrated data acquisition.

After acquisition, the data is stored in the non-volatile memory of the sound level meter until required for use. There is no limit to the time that it can be so stored and thus there is no need to have a computer on site.

Sometime later, the data is transferred to a desktop computer via its RS232 port and stored on the floppy or hard disk of the computer. While the process is called 'transfer', it is in reality a 'copy' process. The original data is not destroyed or modified in any way by the 'transfer' to the computer and the original data is still intact.

As many identical copies of the raw data as required can be made and distributed for processing, which can be done on any suitable computer anywhere in the world; no longer does data have to be processed where it is acquired.

The actual measurements are not directly related to the concept. Each company's software is as individual to the company as is the physical equipment on which it is acquired.

But, providing the data is written to disk in a standard format, any programme will be able to make measurements from any data disk. This standardisation of data was one of the first problems addressed by the three companies and a format, called the DP37 protocol, was agreed and copyrighted by the companies. Now, in 1987, 7 companies in 6 countries have acquired licences to use the DP37 protocol, thus ensuring its support for the future.

The major disadvantage of the 'out-box' processing technique as opposed to 'in-box' processing, where everything is done inside the sound level meter, is that immediate results are not available. As a converse, no decisions need be taken at acquisition time, whereas a wrong acquisition with an 'in-box' unit is fatal in the sense that the noise must be measured again. If it is a "once only" event, a second chance may not occur: the nightmare of the wedding photographer.

DP37 Protocol

The DP37 protocol defines not only the form of the data, but also the method used in its transfer. It was clearly seen by the original workers that the existing data standards should be supported. Accordingly, RS232, IEEE-488 and the EPSON (c) interfaces should be included in the options. Further, the data could not be described in an 8-bit word if the essential requirements of IEC 804 were to be maintained. Thus, a data word of 16 bits was decided upon. The acoustic range was assumed to be between −10 and +190 dB. If 0.1 dB resolution was to be achieved, this would need 2000 data points. The next highest suitable digital number is 2048, or 11 bits, leaving 5 bits which are not required for the actual Leq value. IEC 804 demands that any overload of the system be flagged with a latching flag. Within the DP37 protocol, this is done by attaching an overload flag to each and every data word. Thus 12 bits are needed.

The remaining 4 bits, giving 16 possibilities, are then left for data coding, a concept which opens totally new measurement possibilities.

Data Coding

The remaining 4 bits are organised to give a code, which is used to describe the Leq in that particular word. For example, a noise may be coded "Aircraft". This code can be added during acquisition by the Leq meter itself, or it can be added after acquisition by the computer software. In the DP37 protocol, codes added during acquisition are called "in-situ" codes, while codes added on the computer are given names descriptive of the process used to add them. This could be by reference to a simple threshold level, by timing, by the difference between 2 channels or even visually on screen. Once a code has been added to each Leq word, thus coding the noise source, each source can be measured separately. Thus all the Leq coded "Holden", "Ford" or "Rover" can be compared. Also, all these individual sources can be grouped together in a group code called, for example, "cars" and the overall Leq or any of the Ln series of these sources measured. This technique, new with

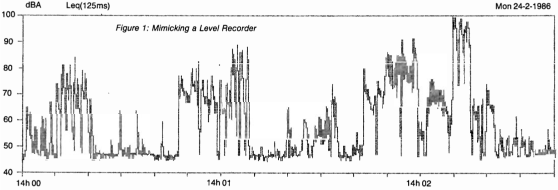

Figure 1: Mimicking a Level Recorder

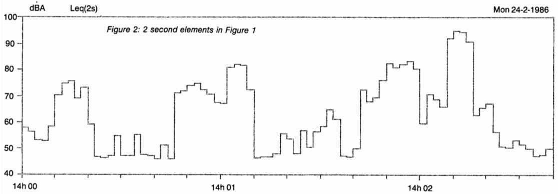

Figure 2: 2 second elements in Figure 1

Short Leq, opens up totally new measurement possibilities. For example, noise events rising out of a background can be identified by their code and measured independently of the rest of the data. On a lighter note, the eternal problem of the little old lady who wants to talk to you in the middle of a street measurement has gone. Using coding, you simply ignore that part of the data file, while in no way modifying the data itself.

Software

As the acquisition and measurement of data have been separated, the software which performs the actual measurement becomes an integral part of the Leq meter. However good the actual acquisition, it will be the software which determines the system performance. While the 7 companies in the DP37 club hold no monopoly of 'Short Leq' software, their combined experience in this field is probably greater than any other single company, particularly those companies who have seen in external computer processing a threat to their established position and concentrated on ever more powerful and expensive 'in-box' processing meters. As the software is a fundamental part of the instrument, it is reasonable that at least the core of the programme should be provided free, as without it the instrument cannot be used.

Measurement Possibilities

At the elementary level, where the ⅛th-second Leq values have been acquired, the computer can simulate the trace from a classic level recorder. Fig. 1 shows a portion of a trace from a measurement, taken on a Cirrus Research CRL 2.36 Leq meter. The source was a television reporter doing an interview. Fig. 2 shows the same data, plotting 2 second combined Leq's. For many uses, this gives more idea of the time history.

An example of the flexibility of the system is shown by the listing of L90 and L99 in Fig. 3, taken at Valmorel in the French Alps. In Europe, L90 is usually used as the background, while in New Zealand L95 is preferred. With Short Leq, this is of no importance and the index required is only decided on replay. ANY Index over ANY time inside the acquisition period can be produced.

Long periods of measurement are possible and Fig. 4 shows part of a 2-hour plot with an elementary period of ⅛th second, plotted on a 10-second basis, taken at an Air Force base in France, using a Soeur-Anne SA 11.40. Superimposed is the same data but plotted on a 10-minute period. The loss of data is alarming. With a conventional "in-box" unit taking 10-minute Leq values it is clear that individual events can be lost. Long periods are possible, up to 30 hours. To plot long periods either one plot can be done, or as many as required to get the resolution.

There are two ways of describing the Leq of a particular noise source. "Partial" Leq and "Proper" Leq. Proper Leq is defined as the energy of the source divided by the time the source is active, while Partial Leq is the energy divided by the whole measuring time. Both of these descriptors may be printed by the programme. In effect, proper Leq is the actual Leq of the source, while partial Leq is the contribution of the source, if no other noise were present over the measuring time. Both of these are shown in Fig. 5, which is part of a file taken in Barcelona, Spain. The coding, half in Spanish and half in English, was started in Spain and completed in England. What is different about Short Leq is that at any time in the future, anyone can re-analyse the data of, say, the Barcelona file without needing to travel to Spain again. Similarly, any question on the noise level of a Mirage fighter can be answered by replaying the French Air Force file. In any case there is, unfortunately, no

Place : Ski cabin Valmorel

from 09h 30
till 09h 40 Tue 18-03-1986

Elementary duration: 1 s dBA
Sub-period 1mn

period	Leq	Lmax	L10	L50	L90	L99
9h 30mn	63.1	70.0	66.5	61.5	51.0	47.0
9h 31mn	70.2	72.5	72.0	70.0	67.0	64.0
9h 32mn	58.9	63.5	62.0	59.0	49.0	47.5
9h 33mn	49.4	52.5	51.5	48.5	47.0	46.5
9h 34mn	55.3	64.5	57.0	50.5	48.0	46.5
9h 35mn	71.6	73.5	72.5	71.5	69.0	65.5
9h 36mn	61.6	70.0	65.0	59.5	50.5	48.0
9h 37mn	53.5	63.0	56.5	50.0	46.0	44.5
9h 38mn	67.8	75.5	70.5	68.5	51.0	45.5
9h 39mn	66.8	71.5	70.0	64.0	55.5	51.5

overall : 66.1 dBA

Figure 3: Ln at a ski resort

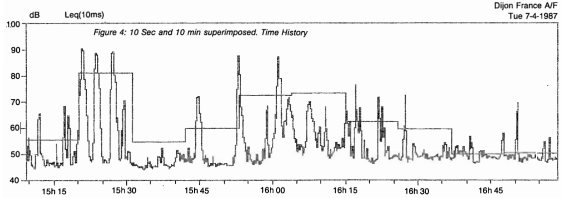

Figure 4: 10 Sec and 10 min superimposed. Time History

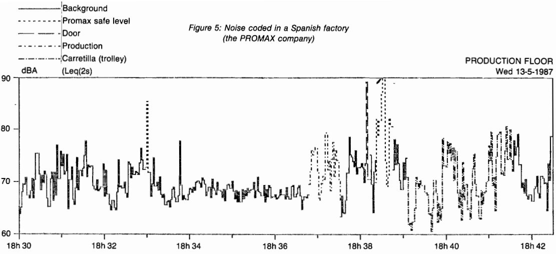

Figure 5: Noise coded in a Spanish factory (the PROMAX company)

excuse to go to Dijon again. The data is useful to predict the sound level that is probable at, say, Darwin, where Mirages are also to be found.

Other predictions are possible. Using "Partial Leq", the contribution of the noise is given as though no other source was present. Thus 'what if?' predictions can be made using actual noise levels instead of some artificial data generated in the laboratory. This is a very powerful technique and one which alone makes the Short Leq method unique among measuring systems.

Using the coding option, the Leq of every source which is active during the measuring period can be found, as can the Ln series for any portion of the acquisition time. Not only can this be done with one Leq meter, but two can be used at the same time to obtain difference and comparative measures, something no other system can do.

If 2 units are in use, the computer can use the data from one to code the data taken by the other. Thus for example, if the noise inside a dwelling is being measured, a second meter near the external noise source can code the fact that the external source is active. This allows quite precise correlation of the external noise and it's effect inside the dwelling. This is often a useful method to prove that the external source is not the cause of a problem.

Many organisations, including companies in the DP37 club, have taken many hundreds of hours of noise data, in countries all over the world, and many of these files are available in their raw form for other people to work on, in a few cases, complete with acquisition notes. Indeed, the programme which performs these calculations, together with many of the data files used in this paper, are available at no charge on an MS-DOS disk from Cirrus Research Ltd in the UK or Davidson Pty Ltd. in Victoria.

Conclusion

The technique of Short Leq with it's separation of the measurement and aquisition phases, allows the computers in the Leq meter and the external unit to each function at full efficiency. If the acquisition unit, i.e. the Leq meter is of adequate performance and can capture the whole of the noise, the software can then perform ANY statistical measuring task where Peak is not involved.

In particular, it is clearly very suitable when measuring environmental noise, which may be anywhere in the range from 20dBA right up to the level of a low flying aircraft or a motor cycle. The data can be captured no matter how impulsive and analysed in many ways by the software. The currently available devices such as the Cirrus Research CRL 2.36, being a hand held unit, require external protection to enable them to be used for long periods outdoors, but otherwise would seem ideally suited to this task.

For Health officers and enforcement agencies, Short Leq can save significant amounts of time. Many acquisition 'sessions' can be taken on a quick visit to the site of the noise and all the analysis done later in the quiet of the office. Not only can the data be made available in presentable form, but the raw integrated information is stored on disk for re-analysis if required. Over 30 hours of data can be taken before the memory is full, typically over three working days of site work before data transfer is required.

In the industrial situation, the size of the first generation of units makes them difficult to use as dosemeters, but accepting this, the performance of Short Leq meters gives a resolution to the measurement of industrial noise that has simply not been possible before. Some of the better dosemeters correctly claim they can resolve the noise climate, actions and probable location of a worker to a minute or so, Short Leq can resolve down to 1/8th of a second; even a sneeze covering several Short Leq elemental periods.

Reference

1 Komorn A. & Luquet P. "Short Leq ,\an LNE report to the EEC" April 1979

(Received 22nd September 1987)

Pitch Control in Harmonica Playing

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ABSTRACT: The technique used by harmonica players to alter the pitch of the note being played, by vocal tract manipulations, is described. Observations of the effect from the player's point of view, and the results of experiments using a mechanically blown instrument are presented. An acoustical analysis of the effect using the small signal approximation, and including both reeds in each airway in the model, yields predictions in accord with the observations.

INTRODUCTION

The purpose of this report is to describe, and explain, the technique which is used by harmonica players (particularly blues and jazz players) to alter the pitch of the note being played by changing the shape of the vocal tract, particularly by changes in the position of the tongue.

There are only casual references to the harmonica in the literature, usually in general discussions of the vibrating reed as a sound source, but the acoustics of the instrument do not appear to have been studied in depth. However, there is an extensive literature of the mechanism of sound generation by vibrating reeds [1], [2], [3], [4], [10], [11], [17], particularly in connection with the clarinet. Also there is a body of evidence for the effect of vocal tract resonances on the performance of wind instruments [5], [6], [7], [8], [9], including their pitch [7], [12].

The instrument on which the technique is most widely used is the simple ten hole harmonica, which is tuned to a diatonic major scale. The more complex chromatic harmonica does not readily respond to the technique, and is much less widely used in this field despite the apparent advantage of a full chromatic scale. We have used Hohner "Special 20 Marine Band" harmonicas, which are a general standard. They are available in any major key.

For a C instrument the tuning is as shown in Figure 1. The missing A4 in the lowest octave is to allow the dominant 7th chord to be played without dissonance.

The "classical" technique of playing the instrument is to cover four holes with the lips and to block the lowest three off with the tongue. The melody is played through the remaining open hole and the tongue can be lifted to allow vamping of accompanying chords. The tongue is not available to alter the shape of the vocal tract, and pitch bending is not used with this method. With this technique, the instrument is very limited because accidentals are not available.

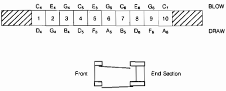

Figure 1: Tuning and reed layout of the ten hole harmonica

The instrument was made much more versatile by the adoption of a different technique by American Negroes, earlier this century. The method involves "kissing" the harmonica to select the note to draw or blow. The tongue is then free to be used to change the shape of the mouth cavity which has the effect of changing the pitch in a remarkably subtle and reliable fashion (changes of up to three semitones can be achieved).

The importance of being able to bend pitch for this type of music is twofold. Firstly, Jazz/Blues music uses a lot of subtle slides of pitch, rather than fixed pitch scale tones. Any instrument that cannot produce these "bent notes" is of little use for the idiom. Secondly, the scales used are not diatonic major scales. They require flattened thirds, fifths and sevenths to be available. This can be achieved by playing modes of the major scale (particularly that with tonic a fourth below the instrument key), and other missing notes are played by bending available ones.

OBSERVATIONS ABOUT PITCH BENDING

Any theory of pitch bending on the harmonica must account for the following observations.

A. The note can only be flattened.

B. Only certain notes can be bent — low draw notes and high blow notes. The detailed rule is simple — the only notes that can be bent are those where the other note in the same channel (i.e. the draw note when a blow note is being played) has a lower pitch than the one being played. For the harmonica shown in Figure 1, this applies to draw 1 to 6 and blow 7 to 10. Blow 1 to 6 and draw 7 to 10 cannot be bent more than a few tens of cents.

C. The degree to which the pitch can be bent is also related to the pitch of the other note in the same channel. The rule is that, for those notes that can be bent, the pitch can be varied from the normal pitch of the note being played, down to approximately a semitone sharp of the pitch of the other note in the same channel (which is flat of the note being played by A).

D. For draw notes the pitch variation is essentially continuous between the upper and lower pitch limits for a continuous change in mouth geometry. For the high notes, the pitch change tends to be abrupt between the limits.

E. The technique that is used to achieve these changes, while complex, is essentially as follows. For medium to high pitched notes the size of the oral cavity, controlled by the position of the tongue, seems to be the crucial factor. For medium pitch draw bends, the tongue is pushed down and back to flatten the pitch. For the high blow bends, the tongue is pushed forward and as mentioned above the pitch drops more or less abruptly. In both cases the higher notes are played with the tongue further forward in the mouth. For very low pitched notes the movement of the tongue is less pronounced and it is noticed that the Adam's apple drops on bending to lower pitch, and this is an indication that the larynx is being lowered [5]. These changes in tongue position from low to high notes are similar to those found in woodwind playing [5], [6].

OBSERVATIONS USING AN ARTIFICIALLY BLOWN HARMONICA

Experiments were performed using a mechanically blown harmonica, to show that the pitch bending effect could be produced by varying the resonance frequency of a chamber through which the instrument was blown. The arrangement is depicted schematically in Figure 2. The effect of changes in the vocal tract geometry was simulated by a variable length cylinder in the air supply. This arrangement has also been used experimentally by Coltman [12]. The frequency was measured with a Cohn Strobe Tuner, and the measurements are taken close to the critical pressure where the small signal approximation is most likely to apply (there is a small flattening of pitch with increasing blowing pressure).

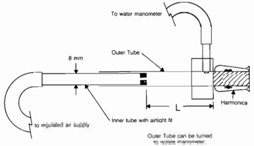

Figure 2: Schematic layout of experimental apparatus

Figure 3 shows the results of an experiment in which the frequency of the sound emitted by blow 8 on a C instrument, a note that bends easily, is measured as the tube was extended. The free reed frequency of the bottom plate reed (i.e. the one not normally associated with the production of the note being played) is then returned sharper, that is towards the pitch of the top plate reed by filing the reed. The pitch variation with cylinder length is re-measured and the process repeated. The results show clearly that the limit down to which the pitch can be bent is determined by the free reed frequency of the other reed in the channel. It is also observed that this reed has a substantial amplitude of vibration when the pitch is lowest. The extremes of pitch that can be produced by this experimental arrangement are in good agreement with what is found playing the instrument normally.

Figure 4 shows the pitch variation with cylinder length, for the note blow 8 on a G instrument, with both reeds in the channel free to vibrate, with the top reed free to vibrate with the bottom reed taped over, and with the bottom reed free to vibrate with the top reed taped over. The results show that the vibration of both reeds is needed if the greatest pitch variation is to be obtained.

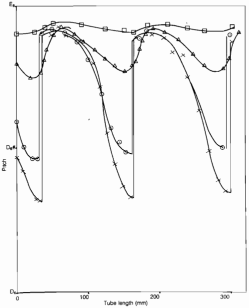

Figure 3: Pitch versus tube length for a blow note that will bend (blow 8 on a C instrument), the bottom plate (draw) reed being tuned to different free reed pitches, approaching the free reed pitch of the top plate.

× — D6 + 30 cents   *△ — D6 + 25 cents*
⊙ — D6 − 44 cents   *□ — E6 − 25 cents*

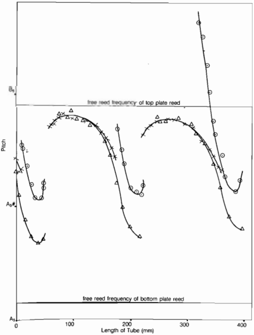

Figure 4: Pitch versus tube length for a blow note that will bend (blow 8 on a G instrument).

△ — Both reeds free to vibrate   *× — Only top plate reed free*
⊙ — Only bottom plate reed free

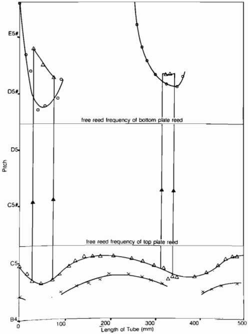

Figure 5: Pitch versus tube length for a blow note that will not bend significantly (blow 4 on a C instrument).
△ — Both reeds free to vibrate ⊙ — Only top plate reed free
× — Only bottom plate reed free

Figure 5 shows the same measurements repeated for a note that will not bend easily — blow 4 on a C instrument. The pitch variation is small, and, with both reeds free, at cylinder lengths where the pitch is flattened, the sound output greatly attenuated. In these length ranges, it is also possible, by increasing the blowing pressure, to produce a second pitch near the pitch produced by blowing with only the top reed free. Such a note can be produced in normal playing by delicate vocal tract manipulation and increased blowing pressure.

Measurements have been made of the critical pressure required to start vibration. For the "bendable" note "blow 8" on a G instrument, for instance, it was found to range from 0.1 kPa to 0.5 kPa for the top reed only, 4.6 kPa to 6 kPa for the bottom reed, and from 0.3 kPa to 1.5 kPa when both reeds are free to vibrate. In this last case, the high value occurs for tube lengths that yield the minimum pitch, that is, the critical pressure increases as the note is bent flat.

That the effect can be produced with such an arrangement, is strong evidence that pitch bending in normal playing is affected by changing the resonant frequency of the vocal tract by changing its shape. That there is an increase in threshold pressure as the note is bent, leads many players to falsely ascribe the bending effect to increased blowing pressure, or to choking the air supply. Furthermore, our experiments show that both reeds in the channel are involved in pitch bending, contrary to the general belief that only one reed is vibrating at any time.

THEORY

Fletcher [3] has shown that the oscillations of the classical wind instruments can be understood by dividing the instrument system into a passive linear distributed acoustic system (the instrument tube), and a non-linear sound generator. Each system is characterised by its impedance (or admittance) function, and owing to the possibility of negative impedance of the sound generator, self sustained oscillations can occur.

This approach can be used to give a qualitative explanation of pitch control in harmonica playing. The passive distributed system is the player's vocal tract with admittance Y_v, at the lips looking into the mouth, and the sound generator is the pair of reeds of the harmonica in the airway of the note being played, with admittance Y_h, looking into the instrument. The condition that the reed system act as a sound generator is that the real part of Y_h be negative, and larger in magnitude than the real part Y_v [3]. In addition, continuity of the volume velocity requires that

$$\tan \phi_h = \tan \phi_v \qquad (1)$$

where ϕ_v and ϕ_h are the phases of the admittance functions of the vocal tract and the reed system. Equation (1) determines the frequency of oscillation of the combined system. Details of the calculation of Y_h, ϕ_h, Y_v and ϕ_v are given in the Appendix.

It is helpful to distinguish, following Helmholtz [1], two ways in which a reed that is coupled to a distributed linear acoustic system can act as a sound generator. In one mode the reed gap is reduced when the reed moves in the direction of the air flow and in the other it is increased when it moves in the direction of the air flow. We shall call the first a closing reed and the second an opening reed. (We have deviated from Helmholtz's terminology because it is only appropriate to blown instruments, not drawn ones.) When playing a blow note the top reed is a closing reed and the bottom reed is an opening reed. The roles

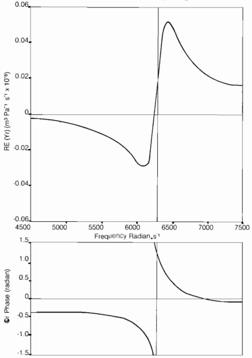

Figure 6: The real part, and the phase of the acoustic admittance versus frequency for a closing reed.

$X_u = 0.2\ mm$	$b = 2.00\ mm$
$M_r = 0.01\ g$	$a = 1.0\ mm$
$S_r = 0.2\ cm^2$	$D_r = 0.05$
$W_r = 6300\ rad.s^{-1}$	$P_o = 1.0\ kPa$
$y = 1$	$z = 0.5$

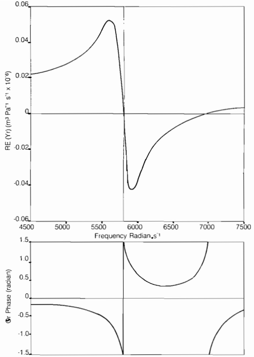

Figure 7: The real part, and the phase of the acoustic admittance versus frequency for an opening reed. Parameters are as for Figure 6 except $X_u = -0.2$ mm, $W_r = 5800$ rad. s^{-1}

are reversed for a draw note. The reeds that are associated with the normal playing of notes are the closing reeds, but the following analysis will show that the opening reed plays a decisive role in bent notes.

Consider first the case where only one reed in the airway is free to vibrate. Figure 6 and Figure 7 show the real part of the admittance Y_r and the phase ϕ_r for opening and closing reeds. This form of the acoustic admittance of reeds has been well confirmed experimentally [4]. Operation near the minimum of $RE(Y_r)$ is favoured by the system, and this occurs for closing reeds at a frequency just below the reed's resonance frequency, and for opening reeds at a frequency just above the reed's resonance frequency, as was found in Figures 4 and 5. The frequency of vibration of the combined system of vocal tract and one reed with be given by

$$\tan \phi_r = \tan \phi_v \qquad (2)$$

For closing reeds, $-\pi/2 < \phi_r < 0$ for the frequencies where $RE(Y_r) < 0$ and for opening reeds $0 < \phi_r < \pi/2$ for the frequencies where $RE(Y_r) < 0$.

Since ϕ_v varies from nearly $+\pi/2$ to $-\pi/2$, with suitable continuous variations in the geometry of the vocal tract, equation (2) can only be satisfied for certain vocal tract shapes for closing reeds, and for certain intermediate vocal tract shapes for opening reeds. It is in fact found that when one reed of a harmonica is covered by tape, the instrument will only sound when certain mouth shapes are assumed. This was also found for the artificially blown instrument with one reed fixed in Figures 4 and 5.

In the real instrument both reeds, which are acoustically in parallel, contribute to sound generation. One reed is opening and the other is closing, so there are two distinct cases:

1. The higher pitch reed is a closing reed and the lower is opening. This applies to HIGH BLOW and LOW DRAW.
2. The higher pitch reed is an opening reed and the lower is closing. This applies to LOW BLOW and HIGH DRAW.

In view of observation B above, it seems that only the first of these cases allows pitch bending. We can see why this is by plotting the admittance given by equations (A7) and (A8) for the two distinct cases. This is done is Figures 8 and 9.

We find that for the first case (closing reed of higher pitch), Y_h is negative essentially only between the two reed resonance frequencies. Furthermore, the acoustic phase angle varies from $+\pi/2$ to $-\pi/2$ in the range where $RE(Y_h)$ is negative when $W_b < W_t$. Since ϕ_v also varies virtually from $+\pi/2$ to $-\pi/2$ with changing vocal tract shape, it will be possible for the instrument to sound at any pitch between the resonance ferquencies of the reeds for some mouth geometry. This is the pitch bending phenomenon.

For the second case (opening reed of higher pitch), by contrast, we find the frequency ranges in which $RE(Y_h)$ is negative are essentially those for the individual reeds, and, in these regions, the phase angle only asumes a small range of values. Thus, sound is possible only for fairly specific mouth geometries at two small frequency ranges; below the closing reed's resonance and above the opening reed's resonance. The first is the frequency of the normal note and the other is the note that can be produced by "overblowing" a low blow note. This latter note can be struck on the low blow notes by applying the same technique for bending low draw notes and

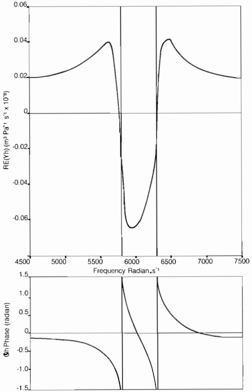

Figure 8: The real part, and the phase of the acoustic admittance versus frequency for the two reed harmonica model when the resonance frequency of the closing reed is higher than the resonance frequency of the opening reed. All parameters are as in Figure 6 except $W_t = 6300$ rad. s^{-1}, $W_b = 5800$ rad. s^{-1}

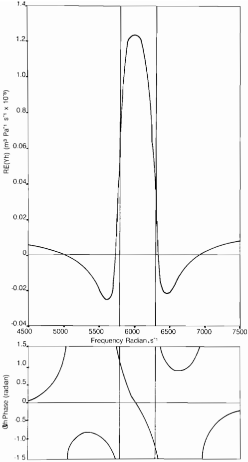

Figure 9: The real part, and the phase of the acoustic admittance versus frequency for the two reed harmonica model when the resonance frequency of the closing reed is lower than the resonance frequency of the opening reed. All parameters are as in Figure 6 except $W_t = 5800$ rad. s^{-1}, $W_b = 6300$ rad. s^{-1}, $P_o = 2$kPa.

blowing very hard. It is very difficult to control and often forms a rapid alternation of pitch with the normal note. This is occasionally used by players as an effect.

Observation C can be understood in terms of our model, when it is realised that it expresses the lowest pitch attainable in terms of the pitch of the other note in the channel when played normally i.e. as a closing reed. Our model suggests that the lowest attainable pitch will be about that of the other reed in the channel played as an opening reed. The minimum of $RE(Y_r)$ for an opening reed occurs at approximately 0.5 D_rW_r above the reed resonance frequency, and the same amount below the resonance frequency for closing reeds [3]. We therefore expect the lowest extreme of pitch to be about D_rW_r above the pitch of the other note of the same channel played normally. This is in agreement with the fixed scale interval relation expressed in C.

The observations D and E are explained by reference to the variation of pitch with tube length shown in Figure 3. When operating in the region of continuous variation in pitch with length, increasing the length of the tube lowers the pitch. Evidently this is the type of change in vocal tract resonance occurring in the technique for the low and middle notes. However the pitch can also be lowered by crossing the discontinuity in pitch with a decrease in length of the pipe. This accounts for the apparently contradictory technique used on high blow notes, and their discontinuous change in pitch.

AERODYNAMIC DAMPING OF THE REED

Observation A is clearly related to the observation that the closing reed requires much less pressure to start vibration than the opening reed in the same channel, and thus the note associated with the closing reeds is taken as the natural pitch of the note. In all notes that can be bent, the closing reed has the higher pitch. If the closing reeds were not easier to sound the instrument would be practically unplayable, requiring constant attention to pitch control. However, this large difference in critical pressure of opening and closing reeds of almost identical parameters is not predicted by the simple model above.

It can be shown from equation (A3) that the minimum critical pressure P_{min} is approximately

$$P_{min} = (2M_r z/S_r \gamma)X_o D_r \qquad (3)$$

and the difference in X_o or M_r/S_r is not sufficient to account for the large observed difference in P_{min}. Only the assumption that the opening and closing reeds have substantially different values for the damping constant D_r will make (3) accord with reality.

The need for different values of D_r for the opening and closing reed is also suggested by other observations. Firstly, as mentioned above, the simple model predicts that the operating frequency of the closing and opening reeds should differ from the reed resonance by a ratio proportional to the internal damping of the reed, whereas we find (Figure 4) that the closing reed operates much closer to the resonance frequency than the opening reed. Secondly the simple model predicts that when the two reeds are tuned to the same fequency $RE(Y_h)$ is always positive so the instrument cannot sound. This is contrary to observation, but the problem is avoided if damping factors are set unequal.

The source of this difference in damping would appear to be the aerodynamic mechanism described by St Hilaire et al [17]. By an analysis of the time varying potential flow around an harmonium reed, they found that terms in the time-dependent Bernouli equation could give rise to an oscillating force on the reed that is in phase with the reed velocity if the reed is a closing reed and of opposite phase to the velocity if the reed was an opening reed. The reeds of a harmonium are always arranged to be closing, and they considered that the aerodynamic mechanism was the cause of the excitation of the harmonium reed. That the opening reeds can be excited while playing the harmonica indicates that the interaction of the reeds with the vocal tract resonances is the most important mechanism for reed excitation in this case, but the aerodynamic force on the reed, being in phase with the velocity of the reed for closing reeds, can be viewed as decreasing the damping of the reed, and being out of phase with the reed velocity for opening reeds, can be viewed as an additional damping mechanism.

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APPENDIX— The vocal tract and harmonica admittance functions

THE VOCAL TRACT

The resonances of the vocal tract have been extensively studied by workers in the field of speed synthesis [13], [14]. In vocalisation, the glottis is the sound source, and the sub-gottal system is generally ignored. The system from the glottis to the lips is then represented by a series of cylinders of varying area, and linear acoustics are used to calculate its response. In reed instrument playing, the sound source is at the lips and in general the glottis is wide open, so it is not so easy to justify ignoring the sub-glottal system.

In principle, we could use the published methods [15] to calculate the complex admittance function of the vocal tract as seen from the lips, given data on the area variation of the vocal tract, glottis and sub-glottal system. Since this data does not exist for harmonica playing this approach is not practical. Fortunately we can make progress in understanding pitch bending, with only the most qualitative knowledge of the variation with frequency of the phase of the admittance of the vocal tract.

To this end we start by considering a tube of uniform cross sectional area S, and length L, open at the far end. The input impedance can be put in the form [3]

$$Z_p = (R_oC/S)(1 + jH\tan(KL))/(H + j\tan(KL)) \qquad (A1)$$

where R_o is the density of air, C the speed of sound and K the wave number. H is the height of the impedance maxima above the reference level R_oC/S. The admittance is $1/Z_p$. The phase of the admittance, that is, the phase of the flow into the pipe, relative to the pressure in the pipe, ϕ_p, is thus given by

$$\tan(\phi_p) = -[(H^2 - 1)/2H]\sin(2KL). \qquad (A2)$$

Since H is typically 10—100 for a tube of these dimensions, ϕ_p varies from nearly $-\pi/2$ to $+\pi/2$ as frequency is increased through a resonance, with the change being most rapid near a resonance. (See ref. [16] for experimental measurements of acoustic phase for a straight tube and for various horns.) The same type of variation of phase with frequency near resonance is found for tubes of non-uniform area also [3], [16] although the resonance frequencies are no longer harmonically related and are related in a complex way to the area variation of the tube. Thus, while the exact relation between resonance frequency and vocal tract geometry remains obscure, we can make the following deduction; for a given frequency of operation, the phase of the acoustic admittance of the vocal tract seen from the lips, can be varied from nearly $+\pi/2$ to $-\pi/2$, by suitable continuous variations in the geometry of the vocal tract (mainly affected by changes in tongue position) that alter the relationship of the vocal tract resonances to the operating frequency.

THE HARMONICA

On the basis of a small signal model of the vibrating reed first introduced by Backus [2], Fletcher [3] has given expressions for admittance of reeds near the threshold blowing pressure.

The admittance of the reed Y_r, seen from the passive system, is given by

$$Y_r = (1 - B)/[(|P_o|/zU_o)\cos\phi_r - W(R_oa/b|X_o|)\sin\phi_r] \qquad (A3)$$

where

P_o = the blowing pressure in the mouth referred to atmospheric
U_o = the magnitude of the constant part of the volume flow
W = the frequency of vibration
W_r = the resonance frequency of the reed
a = the length of the mass of air bounded by the reed opening
b = the width of the reed
X_u = the unblown displacement of the reed toward the inside of the instrument
X_o = the equilibrium displacement of the reed toward the inside of the instrument
$X_o = X_u - (S_r/M_rW_r^2)P_o$
M_r = the effective mass of the reed
S_r = the effective area of the reed
y,z = reed parameters that relate to the pressure/volume relation that is assumed in the model
D_r = the reed damping coefficient
$A = [S_r(P_oy/zX_o)WW_rD_r]/\{M_r[(W_r^2 - W^2) + (D_rWW_r)^2]\}$
$B = [S_r(P_oy/zX_o)(W_r^2 - W^2)]/\{M_r[(W_r^2 - W^2) + (D_rWW_r)^2]\}$

and the phase, ϕ_r, of the admittance is

$$\phi_r = \frac{(|P_o|/zU_o)A + W[R_o(a/b)|X_o|(B-1)]}{(|P_o|/zU_o)(1-B) + W[R_o(a/b)|X_o|]A} \qquad (A4)$$

Equations (A3) and (A4) are generalisations of Fletcher's results to allow positive or negative pressures in the pipe. When P_o/X_o is positive, the reed is a closing reed and, when P_o/X_o is negative, it is opening.

The real and imaginary parts of Y_r are

$$RE(Y_r) = Y_r\cos\phi_r \qquad (A5)$$

$$IM(Y_r) = Y_r\sin\phi_r \qquad (A6)$$

and the condition that RE (Y_r) be negative is essentially that $(1-B)$ be negative.

For a model of the harmonica in which both the opening and the closing reed contribute to the generation of sound, we take the volume flow velocity in the channel to be the complex sum of the velocities through the two reeds. Since the pressure acting on both reeds is essentially the same, (that is the two reed generators are acoustically in parallel) we can write

$$RE[Y_h(W)] = RE[Y_r(W_t,W,X_o)] + RE[Y_r(W_b,W,-X_o)] \qquad (A7)$$

$$IM[Y_h(W) = IM[Y_r(W_t,W,X_o)] + IM[Y_r(W_b,W,-X_o)] \qquad (A8)$$

$$\tan\phi_h = IM[Y_r(W)]/RE[Y_r(W)] \qquad (A9)$$

where

Y_h = the admittance of the two reed harmonica seen from the mouth
ϕ_h = the acoustic phase of the two reed harmonica
W_t = the resonant frequency of the top plate reed
W_b = the resonant frequency of the bottom plate reed

We have assumed in equations (A7) and (A8) that the physical parameters of both the reeds are the same and that they only differ in the sign of the equilibrium opening and in their resonance frequency. This is only a computational aid, and in any case it is a good approximation since the reeds in the same channel, sounding at nearby pitches, are very similar in dimensions.

There are apparently four cases to consider:

1. P_o positive and $W_t < W_b$. This applies to blow notes 1–6. (LOW BLOW)
2. P_o positive and $W_t > W_b$. This applies to blow notes 7–10. (HIGH BLOW)
3. P_o negative and $W_t < W_b$. This applies to draw notes 1–6. (LOW DRAW)
4. P_o negative and $W_t > W_b$. This applies to draw notes 7–10. HIGH DRAW)

However, because of the invariance of equation (A3) under the simultaneous change of sign of P_o and X_o, if we use the same pair of resonance frequencies, case 1 and 4 would yield an identical admittance function as would cases 2 and 3. That is to say, there are only the two distinct cases considered in the text.

Acoustic Emission Monitoring During a Proof Test on a Repaired Steam Locomotive Boiler

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Introduction

The workhorse of the past railway systems was the steam locomotive, and to some it was purely a workhorse, and to others there is a romance that makes the steam locomotive live. With the change from steam to diesel locomotives there was a determined effort to ensure that the age of steam would live on for future generations to experience and enjoy. The flagship of the past for the New South Wales Railway, a specially streamlined locomotive identified as 3801, has been restored by the Newcastle State Dockyard and the State Rail Authority of New South Wales to be used on special passenger trips for both transport and enjoyment of rail enthusiasts. Inspection of the boiler prior to restoration revealed a number of cracks radiating from washout plug holes on the back corners of the boiler. These areas were cut out of the boiler; the cracks ground out; and the metal replaced by welding techniques. Acoustic emission techniques were used during the proof test of the boiler to evaluate these repairs and to identify any areas of significant defect activity.

Acoustic Emission Event Monitoring

Event counting is the most widely AE technique which gives the number of times the waveform crosses over a preset threshold for some measurement time. The required equipment consists of a transducer, preamplifier, main amplifier, and a computer for data gathering. The deadtime of the system can be modified so that the count may reflect the entire waveform or only the event activity. The counting of each crossover gives the waveform dominant data, while counting the envelope gives only event activity. These techniques are the most useful of all AE techniques, but without other data it does not adequately describe the activity from the monitored object.

Four AE transducers were located on each side of the boiler in the areas of the repairs. The locations were cleaned and the transducers located so that the Flaw Locating and Imaging Computer triangulation techniques could be used for precise source location and the CSIRO-developed CSIRO-EAR acoustic emission monitoring equipment was used for zone location, event activity, and peak amplitude analysis. The transducers used had a frequency response in the 120 to 600 kHz band; the preamplification was 40 dB; and an additional 20 dB from the main amplifier gave a 60 dB total system gain.

Test Procedure

The boiler was to be tested under proposed operating conditions, and the various stay pins were adjusted at the relevant hold periods in the test. The hot pressurised water was supplied from a 59 class steam locomotive (shown in the photograph on the cover of this journal), which was connected to the boiler of 3801.

Following the instrumentation of the vessel, measurements of both the velocity and attenuation of the surface wave on the vessel were made using an artificial source.

The equipment was then calibrated and the basic test procedure was followed which consisted of increasing the pressure to initially 50 psi, monitoring AE during pressure increase and a specified hold period; then the SRA staff measured and adjusted the stay pins to allow for the temperature and pressure expanding the boiler.

This procedure was followed for each pressure increase to 75, 100, 125, 150, 175, 200, 225 and 247 psi. Two hold periods were included at the maximum pressure of 247 psi before depressurising.

The background noise levels and the equipment calibration were checked at the end of the test program

Results and Discussion

The test procedure was designed to provide data from various sections of the test vessel and to enable the integrity of the vessel to be progressively evaluated. The acoustic emission generated surface wave velocity was measured as 2332 metres per second for a surface simulated source. The attenuation coefficient of the propagating surface wave gave results between 2.25 and 3.5, with the attenuation being measured at between 19 and 30 dB per metre, depending on the surface condition and source to transducer separation. The low velocity values and the high attenuation together with the wide scatter of results are a result of the rough surface; the surface coating; and the geometry of the vessel. It was estimated that each transducer had a surveillance area of at least 3 metres radius.

Some low level acoustic emission activity was detected during the first pressurisation up to 50 psi. The detected waveforms indicated that the source was mechanical noise. Data was also collected during a second monitoring period while the pressure was held constant at 50 psi. No defect activity was detected during the hold period. This pattern of activity was repeated for each of the subsequent pressure increases.

Activity during the pressure increases can be associated with mechanical impact and/or movement, defect activity, or elastic/plastic material effects. This activity can usually be located and identified during the test; however, the more significant activity occurs during pressure hold periods. During this test program, a small number of acoustic emission events were detected during the pressure increase periods, and the source areas were broadly located in the area of the pipe fittings, on both sides of the vessel. Some acoustic emission activity which was not precisely located was detected just prior to the fracture of the glass in the pressure gauge located in the driving cabin, and so this activity is thought to be associated with that event. In the last three hold periods some larger peak amplitude events were detected and the approximate source location was again at the two pipe fittings.

The transducer locations were chosen primarily to monitor the repaired areas on the upper corners of both sides of the boiler. These areas were not identified as source areas for any of the acoustic emission events detected indicating adequate repairs in this area.

Conclusions

This test program was not required to be a full integrity evaluation of the vessel. The requested purpose of the program was to detect any active cracking and evaluate a number of previously cracked sections on the back to side corners of the vessel which had been repaired. Accordingly, the vessel monitoring was concentrated on these areas. The pre-pressurisation tests indicated that each transducer effectively monitored an area 3 metres in radius, and the areas of concern were monitored by all transducers.

The detected acoustic emission data did not indicate any persistent or recurring sources of activity indicative of crack growth and/or defect activity. The activity detected is thought to have been associated with the gasket leaks; some rivet movement; movement associated with the pipes; and the pipe fittings.

The data obtained from this test indicated that there was no defect and/or crack activity from the areas repaired at the time of testing and under the prevailing test conditions. The acoustic emission activity from other source areas was detected and identified during the test, and was consistent with mechanical movement and material effects normally related to increases in both pressure and temperature.

Acknowledgements

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The assistance of the Lucas Heights CSIRO Acoustic Emission Team who participated in this test program is acknowledged.

(Continued from page 64)

The processor then directs a speaker to broadcast sound waves that are 180 degrees out of phase with the engine noise.

Since car noise is not completely repetitive a noise cancellation muffler would not create a completely silent car. It would, however, make it a quieter and more efficient one.

Anti-noise can create "zones of quiet" in loud workplaces. To make such a zone, microphones can be suspended around a workstation on a factory floor.

Speakers that generate the out-of-phase sound waves can then be put close to the worker — say, under a desk or bench.

The company has tested prototypes of this system and says it cut noise-levels enough for someone inside the zone to hear conversations from another part of the room.

Yet the rest of the room remained noisy. Shouts from the quiet zone could not be heard over the factory noise by those outside it. NCT is now actively marketing this system.

From The Australian, 27th October and 10th November, 1987

Hearing Problems in Orchestras

Notes for a presentation to the Performing Arts Medicine Society,* NSW Branch, October 18, 1987

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Is there a problem?

We expect that all musicians in an orchestra would have at least normal hearing. At a symphony concert, we expect and hear (usually?) good intonation or pitch, rhythm, ensemble, tone colour and dynamics.

It is incongruous to call music noise, although some contemporary works, respectfully, appear to bear a close resemblance! From the viewpoint that intense sound can damage hearing, the orchestra, brass bands, rock bands and other groups who present rousing types of music are placed in the "at risk" category! The hearing sense seems incapable of differentiating between loud sounds we like, or loud sounds we do not like, that is with respect to its capacity. However, intensity and loudness are not equal. Intensity is a physical measurement, loudness a psychological one. Certain disturbing noises may be quite loud, but their intensity structure is insufficient to cause hearing damage.

Hearing problems among orchestral musicians?

Let us look now at the evidence. There have been several recent major studies into the hearing of orchestral musicians: in Sweden,[1] in-depth studies, Swedish major orchestras; Switzerland,[2] Suisse Romande Orchestra; UK,[3] among 34 musicians from several English orchestras; Australia,[4] among 38 musicians from the Sydney, Adelaide, West Australia orchestras of the Australian Broadcasting Corporation.

Sound intensities in orchestras, measured in decibels with respect to time, often exceed the limits prescribed by health authorities. Hearing impairment is present among all of the orchestras surveyed, and it appears that 20 to 25% of players in an orchestra can sustain losses in hearing sensitivity due to the music alone, but measured losses are often small.

The hearing loss caused by noise exposure commences with a characteristic notch or loss of sensitivity at 4 to 6 kHz, which widens with more noise exposure. The judgment as to the proportion of hearing loss due to the music alone is made after considering the noise exposure history of the person. Other diagnoses for impairments among these musicians included disease, gunfire, heredity, injury, presbycusis, or previous noisy job. Nevertheless, following verbal enquiries in the USA, UK, Europe and Australia, it appears that very few musicians have been retired because of hearing problems, that is within recent years.

If musicians are at risk, what is being done to prevent changes in hearing sensitivity?

Most palliatives or evasive actions have been taken by the musicians (the world over) to reduce intense music exposures, for instance, raising the noisy instruments — platforms, risers for brass and percussion; distancing the louder instruments and placing them away from hard walls; plexiglass shields on chairs for bassoons and other woodwind players; voluntary use of ear plugs (these actions are supported by managements); stopping playing and covering both ears during noisy passages.

The elements of a hearing conservation program (HCP)

- Noise survey, to decide upon the need for a HCP: sound intensity levels within orchestras have been documented in the studies mentioned; further work is necessary to look at the impulsive sounds within orchestras.
- Engineering noise control: basic to a HCP, to control noise at the source. A paradox: controlling the sound intensity of musical instruments defeats the purpose of the orchestra.
- Administrative noise control: for instance —
  - rotation of players of intense sounding instrument and those nearby.
  - music planning (loud, soft, combinations for music programs. A Swedish approach rates compositions as "heavy", "medium" and "light"). Tradition may be an obstacle!
  - Attention to breaks during rehearsal and the 12 hour rule.
- Ear protection: about 15% of players in Australia use ear plugs. Problems —
  - Occluded ear effect — bone conducted sounds amplified. This occurs with violinists and viola players via chin rest and jaw bone.
  - Clarinet — buzzing sound heard, caused by bone-conduction, since mouth-piece contacts top row of teeth.

Attention to the environment (studio, concert hall, stage) is needed to reduce high level sound exposures. A poor acoustic and too small an enclosure for, say, rehearsals and recording may result in higher sound levels.

Solutions for hearing conservation require the judicious application of many disciplines.

- Health aspects — health professionals and audiologists/otologists.
- Acoustics — studio, hall
  — measurements
  — psychoacoustics — perception of sound (music perception).
- Physics — musical instruments and sound radiation patterns.
- Engineering — noise control (risers, etc.).
- Broadcasting/recording and its constraints (tape recording, CD's, electro-acoustics).

Future directions

The whole problem of hearing among orchestral musicians was investigated last year by myself in conjunction with Professor E. C. Carterette (Psychology), Professor D. E. Morgan (Audiology), both of UCLA, Los Angeles, California. The findings will be published later this year in the journal Music Perception (University of California Press).

*The Performing Arts Medical Society began three years ago in Melbourne and holds three or four meetings each year where performing artists in all fields meet with members of the medical profession and their associates. The accent of this Society is on performance and knowledge in music, theatre, dance and canvas.

Recommended was a three-phase study:

(1) A comparative study of hearing among orchestras (a joint Australian/USA venture).

(2) Development of comprehensive tests for hearing-related performance.

(3) The providing of a rational basis for hearing criteria in the case of musicians for their employment, retirement, transfer, disability, handicap and the award of compensation. (Present medical-legal rules used for the rating of hearing for compensation awards are oriented to health and speech communication. There are no tests that we know of that relate hearing impairment to music perception and performance.)

Reported also was a summary of hearing tests among 13 members of the Los Angeles Philharmonic Orchestra and discussion of the results. The players were selected randomly. Changes to auditory sensitivity and other differences from the "norm" were recorded among these musicians. Published findings will include reference to perceptually-related aspects of musical performance such as pitch, timing, timbre and dynamics.

An interesting concept arose, attributed to Professor A. T. Welford, psychologist: When specific actions were done under deficiencies owing to fatigue, age or injury, the doer adjusted the method of performance to shift the load from impaired to intact capacities, with the result that the required ends were achieved in different ways ("Fundamentals of Skill", A. T. Welford, 1967).

The musician has many laid-down skills in technique. There is also constant feedback from the instrument, the printed music, the music he or she hears, the conductor and other musicians. Whatever the impairment, overuse syndrome, mild hearing impairment, or other, the output of the orchestra appears to substantiate Welford's finding!

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★

TECHNICAL NOTES

Roaring and screaming

Why DO lions roar and cats merely miaow? The answer has nothing to do with size or the fact that one is a fearful predator and the other a pussycat. The structure of the voice box, an organ overlooked until now, explains the difference.

Since 1916, biologists have divided cats into roarers (*Panthera sp*) and non-roarers (*Felis sp*). Roaring cats have a bone missing from their hyoid apparatus and have a ligament in its place. This explains why these cats have deeper voices but it does not account for roaring. And the snow leopard (*Panthera uncia*), which anatomically falls into the roarer group, does not roar at all. It screams.

Malcolm Hast, professor of otolaryngology at Northwestern University School of Medicine, Chicago, dissected out the larynges of 12 species of cat and found not only what makes some cats roar but also a new and better system of classifying cats.

Real roarers, Hast found, have very large, undivided vocal cords with a large pad of fibroelastic tissue at one end. The resulting tube is like the tube of a trumpet. This allows sound to pass from high to low air resistance with a better transfer of acoustic energy — resulting in a booming roar.

All cats in the genus *Panthera* have this structure except the screaming snow leopard, which Hast suggests should be a separate genus, *Uncia.*

From New Scientist, 19 Feb. 1987

Car alarm's painful noise drives out thieves

Car alarms are triggered so frequently by accident that they are ignored. An American inventor has introduced an extra element of deterrence — "a pain generator".

A siren in the car produces a howl well above the pain threshold, driving out a thief in seconds.

Bystanders are said to be safe, however, since outside the car all that can be heard is the noise of a conventional car burglar alarm.

The "pain generator" was devised by **Mr. Allen Arzoumanian,** and is made by a Californian company, Integrated Alarms of Encino.

Mr. Arzoumanian claims burglars are avoiding cars with a pain generator sticker.

He has no qualms about the pain generator.

"I don't care what you say about torture and pain," he says. "The reason there is so much of it around the world is because it works."

Weekend Australian, 5th September, 1987

Walls will have loudspeakers

Within a few years, homes could have hi-fi loudspeakers built into the walls, and ceilings, to save the space normally wasted on large speaker cabinets. A team of engineers at Matsushita's acoustic laboratories in Osaka, Japan, has built a prototype. It is 12 metres square, but only 6 centimetres thick.

Shuichi Obata, the research director, says that the target is to make the speakers 3 centimetres thick, and to incorporate them as cladding in walls and ceilings. Obata showed off the speakers in Vienna.

To stop sound radiating from the rear, most of the diaphragm in Obata's prototype is sealed in an airtight chamber. Small air vents prevent pressure build-up inside the chamber. The difficult trick, solved by computer analysis, was to tailor the size of the air vents.

The demonstration cost Matsushita dearly. Each speaker must have powerful magnets that hold the diaphragm in place and heavy wooden framing. So they weigh nearly 300 kilograms each. With protective packaging, the stereo pair weighs 800 kilograms. Matsushita managed to get both loudspeakers on a single jumbo jet from Japan to Frankfurt, but for the local flight on to Vienna the company needed a jet for each loudspeaker.

From New Scientist, 11 June 1987

Primitive man 'rocked around the rock'

Scientists at the Swedish Institute of Geophysical Phenomena in Stockholm have discovered evidence that prehistoric man enjoyed a crude form of recorded music.

Head of the research team, **Dr. Lirpa Loof,** who visited Australia in April for talks with CSIRO colleagues, said the startling discovery has shattered the belief that ancient Man had little to amuse himself with except cave painting and story telling.

The find was made near Ouagadougou, Upper Volta, in West Africa, about 18 months ago during a research venture to examine potential oil resources in that very poor country.

Dr Loof said circular tablets dating back 10,000 years, painstakingly engraved using unknown methods, had the rudiments of recorded sound when played with a modern-day (slightly modified) needle.

The original stylus was supposedly a thin reed, although no firm evidence of this remains after so many years.

During a visit to the Swedish Embassy in Ouagadougou the scientist (who had been attending a cocktail reception) asked to try his "theory" for a laugh. To everyone's surprise the tablet, played at a speed of 33⅓ on the Embassy turntable, produced a discernible tune.

Further research is now underway to determine just how the ancients were able to reproduce sound using primitive methods.

CoResearch, CSIRO, April 1987

Erasable optical discs?

Materials that promise erasable optical recording of either analogue or digital data have been discovered at the Philips Research Laboratories in Eindhoven. These are semiconductors such as gallium antimonide and indium antimonide that have been doped with small quantities of undisclosed impurities, deposited on to the disc surface as a thin crystalline layer.

Information is recorded by scanning the disc with a high power laser which is pulsed to represent digital data. This rapidly heats very small areas in the material to slightly above melting point; these areas solidify to produce amorphous spots within crystalline surroundings. The spots can be detected optically because of their different reflectance, and the pattern is sufficiently well defined for digital audio and analogue video readout. To erase recordings the amorphous spots are heated to just below melting point, whereupon the material regains its crystalline state.

Philips claims that information can be recorded and erased about a thousand times. It should be possible to play crystalline amorphous discs on existing hardware after only slight modifications.

Physics Bulletin, September 1987

BOOK REVIEWS

NOVEL TECHNIQUES OF NON-DESTRUCTIVE EXAMINATION

E. A. Ash and G. B. Scruby (Editors)

University Press, Cambridge, 1985, 378 pp., ISBN 0 85403 292 4. Review copy from The Royal Society, 6 Carlton House Terrace, London, SW1Y 5AG, U.K. Price £45.00 (includes international postage).

In response to the need to measure quality and predict reliability a wide range of monitoring techniques, many of them non-destructive examination (NDE), is being researched and developed. Research on NDE has led to the development of a number of novel NDE techniques and in response to a combination of industrial and academic interest a Discussion Meeting was held at the Royal Society on 9th and 10th July, 1985.

Eighteen papers were presented at the meeting and are reproduced in this book (378 A4 pages). These papers covered the three major types of technique — particle (neutrons), electromagnetic (optics, magnetics, microwave) and elastic wave (ultrasonic) — the largest number being in this latter field, reflecting current NDE interests. The papers presented describe some novel and interesting developments which may lead to friction in future years. Although at present the techniques are not at a usable stage, they present an invaluable insight into current trends. Following each paper is a reproduction of the discussions which ensued. The papers are listed.

1. Ultrasonics for microcrystalline structure examinations. — K. Goebbels.
2. Acoustic resonance techniques for temperature, stress and impurity characterizations in piezoelectric materials. — J. J. Gagnepain.
3. Imaging with optically generated thermal waves. — G. Busse.
4. Textures and stress determination in metals by using ultrasonic Rayleigh waves and neutron diffraction. — C. M. Sayers, D. R. Allen, G. E. Haines and G. G. Proudfoot.
5. Acoustic microscopy of surface cracks. — J. M. Rowe, J. Kushibiki, M. G. Somekh and G. A. D. Briggs.
6. Acoustic microscopy from 10 to 100 MHz for industrial applications. — R. S. Gilmore, K. C. Tam, J. D. Young and D. R. Howard.
7. Scanning acoustic microscopy of partly embedded cracks in polycrystalline alumina. — G. C. Smith, A. E. Almond, M. G. Gee and M. Nikoonahad.
8. Scanning electron acoustic microscopy and its application. — D. G. Davies.
9. Photodisplacement techniques for defect detection. — Y. Martin and E. A. Ash, F.R.S.
10. The use of AC-field measurements for crack detection and sizing in air and under water. — W. D. Dover, R. Collins and D. H. Michael.
11. The Russell effect and its use in non-destructive testing. — V. Daniels.
12. Novel Applications of Raman microscopy. — D. J. Gardiner, M. Bowden and P. R. Graves.
13. Integrated circuit metrology with confocal optical microscopy. — S. D. Bennett, J. T. Lindow and I. R. Smith.
14. Surface - acoustic - wave generation by thermoelasticity. — W. Arnold, B. Betz and B. Hoffman.
15. Characterization of surface-breaking defects in metals with the use of laser-generated ultrasound. — J. A. Cooper, R. J. Dewhurst and S. B. Palmer.
16. Use of ultrasonic models as tools in the design and validation of new NDE techniques. — R. B. Thompson and T. A. Gray.
17. Ultrasonic measurement of internal temperature distribution. — H. N. G. Wadley, S. J. Norton, F. Mauer and B. Droney.
18. Magnetoacoustic and Barkhausen emission in ferromagnetic materials. — D. J. Buttle, G. A. D. Briggs, J. P. Jakubovics, E. A. Little and C. B. Scruby.

John Dunlop

NOISE-CON 87 PROCEEDINGS

Institute of Noise Control Engineering, P.O. Box 3206, Arlington Branch, Poughkeepsie, N.Y. 12603, U.S.A. 1 volume, 780 pp. Price $U.S.60 (extra $U.S.16 for airmail postage).

The theme of the 1987 National Conference on Noise Control Engineering was "High Technology for Noise Control". The conference was held at the Pennsylvania State University in June 1987 and was jointly sponsored by the Penn State Graduate Program in Acoustics and the Institute of Noise Control Engineering (INCE). The proceedings comprise the 125 papers on technical topics presented at the conference.

The three papers which formed the "Distinguished Lecture Series" are each 12 pages long. The first, by L. Meirovitch, is on the "Control of Distributed Structures". These types of structures are infinite-dimensional systems and the determination of their control gains presents problems not encountered in lumped-parameter systems. The second is by Tony Embleton on "Outdoor Sound Propagation" and is a review paper presenting the effects of the various out propagation mechanisms including geometrical spreading, molecular absorption, interference, refraction, diffraction, non-flat terrains and turbulence. The third distinguished lecture was given by M. Junger on "Shipboard Noise: Sources, Transmission and Control" and the three transmission paths, namely, air-, water- and structure-borne, are discussed.

The contributed papers, each six pages, are divided into nine areas:

	No. of Papers
Emission: Noise Sources	24
Physical Phenomena	17
Noise Control Elements	19
Vibration: Generation, Transmission and Reduction	6
Immission: Physical Aspects of Environmental Noise	13
Immission: Effects of Noise	7
Analysis	31
Requirements	1
Biomedical Uses of Acoustics	5

As with the proceedings of any conference, the quality of the contributed papers varies. Some of the papers are theoretical while others present practical solutions to noise investigations and control. The allowance of six pages means that the essence of each paper is published, not just a hint as for one page abstracts. Most will find some papers in their area of interest. One paper which caught my eye during a scan through the contents was "Classification of soybeans by impact-force response". The results presented in this paper indicated that it was possible to use such a non-destructive test to differentiate soybean seed of different quality.

These proceedings would be a worthwhile addition to the acoustics section of any library.

Marion Burgess

SOUND INSULATION OF PARTITIONS IN BROADCASTING STUDIOS Field Measurement Data

K. E. Randall, D. J. Meares and K. A. Rose

B.B.C. Engineering Publication, 1986, 122 pp. Review copy from B.B.C. Engineering Department, Kingswood Warren, Tadworth, Surrey, U.K. KT206NP. Price £30 (£35 for overseas).

The publication is A4 in size with a soft cover and spiral binding. This is a very useful and cost effective method of presenting information.

The publication was written for a specific purpose; that was to publish test results of sound insulation field measurements on partitions in BBC studio centres in the UK. The results are presented in tabular and graphical forms. There is no attempt by the authors to derive the sound reduction index from the field measurements.

The tests deal mainly with masonry construction and the lighter weight BBC "Camden" system, with and without doors and double (triple) windows. Other lightweight partitions with combinations of metal, timber and absorptive materials have also been tested. There did not appear to be any information on the weight of the materials tested which can be useful in comparing the data.

The results should be useful to designers of sound studios and spaces which require high sound insulation. This publication is highly commended.

Mark Eisner

NEW PRODUCTS

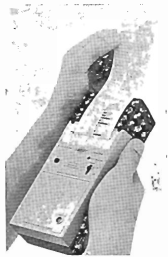
Bruel & Kjaer

Modules and Printer for Sound Level Meter

There are now seven modules for the Modular Precision Sound Level Meter type 2231.

- Event Recording Module BZ 7107 is designed for the automatic recording of up to 99 noise events with the option of short printout or full documentation.
- Reverberation Processor Module BZ 7104, in combination with Filter Set type 1625, measures the reverberation time and early decay time in octave or one-third octave bands.
- Short Term L_{eq} Module BZ 7106 enables the 2231 to measure short term L_{eq} over consecutive user-definable time periods.
- Frequency Analysis Module type BZ 7103, when combined with the Filter Set type 1625, enables automatic, serial octave or one-third octave band frequency analysis to be performed.
- Integrating Module type BZ 7100 produces a general purpose integrating sound level meter.
- Statistical Analysis Module BZ 7101 calculates L_n as well as cumulative and probability distributions.
- Taktmaximal Module BZ 7102 allows for measurements in accordance with the administrative regulations in the Federal Republic of Germany.

The Graphic Documentation Printer type 2318 is a small, lightweight, battery-operated printer for graphic and alphanumeric printouts from instruments with a serial interface. When it is used with Bruel & Kjaer's Modular Precision Sound Level Meter type 2231, all information necessary for an accurate analysis of the measurement data (e.g., bandwidth, range, weighting factor, and module in use) is recorded on the printout. A space is left for the operator to record any extra information. The presentation of data from the type 2231 can be in the form of fully annotated graphs, tables or multi-component bar charts, a brand new feature.



Further information: Bruel & Kjaer Aust., 24 Tepko Road, Terrey Hills, N.S.W. 2084. Telephone (02) 450 2066.

Cirrus

Data Logging SLM

The CRL 2.36 Memory L_{eq} Meter takes a series of "short L_{eq}" values, each representing the actual energy occurring during 1/8th second. Up to 114,000 sets of data can be stored and the data can subsequently be transferred to an IBM compatible computer for storage on disk. Any acoustical measurement can be made on the stored data e.g. statistical indices, average sound level, single event levels, etc. The meter is capable of measuring over a 150 dB range with a resolution of 0.1 dB.

Short Leq Noise Meter Kit

Cirrus Research announce a complete noise measurement kit for the CRL 2.22 series of integrating noise meters, the CRL 2.22K.

The "industrial" measurement kit is contained in an attache style briefcase and includes a CRL 5.11D dual range calibrator, windshield, calibration screwdriver and spare batteries; in fact all the accessories needed for full industrial measurement to British Standards.

A second version of the kit, the "computer acquisition kit CRL 2.22K/2", is intended to provide everything needed for the data acquisition by the "Short Leq" method. This technique allows the CRL 2.22 to be used as the input unit to a desktop computer and measure the noise level in one second intervals over a full working day. In effect, the CRL 2.22 becomes an extremely powerful data logger and can take and process data with an ease and speed that simply was unthinkable even five years ago.

The kit contains full acquisition and processing software together with an interface cable for use with the computer of your choice. A very comprehensive tutorial booklet is provided and nothing else is needed except the computer.

Provision is made in both kits for the digital readout unit CRL 222-07. This allows remote digital readout of the 2.22 for use in remote locations to give high resolution repeated readings.

The performance of the CRL 2.22 is exceptional. Both Leq and Sound Level can be measured over a full 53 dB span and the maximum Leq time is more than 10 hours; allowing use over a full working day. The accuracy is to the full specification of BS 5969 or IEC 651 Grade 2 and the CRL 2.22 also meets the new IEC 804 specification for Integrating (Leq) Meters. Sound Exposure Level is fitted as standard so that the noise dose of individual workers can be measured on a true energy related scale.

The British made CRL 2.22 is the world's first industrial "Short Leq" meter and is priced well below many simple sound level meters, none of which as yet has a COMPUTER output and "Short Leq" function.

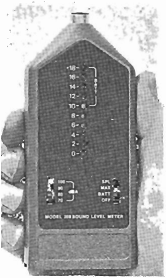
Both IBM and compatibles together with the BBC computer are supported.

Further information: MB 7 KJ Davidson Pty. Ltd., 17 Roberna Street, Moorabbin, Vic. 3189. Phone (03) 555 7277.

Pulsar

Noise Indicators

The Model 208 series of noise indicators use a series of light emitting diodes to display the sound level. This means that the instruments are easy to read and more robust than previous inexpensive units. Four overlapping 20 dB Ranges are fitted and the sound



level is displayed in increments of 2 dB.

The Models 208 and 208L measure sound in an A weighted, "slow" response mode. The former within a range from 70 to 120 dB and the latter from 50 dB. The Model 208F has been specially modified for hi-fi enthusiasts with a "flat" response.

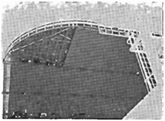
Further information: Pulsar Instruments, Acoustic House, Bridlington Road Industrial Estate, Hunmanby, North Yorkshire, Y014 OPH, U.K.

Bradford

Insulating Retractable Tennis Centre Roof

Bradford Insulation's Tuff-skin Fibreglass Multi Service Board was used recently to acoustically insulate the retractable roof and ceiling of the new National Tennis Centre in Melbourne. The retractable roof, which is about 2.5 hectares in area, is unique as it can be opened to make the stadium an open air complex. The roof and ceiling were insulated by Chadwick Industries, with acoustic design by Graeme Harding.

Bradford's Tuff-skin Fibreglass Multi Service Board, the product used in this application, suits a wide range of general industrial and acoustic applications and was selected on the basis of its



excellent acoustic performance. In addition Bradford's flexible production process enabled the product to be manufactured to a special density (18 kg/m^3) and thickness (58 mm) to suit the acoustic design required. The stadium has been designed so that the sound absorption is the same when the sliding roof is open or closed.

The roof structure consisted of 58 mm thick Bradford Tuff-skin Fibreglass Multi Service Board laid on 18 mm thick Structawood which was then covered by a roof felt. The mobile retractable roof was insulated with three layers of Bradford Tuff-skin Multi Service Board. When completed the roof will be raised by huge jacks and positioned above the stadium onto tracks where it will open and close depending on the type of entertainment.

CSIRO

Fast Fourier Transform chip

CSIRO's Division of Radiophysics, in conjunction with Austek Microsystems Pty.. Ltd., has designed a VLSI/FFT chip and commenced fabrication of a prototype chip that will be at least five times faster than its known VLSI competition and will have versatile cascading functions.

The prototype chip will perform a fast-Fourier-transform process a hundred times faster than a $150,000 VAX computer. It is the speed and low cost of VLSI/FFT devices that will result in revolutionary changes to electronic equipment, including:

- sonar, sonabuoys, radar, multi-channel radio scanning/surveillance;
- digital audio equalisers, filters and electronic music;
- deblurring of photographs, enhanced slow-motion video;
- forensic science;
- sonic imaging.

CSIRO Industrial Research News, No. 182

New Publications

The following publications have been received by the Society and are held, temporarily, in the Acoustics Laboratory, School of Physics, University of NSW. They are available for inspection or loan by members. Photocopies (not in contravention of copyright conditions) may be ordered by contacting Cronulla Secretarial Services on (02) 527-3173. A charge will be made for photocopying and postage.

Hearing Protectors

The 5th Edition of the National Acoustic Laboratories report **"Attenuation of Hearing Protectors"** has just been released. It includes information on all hearing protectors tested by NAL up to May 1987. Attenuation data are reported for 97 earmuffs, 35 earplugs and 35 helmet-mounted earmuffs. A new section introduced with this revision reports measurements of the total attenuation obtained when earplugs and earmuffs are worn together. The report costs $3.95 at Australian Government Publishing Service Bookshops.

Aircraft Cabin Noise

The National Occupational Health and Safety Commission (Worksafe Australia) has published a report entitled **"Aircraft cabin noise and noise attenuation of aircrew headsets"**. The report includes the results of cabin noise surveys undertaken by the Department of Aviation of light aircraft and small commuter aircraft, the noise attenuation of a number of pilot's headsets measured by the National Acoustic Laboratories and guidance on selection of appropriate headsets for hearing conservation purposes. The report is available free of charge from the Information Service, Worksafe Australia, G.P.O. Box 9, Canberra City, A.C.T. 2601.

JOURNALS

Acta Acustica
Vol. 12, Nos. 2, 3 (1987).

Applied Acoustics
Vol. 22, Nos. 1, 2, 3 (1987).

Archives of Acoustics
Vol. 11, No. 2 (1986).

Chinese Journal of Acoustics
(in English)
Vol. 6, No. 2 (1987).

Contents include: **D. Heping and Y. Chongzhi,** Adaptive lattice noise canceller and optimal step-size; **F. Leping,** Analysis to the effective depth of acoustic cavity of combustion chamber using finite element method; **Z. Minhua, C. Xiulan, C. Tong,** Finite element analysis of the Yongle bell; **R. Shuchu, W. Rongjin, Z. Kesen,** Measurement of mechanical input impedance of plane array element using impulse sound tube; **T. Duchun,** A practical approach to leakage correction of frequency and amplitude in FFT power spectrum.

J. Catgut Acoustical Society
No. 48, November 1987.

Contents include: **C. Gough,** Microcomputers for acoustic measurement and violin assessment; **R. Hansen,** Analysis of "live" and "dead" guitar strings; **I. Firth,** Modal analysis of the air cavity of the violin; **R. Sacksteder,** How well do we understand Helmholtz resonance?

REPORTS

ISVR Technical Reports

No. 145 Eustachian Tube Function: A Review.
S. M. Moss, A. M. Martin, R. J. Marchbanks.

No. 146 Active Minimisation of Acoustic Fields.
P. A. Nelson, S. J. Elliott.
Summary:

Quadratic optimisation theory is shown to provide a useful analytical framework for consideration of problems associated with the active control of sound. The theory is used in establishing the absolute physical limits of the ability of arrays of discrete secondary sources to suppress or absorb free field acoustic radiation. The problem of controlling enclosed sound fields is similarly dealt with. The same theoretical basis is also used to describe multichannel systems for the implementation of active control and a new class of adaptive control algorithm is introduced.

ISVR Annual Report, March 1987

I. INCE Newsletter
Nos. 45, 46 (1987).

Vibration Institute

Arrangements have been made for an exchange of publications between Acoustics Australia and the Vibration Institute of Illinois, the main publication of which is Shock and Vibration Digest.

Shock and Vibration Digest
Vol. 19, No. 9 (September 1987).

Includes a feature article entitled "Fatigue and Fracture Mechanics: Ground Vehicles", by R. W. Landgraf.

Vol. 19, No. 11 (November 1987)
Includes a feature article entitled "Airworthiness of long-life jet transport structures" by U. G. Goranson.

Technical Books at Discount Rates

The Australian Acoustical Society has an account with a major bookshop in the United Kingdom and offers a technical book purchase service to members of the Society on a no-profit basis.

Discounts vary according to the country of publication and generally are a maximum for British ranging to a minimum for American sourced publications. Books are ordered on written advice from members, who should specify if the book is to be placed on back order if not immediately available. Members pay the invoiced amount (which includes postage) on delivery of the book.

ADVANTAGE: Cheap books.

DISADVANTAGE: There is a delay of about 14 to 16 weeks on delivery of books unless airmail or accelerated surface mail is specified.

Please send orders to:

G. B. Gore
National Acoustic Laboratories
126 Greville Street
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Information for Contributors

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Diagrams will normally be reduced to single column width: authors are requested to plan diagram proportions and letter size accordingly. Full stand-alone captions should be provided for each diagram (these will be typeset).

Types of articles accepted include technical, tutorial and review. Short reports (1 page printed) on current research or a group's activities are welcome, as are shorter notes for inclusion under Technical Notes.

Articles and reports may be submitted in the form of a computer disk, accompanied by a hard copy for editorial purposes.

ADVERTISER INDEX

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

FUTURE EVENTS —

● Indicates an Australian Conference

1988

● January 25-29, SYDNEY

BICENTENARY CONGRESS OF PHYSICISTS

Details: Dr. Collocott, CSIRO Division of Applied Physics, P.O. Box 218, Lindfield 2070.

● January 28, SYDNEY

SEISMIC AND UNDERWATER ACOUSTICS

Details: Dr J. Dunlop, School of Physics, University of NSW, PO Box 1, Kensington, NSW 2033.

● February 16-24, CANBERRA

REMOTE SENSING OF THE ATMOSPHERE AND OCEANS.

Details: Sec. for Remote Sensing Conference, Physics Department, University College, Australian Defence Force Academy, Campbell, A.C.T. 2600.

March 1-3, MODENA

URBAN NOISE AND TERRITORIAL ADMINISTRATION.

Details: Prof. P. Zaniol, PMP-Settore Fisico Ambientale, USL n16, c/- Policlinico, Via del Pozzo 71, 41100 Modena, Italy.

March 15-17, GERMANY

DAGA '88

Details: R. Martin, Abt. 1-Mechanik and Akustik, Bundesalle 100, D-3300 Braunschweig.

May 4-7, BUDAPEST

9th CONFERENCE ON ACOUSTICS

Details: Optical, Acoustical & Filmtechnical Society, Budapest, Fo u.68., H-1027.

May 11-13, HUNGARY

15th AICB CONGRESS
Noise Abatement — State of the Art & Application.

Details: Dr B. Buna, Instit. for Transport Services, Dept. Env. Protection, 1119 Budapest, Than Karoly u. 3/5, Hungary.

May 16-20, SEATTLE

MEETING OF ACOUSTICAL SOCIETY OF AMERICA

Details: Mrs. B. Goodfriend, A.S.A., 335 East 45th St., New York, NY 10017, U.S.A.

June 6-10, YUGOSLAVIA

XXXII ETAN CONFERENCE

Details: Prof. P. Pravica, Electrotechnical Faculty, Bulevar Revoluci je 73, YU-11000 Belgrade.

June 9-10, LONDON

NVC 88
2nd International Noise & Vibration Control Conference.

Details: Trade & Technical Press Ltd, 13/15 Creek Rd, East Molesey, Surrey KT8 9BE, England.

June 20-22, PURDUE

NOISE-CON 88
Noise Control Design: Methods and Practice.

Details: Conference Secretary, Ray W. Herrick Labs, Purdue Uni., West Lafayette, IN 47907, USA.

August 21-25, STOCKHOLM

5th INTER. CONGRESS ON NOISE AS A PUBLIC HEALTH PROBLEM

Details: Noise '88, C/- Reso Congress Service, S-113 92 Stockholm.

August 22-26, EDINBURGH

7th FASE SYMPOSIUM ON SPEECH

Details: Mrs. C. Mackenzie, I.O. Acoustics, 25 Chambers St., Edinburgh, EH1 1HU, Scotland.

August 30 - September 1, AVIGNON

INTER-NOISE 88.

"Sources of Noise."

Details: Inter-Noise 88 Secretariat, BP 23, 60302, Senlis Cedex, France.

October 3-5, CHICAGO

IEEE ULTRASONICS SYMPOSIUM

Details: Institute of Electrical and Electronics Engineers, 345 E 47th Street, New York, NY 10017, U.S.A.

October 17-19, MANNHEIM

VDE-KONGRESS 88

Details: VDE-Zentralstelle Tagungen, Stresemannallee 15, D-6000, Frankfurt 70.

November 2-4, SHANGI

WESTPAC III

Developments of Acoustics in the Western Pacific Region.

Details: Secretariat Westpac III, Institute Acoustics, Academia Sinica, 17 Zhongguancun St, Beijing, China.

November 14-18, HONOLULU

2nd JOINT MEETING OF ACOUSTICAL SOCIETIES OF AMERICA AND JAPAN

Details: Secretariat ASA-ASJ Joint Meeting, Ac.Soc.Japan, Ikeda Bldg 4F, Yoyogi 2-7-7, Shibuya, Tokyo 151, Japan.

November 14-17, KOBE

9th INTERNATIONAL ACOUSTIC EMISSION SYMPOSIUM

Details: Prof. Dr. I. Kimpara, Dept. Naval Architecture, Faculty of Eng., University of Tokyo, 3-1, Hongo-7, Bunkyo-ku, TOKYO 113, JAPAN.

November 28 - December 2, HONG KONG

POLMET 88
Pollution in the Metropolitan and Urban Environment.

Details: Polmet 88 Secretariat, c/- Hong Kong Institution of Engineers, 91F, Island Centre, No 1, Great George St, Causeway Bay, Hong Kong.

1989

May 22-26, SYRACUSE

MEETING OF ACOUSTICAL SOCIETY OF AMERICA

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August-September, YUGOSLAVIA

August 24-31, BELGRADE
13th ICA

September 4-6
SYMPOSIA
Sea Acoustics — Dubrovnik.
Electroacoustics — Zagreb.

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

November 6-10, ST LOUIS

MEETING OF ACOUSTICAL SOCIETY OF AMERICA

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May 21-25, PENNSYLVANIA

MEETING OF ACOUSTICAL SOCIETY OF AMERICA

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November 26-30, SAN DIEGO

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