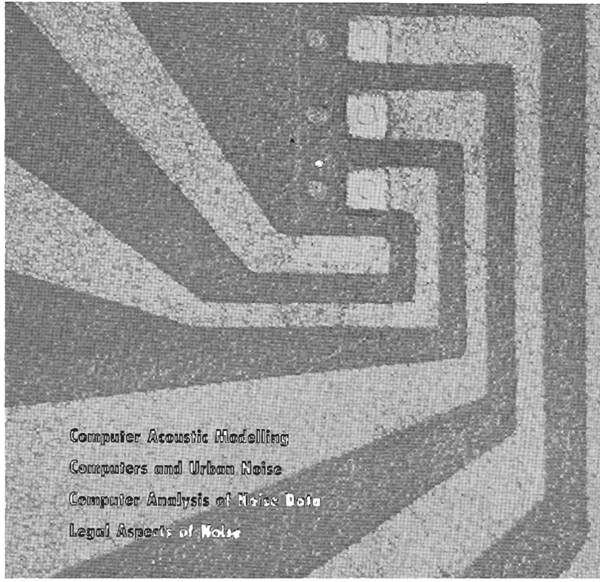
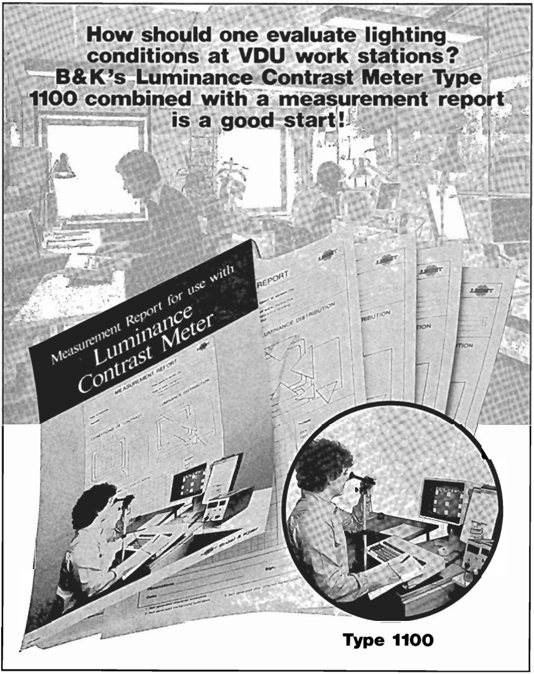
Acoustics Australia

Vol. 13 No. 3, December, 1985

THE BULLETIN OF THE AUSTRALIAN ACOUSTICAL SOCIETY




How should one evaluate lighting conditions at VDU work stations?
B&K's Luminance Contrast Meter Type 1100 combined with a measurement report is a good start!
Measurement Report for use with
Luminance Contrast Meter
MEASUREMENT REPORT
REPORT
LUMINANCE DISTRIBUTION
Type 1100

Acoustics Australia

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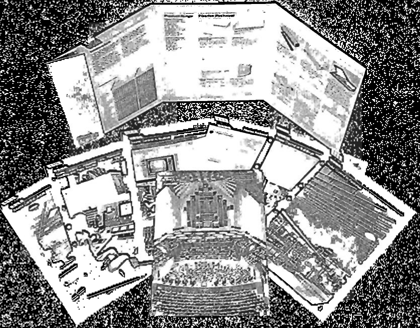
New Acoustic Literature available!



Bradford Insulation have produced a comprehensive range of acoustic literature.

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

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

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

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

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

BRADFORD INSULATION

AUSTRALIAN NEWS —

VICTORIA

July Technical Meeting

A review seminar on Machine Condition Monitoring was held on 25th July, 1985. The speakers included **John Simmonds** from Vipac and **Joseph Matthew** from Monash University.

Many machine faults and structural failures involve the generation of discernible vibration. Analysis of vibration response can detect incipient failure well in advance of other signs such as undue noise, high temperature and harsh (felt) vibration. This detection has enabled predictive maintenance and fault correction. Consequently, production uptime is improved and further consequential maintenance cost is minimised. Plant start-up vibration "signatures" are widely used as a tuning tool for commissioning.

Vibration assessment techniques and equipment have advanced significantly in recent years. Indeed, such techniques are now being applied to reciprocating engines as well as rotating machines while research work is aimed at developing techniques for analysis of slow speed roller and journal bearings and with wear debris and contaminant monitoring. Thermography, Ferrography and Spectrographic Oil Analysis are additional Condition Monitoring tools that are being applied.

September Meeting and A.G.M.

The Annual General Meeting of the AAS Victoria Division was combined with a tour of inspection of the Rialto building and followed by an informal dinner. It commenced with an hour long tour of the Rialto building, with particular emphasis on acoustic and other engineering features. The A.G.M. followed and comprised a succinct wrap up of the year's activities and plans for the following year. Following this an informal dinner was held in the York Butter Factory, a bistro which is part of the Menzies Hotel complex at the Rialto.

For the Record

The end of year function for the Victorian Division was held on November 23rd, 1984 at the "Rumpoles" cinema restaurant. Many senior members and guests were invited to celebrate the twenty years since the first formative meetings were held which led to the formation of the Australian Acoustical Society.

After enjoying a delicious dinner the Victorian Division Chairman, **Mr. Jim Watson** gave a short speech about the formation of A.A.S. twenty years ago. He introduced four of the founders of A.A.S., namely **Mr. Gerald Riley, Dr. Ron Barden, Mr. Paul Dubout** and **Mr. Ron Carr** who cut the cake for this memorable occasion.

The March technical meeting was a talk given by **Peter Crossley** of Lobley, Triedal, Davies on Theatrical Services Design. He discussed all aspects of stage facilities, lighting and audio systems for both front and back of the house with emphasis on the integration of all these services.

NEW SOUTH WALES

July Technical Meeting

A joint meeting with the Institution of Engineers was held on 17 July. **Mr. Ian Woonton** from the Dept. of Aviation discussed the second airport for Sydney. The meeting was well attended although the Society representation was very small. Mr. Woonton discussed the noise aspects of the current airport and the proposed second airport at either Wilton or Badgery's Creek.

August Technical Meeting No. 1

A meeting on the Isolation of Quiet Areas from the Building Structure was originally scheduled for late July. As Mr. Lama's departure from the U.S.A. was delayed at the last minute the meeting was postponed and the members of the Division were advised of this by telegram.

The rescheduled meeting was held on 7th August and all the seating in the Conference Room at the S.P.C.C. was occupied when **Mr. Pat Lama** began to speak. He is the Vice-President of Mason Industries which manufactures vibration control products which are available in Australia from Aq-vib (Sustaining Member of the Society). Pat Lama supplemented his talk on basic principles of vibration isolation with some case histories of effective vibration isolation.

August Technical Meeting No. 2

This meeting was in the form of a visit to the Motor Testing Laboratory at Lidcombe on 21st August, 1985. This laboratory, which is part of the State Pollution Control Commission, undertakes stationary and drive-by tests on motor vehicles as one of the methods of controlling motor vehicle noise. The staff from the laboratory demonstrated the procedures for these tests and then **Lex Stewart** outlined their significance and explained the work undertaken by the laboratory.

September Technical Meeting and A.G.M.

The 15th Annual General Meeting of the N.S.W. Division was held on 25th September, 1985. The term for five of the committee members expired: **John Mazlin** and **Andrew Zelnik** were re-elected together with new committee members **Graham Atkins, Jack Rose** and **Colin Tickell.**

After the A.G.M. **Peter Knowland** gave an interesting talk on the "Acoustics of the Queensland Cultural Centre". This centre comprises a 2000-seat Lyric Theatre, a separate 2000-seat Concert Hall, and a 250-seat Studio Theatre. The complex was completed in late 1984 and received its debut in February and March 1985. Peter traced the work which was carried out on the initial stages and which resulted in the development of an overall brief for the Cultural Centre. The talk covered some of the initial acoustic design concepts and explained the importance of overall acoustic management which must be carried out if the design objectives are to be realised.

QUEENSLAND

July Technical Meeting

On 10th July, 1985 the staff of the Division of Noise Abatement discussed the operations of the division, including the assessment of complaints and development proposals, and conducted tours of the Acoustic Laboratories.

It was possible to participate in the measurement of sound power level, reverberation time and transmission loss in the division's reverberation chambers.

October Technical Meeting

A Workshop on Noise Annoyance was held on 16 October. The objectives of this meeting were to discuss the nature and assessment of noise annoyance to review the provisions of relevant authorities, to examine critically the present situation and to invite comment on future needs. The Chairman, **Lex Brown** introduced the speakers, **R. Rumble** and **R. Hooker** and their comments were followed by an open discussion.

Formation of Division

After more than twelve months of negotiations, the legal formalities for the formation of the Queensland Division of the Society are complete. The Division will be officially formed after the resolution has been passed at the Council Meeting on 23/24 November.

SOUTH AUSTRALIA

March Technical Meeting

On 20th March, 1985 a visit to the South Australian Film Corporation Studios was arranged. **Dr. Peter Swift** of Pryce, Goodale and Duncan Pty. Ltd. gave a short talk on the acoustic design philosophy of the complex and the Dolby Stereo mixing theatre in particular. This was followed by a talk and tour of the facilities, conducted by the Hendon Studio Manager, Mr. Michael Rohan.

April Technical Meeting

On 29th April, 1985 **Dr. Neil Halliwell** gave a talk on the portable Laser Doppler Anemometer. He is the inventor of this machine which can be used to investigate the vibrations of hot or remote surfaces.

June Technical Meeting

On 26th June, 1985 **John Lambert** and **Leanne Reichelt** from the Noise Abatement Branch of the Department of Environment and Planning presented two papers on Product Labelling for Noise Control.

Many products including airconditioners, lawnmowers, circular saws, garden mulchers etc. have the potential to cause severe stress when operated near residences because of their high noise levels. The two main methods of control, i.e. design rules limiting maximum noise levels, or labelling which gives the purchaser the opportunity to decide, were discussed. Product labelling is considered a soft approach to product noise control but allows both manufacturers and purchasers the opportunity to decide on the quality needed.

AUSTRALIAN NEWS

(Continued)

WESTERN AUSTRALIA

June Technical Meeting

On 20th June, 1985 **Ross Emslie** from Vipac in Perth addressed the division on Acoustic and Vibration Assessments using dynamic scale models.

The use of physical scale models for engineering dynamic analysis is a well established practice and this technique has many advantages over mathematical modelling using finite element analysis when large mining structures are involved. A number of case studies were cited where electromagnetic shakers and transfer function theory has been used to assess structural performance during the design stage. A brief resume of the results of an investigation into the sound radiation characteristics of a crusher feed cone was also presented whereby modal analysis of a one-third scale model was undertaken.

August Technical Meeting

The title for this meeting was Impulse Noise and Sound Exposure Meters and the speaker was **Michael Coates** from the Noise Control Branch of the Department of Occupational Health, Safety and Welfare.

A sound exposure meter (SEM) is an essential tool in determining the noise dose received by employees whose work takes them into varied noise environments. However, it is not clear that the measured dose is accurate when the noise is impulsive in nature. Funding by the Commonwealth Department of Employment and Industrial Relations made possible a project in which tests able to determine the accuracy of various commercially available SEMs could be developed.

* * *

Company Merger

K.H. Consolidated Industries has acquired **Stramit.** K.H. Consolidated is a major supplier of steel building products including studs, purlins, clip fix and screw fix roofing, siding, and composite floor decking. The joining of K.H. Consolidated and Stramit puts all of the K.H. products and services, and Stramit's products and services, under a single corporate umbrella. The new organisation will continue to offer quality and service to the building and construction industries.

* * *

Award to Bradford Insulation

Bradford Insulation, a Sustaining Member of our Society, is the overall winner of the inaugural Australian Financial Review/Polaroid Prize for Business Communications for their range of literature containing detailed information on acoustic products.

The Bradford project was selected from 85 entries in the areas of literature, graphics and audio visual communication. The judges said the entry ". . . emphasised Bradford's technical expertise in a complex field, presented the message with graphics and in language which its target readers would find persuasive, and selected a format which enabled constant reinforcing of the message".

* * *

Scientific and Technological Exchanges

The deadline for applications for 1986 has now passed but members of the Society may be interested to apply early for 1987.

The Australian Academies signed a Memorandum of Understanding with the Royal Society of London to foster cooperation in the natural and technological sciences between Australia and the United Kingdom by means of interchange and collaboration of scientists and technologists of the two countries. The academies invite applications from Australians who wish to visit the United Kingdom to conduct short or long term research projects. Proposals should be specific and developed in consultation with contacts in the United Kingdom. The scientific and/or technological merit of the proposal will be a major criteria for selection.

The Australian Academy of Science invites applications from scientists resident in Australia to participate in a post-doctoral exchange programme with the Japan Society for the Promotion of Science. Applications for fellowship will be considered from biological and physical scientists who have less than five years post-doctoral experience. Fellowships will be for visits to Japan of six to twelve months.

Successful applicants for either exchange will receive an advance purchase international air fare and a contribution towards living and travel costs associated with their stay.

Further details:

International Relations N
Australian Academy of Science
G.P.O. Box 783
Canberra, A.C.T. 2601
Tel. (062) 47 3966

LETTERS —

The "Grandfather" Clause

Dear Sir,

I heartily support the call by Fergus Fricke (AA Vol. 13, No. 2) for the Council to pay heed to the fact that 16 (d) is a vital part of our Memorandum and Articles of Association. If, as he suggests, the Council of the Society has been resisting attempts to bring in new members using Clause 1b (d) I can only say that in my opinion it is the beginning of the end of the Society.

Can I also remind the Council that the aim of the Society is "the promotion and advancement of the science and practice of acoustics in all its branches and the exchange of ideas in relation there to".

Please note that the Society is for the advancement of the science, etc., not the members, and more particularly it must provide the opportunity for the exchange of ideas for the benefit of anyone interested in acoustics.

Ron Carr

Ron Carr Acoustics
60 Albert Road
South Melbourne 3205
5 August, 1985

Australian Standards

The following Australian Standards have been recently released and may be of interest to members of the Society.

AS2772 "Maximum Exposure Levels — Radio Frequency Radiation — 300 k Hz to 300 G Hz."

The purpose of the standard is to provide guidance on the exposure of the body either wholly or partly to non-ionizing radiation and to set limits to avoid known hazards of radio-frequency radiation based on current knowledge of biological effects of such radiation.

AS1217 "Acoustics — Determination of Sound Power Levels of Noise Sources, Parts 1 to 7."

The new seven-part standard supersedes AS1217-1972 and provides guidelines which are essential to the proper application of the basic acoustical measurement standards and to the preparation of specific sound test codes for various types of machines and equipment.

AS2775 "Vibration and Shock — Mechanical Mounting of Accelerometers."

The new standard gives the user recommendations concerning the mounting of accelerometers and lists the applicable characteristics to be specified by the manufacturer.

AS2752 "Preferred Numbers and their Use."

This is a revision of MP19 and was prepared to assist people in developing rational series of sizes or of ratings, and who wish to make use of the internationally adopted system of preferred numbers.

AS2785 "Suspended Ceilings — Design and Installation."

This standard was prepared at the request of the building industry and sets out requirements for the design and installation of ceilings suspended from a supporting structure.

AS1633 "Acoustics — Glossary of Terms and Related Symbols."

This revision has been prepared to cover the latest developments in the acoustics field. The principal changes from the previous edition are the inclusion of many new terms that are related to the measurement of sound and the inclusion of an appendix listing the symbols and their units.

AS2452-3 "Non-Destructive Testing — Determination of Thickness by the Use of Ultrasonic Testing."

AS2452-3 is one of a series of standards on the determination of thickness using non-destructive testing, the other two parts utilizing radiography. It provides five methods for the determination of thickness of material based on the use of pulse-echo principles where scanning and reflecting surfaces are substantially parallel.

AS1191 "Methods for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions.

This standard sets out the method for the measurement of the airborne sound transmission loss of buildings partitions such as walls, floor/ceiling assemblies. It supersedes the 1976 edition and aligns more with the equivalent international standard on the subject.

8th International Acoustic Emission Symposium

Tokyo, Japan
October 21-24, 1986

This symposium is sponsored by the Japanese Society for Non-Destructive Inspection and Nihon University and aims to bring together all who have had a significant involvement in applications, research, instrumentation, and standards for acoustic emission.

The four days will be devoted to invited papers, original papers, review papers and technical reports. In addition there will be poster sessions and commercial sessions. The Call for Papers requests an abstract of 200 to 300 words with an indication of the type of paper. The deadline for submission of abstracts is March 31, 1986.

Further details:
Prof. Dr. K. Yamaguchi
Institute of Industrial Science
University of Tokyo
22-1, Roppongi-7, Minato-ku
Tokyo 106, JAPAN
Telex 0242-3216 IISTYO J
Tel. 03-402-6231

INTER-NOISE 86

Massachusetts, U.S.A.
July 21-23, 1986

The theme of INTER-NOISE 86 will be "Progress in Noise Control". The conference is being sponsored by the Institute of Noise Control Engineering in co-operation with the School of Engineering at MIT and it will precede the 12th International Congress on Acoustics (ICA).

Sessions are planned from issues of noise regulation, compliance, and worker protection to fundamental aspects of noise generation and measurement. The newer areas of concern such as machinery monitoring and diagnostics, complex acoustic mobility measurement and computational methods for sound radiation and vibration transmission will also be covered. A major exhibition of instruments, materials and facilities for noise control will be held and Wilham Cavanaugh is the exhibits chairman.

The INCE Seminar on "Advanced Techniques for Noise Control" will be offered prior to INTER-NOISE 86 on 17th-19th July, 1986. Topics being considered for presentation are: computers for noise control; modern instrumentation; structural damping; modal analysis; sound intensity applications; active noise control; and airport noise and monitoring systems.

The MIT summer course, "Machinery Noise and Diagnostics" will be offered on 14th-19th July, 1986. Tuition for their the INCE seminar or the MIT course will be reduced by 20 per cent for registrants of INTER-NOISE 86.

Further details:
Inter-Noise 86 Secretariat
MIT Special Events Office
Room 7-111
Cambridge
Massachusetts 02139, U.S.A.

5th Hungarian Seminar and Exhibition on Noise Control

Szeged, Hungary
June 3-6, 1986

The seminar, to be organised with international participation, helps the professionals, dealing with noise and vibration control, to get acquainted with the latest theoretical and practical results. It provides possibilities for national and international exchange of views and helps to realise the scientific result in practice. The theme for the seminar is "The Practice of Noise and Vibration Control".

Further details:
Optical, Acoustical and
Filmtechnical Society
(OPAKFI)
H — 1061 Budapest — Hungary
Anker koz 1.
Telefon: 222-086
Telex: MTESZ—OPAKFI
Budapest 22-5369 h

A New Journal in 1987

"Mechanical Systems and Signal Processing" aims to provide a forum of engineers and scientists dealing with research/development and industrial applications in the field of Mechanical Sciences. Intended as a companion to the Journal of Sound and Vibration, it is especially oriented towards these involved with experimental aspects. The main areas to be covered are:

Machine dynamics and test methods,
Structural integrity and analysis,
Vibration monitoring and diagnostics,
Dynamic properties of materials,
Acoustic aspects of machines and components,
Dynamic phenomena.

These subjects and the various disciplines associated with them have been treated in diverse environments and publications. "Mechanical Systems and Signal Processing" is intended to fill the need for a refereed journal, with stringent editorial standards, having a strong aspect of practicality, A balanced mixture of applied papers stressing experimental and basic/theoretical aspects will be sought. The explicit goal of the journal is to promote the integration of both aspects in the field of Mechanical Sciences by establishing a common forum for researchers and practitioners in the different sub-areas.

Papers for the first issues should be forwarded to Professor S. Braun, Faculty of Mechanical Engineering, Technion, Israel Institute of Technology.

Noise-Con 85 Proceedings

This Conference was held in Ohio in June 1985 and the theme was "Computers for Noise Control". The **Proceedings** were edited by the General Chairman, Rajendra Singh, and contain a wealth of information on the uses of computers for noise control engineering. Also included are papers which deal with noise from computers and other machines.

Copies are available from Noise Control Engineering, P.O. Box 3469, Arlington Beach, Poughkeepsie, N.Y., 12603, U.S.A., for $48 (U.S.) per copy, which includes surface mail ($12.50 per volume additional for air mail).

A Good Excuse?

Heat acclimatization refers to the physiological adjustments that can occur when a person not accustomed to hot environments is exposed to heat for a period of time . . . The effect of acclimatization may last several weeks after a period of exposure to heat. A certain decrease in heat tolerance can be seen after a couple of days following the heat exposure. This may happen after a long weekend, so it is always recommended not to work under most severe conditions on a Monday. This is especially important if the person is tired and has consumed alcohol.

From: Heat Stress by B. W. Olesen, B & K Technical Review No. 2 — 1985.

Internal Friction and Ultrasonic Attenuation

The study of dissipation of mechanical vibrational energy in solids has become a very powerful tool for investigating both fundamental aspects of the mechanical properties of solids (phase transitions, dislocation mechanics, quantum solids) and a wide range of applications in the field of the science of materials where mechanical energy dissipation plays an essential role (e.g. hydrogen in metals, materials with high mechanical damping, composite materials, radiation damage, etc.).

An International Summer School on **Internal Friction Processes** will be held in Antwerp, Belgium, on July 15-25, 1987. This will be followed by the 5th European Conference on **Internal Friction and Ultrasonic Attenuation in Solids** on July 27-30, 1987. This conference will focus on recent developments in the science of dissipation of vibrational mechanical energy in solids.

Further details:
R. De Batist
S.C.K. — C.E.N.
Boeretang 200
2400 MOL
BELGIUM

PEOPLE —

NEW MEMBERS

• Admissions

We have pleasure in welcoming the following who have been admitted to the grade of Subscriber while awaiting grading by the Council Standing Committee on Membership.
New South Wales
Mr. H. K. Clarke, Mr. B. G. Marston.
Queensland
Mr. J. F. Hayes.

• Graded

We welcome the following new members whose gradings have now been approved.
Subscriber:
Western Australia
Mr. K. Fisher.
Member:
South Australia
Mr. G. C. Halyburton.
Western Australia
Mr. R. J. Emslie.

* * *

Dennis Gibbings, our consulting editor for instrumentation, transducers and vibration, has decided to hang up his microphones and retire from the CSIRO Division of Applied Physics in Sydney. Dennis was a member of the staff at the National Measurement Laboratory for many years, the last 14 having been spent in the field of acoustics, during which time he made significant contributions to the work of the Laboratory. We would like to wish Dennis all the very best as he joins the ranks of the liberated.

* * *

Cedric Roberts who has been with Vipac in Perth and Brisbane has now joined the ranks of the Queensland Division of Noise Abatement.

* * *

Lex Brown from Griffith University, Qld., has recently returned from six months' study leave. He spent most of the time at ISVR in Southampton where he worked on EEC projects dealing with response to impulse and aircraft noise.

* * *

John Severy has been recently spreading the gospel of noise control at meetings of learned societies in Queensland. Firstly, John was invited to address the Institution of Engineers at Mount Isa to discuss noise control in the mining environment. Then he spoke at Maroochydore on aspects of noise emission and control from entertainment centres and theme parks.

* * *

Moves . . . **David Spearrett** has recently joined the staff of Richard Heggie and Associates: **Rob Bullen** has moved from NAL to the NSW Electricity Commission. **Tony Hewitt** assures that the Environmental Noise Control Manual will definitely be on sale by late October (1985).

* * *

The Melbourne operations of **Sound Attenuators Aust.** are being shifted and reorganised. As I understand it their present office and factory is being auctioned on October 29. Their manufacturing operations will be transferred to their parent company, D. Richardson and Sons Ltd. at Braybrook. Their sales and technical operations will continue from a new office to be located in the Eastern Suburbs of Melbourne.

* * *

David Buckle's new car . . . From one of our readers I am indebted for the following: "The Sydney offices of Sound Attenuators Australia was recently deprived of its number 1 acoustical strike vehicle when David Buckle's super-silent Commodore (registration number DBA-000) was stolen from the Sydney office carpark. David's car was eventually recovered by police after it had been used in an unsuccessful $40,000 hold-up at the Menzies Hotel. This was good news for the insurance company but bad news for David whose plans by this time for selecting a new car were well advanced. The robbers demonstrated their complete lack of good taste by leaving untouched in the car David's WWII airforce sunglasses, his well loved pullover and his grubby old set of golf clubs."
Since this episode I gather David has brought in such a big order that a new car might be a consideration.

* * *

Bob Snow who was once a prominent member of the Victorian Division and Chief Noise Control Officer of the Environment Pollution Authority retired from the stress and limelight and joined the Helen Vale Foundation. Recently I learnt a bit about his activities from a letter accompanying his annual subscription. He says that although a long way from acoustics these days he still keeps in touch through Acoustics Australia and occasional visits to E.P.A. He is still involved in managing the bakeries and finances of the School of Helen Vale Foundation, and this year is doing a Diploma of Education parttime at Monash just to fill in spare time.

* * *

Nice to see **Bob Fitzell** has joined the ranks of Authors. He is a regular contributor to the new magazine "The Australian Electronics Monthly". In the first three issues they have published a review of a tapedeck, a review of cassette tapes and a discussion on objective and subjective testing.

* * *

As an extension to my usual appeal for items of interest, may I wish all readers a **Happy Christmas** and a **Prosperous New Year.**
Remember to send your news to me at 22A Liddiard Street, Hawthorn 3122. Telephone (03) 819 4522.

Graeme Harding

FROM THE PRESIDENT —

In the last issue of ACOUSTICS AUSTRALIA I made reference to the proposed formation of a Federation of Australian Scientific and Technological Societies (FASTS). Since that time the interim committee, chaired by Professor Smith of Monash University, has produced a Draft Constitution and By-Laws as well as a document on the proposed structure, operation and financial requirements of FASTS, and called a Foundation Meeting for 12 November, 1985, in Canberra. Our society, with some 60 others, will be represented at that meeting (AAS representative will be A/Professor Anita Lawrence).

At this meeting a new committee will be elected and hopefully it will be succesful in pursuing the Federation's aims and objectives. I am sure that our society will greatly benefit by being a foundation member of such a body.

Professor Smith, who is President of the Australian Institute of Physics, is also involved with the planning of the 8th Congress of the Australian Institute of Physics to be held in Sydney as a **Bicentennial Congress** from January 24 to 29, 1988. He has invited our society to participate at the Congress with our programme as a parallel session. I believe that we should take up this offer, as we have demonstrated our capacity to organize successful national and international scientific meetings.

Still on conferences and still in 1988, I received a letter signed jointly by Dr. Dunn, President Acoustical Society of America, and Dr. Miura, President Acoustical Society of Japan, inviting the members of our society to participate at the **second joint meeting of ASA and ASJ** in Honolulu during November 14-18, 1988. Whilst the Acoustical Society of America will be the host society, the following exemptions will apply at this meeting:

- Technical program will be organized by members of the ASA and ASJ;
- Participating Pacific rim acoustical societies will be explicitly recognized in the program;
- Members of the participating acoustical societies will be extended all privileges of the ASA and ASJ members during the meeting, e.g., the registration fee will be the same for members of ASA, ASJ and participating societies (currently $30.00, but subject to change).

This meeting would, once again, provide opportunity for our members to meet ASA and ASJ acousticians and our participation may well reinforce the importance of the role of the Australian Acoustical Society in the Pacific Region.

TIBOR VASS

Satisfies All Industrial Hygiene, Safety and Community Needs.

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

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

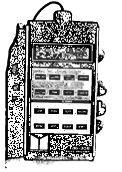
The db-308 operates simultaneously as a noise dosimeter, integrating/averaging and true-peak sound level meter, and time history monitor. A unique plant-survey mode allows separate time history plots for individual measurement sites.

Universal Noise Dosimeter

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

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

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



Integrating/Averaging And True Peak Sound Level Meter

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

Time History Monitor

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

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

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

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

Report Generation

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

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

Amplitude Distribution, Average Level, And L_n

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

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

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

Time History

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

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

Real Time Computer Interface

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

Easy To Set Up And Operate

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

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

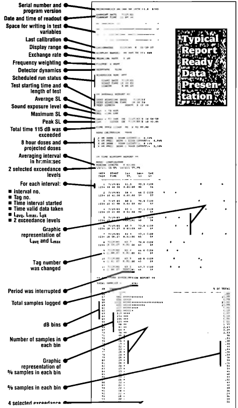
For the convenience of users who dispense more than one dosimeter at a time, or who cannot dispense them at the work station, the SCHEDULED RUN mode allows the db-308's start time and duration to be pre-programmed for automatic operation. Consequently, the work load of administrative personnel is greatly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

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

Go Anywhere Use

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

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



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Computer Acoustic Modelling

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ABSTRACT: A description of the design methodology of a room acoustic modelling program designed to run on a 16-bit personal computer is given, together with some preliminary results. The program allows visual tracing of rays on screen, can store and graph the record of sound rays arriving at "targets" within a volume, and can analyse the graphs to determine reverberation time.

INTRODUCTION

The method of ray-tracing, where the paths of discrete "rays" of sound are followed around a room, has been long regarded as a good simulation of real life acoustic behaviour at mid and high frequencies. The major drawback is the huge amount of calculation involved.

There have been computer programs designed to "crunch" through the large amount of arithmetic required to find useful solutions, but they have all been designed to run on *mini*-computers (which, despite the name, can be as large as a wardrobe). While the cost of these systems has fallen dramatically since the introduction of computers, the majority of firms and individuals have adopted the "personal computer" as the appropriate trade-off between cost and power.

The challenge then has been to create a ray-tracing program which can be run on a 16-bit personal computer, providing sufficient power to remain practical, while keeping within the restrictions imposed by the architecture of the hardware.

This paper attempts to highlight the major considerations involved in designing the system, and to observe the types of information generated, with emphasis upon its usefulness.

LANGUAGE AND HARDWARE

The main factors limiting the performance of a computer program are *speed* and processor *memory*.

The speed is very much dependent on the programming language used. Interpreted languages, such as **Basic**, are slow because as each line of program is encountered it must be translated into the language that the particular processor chip comprehends, even if it is a repetitive command.

In a compiled language, such as **Pascal**, the program is *compiled* to create a machine-understandable version before running, and from then on the processor can quickly execute the machine code. Also there is no interpreter program taking up valuable memory during a run.

The memory on the chip holds the operating system (which does the housekeeping chores and knows how to arrange for programs to be run, etc), and the particular program running. What is left over is used for storage of variables, and for calculations. While it is possible to move data to and from disks, this can greatly reduce efficiency during a run. It is important then to make sure that the program is as small as possible, and that there are not too many demands on the remaining memory by the data.

The program in question was written in Pascal to take advantage of the speed and compactness of code possible, and because of the advanced forms of data storage available (in particular, the *linked-list*, of which more will be said later).

It was envisaged that any 16-bit computer with at least 128K of random access memory (RAM) should be able to successfully run the program, though the prototype is compiled specifically for the Intel 8086 chip used in the most popular computers, including the IBM PC.

Improved performance can be obtained with the addition of a maths co-processing chip (one which specialises in high-speed real number mathematics) such as an Intel 8087. This can increase real-number calculation speeds by a factor of up to ten times.

A program feature is 8-colour 640 × 400 pixel high resolution graphics, to give clear pictures of the rays and sharp analysis graphs. For computers without the ability to run such powerful graphics, the program can be modified relatively simply to cope with various resolution/colour combinations, or, in many cases, the computers can be upgraded with the addition of graphics cards.

PROCESSES

The major stages in the running of the program are:

- Determining display modes
- Inputting rooms (and targets, if required) from disk
- Allocating reflectances of surfaces
- Locating source, determining number of rays
- Running ray tracing
- Analysing results.

DETERMINING DISPLAY MODES

There are four projections available; isometric, oblique, plan and elevation. Normally only rays striking the target are displayed, in the interests of speed and clarity. However any of the following options can be added:

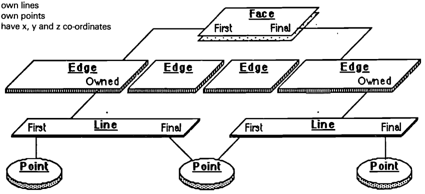
- Display faces tested (for intersection with a ray)
- Display faces struck (by any ray)
- Show all rays and reflections for *n* bounces

INPUTTING ROOMS (AND TARGETS, IF REQUIRED) FROM DISK

Rooms and targets are stored on disk as a file of numbers. Each has a name, and by typing the name of room or target when requested, the object is loaded into the computer, drawn on screen, and all necessary plane equations calculated.

The room to be analysed (and any target volumes) are represented within the computer as a series of points, lines, edges, and planes. To save memory, each element is stored only once, and rules of ownership are used to define the object. This means that a point at the corner of three planes, for instance, is stored only once, even though it is *shared* by three lines.

Objects own faces
Faces own edges
Edges own lines
Lines own points
Points have x, y and z co-ordinates



Simplified schematic diagram of data structure

With this method, there are few measurements which need to be stored. The face records are the most complex. Each face owns a number of edges, and stores a plane equation (to define it geometrically), the highest/lowest co-ordinates found on the surface, and a reflectance value. The point records contain x, y and z co-ordinates. All the other records contain only "pointers", which locate their neighbours in their own class, and show any other types of record they "own".

The *linked list* is the basic data structure. Conventional arrays are like a set of pigeon-holes; they have a predetermined size, and when they are full there is no more room. Enough space must be allocated to cover the worst eventualities for each type of information, which means that many memory cells may be empty while one type of information has run out of room. Linked lists, on the other hand, work like the links in a chain: only when a new bit of data needs to be stored is it added, like a link to a chain. The chain can be any size, as long as there are spare links (in this case, memory) available. There are no blank spaces. In addition, a new link can be inserted at any point in the chain, so that the records can be kept consistently in any order required — a very difficult task with the rigid pigeon-hole system. Another great advantage is that it is easier for the programmer to write programs which are understandable, and easy to expand. For instance when referring to the x co-ordinate of a certain point:

```
Point(Line(Edge(Object(n,1),m),z),1)     becomes

    This_object^.first_face^.next_edge^.
        owned_line^.final_point^.x
```

which, if one reads "^." as " 's", instantly becomes a great deal more meaningful.

ALLOCATING REFLECTANCES OF SURFACES

The program in turn highlights each side (in the order stored), displays the default or existing reflectance, and accepts a value of 0-1 from the keyboard. A carriage return by itself signals acceptance of the current value. Entering "-" reverses the order of display, while a following "+" sets it forward again, and values may be reset as many times as desired. Typing "Q" will quit this section, leaving any untouched reflectances at the default value.

LOCATING TARGETS

Targets are selected by name from a disk, and stored in the computer in a very similar manner to the room; in fact they are both stored in the same data structure. There can be many targets, however, inside the one room. Each target is located by typing in the co-ordinates where the centre of the target's base should lie.

Because the target is really a sampling field, its shape and size should be carefully considered. A target which is not cubic will intercept more rays on its larger faces, and henceforth display a crude directionality. The size should be related to the number of rays being used; a small target can pinpoint dead areas in a room, for instance, but a large number of rays is required to ensure that enough actually hit the target.

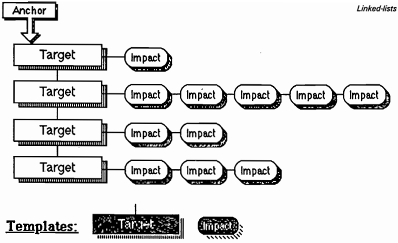
LOCATING SOURCE, DETERMINING NUMBER OF RAYS

To locate the source it is simply a matter of inputting its x, y and z co-ordinates. Finally it is necessary to enter the number of rays which will be used in the simulation. Using more rays will lead to a more realistic sample of sound waves impinging on a target, and gives a more accurate reverberation time figure. The program has been run using 6000 rays over an hour and a half, and could indeed be run with far more if run-time is not an important consideration. However experimentation has indicated that somewhere between 500 and 3000 rays give adequate results in a reasonable time.

RUNNING RAY TRACING

As soon as the number of rays has been entered, the program begins execution, and may be left unattended until it is finished. A count of rays traced is constantly on screen, and target impacts (and any optional displays) are shown as they are calculated.

The core process taking place is the generation of a field of rays. An analogy is a ship's gun which is swept in a series of circles, each at a different altitude. An algorithm takes the number of rays requested, and calculates the number of altitude steps to be taken. At each step the number of azimuth steps is calculated (based on the sine of the altitude angle, to ensure an even spread), and the actual altitude and azimuth



Linked-lists used to store impact information

angle at each step is used to calculate the line equation of the ray. Once the ray has set off, it repeats a series of actions:

- The ray's equation is solved with the plane equations of the sides of each target until an impact is proved, or all sides have been tested unsuccessfully. Successfully solving the plane equation proves that the ray has hit the infinite plane on which the surface is drawn, but more tests are necessary to verify impact. Next it is established whether the point of intersection is within the smallest and largest co-ordinates to be found on the surface. This is a quick and simple calculation which can rapidly disprove impact in the majority of cases. Finally, there is a slow and exhaustive test which puts the vertices of the surface in a regular order, and calculates the angles between adjacent points subtended from the suspected point of impact. If the angles correctly add up to 360° then impact is verified.

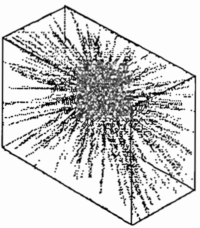
  Once an impact is proved, an impact record is created and attached to this target, storing the time of impact (calculated from the cumulative distance travelled by the ray), the intensity, and the display colour of the ray (for clarity later).

- Test for impact is carried out on the surfaces of the room to see which one is hit, and the intensity of the ray is decreased according to the reflectance of the surface in question. If the new intensity of the ray is still above the threshold value then the direction cosine of the ray is altered to signify reflectance, the distance travelled is updated, and the whole process is repeated.

There are other small considerations to be made. For instance, each direct ray (i.e. not reflected) "starting" from the source is a line of infinite length going in both directions as far as its line equation is concerned. This means that, though we desire it to "travel" in a given direction, the ray will solve the plane equation of the surface on *either* side of the source with equal success, necessitating an additional test of impact. This is done by generating a nominal (and invisible) plane, going through the source, with the ray at a normal to it. Since the nominal plane's equation is derived from the direction cosines of the ray, solving the suspected point of impact with the equation will show whether the point of impact is on the "correct" side of the nominal plane or not.

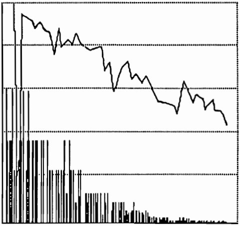
ANALYSING RESULTS

When the run is complete, the screen shows the room, targets and impacts. The rays are colour coded to show how many reflections occurred before the ray struck. Direct rays are always in green. If the information seems useful, the screen can be photographed, or a printout done at this stage.

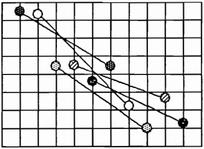


Enhanced image of screen printout

At the top of the screen is a request for the duration of decay which is to be examined (in seconds), and the number of intervals the graph should be broken into. The latter is very important, because of the assumptions of the ray-tracing method. In real life, sound basically diminishes in proportion to the square of the distance travelled from the source. With ray tracing it is assumed that the only factor affecting the ray's intensity is absorption by the surfaces in the room; it is the *spreading* of the rays with distance which effectively mimics the lessening of strength with distance. The rays can be visualised as the audio equivalent of photons; the more that strike, the more intense the sound. This means that intervals of time must be sampled, and the intensity of sound determined by the *total* (not average) intensity of the rays arriving within that period (if this is hard to comprehend, remember that if averages are used, then one ray of a given intensity could yield the same result as ten arriving within the same period). The sampling must also relate to the number of impacts recorded; the fewer impacts there are, the coarser must be the sampling. This becomes clearer when actual plots are made.



Computer-enhanced example of printout



Slopes used in Thiel's Incomplete Theorem

As soon as the time and sampling are determined, the screen clears, and the axes of a *raw intensity vs time* graph are drawn. Next, the impacts are plotted (in the order they were recorded) as a series of fine vertical lines. They are colour-coded so that it is possible to see at a glance when the effects of each reflection begin to predominate. However this is only a rough guide; the limited number of lines available on screen means that many lines may overlap. Also there may be gaps in the display, their size depending on the number of rays used, and in this model the gaps are as significant as the actual plots. When all the individual impacts have been displayed, the program begins the analysis. The total intensity of rays arriving within each slice of time is arrived at, and its logarithm to base 10 plotted on a white line-graph which overlaps the raw intensities. This process is rapid, taking a matter of seconds, and may be repeated using different intervals to alter the smoothness of the line. Each time, a line of best fit is calculated for the total intensities, using Thiel's Incomplete Theorem. This method was selected because of its rejection of outstanding values, which become more apparent as fewer rays are used. Briefly the way it works is that lines are drawn in order from points to the left of the middle value to those on the right. The slope becomes the median of all the slopes (thus rejecting any outrageous values, which will occur at either end). The line of best fit can be written in the form $y = mx + b$, where m is the slope, and b the constant determining the height of the line. The known x and y values are put into this equation, along with the slope, and the median of the values of b generated is accepted as the best.

Once the slope has been established, it is simple to determine reverberation time. Because of the logarithmic plotting of total intensities, 60 dB is represented by 6 graduations on the vertical axis. Dividing the distance on the plot representing 60 dB by the slope gives the time taken for that drop (i.e. dB/(dB/time) = time). The reverberation time arrived at varies slightly with the sampling used, and it is interesting to see how the variance increases as the number of rays decrease.

CONCLUSIONS

The basic problems of ray-tracing have been overcome by the program. It is sparing in its use of memory and has a reasonable amount of speed, considering the work it must do. It allows truly elaborate ray-traces to be generated, even overnight as supervision is not required. In addition there is a fair degree of flexibility built in, allowing further experimentation and refinement. It will now be necessary to evaluate the program side by side with existing techniques, to see what weaknesses or omissions there may be, and to determine the implications of using different target and ray-count combinations. Also, different methods of curve fitting may be tried to evaluate the reverberation time. The examples used so far have been rather simplistic, but there is no reason why much more complex shapes cannot be examined — the principles remain the same. Like any tool, the program must now be used before its full potential can be assessed.

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The groundwork for this program was laid by David Cornell at the Department of Architectural Science at Sydney University, who wrote a basic program from which many of the 3-dimensional geometry algorithms have been translated and/or adapted.

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Application of Computers to the Study of Urban Noise Problems

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ABSTRACT: Methods of traffic noise simulation are discussed which include models for freely flowing traffic as well as those for traffic with restricted flow caused by road intersections or roundabouts. Models are also discussed which allow for the effects of buildings in urban areas.

INTRODUCTION

The problem of urban noise pollution has been a subject of great interest over the last few years. A considerable amount of work has been carried out with the aim of developing models that can be used to predict the noise levels generated by road traffic in urban areas and the propagation characteristics of sound from stationary sources such as industry.

Urban noise prediction methods have been developed based upon three approaches. These are field measurements made on actual sites, measurements on acoustic scale models and computer modelling. Predictive techniques based upon field measurements avoid the doubts that sometimes arise concerning scale and computer modelling in that these methods are based upon real data. The disadvantage of relying only on real data is that it is usually impossible to exercise any control over the various parameters which determine noise levels. There are also dangers in interpolating between data obtained from very different sites.

Acoustic scale modelling can be a useful technique to employ in situations which are too complex for direct analytical or numerical treatment. This technique also allows the investigator some control over meteorological conditions, which are some of the chief problems associated with field measurements. The disadvantage of using acoustic scale models is that if a reasonable scale factor is employed then only a small site can be modelled. Acoustic scale model work also tends to be an expensive process and very time-consuming.

Predictions based upon computer models can be achieved more economically than by the two other methods. It is also possible to examine the effect of varying different parameters with relative ease. Noise generated by complex traffic situations and road configurations can also be easily investigated.

In order to ensure that the results given by a computer model are sensible it is usual to validate the model by comparing predicted noise levels with measured levels for a number of typical sites.

Computer models developed for the study of urban noise problems can be divided into two types. The first type deals with the generation and propagation of sound in the open and typically involves the simulation of a traffic stream while the second type is concerned with the propagation of sound in urban areas.

Some computer models are based upon mathematical models obtained as a result of a theoretical analysis of the situation. These usually result in equations which can be easily programmed on a computer. Other models are based on a simulation approach in which the noise levels at a given position resulting from a simulated traffic stream are sampled at regular intervals. The approach is similar to acoustic scale modelling and the computer may be regarded as performing "numerical" experiments.

TRAFFIC NOISE SIMULATION

Models based on a mathematical analysis of a given situation result in expressions which can be incorporated into relatively simple computer programs. The disadvantage of this approach is that the situation modelled usually represents a gross over-simplification of the urban environment and hence the results obtained are sometimes suspect. The alternative approach, a fully fledged computer simulation, involves the writing of a more complex program which may take an appreciable amount of time to run.

Traffic noise arises from the combination of noise levels generated by individual vehicles in traffic streams. The noise level detected by an observer from a single vehicle will depend mainly upon vehicle velocity, type and the ground cover. Noise levels from a stream of traffic will depend upon the composition of the traffic stream and the headway distributions within that stream. To simulate this noise source, computer models have been developed using the following techniques.

The traffic stream is usually simulated by Monte Carlo methods in one of two ways [1]. The *first* is the "random snapshot" method where a distribution of vehicles is generated in front of the receiver and the instantaneous level is calculated. (The distance between successive vehicles in a traffic stream has been found to follow a negative exponential distribution and this is usually taken into account in simulation models.) Successive distributions are then generated independently of all others.

The *second* approach is the "time history" method where an initial distribution is generated and all subsequent distributions in the sampled series are obtained from this by moving the vehicles along the roadway by a distance determined by their speeds and the sampling interval employed. New vehicles enter the system at the end of the stream as required.

The majority of models produce simulated freely-flowing traffic conditions but there are some in which the basic techniques have been extended to deal with restricted flow situations more typical of urban areas.

Galloway, Clark and Kenrick [2] developed a computer model to simulate freely-flowing traffic using the Monte Carlo random snapshot technique, where a set of sources are arranged on both sides of the observation point with the distance between

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successive vehicles following a negative exponential distribution of the form:

$$S = -\ln(RN)V/Q \qquad (1)$$

where
RN is a random number between 0 and 1
V is the mean speed
Q is the vehicle flow rate
S is the spacing between vehicles

The class of each individual vehicle in the traffic stream is also chosen randomly according to the proportion of heavy vehicles in the traffic stream. Additional vehicle sources are added on both sides until the last ones added do not increase the noise level at the observer by more than 0.5 dBA. The total noise level resulting from this snapshot is registered and the above steps are repeated to obtain the required number of sampled noise levels. A cumulative level distribution can then be plotted and from this various noise indices can be determined.

A model developed by Diggory and Oakes [3] is capable of predicting noise levels generated by traffic passing through road intersections controlled by roundabouts where departures from freely-flowing traffic conditions occur. It simulates traffic streams vehicle by vehicle and calculates the noise level from each vehicle as it is being introduced and shifted along the road according to the assumed speed. The time interval between vehicles is assumed to follow a negative exponential distribution of the form:

$$t = T - (\bar{t} - T)\ln(RN) \qquad (2)$$

where
t is the time interval between consecutive vehicles
T is the minimum time delay between consecutive vehicles
$\bar{t}$ is the mean time delay between consecutive vehicles

Two types of vehicles are considered in the model. They are light vehicles and heavy vehicles. The noise emitted from each type is assumed to depend on the speed as shown in Figure 1.

The simulated road may have up to eight lanes. After sampling all vehicles in a particular lane the process is repeated for all lanes. A flow chart describing the operation of the program is shown in Figure 2.

The situation at roundabouts was simulated in the model after a simplified account of the behaviour of a vehicle as it approaches the stopline had been developed. At some distance

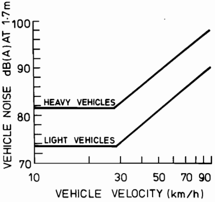

Figure 1: Vehicle speed relationships

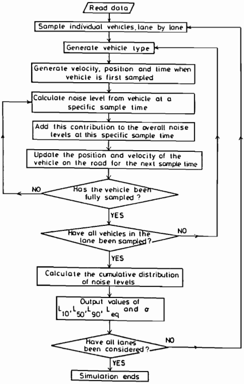

Figure 2: Flow chart (after Diggory and Oakes)

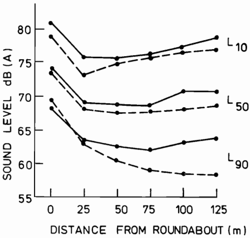

Figure 3: Comparison of measured and predicted data (Diggory and Oakes)
– – – – – predicted; ———— measured

from the stopline vehicles are considered to be travelling with constant velocity (V_o). As the source moves closer to the roundabout its velocity decreases to a minimum (V_m) at the stopline. The vehicle then accelerates until it achieves a constant velocity. The vehicle's velocity is assumed to follow the following relationship:

$$V = V_o[1 - f \exp(-\lambda x)] \quad (3)$$

where

$$f = (V_o - V_m)/V_o \quad (4)$$

and is a constant for each lane.

The predictions for freely-flowing traffic noise levels obtained from this model were found to be comparable to values obtained using the standard U.K. prediction method. In the case of interrupted flows, the predicted values were compared with measurements made on three sites and good agreement was found between them as can be seen in Figure 3.

Another computer model for predicting noise levels from restricted flow situations has been described by Jones, Hothersall and Salter [4]. The model is based on the Monte Carlo method. The results obtained from an application of this model are presented in the form of correction contours which can be applied to the predicted free-flow traffic levels obtained using standard techniques. These are then modified to allow for flow restrictions. Flow restrictions of the type encountered at traffic signals, priority intersections, pedestrian crossings, and roundabouts, have been studied using this program.

Two types of vehicles are considered in the model, light and heavy vehicles. They enter the simulation system at a time obtained from a shifted negative exponential headway distribution. They interact with each other within four lanes, two in each direction, and no overtaking is assumed to occur. Knowledge of the position, velocity and acceleration of each vehicle allows the noise level at an observation point to be calculated at regular time intervals. The relationships between the noise level and velocity and acceleration (observed at a distance of 7.5 metres from the road) employed in the model are:

$$L_{light} = 33.2 + 23.8 \log C + 10.6A - 0.08\,A2 - 5.73\,A \log V \ \text{dBA} \quad (5)$$

$$L_{heavy} = 48.5 + 18.9 \log V + 7.5A - 0.11A - 4.29\,A \log V \ \text{dBA} \quad (6)$$

where
V is the vehicle velocity
A is the vehicle acceleration

A description of the behaviour of the vehicles at the intersections was provided to the main program in order to calculate noise levels at these situations.

Validation studies of this model were again done by comparing predicted results with measured ones. Good agreement between the two sets of data was reported.

A rather different approach was adopted by Nelson [5] who developed a mathematical model for predicting traffic noise level from consideration of the acoustical and flow characteristics of a single vehicle travelling along a road. The overall noise generated by a traffic stream is deduced by combining the single vehicle noise distribution with itself in a statistically correct manner.

The single vehicle distribution is obtained by calculating the instantaneous level at the receiver position and the distance along the road which gives rise to the level (Figure 4). The distance D at which noise level, L, occurs is given by

$$D = (R^2 10^{(L_R - L)/10} - d^2)^{1/2} \quad (7)$$

where L_R is the sound pressure level at a distance R from the source and d is the road-receiver distance.

The length of the simulated road is to be taken such that a vehicle takes one hour to traverse it. Thus, the percentage of time, t%, when the level is exceeded is given by

$$t\% = D/(500V) - 100 \quad (8)$$

where V is the vehicle speed.

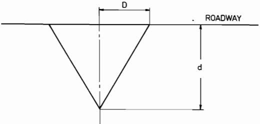

Figure 4: Nelson's method

By substituting different values of L into equation (7) a cumulative time-level distribution can be obtained which represents the distribution for a traffic flow of one vehicle per hour. The cumulative level distribution for two vehicles per hour can be obtained by combining the distribution for one vehicle per hour with itself. The procedure can be repeated to yield a cumulative level distribution corresponding to any desired flow rate.

Nelson applied his technique to predict levels of noise propagated over short grass land. The usual two types of vehicle were considered in the model.

Nelson reported good agreement between predicted and measured data for a number of situations.

NOISE PROPAGATION IN URBAN AREAS

Computer models have been developed to study the effect of buildings in urban areas on resultant noise levels.

One such model has been developed by Claydon, Culley and Marsh [6]. The model first defined a horizontal plan of specific dimensions. The position of a stationary source is defined by its (x,y) co-ordinates. Then the positions of diffracting or reflecting boundaries of buildings are defined by a number of straight lines (see Figure 5). Any surface may have its absorption coefficient specified. The model then calculates the sound intensity at a receiver point as the sum of direct, reflected and diffracted sound. Only the first reflections from all possible reflecting surfaces are considered in this model.

The reflection point may be calculated by defining the reflecting line equation which is assumed to be of the form $y = mx + c$.

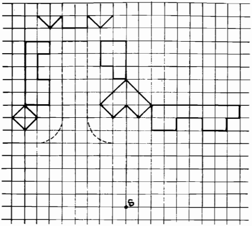

Figure 5: Representation of a cul-de-sac (Claydon, Culley and Marsh)

The reflection point, source point and receiver point have the co-ordinates (XR, YR), (XS, YS), and (XP, YP) respectively.

Then $$XR = (C + F.XP - YP)/(F - m) \quad (9)$$

$$YR = m.XR + c \quad (10)$$

where

$$F = \frac{YP - \{[2m\,(XS + m(YS - c))/(m^2 - 1)] + 2c - YS\}}{XP - \{[2\,(XS + m(YS - C))/(m^2 + 1)] - XS\}} \quad (11)$$

Knowing the reflection point, and the total length of the reflected ray, its contribution to the total intensity can be calculated.

For the diffracted sound the program calculates the sound intensity at a point by first calculating the path difference between the length of the diffracted ray and the length of the direct ray from the source to the receiver; then calculating the corresponding Fresnel number and then applying a simplified relationship between the Fresnel number and attenuation.

A second model is described by Holmes and Lyon [7]. It employs a combination of the Monte Carlo method and the quantum approach. The model defines an urban situation by a rectangular grid where all building facades lie along grid lines. Each cell of the grid is either part of a street (open cell) or part of a building (closed cell) [Figure 6]. All surfaces are assumed to have the same scattering and absorption coefficients. The source is positioned in one of the open cells and emits rays in random directions. Each ray travels in a straight line from one cell to another as long as these cells are "open". When a ray meets a closed cell it is either reflected, scattered or absorbed according to the mathematically calculated probability of each phenomenon. The model traces each ray until it meets the outer boundaries of the grid. The process is then repeated for the next ray and so on. All rays that pass through the receiver cell are noted and the sound energy level at the receiver is calculated by summing all the energy contributions of the rays. Results obtained from this model were tested against measurements made on a scale model experiment. The agreement between the two sets of data was excellent as can be seen from Figure 7.

The two models described above relate to the propagation of noise from a stationary point source. A number of workers have combined traffic noise simulation models with models simulating the geometry of built form.

Fisk used such a technique to investigate the performance of an infinitely long barrier on traffic noise [8]. Oldham and Mohsen investigated the screening effort of balconies and courtyards in order to assess the performance of these self-protecting building types [9] [10].

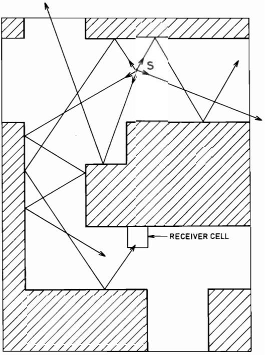

Figure 6: The "quantum" technique of Holmes and Lyon

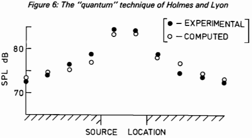

Figure 7: Comparison of computed noise levels with those measured using a scale model (Holmes and Lyon).
• experimental; o computed

CONCLUSIONS

The way in which noise propagates in urban areas is still not fully understood. In order that a satisfactory noise environment is achieved in urban areas it is necessary for the planner to be able to predict noise levels at the design stage. The use of computer simulation techniques, supported by field and model measurements, can help to fill the gaps in our knowledge and ultimately result in a better acoustic environment.

(Received 20 September 1985)

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Statistical Analysis of Threshold-Limited Data:

An Example of Computer-Intensive Statistical Methods in Acoustics

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ABSTRACT: A method is described for performing regression analysis on data whose values are only known to be less than or greater than some threshold value. The method has been applied to two noise level surveys conducted by the National Acoustic Laboratories.

1. INTRODUCTION

It has long been recognised that standard statistical techniques for data analysis, such as regression analysis and time-series analysis, involve assumptions which are almost never met by real data. This is especially true in the environmental sciences, where data are gathered under field conditions. For example, environmental data used in statistical analyses rarely come from a simple random sample from the population of interest. Measurements may be clustered in time or space, they may be impossible to perform under some conditions, and data may be included or rejected for a variety of reasons. Unfortunately, if the assumptions of traditional statistical methods are relaxed, one generally finds that problems of statistical estimation have no closed-form solution. However, the use of computers often allows such problems to be solved by numerical methods, substituting number-crunching power for mathematical finesse. This paper gives an example of the application of computer-intensive methods to such a problem in environmental acoustics.

In a series of environmental noise measurements (for example, measurements on a number of similar sources, or on the same source under a number of different meteorological conditions) it is rare that every measurement results in a unique, definable noise level. For some measurements, noise from the source may be completely inaudible, or below the measurement threshold of the instrumentation. Sometimes the source may be obscured by background noise, either because the source level was unusually low or because the background level was unusually high. Unexpectedly high source levels may result in over-range readings on the instrumentation. The usual procedure is to ignore such measurements. However, this obviously produces biased results, since measurements registering unusually high or unusually low levels are being selectively ignored. For example, suppose one wishes to determine the rate of change of noise level with distance from a source, up to large distances (say, over 5 km). At such distances, the source is likely to be inaudible most of the time. However, unusual meteorological conditions will sometimes produce levels which are as high as those close to the source. By performing a standard regression analysis, and ignoring inaudible measurements, one could show that the mean noise level from the source was independent of distance! An alternative approach to such problems is set out below.

2. THEORY

Assume that one has conducted N noise level measurements and that for n of these one has obtained measured noise levels L_i ($i = 1, \ldots, n$) with some small measurement error δL. For the remaining measurements, one can only state that the true noise level from the source was below some threshold T_i ($i = n+1, \ldots, N$). (The extension to the case where the level is known to be *above* some threshold is obvious, and will not be discussed.) One wishes to describe the noise level by a regression equation

$$L = B_0 + \sum_{j=1}^{m} B_j X_j$$

where X_j are predictive variables and B_j are regression coefficients which one wishes to estimate. Noise levels from individual measurements are assumed to be normally distributed about the value predicted by this equation, with an unknown standard deviation σ. In the simplest case, $m = 0$, this amounts to estimating the mean and standard deviation of the noise level. The values of X_j are assumed to be known for all the values of the measurements, and they are denoted x_{ij} ($i = 1, \ldots, n$). For any particular values of B_j and σ, the probability of obtaining the data, under the above assumptions, is

$$P = \prod_{i \leq n} \{\exp[-(L_i - \hat{L}_i)^2/(2\sigma^2)] \,.\, \delta L/[\sigma \,.\, (2\pi)^{1/2}]\} \,.\, \prod_{i>n} \{\int_{-\infty}^{T_i} \exp[-(t-\hat{L}_i)^2/(2\sigma^2)] \,.\, dt/[\sigma.(2\pi)^{1/2}]\} \qquad (1)$$

where $\hat{L}_i$ is the predicted value of L for the measurement — i.e. $\hat{L}_i = B_0 + \sum_{j=1}^{m} B_j x_{ij}$. The contents of the first bracket represent the probability that the level from measurement i is within δL of L_i, while the contents of the second bracket represent the probability that the level from measurement i is somewhere below T_i. The probability P is known as the *likelihood* of the data, and under the principle of maximum-likelihood estimation (a very general statistical principle), one estimates the true values of B_j and σ by choosing the values which maximise P — that is, the values which maximise the probability of obtaining the measured data. Taking the logarithm of the right-hand side of Equation 1 and discarding constant terms, the required values of B_j and σ are those which maximise the expression

$$-n\ln(\sigma) - [1/(2\sigma^2)] \sum_{i \leq n} (L_i - \hat{L}_i)^2 + \sum_{i>n} \ln\{N(T_i - \hat{L}_i)/\sigma\} \qquad (2)$$

where N(·) is the normal probability integral,

$$N(x) = [1/(2\pi)^{1/2}] . \int_{-\infty}^{x} dt . \exp(-t^2/2)$$

The values of B_j and σ which maximise expression 2 do not appear to be available in algebraically closed form. However, the problem can be attacked directly by using any of a number of standard computer algorithms for finding the maximum of a function. These are described in many books on numerical methods. They generally involve specifying an estimate of the required values of the parameters (B_j and σ), and moving towards the true maximum using numerical estimates of the first and second derivatives of the function with respect to each of the parameters. At most computing installations, such algorithms are available as library subroutines. The author has found the function-maximisation subroutines produced by the NAG numerical algorithms group [1] to be very useful for this purpose.

Maximising expression 2 using two predictive variables and 200 measurements, 100 of which have below-threshold values, requires about 3 seconds CPU time on a CDC Cyber 845 main-frame computer. A flow-chart and a copy of the FORTRAN IV source code is available from the author. In programming, it is useful to note that the first summation in equation 2 can be written as

$$(\sum_i L_i^2) + \sum_j \sum_k B_j B_k (\sum_i x_{ij} x_{ik} - 2 \sum_j B_j (\sum_i L_i x_{ij})$$

where the summations within brackets are independent of B_j, and therefore do not need to be re-calculated each time the expression is evaluated.

3. ACCURACY

The accuracy of the values computed by this method was checked for the case when only the mean and standard deviation of the noise levels are to be estimated (m = 0). Four hundred sets of 200 data points were generated by computer, the values being randomly chosen using a normal distribution with mean 0 and standard deviation 1.0. A threshold value was defined, and data points whose true values were below the threshold were assumed to have unknown values (except that the value was known to be below the threshold). The maximum-likelihood procedure above was then used to estimate the mean and standard deviation of the data values for each of the 400 data sets. Results, for threshold values ranging from −2.0 to +2.0, are shown in Table 1. Even when only 5% of the "measurements" are above the threshold level, the true mean and standard deviation of the data values can be estimated with very little bias, and with standard errors of estimate about six times greater than would be the case if all "measurements" had known values.

Threshold	Average pecentage of values above threhold	Estimated mean		Estimated standard deviation	
		Bias	Std. Error	Bias	Std. Error
-2.0	97.7	-.003	.072	-.003	.052
-1.6	94.5	-.004	.072	-.003	.053
-1.2	88.5	-.003	.074	-.005	.056
-0.8	78.8	-.003	.076	-.004	.062
-0.4	65.5	-.006	.079	-.002	.069
0.0	50.0	-.007	.086	-.001	.079
0.4	34.5	-.[illegible]	.115	.003	.107
0.8	21.2	-.[illegible]	.150	-.007	.130
1.2	11.5	.020	.246	-.022	.172
1.6	5.5	.046	.429	-.040	.240

Table 1: Bias and standard error in calculated values of the mean and standard deviation of 200 normally-distributed data points (relative to the standard deviation of 1.0). Bias is calculated from the mean of the estimated values for 400 sets of points, and standard error is calculated from the standard deviation of the estimated values.

Threshold	Average pecentage of values above threhold	Estimated mean		Estimated standard deviation	
		Bias	Std. Error	Bias	Std. Error
-1.0	100.0	-.002	.068	-.013	.095
-0.6	67.0	-.227	.090	.262	.135
-0.2	44.9	-.469	.142	.489	.189
0.2	30.1	-.725	.228	.689	.247
0.6	20.2	-.973	.317	.855	.305
1.0	13.5	-1.196	.466	.998	.381
1.4	9.1	-1.512	.825	1.153	.530
1.8	6.1	-1.728	1.141	1.251	.650
2.2	4.1	-1.946	1.523	1.346	.809

Table 2: Bias and standard error of the mean and standard deviation of 200 data points. The points are distributed according to an exponential distribution with a mean of 0 and standard deviation 1.0.

Of course, measured noise levels need not be normally distributed. To test the method under a fairly extreme departure from the assumption of normality, the above procedure was repeated with data values generated using an exponential distribution, again with zero mean and unit standard deviation. Estimated means and standard deviations for the 400 data sets are summarised in Table 2. In this case, the method produces estimates which are not very reliable when more than about 70% of the "measurements" are below the threshold, although it still gives good estimates when most "measurements" have known values.

When more than about 70% of measurements have values below the threshold, the accuracy of predicted mean levels can be substantially improved by using an approximate value for σ, found by some other method, and using maximum-likelihood only to estimate regression co-efficients. For example, Table 3 shows estimated mean levels of the exponentially-distributed data, where pre-set values of σ have been assumed, and the mean has been estimated by maximising expression 2. The bias in the estimated mean values is substantially reduced compared with Table 2, even when the estimated value of σ is 1.5 or .667 (i.e. inaccurate by +50% or −33%).

4. CONCLUSIONS

A method has been proposed for performing regression analysis on a set of data which contains points whose values are only known to be less than (or greater than) some threshold. The method relies heavily on the processing power available from a medium-to-large computer, and provides an example of the use of computers to perform statistical analysis in cases where the problem is intractable using normal analytical methods. The method has been used on data from two noise level surveys conducted by the National Acoustic Laboratories [2], with very satisfactory results.

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Threshold	Average percentage of values above threshold	Std. Devn. estimated at 1.0 Bias/Std. Err.	Std. Devn. estimated at 1.5 Bias/Std. Err.	Std. Devn. estimated at 0.667 Bias/Std. Err.
-1.0	100.0	-.002/.068	-.002/.068	-.002/.068
-0.6	67.0	-.150/.086	-.296/.100	-.058/.[illegible]
-0.2	44.9	-.192/.093	-.472/.115	-.012/.[illegible]
0.2	30.1	-.163/.102	-.568/.129	.010/.[illegible]
0.6	20.2	-.081/.111	-.600/.143	.259/.[illegible]
1.0	13.5	.042/.127	-.584/.167	.452/.[illegible]
1.4	9.1	.187/.152	-.545/.208	.665/.114
1.8	6.1	.354/.177	-.471/.247	.899/.130
2.2	4.1	.535/.194	-.385/.272	1.144/.143

Table 3: Bias and standard error in calculated values of the mean of a set of exponentially-distributed data points, the true mean being 0 and standard deviation 1.0. The estimates are made using the maximum-likelihood technique, assuming a known value for the standard deviation. Three different values of the standard deviation are assumed, as shown.

Noise: Problems and Remedies

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ABSTRACT: The legal aspects associated with noise are examined in detail including difficulties encountered in the definition of noise and its measurement. Copious references are given to legal cases together with a list of examples in which courts have held noise to constitute a nuisance.

AN OLD BUT GROWING PROBLEM

Noise as an environmental problem is one which extends back over many centuries. Recorded complaints about noise go back at least into the second century B.C. Today it is a major and growing problem. The Royal Town Planning Institute, in a submission to the then English Minister of Health (1966), said:

> "Noise in various forms is becoming a serious threat to the maintenance of satisfactory living and working conditions. Nuisance from the noise of motor traffic and noise made by building and engineering works are now widespread. Furthermore the flight lanes along which aircraft approach and leave airfields are areas in which there is a reduction, sometimes considerable, and for most of the day and night, in the standards of living and working":
> 11 *Town Planning and Local Government Guide* par. 384.

AURAL AGGRESSION AND ITS EFFECTS

An English judge (Watkins J.) has written of noise in trenchant terms, saying that "It is ... well recognised that excessive noise is one of the curses of the modern age": *R. v. Fenny Stratford Justices ex p. Watney Mann (Midlands) Ltd* [1976] 1 WLR 1101, at 1103; 26 *Town Planning and Local Government Guide* par. 1558. The Privy Council has expressed itself forcibly on the need for the citizen to be "protected against 'aural aggression'": *Francis v. Chief of Police* [1973] 2 All ER 251, at 259; 25 *Town Planning and Local Government Guide* par. 2436.

It has been held by the then Supreme Court (now High Court) of New Zealand that "Noise at its highest level can certainly be harmful to 'health'": *Bitumix Ltd v. Mount Wellington Borough Council [1979] 2 NSLR 57 at 61; [1981] Town Planning and Local Government Guide* par. 263.

Noise, as doctors have proved, plays a substantial part in causing fatigue. Noise, as was held in the *Bitumix* case "may affect the 'general welfare' of people and the 'amenities of an area' by turning what should be a pleasant residential locality or a quiet work area into an unpleasant environment by reason of noise": *Bitumix Ltd v. Mount Wellington Borough Council* [1979] 2 NZLR 57 at 61; [1981] *Town and Planning and Local Government Guide* par. 263.

The then Victorian Town Planning Appeals Tribunal (now the Planning Appeals Board) has held noisy events to be inimical to farming: *International Sportsland of Australia Pty Ltd v. Melbourne & Metropolitan Board of Works* (1977) 6 VPA 227; 27 *Town Planning and Local Government Guide* par. 884.

A leading ear specialist has said that by the time the average teenager of today reaches the age of 21, ten per cent of their hearing capacity has been lost because of the noise to which they have been subjected.

THE NEED TO DEFINE TERMS

In an age when noise is intruding into so many facets of life, it is unfortunate that there is no clear definition of what constitutes "noise". It has been held that "'noise' is not synonymous with 'sound'": *Bankstown Municipal Council v. Burzins* (1961) 8 LGRA 261 at 264; 8 *Town Planning and Local Government Guide* par. 339. The judges themselves are divided. In *Leslie v. City of Essendon* [1952] VLR 222, the three judges comprising the Full Court of the Supreme Court of Victoria differed as to what constitutes noise. O'Bryan J. regarded "noise" as "a loud or harsh sound or a din or a disturbance made by one or more persons". Sholl J. had regard only to loudness. Coppel A.J. seemed to favour the view adopted by O'Bryan J. although perhaps adding to it. In the subsequent case of *Schofield v. City of Moorabbin* (1966) 13 LGRA 200 at 202, Menhennitt A.J. (later Menhennitt J.) said of that earlier decision that:

> "It appears to me that all three members of the Full Court considered that the expression 'noises' meant more than sounds, but that there was no definite decision in that case as to whether merely a loud sound would be sufficient to constitute a noise or whether something more or different was necessary".

Unfortunately, his Honour found it unnecessary to decide that question and no other court appears to have done so. The question is not made any easier by the decision that "statements such as ... that the noise was excessive do not take the matter any further when there is no standard of measurement": *Philpott v. Ministry of Transport* [1972] NZLR 518 at 522; 22 *Town Planning and Local Government Guide* par. 491. As Perry J. pointed out in that case (at p. 521); 22 *Town Planning and Local Government Guide* par. 491: "This is an age of machines and particularly of vehicular machines, and noise seems to be an unavoidable accompaniment of that use". His Honour found an answer in the test of "annoyance" (a test prescribed by the legislation involved in that case) but his test of "annoyance" was one which required the court to "be satisfied that the noise is or would be an annoyance to ... 'a reasonable, sensible person'". That, with all due respect to his Honour, begs the question. His Honour's test has the support of a classical test of noise nuisance, "the standard [of which]

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is that of the ordinary reasonable and responsible person who lives in [the] particular area": *Halsey v. Esso Petroleum Company Ltd* [1961] 1 WLR 683 at 692; 7 *Town Planning and Local Government Guide* par. 49. Indeed, that is the classical test of the nuisance, whether by noise or otherwise, but it has the disadvantage that views may differ substantially as to what that "ordinary reasonable and responsible person" would think in any particular case. As his Honour pointed out in the *Esso* case (at p. 691; 7 *Town Planning and Local Government Guide* par. 49):

> "Nuisance by ... noise is something to which no absolute standard can be applied. It is always a question of degree whether the interference with comfort or convenience is sufficiently serious to constitute a nuisance. The character of the neighbourhood is very relevant and all the relevant circumstances have to be taken into account. What might be a nuisance in one area is by no means necessarily so in another".

The problem of defining "noise" is one that is unlikely to be solved by any attempt at definition in an Act of Parliament or in any delegated legislation. It stands as a fundamental problem to the quick and effective enforcement of protective provisions.

DIFFICULTIES IN THE MEASUREMENT OF NOISE

Not only is there the difficulty in defining "noise" but there is the difficulty of measuring it in terms which will be understood by those who have the responsibility of administering and enforcing noise control requirements. Used to measures which are defined with certainty, they are confronted in noise control with the decibel, which "is not an abstract measure but always a relative one": Parkin & Humphreys "Acoustics, Noise and Buildings" p. 30; 18 *Town Planning and Local Government Guide* par. 165. True it is that the then Supreme Court (now High Court) of New Zealand has accepted a noise control expressed in dB(A) as sufficiently certain when maximum decibels are expressed at different levels for different times of the day and night and with measurements taken at a specified point (*Bitumix Ltd v. Mount Wellington Borough Council* [1979] 2 NZLR 57 at 65; [1981] *Town Planning and Local Government Guide* par. 266) but there remains the difficulty of equating those decibels with actual experience. As Griffiths J. expressed it, in the English Queen's Bench Division:

> "I have had it all turned into decibels by various experts. I am bound to say that I do not find such evidence very helpful because unless I am looking at a machine and at the same time listening to a child scream so that I can correlate the number of decibels with the noise I hear, I am unable to appreciate just how loud a sound is by being told it is 60 or 50 decibels":

Dunton v. Dover District Council (1977) 76 LGR (UK) 87 at 89; 29 *Town Planning and Local Government Guide* par. 103. Thus, the Victorian Town Planning Appeals Tribunal has held that evidence that on two occasions on the one day the noise level from a laundry, when measured at a residential property boundary immediately adjacent to the laundry, exceeded the ambient noise level by 14 dB(A) did not establish that the amenity of the locality was injured or prejudicially affected: *Brighton Laundry and Dry Cleaners Pty Ltd v. City of Brighton (No. 2)* (1976) 4 VPA 200; 26 *Town Planning and Local Government Guide* par. 1853. In words spoken of land in the vicinity of a waterfront, but equally applicable to other urban areas, Else-Mitchell J. observed that:

> "It is, in my view, quite impossible to predicate of any noise on or near the waterfront that it will have a static quality and measurement regardless of such things as the force and direction of the wind, apart altogether from ambient noises from ... traffic":

Howard Smith Industries Pty Ltd v. Leichhardt Municipal Council (1968) 16 LGRA 348 at 352; 15 *Town Planning and Local Government Guide* par. 207. Sugerman J. (later Sugerman P.), a very distinguished judge in this field, held "Such discomfort as may be experienced by individuals in residences as a result of ... noise is not, of course, a thing capable of scientific measurement but may well be dependent upon subjective factors": *Pacific Moulding Co. Pty Ltd v. Bankstown Municipal Council* (9161) 7 LGRA 71 at 75; 7 *Town Planning and Local Government Guide* par. 386. Of course, as Davison C.J. pointed out in the *Bitumix* case ([1979]) 2 NZLR 57 at 67; [1981] *Town Planning and Local Government Guide* par. 267) such difficulties should not be used as an argument to delay controls which are necessary in the public interest. Nevertheless, as he himself recognised in that case (at p. 65; [1981] *Town Planning and Local Government Guide* par. 265):

> "One of the major problems in noise assessment is that usually there will be many contributors to noise in a given area. It is not simply a matter of taking a meter and recording a reading at the boundary of the site and saying that the user of that site is producing a certain level of noise. Noise from adjoining sites may all contribute to the noise level as recorded on the meter".

Despite Davison C.J's acceptance of the sound pressure level test in the *Bitumix* case, and without in any way reflecting on the competence of the skilled, dedicated and entirely professional acoustic experts, the difficulties with which they are faced in performing their work are such that, as expressed by the Full Court of the Supreme Court of New South Wales:

> "We are very conscious of the difficulties which must *of necessity* be experienced by those of us who have no specialised training in these matters in appreciating the abstruse scientific basis upon which the acoustic practice rests":

Attorney General v. Farley & Lewers Ltd ex rel. Hornsby Shire Council (1962) 8 LGRA 186; 10 *Town Planning and Local Government Guide* par. 49. Furthermore, again to quote Else-Mitchell J., an experienced and expert judge in the field:

> "Despite the assertions of expert witnesses ... that the noise of blasting can be reduced below the range of human perception, it is obvious that individual reactions will differ and that the residents of the locality may experience discomfort and be sensitive to blasting noises where engineers accustomed to such noises would not themselves experience such discomfort":

Crane & Williams Pty Ltd v. Hornsby Shire Council (1966) 12 LGRA 396 at 405; 22 *Town Planning and Local Government Guide* par. 31.

With those difficulties in mind, it is desirable to appreciate the very wide-ranging situations in which noise nuisances have been held to occur, before turning to the available remedies.

AREA OF NOISE NUISANCE

The wide range of activities that can produce noise, unreasonably interfering with the amenities of other people, is illustrated by the following list of alphabetically arranged examples, in each of which the courts have held the noise to constitute a nuisance:

Aerodrome: *Huron Portland Cement Co. v. Detroit* 93 NW (2d) 888; 4 *Town Planning and Local Government Guide* par. 305.

Aeroplane engine factory: *Bosworth-Smith v. Gwynnes Ltd* (1919) 89 LJ Ch 368.

Amplifier: *Field v. South Australian Soccer Association* [1953] SASR 224; *Francis v. Chief of Police* [1973] 2 All ER 251 at 259; 25 *Town Planning and Local Government Guide* par. 2436; *R. v. Fenny Stratford Justices ex p. Watney Mann (Midlands) Ltd* [1976] 1 WLR 1101 at 1103; 26 *Town Planning and Local Government Guide* par. 1558.

Building Construction: *Daily Telegraph Co. Ltd v. Stuart* (1928) 28 SR (NSW) 291.
Church bells: *Soltau v. De Held* (1851) 2 Sim NS 133; 61 ER 291; *Haddon v. Lynch* [1911] VLR 230.
Circular saw: *Gort (Viscountess) v. Clark* (1868) 18 LT 343.
Dairy: *Munro v. Southern Dairies Ltd.* [1955] VLR 332.
Dancing: *Goldfarb & Ono Ltd v. Williams & Co. Ltd* [1945] IR 433.
Dancing class: *Jenkins v. Jackson* (1888) 40 Ch D 71.
Haulage contractor: *Kidman v. Page* [1959] Qd R 53.
Hotel: *Vanderpant v. Mayfair Hotel Co. Ltd* [1930] 1 Ch 138.
Motorboat racing: *Kennaway v. Thompson* [1980] 3 All ER 329 at 333; [1981] *Town Planning and Local Government Guide* par. 1300.
Motorcycle racing: *Field v. South Australian Soccer Association* [1953] SASR 224.
Oil depot: *Halsey v. Esso Petroleum Co. Ltd* [1961] 1 WLR 683.
Pigeon keeping: *Fraser v. Booth* (1949) 50 SR (NSW) 113.
Playground: *Dunton v. Dover District Council* (1977) 76 LGR (UK) 87 at 89-93; 29 *Town Planning and Local Government Guide* par. 115.
Printery: *Heather v. Pardon* (1877) 37 LT 393; *Polsue & Alfieri Ltd v. Rushmer* [1907] AC 121.
Quarry: *Attorney General v. P.Y.A. Quarries Ltd ex rel. Glamorgan County Council* [1957] 2 QB 169; *McMahon v. Catanzaro* [1961] QWN 22; *Crane & Williams Pty Ltd v. Hornsby Shire Council* (1966) 12 LGRA 396 at 405-6; 22 *Town Planning and Local Government Guide* pars. 31 & 33.
Riflerange: *Jerram v. Hood* [1954] NZLR 909.
Sawmill: *Dunstan v. King* [1948] VLR 269.
Telephone calls: *Stoakes v. Brydes* [1958] QWN 5.
Tenniscourt (night use): *Abbott v. Arcus* (1948) 50 WALR 41.
Wood merchant: *Spencer v. Silva* [1942] SASR 213.

TRAFFIC NOISE

There can be no doubt that traffic noise is a very real problem in our community. As Else-Mitchell J. has so rightly observed:

> "Heavy diesel-powered vehicles are notorious for the engine and exhaust noises which they emit and whilst mufflers can reduce this noise they cannot eliminate it or reduce it to the level of an ordinary motorcar without loss of efficiency; the constant variations in noise pitch by gear changes can also be an annoyance whilst at fast speeds the mere tyre noises of such vehicles can be significant. Empty vehicles of this type cause no less annoyance and, indeed, there is evidence ... that empty trucks cause more noise and disturbance than those which are fully laden":

Crane & Williams Pty Ltd v. Hornsby Shire Council (1966) 12 LGRA 396 at 409; 22 *Town Planning and Local Government Guide* par. 543.

In the United States of America the Environment Protection Authority published a statement that "the increase in truck and bus noise between 1950 and 1970 ... was 110 per cent": (1978) 13 "Cry California" No. 3, p. 19; 28 *Town Planning and Local Government Guide* par. 672.

Although a mere increase in traffic as a result of traffic generation from a particular site does not give the private individual affected by that traffic generation any right of action (*Howes v. Victorian Railways Commissioners* (1970) 23 LGRA 227 at 250; 21 *Town Planning and Local Government Guide* par. 298), there are circumstances in which an injunction can be obtained: *Halsey v. Esso Petroleum Co. Ltd* [1961] 1 WLR 683; 7 *Town Planning and Local Government Guide* par. 79, whilst an injunction has been granted to a private landowner as a result of "a collection of instances of ... noise" by a particular operator: *Kidman v. Page* [1959] Qd R 53 at 55-6; 6 *Town Planning and Local Government Guide* par. 742.

PROTECTIVE ACTION

It is in the devising of appropriate protective action that the acoustic engineers have rendered outstanding service to the community in those areas in which their undoubted expertise has been called upon. Moreover, their professionalism has enabled planning appeal bodies to devise self-enforcing noise control conditions by requiring the applicant for planning permission to produce periodic reports by an acoustic consultant: *Burns v. Melbourne & Metropolitan Board of Works (No. 6)* (1978) 10 VPA 199; 28 *Town Planning and Local Government Guide* par. 1207.

BYLAW CONTROLS

Numerous attempts have been made by local authorities to introduce bylaws controlling noise levels. If such a bylaw prohibits noise that causes annoyance to the inhabitants of the neighbourhood, it may be unnecessary to call evidence to prove that anyone was actually annoyed because "the facts may speak for themselves". Alternatively, the evidence of only one person could be sufficient: *Raymond v. Cook* [1958] 1 WLR 1098; 3 *Town Planning & Local Government Guide* par. 1202 — a case in which (see 3 *Town Planning and Local Government Guide* par. 1281) the electrically amplified musical bell sound of an itinerant icecream vendor was held to be a "noisy instrument".

If the bylaw-making power authorises bylaws "prohibiting or minimising noises in any public highway" the bylaw-making authority can validly select "a certain category of noises" because "the fact that the category is limited ... does not ... produce the result that the bylaw is any less a bylaw with respect to noises": *Schofield v. City of Moorabbin* (1966) 13 LGRA 200; 12 *Town Planning and Local Government Guide* par. 239 (a case in which — see 12 *Town Planning and Local Government Guide* par. 363 — it was held that the only effective way to control highway noises by bylaw is by a system of granting and refusing of consents).

NOISE ZONING

In the vicinity of airports, the Australian Department of Aviation produces N.E.F. contours — noise exposure forecast bands around the airport and under the flight paths. These N.E.F. contours do not have any legal effect — a feature of the provision of airports which I consider unfortunate. It has been pointed out by Cooke J., in the New Zealand Court of Appeal, that:

> "The noise of aircraft engines in taking off, landing and testing can disturb people living near an airport, so if the airport is to function most efficiently as an airport it may be better that people should not be allowed to live near it. Then there are less likely to be demands for restriction of hours of operation or noise levels":

Laing v. Waimairi County [1979] 1 NZLR 321 at 326-7; [1981] *Town Planning and Local Government Guide* par. 535. As his Honour pointed out in that case (at 327; [1981] *Town Planning and Local Government Guide* par. 536) "An obvious way of avoiding conflict between air transport and other land or building uses is to prohibit or limit residential uses near airports". The noise exposure forecast contours provide an obvious way of imposing such a prohibition or limitation but the relevant authorities have not acted to give the N.E.F. contours the force of law. The unfortunate result of failing to give legal effect to the N.E.F. contours is well illustrated by the conflicting decisions of the then Victorian Town Planning Appeals Tribunal, in which it held N.E.F. levels below 30 to be compatible with residential development (*Tadstan Pty Ltd v. Melbourne & Metropolitan Board of Works* (1975) 3 VPA 173; 25 *Town Planning and Local Government Guide* par. 2603) and that residential development can be allowed with caution within the 25-30 N.E.F. contours (*F.C.A. Finance Ltd v. Melbourne & Metropolitan Board of Works* (1975) 3 CPA 108; 25 *Town Planning and Local Government Guide* par. 2604) yet, on the other hand, prohibited residential development within the 25-30 N.E.F. contours because, even if houses were completely insulated against noise, outdoor amenity would be adversely affected by the noise (*Caviar Investments Pty Ltd v. City of Sale* (1979) 13 VPA 94; 29 *Town Planning and Local Government Guide* par. 1239).

Noise zoning has been advocated by J.A. Rose, although he sounded the warning that:

> "noise zoning must be administered only by those with sufficient expertise to handle the complex calculations and interpretation of results needed if all the inter-related factors are to be given due consideration":

(1971) 64 Shire & Municipal Record 229 at 232; 21 *Town Planning and Local Government Guide* par. 561. Undoubtedly there is power for a planning authority to introduce and implement noise zoning. As Davison C.J. observed in the *Bitumix* case, "Indeed it would be certainly strange if modern planning law did not authorise the control of noise by a local authority in its district scheme" (*Bitumix Ltd v. Mount Wellington Borough Council* [1979] 2 NZLR 57 at 61; [1981] *Town Planning and Local Government Guide* par. 264).

PERMIT CONDITIONS

A planning authority has power, in granting planning permission, to impose a condition specifying a maximum noise level and to do so in terms of decibels. However, the very case in which that power was held to exist illustrates the care with which any such condition must be drafted because, in that case, the condition was held void for uncertainty because it merely required that "the level of noise in the said premises ... shall not exceed 70 dB(A)" (*R. v. Fenny Stratford Justices ex p. Watney Mann (Midlands) Ltd* [1976] 1 WLR 1101 at 1106 & 1107; 26 *Town Planning and Local Government Guide* par. 1557. As the court pointed out in that case, the condition should have been so drafted as to specify "a spot ... at which sound meter readings should be taken so as to judge whether the terms of the [condition] were being kept or not".

ENFORCEMENT ORDERS

If noise is being produced in breach of a town planning permit or in breach of some other legislative control, it is usual to find that the statutory authority concerned has a statutory power to give an enforcement order requiring the breach to cease. The then Lord Chief Justice of England, Lord Parker C.J., appears to have been of the view that reliance upon an acoustic expert's opinion would be a reasonable excuse for failure to comply with an enforcement order: *Saddleworth Urban District Council v. Aggregate & Sand Ltd* (1970) 69 LGR (UK) 103 at 107; 18 *Town Planning and Local Government Guide* par. 410. What the court did hold specifically in that case (at 108; 18 *Town Planning and Local Government Guide* par. 409) was that "It is ... quite clear that the lack of financial credit facilities, the lack of money, cannot form any excuse" for noncompliance with such an order.

The validity of such an order is to be considered as at the date at which it was given, and not as at some later date when the challenge arises for hearing: *Northern Ireland Trailers Ltd v. Preston Corporation* [1972] 1 WLR 203; 20 *Town Planning and Local Government Guide* par. 497.

NOISE PROSECUTIONS

If a person is prosecuted for breach of noise controls, the question as to whether or not there is such a breach is a question of fact: *Smith v. Cornish* [1971] Tas SR (NC) 17; 27 *Town Planning and Local Government Guide* par. 1353.

If the noise in respect of which the prosecution is brought is noise made by a motor vehicle, it is no defence that the defendant did not intend to create excessive noise or that the noise occurred because the action of another motorist caused him to accelerate rapidly: *Sargent v. Fuss* (1979) 25 SASR 134 at 136-7; [1981] *Town Planning and Local Government Guide* pars. 1494-5.

THE REMEDY BY INJUNCTION

The power of the superior courts to restrain by injunction the making or continuing of a nuisance has long been established. In recent times it has been used to restrain such a diversity of noises as those made by aeroplanes when flying at low level on approaching an aerodrome (*Scott v. Dudley* 105 SE (2d) 752; 4 *Town Planning and Local Government Guide* par. 304), the noise made by children under 12 using the children's playground before 10 a.m. or after 6.30 p.m. (*Dunton v. Dover District Council* (1977) 76 LGR (UK) 87 at 89-93; 29 *Town Planning and Local Government Guide* par. 115), and the noise made by a person singing, shouting, whistling and sometimes using unseemly words in his own premises, in the street, and in a public park (*Vincent v. Peacock* [1973] 1 NSWLR 466; 24 *Town Planning and Local Government Guide* par. 1583).

An injunction to restrain a noise nuisance will not be granted unless the effect complained of is substantial (*Luscombe v. Steer* (1867) 17 LT 229), and it will not be granted to restrain a temporary situation (*Cleeve v. Mahany* (1861) 25 JP 819).

(Received 3 September 1985)

ABC Advisory Committee on Science and Technology

The Advisory Committee on Science and Technology to the Australian Broadcasting Corporation wishes to make contact with members of the Australian Acoustical Society. The Committee is, in essence, a group offering advice to the A.B.C. in matters related to science and technology, particularly the programs on radio and television that fall in this area. The Chairman of the Committee, Professor Brown of Monash University, says in a letter: "We are also seen as a link between the Corporation and the scientific community. In order to fulfil this role we are anxious to have some feedback as to audience reaction to various scientific and technology programs. We particularly wish to obtain feedback from members of your Society and would be readv to pass on any comments that we receive in writing or by telephone. Programs on A.B.C. radio at present are: Technology Report, The Science Show, Ockham's Razor, Science Bookshop, Science Review, Science Talkback, Warmboot, and on television the new program Quantum."

"I am most anxious to encourage members of the scientific community to communicate with the Committee so that we can digest the opinions and comments and pass on such information."

If you wish to help the Committee, please contact Professor R. D. Brown, Dept. of Chemistry, Monash University, Clayton 3168; phone (03) 541 0811.

Acoustics Emission Equipment Based on an Apple Computer

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ABSTRACT. Acoustic Emission analysing equipment is usually based on special purpose microprocessor units; however, a versatile unit using peak amplitude statistics has been developed based on the APPLE IIE microcomputer. The use of suitable transducers with a preamplifier, a main amplifier followed by an envelope detector, a fast analog-digital convertor inside the microcomputer, and special software, has provided a suitable inexpensive acoustic emission monitoring unit.

1. INTRODUCTION

The analysis of acoustic emission data requires the computation of some pertinent statistic for a series of pulses. One useful statistic is the distribution of peak amplitudes and this was relatively simple to implement using a commercial APPLE IIE microcomputer and a Mountain Hardware fast analog-digital computer. The use of a commercial microcomputer system meant that maintenance was simplified and program development and modification simplified. The requirement to handle reasonable pulse rates for up to 16 channels of data was achieved; however, sophisticated graphics displays were not possible during the data acquisition phase. Display and further processing of the data was only possible after data acquisition was completed. The software is easily modified as the data acquisition phase uses a machine language patch called from a BASIC program while all the post-acquisition procedures are written in BASIC. The use of BASIC as the primary high-level programming language ensures that an interactive and user-friendly environment is available to the user.

2. AMPLIFIERS

The amplification of the raw signals is done in two stages. There is a fixed gain preamplifier close to the transducer and a remote main amplifier with variable gain close to the computer. The preamplifier which is of local design has a frequency response from 5 kHz to 2 MHz (-1 dB points) and a fixed gain of either 40 or 60 dB which is selectable by an internal link. The signal and power for the preamplifier are via a common coaxial cable to the main amplifier unit. The main amplifier has a similar frequency response to the preamplifier and a switch selectable gain from 0 to 40 dB in 5 dB steps. The output of the main amplifier is available for examination and also passes to a peak-follower unit for signal conditioning prior to being routed to a multicore cable which goes to the analog-digital converter inside the APPLE IIE. Up to 16 amplifier units can be connected to the multiplexer of one analog-digital converter.

3. DATA ACQUISITION

The aim of the data acquisition phase is to build up a histogram representing the peak statistics of the signals. Up to 16 channels of conditioned analog data are routed to the analog-digital converter. A special machine language program is started by calling it from a BASIC program. The special program ensures that each channel is selected consecutively by the multiplexer and the sample converted to a digital value. When the sample from a certain channel exceeds the preset threshold, then that channel is continually sampled and the values digitised for a preset time (deadtime). The digitised values are used to produce an updated maximum value and after the deadtime is exceeded a counter for that channel is incremented in the block corresponding to the maximum value. A square on the display screen is changed from white to black or vice versa to indicate than an event has been recorded, and the scan of the channels continues until another channel has a voltage above the preset threshold. The program also checks to see if an appropriate key on the keyboard has been pressed (& or SHIFT/7 has been chosen) and if so, returns control to the BASIC program. On return to the calling program the option of storing up to three complete sets of data in high core using a special machine language shift program is available so that the time to store sequential sets of data on disk may be bypassed for up to four consecutive time periods. The counters in core use 2 bytes for each peak voltage bin so that a maximum count of 65,535 is possible and a software check has been implemented so that an overflow will be detected, flagged, and then a return to the BASIC program will occur.

The analog-digital converter has a conversion time of 9 microseconds so this allows, with the software overhead and a deadtime of 1 millisecond, a pulse throughput of the order of 700/(number of channels) per second. The converter uses 8 bits to represent the range —5 to +5 volts so that the voltage resolution is 39 millivolts. The end result of the data acquisition is a series of up to 16 tables in core storage in binary format of the number of peak pulse heights versus voltage for 128 voltage bins.

4. BASIC PROGRAM

The BASIC program has been written so that the user selects items from menus. Previous values of various parameters are stored on disc so that the program can recall them to be used as default values. The attributes file can be changed at any time using options in the program. The parameters that are set up include the number of channels, the threshold, the deadtime, the printer slot, and the type of printer.

The user has three initial options: acquire data; examine data in core; or retrieve data from disc. The acquisition mode calls the machine language patch and sets up the computer display to show any activity. The retrieve data from disc mode puts the data in core storage for further analysis. The examine data in core mode provides a number of options. The raw data can be printed; a histogram of number of counts versus voltage displayed on the screen or outputted to a printer; or parameters relating to the peak value statistics can be computed and displayed (such as weighted mean, maximum count, standard deviation for distribution of peak values, etc.). The format of the histogram can be linear or logarithmic for the number of counts; as-is or cumulative; as-is or compressed from 128 to 64 voltage bins to produce a display of more useable dimensions on the printer. All options are selectable from menus and default conditions can be simply obtained by pressing the return key.

In many cases a whole series of data on different datasets on disk is available and it is desired to produce histograms and other analyses for each channel of each set of data. A sequencing alternative is available in the disk retrieve mode to allow the names of different datasets to be entered and the program will sequentially retrieve each one and produce the output for each channel in each dataset.

A typical output obtained on the printer for the compressed histogram is shown in figure 1. Figure 2 shows some of the menus that appear on the screen.

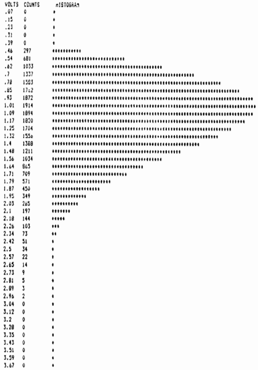


Figure 1. Typical histogram produced on line printer.

MENU 1

ACQUIRE DATA	(A)
RETRIEVE DATA (CORE)	(C)
RETRIEVE DATA (DISK)	(D)
EXIT	(E)

MENU 2

OPTIONS ARE . . .

STORE ON DISK	(S)
DISPLAY OUTPUT	(D)
RETURN TO MAIN PROG.	(E)

MENU 3

OPTIONS . . .

PRINT RAW DATA	(L)
PLOT SCALED DATA	(P)
OTHER ANALYSES	(O)
EXIT THIS SECTION	(E)

Figure 2. Some of the Menus used to control the data acquisition program.

5. ACKNOWLEDGEMENTS

The authors gratefully acknowledge the work of Mr. P. Hartley and his group who were responsible for the development of the preamplifiers and main amplifiers.

NAL

In 1986 the National Acoustic Laboratories (NAL) will relocate to a new purpose-designed building at Chatswood in Sydney.

The building includes an unrivalled complex of acoustical test chambers. These facilities have been designed to allow subjective or objective testing over the full range of frequencies and levels spanned by human hearing, in either diffuse or free-field environments.

It is intended that the facilities will include:

(i) four anechoic chambers, of varied sizes, with cut-off frequencies as low as 50 Hz;
(ii) two coupled reverberation rooms, each of nominal volume 200 cubic metres;
(iii) two rooms designed specifically for tests at high sound intensities;
(iv) three plane wave tubes of differing cross sections covering the frequency range 15 Hz to 560 Hz;
(v) one large, quiet, low-reverberation room;
(vi) ten audiological test rooms.

All rooms have associated control rooms, are air-conditioned, vibration-isolated, and have been planned for maximum versatility in the provision of signal cabling, intercom, data cabling and CCTV.

Consideration is currently being given to means of implementing the Government's intention to make the facilities available for use by a wide range of outside organisations, both public and private. Informal expressions of interest regarding the use of these facilities would be of value in determining the likely range of users.

For more information about the facilities and their availability for your purposes, write to:

Director
National Acoustic Laboratories
5 Hickson Road
Millers Point, N.S.W. 2000

NEW PRODUCTS —

BRUEL & KJAER

DELTA SHEAR PIEZOELECTRIC ACCELEROMETERS

For reliable and accurate measurement of vibration and shock, Delta Shear accelerometers, covering both very wide dynamic and frequency ranges, have the advantage of very low sensitivity to environmental influences. Bruel & Kjaer have now released 10 new accelerometers, all based on the unique Delta Shear principle.

LABORATORY STANDARD CONDENSER MICROPHONE

In response to growing demands for a high stability, laboratory standard half-inch microphone, Bruel & Kjaer introduces the Type 4180. This conforms to Type M configuration 2b of the forthcoming revision of ANSI S1.12—1967, and features excellent long term stability and extreme reliability with respect to environmental influences. It has a frequency response which is flat (±1.5 dB) up to 10 kHz and it can be used for accurate measurements up to 40 kHz. The Type 4180 will find application in coupler measurements and in pressure and free-field reciprocity calibrations.

PORTABLE MACHINE VIBRATION ANALYZER

Bruel & Kjaer's Type 2515 is a portable battery-powered FFT analyzer designed for the requirements of everyday machine monitoring. The solidly built single-channel analyzer has waterproof and dust-proof characteristics better than IP 44 in accordance with IEC 529. A large non-volatile memory holds up to 100 constant percentage bandwidth spectra or 50 constant bandwidth spectra, cepstra or time records, along with the pushbutton settings used in the recording. When a recording is recalled and displayed, the original pushbutton settings are also reactivated.

With its clearly laid-out front panel, the Type 2515 is easy to operate and makes day-to-day monitoring a straightforward matter. Newly measured spectra are easily compared with reference spectra. The built-in charge preamplifier allows acceleromoters to be connected directly, and the 2515 also incorporates Bruel & Kjaer's unique speed compensation technique.

TRACKING FILTER

The Tracking Filter, Type 1626 is a development of the earlier Type 5856, which has been available on special order for some years. The battery operated Type 1626 is specifically designed for field balancing of rigid rotors and vibration analysis when used with other suitable instruments from B & K. It is a highly selective band-pass filter which automatically tracks the rotation frequency of the rotor to be balanced, preventing unwanted vibrations from interfering with the measurements. The Tracking Filter has three fixed bandwidths of 0,1; 1 and 10 Hz, automatically selected as a function of the tracking frequency.

Details: Bruel & Kjaer Aust. Pty. Ltd., 33 Majors Bay Road, Concord, N.S.W. 2137.

METROSONICS

CL-304 ACOUSTICAL CALIBRATOR

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

Features: *102 dB nominal SPL. *1000 Hz frequency. *± 0.3 dB standalone accuracy. *Cavity for 1-inch microphones. *Adaptors for mk-301 and other microphones. *Robust aluminium construction.

NEW NOISE ANALYZER

Metrosonics announces the db-308 Sound Analyzer that can serve as a personal noise dosimeter, integrating sound level meter, amplitude distribution analyzer, and time history monitor. This easy-to-use analyzer provides all survey and exposure data required for hearing conservation and community noise surveys.

The db-308 is microcomputer-based and provides a large LCD display, as well as RS-232C output, for real-time and logged data. When connected to a serial printer, a set of completely formatted test reports are automatically produced including graphics, time of day correlation, pre and post test calibration, and test specifics.

The software can compute statistics for different criteria from a single test, without the uncertainties otherwise introduced by separate tests. For performing surveys on different individuals or at different locations, the db-308 can automatically time each measurement, separate the data on the printout, and identify each measurement with its own tag number. This unique feature saves valuable time and often allows use of a single instrument in situations otherwise requiring use of several instruments. START/STOP times can be pre-programmed for automatic operation of the db-308.

Details: Australian Metrosonics Pty. Ltd., P.O. Box 120, Mt. Waverley 3149, Vic.

TUNING FORK WEIGHING SCALES

CHK Engineering has released the Shinko Denshi Vibra weighing scale using tuning fork technology.

The Vibra scales use specially designed tuning forks as measuring elements of load. The principle of this accurate system is based on the tuning fork principle where two tuning forks are used. One, when energized, starts to oscillate and the other will pick up the vibrations as frequency.

The weight value will be given as the variable of the frequency.

Details: CHK Engineering, 1 Jordan Street, Gladesville, N.S.W. 2111.

ULTRASONIC LEAK DETECTOR

An ultrasonic leak detector and mechanical fault finder has been released by **Sunrise Technology.** Every leak or mechanical problem is associated with various noise levels within the ultrasonic wave band. The Noronix ultrasonic leak and fault finder detects these minute sounds and presents the user with an audible and optical display in relation to the fault.

The unit can be used to locate leaks in vacuum, gas and hydraulic systems, pressure vessels, steam pipes and containers; water leaks in roofs, boats, windows, cars and aeroplanes; heat losses in industrial systems, oven and environmental chambers; around doors and seals; other temperature losses in cold stores and refrigerated systems of all kinds.

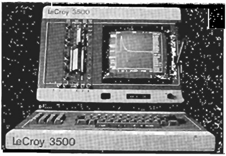
Details: Sunrise Technology, P.O. Box 498, Baulkham Hills, N.S.W. 2153.

FFT SPECTRUM ANALYSER

LeCroy Model 3500SA200 FFT spectrum analyser covers the 0-100 MHz frequency range with a resolution of 0.2 MHz. Finer frequency resolution is available by reducing frequency coverage and spectra of single transients, averaged waveforms and periodic signals are calculated. The unit incorporates an intelligent mainframe and a plug-in 200 megasample/sec transient recorder operating with 8-bit amplitude resolution. Frequency spectra and digitized waveforms can be displayed simultaneously.

Applications for the instrument include the analysis of switching impulses, electrostatic discharges, and signals encountered in EMP testing.

Details: ETP-Oxford, 31 Hope Street, Ermington, N.S.W. 2115.



FUTURE EVENTS —

● Indicates an Australian Conference

1986

March 24-26, LONDON

INTERNATIONAL CONFERENCE ON SPEECH INPUT/OUTPUT
Techniques and Applications
Details: Conference Services, IEE, Savoy Place, London WC2R OBL, U.K.

April 8-11, TOKYO

INTERNATIONAL CONFERENCE ON ACOUSTICS SPEECH & SIGNAL PROCESSING
Details: Prof. H. Fujisaki, General Chairman of ICASSP 86, Dept. Electronic Eng., University of Tokyo, Bunkyo-ku, Tokyo, 113 Japan.

May 12-16, CLEVELAND, U.S.A.

Meeting of the Acoustical Society of America.
Chairman: Arthur Benade, Case Western Reserve University, Physics Department. Cleveland, Ohio 44106.

May, WIEZYCA, POLAND

3rd International Spring School on Acoustoopics and Applications.
Details from: Prof. A. Sliwinski, Uniwersytet Gdanski, Instytut fizyki Dosw. ul. Wita Stwosza 57, 80-952 Gdansk.

June 3-6, SZEGED, HUNGARY

5th Hungarian Seminar and Exhibition on Noise Control.
Details: Optical, Acoustical and Filmtechnical Society Budapest, Anker koz 1. H—1061 Hungary.

July 15-21, BRAZIL

4th BRAZILIAN ACOUSTICAL SYMPOSIUM
Details: Brazilian Acoustical Assoc.-ABRAC, Avenida Ataulfo de Paiva, 1079-Grupo 405, Leblon-CEP 22.440, RIO DE JANEIRO.

July 21-23, MASSACHUSETTS

INTER-NOISE 86.
Progress in Noise Control.
Details: Inter-Noise 86 Secretariat, MIT Special Events Office, Room 7-111, Cambridge, Massachusetts, 02139, U.S.A.

July 16-18, HALIFAX

ICA SYMPOSIUM.
Underwater Acoustics.
Details: See 12th ICA.

July 21-22, MONTREAL

ICA SYMPOSIUM.
Units and their Representation in Speech Recognition.
Details: See 12th ICA.

July 24-August 1, TORONTO

12th ICA.
Details: 12th ICA Secretariat, Box 123, Station 'Q', Toronto, Canada M4T 2L7.

August 4-6, VANCOUVER

ICA SYMPOSIUM.
Acoustics and Theatre Planning for the Performing Arts.
Details: See 12th ICA.

September 2-6, HUNGARY

6th FASE SYMPOSIUM.
"Subjective evaluation of objective acoustical phenomena."
Details: 6 FASE-Opt. Akuszt. Filmt., Anker-koz 1, H—1061, Budapest.

● October 1-3, TOOWOOMBA

CONFERENCE ON COMMUNITY NOISE.
Details: Ms Nola Eddington, Division of Noise Abatement, 64-70 May Street, BRISBANE, Q. 4000.

October 21-24, TOKYO

8th INTERNATIONAL ACOUSTIC EMISSION SYMPOSIUM.
Details: Prof. Dr. K. Yamaguchi, Institute of Industrial Science, University of Tokyo, 22.1 Roppongi-7, Minato-ku, TOKYO 106, JAPAN.

November 3-6, CZECHOSLOVAKIA

25th ACOUSTICAL CONFERENCE ON ULTRASOUND.
Details: House of Technology, Ing. Vani Skultetyho ul. 1 832 27 Bratislava.

December 8-12, CALIFORNIA

MEETING OF THE ACOUSTICAL SOCIETY OF AMERICA
Chairman: Alan H. Marsh, DyTec Engineering Inc., 5092 Tasman Drive, Huntington Beach, CA 92649, U.S.A.

1987

May 19-21, POLAND

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

July, ANTWERP, BELGIUM

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

Motor Vehicle and Traffic Noise Proceedings

The Proceedings of the 1985 Conference of the Australian Acoustical Society are now available for purchase. These Proceedings include the Keynote Paper by Dr. A. Alexandre, from the OECD, on "Strengthening Motor Vehicle Noise Abatement Policies". The other 28 contributed papers deal with the many aspects of traffic noise and the noise from different types of motor vehicles.

The cost of the Proceedings, including handling, packing and surface postage, is $35 (Aust.).

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Information for Contributors

Articles for publication in The Bulletin may be of two types:

(a) Short articles which will appear as a Report or Technical Note;
(b) Long articles which may take the form of a discussion, review, tutorial or technical paper. A referee's report will be sought for the latter.

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

Vol. 14, No. 1 — Long articles: January 10 — Short articles: February 21.

Vol. 14, No. 2 — Long articles: May 16 — Short Articles: June 20.

Contributions should be sent directly to the Chief Editor.

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