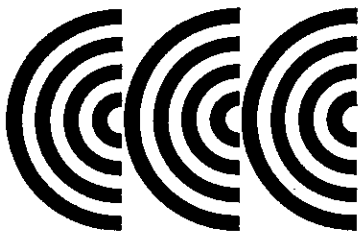

Acoustics Bulletin

October 1983 Volume 8 Number 4

INSTITUTE OF ACOUSTICS

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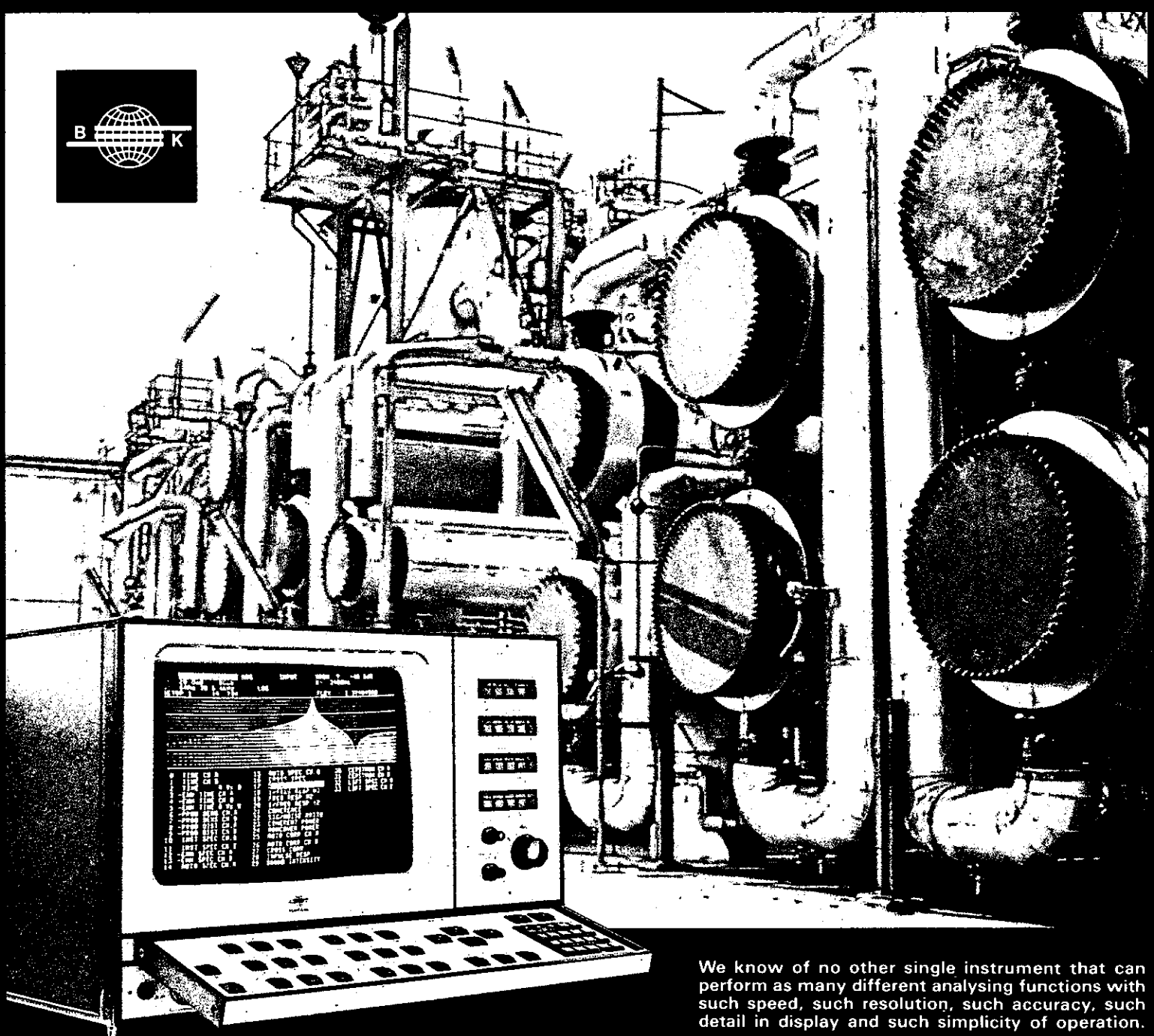

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The Institute of Acoustics was formed in 1974 by the amalgamation of the Acoustics Group of the Institute of Physics and the British Acoustical Society and is now the largest organisation in the United Kingdom concerned with acoustics. The present membership is in excess of one thousand and since the beginning of 1977 it is a fully professional Institute.

The Institute has representation in practically all the major research, educational, planning and industrial establishments covering all aspects of acoustics including aerodynamic noise, environmental acoustics, architectural acoustics, audiology, building acoustics, hearing, electroacoustics, infrasonics, ultrasonics, noise, physical acoustics, speech, transportation noise, underwater acoustics and vibration.

ISVR: A Celebration

A little nostalgia, a certain amount of good spirit and a wealth of old friends were indeed the successful ingredients of the 20th Anniversary Birthday Celebrations at the Institute of Sound and Vibration Research, Faculty of Engineering, University of Southampton.

Over 400 staff members, ex-students and their wives gathered at Glen Eyre Hall on the memorably balmy evening of July 9 for a formal dinner, where they welcomed many ex-ISVR members including Margaret and Brian Clarkson, now Principal of University College Swansea; Grace and Albert Hyde, retired and enjoying a Spanish life style; Graham Rood, now with RAE; Colin and Valerie Mercer and Roger and Hilder Pacifico who left the Institute to successfully pursue their own business careers.

Guests were treated to a feast of cold roast sirloin of beef, baked ham, roast turkey, platters of various seafood, numerous salads and a variety of gourmet desserts that destroyed the resolve of the most determined dieter!

After dinner Professor E J Richards, founder of the Institute and now, in his retirement, a Research Professor, proposed a toast to the continued vitality, co-operative spirit and prosperity of the Institute. He recalled his decision in 1961 that 'if aeronautics was to grow, acoustics should separate out into a clearly defined Institute of Noise and Vibration Research'.

He mused that 'in these early times, noise was an emotive word like bother, and many faculties within the University did not share in my vision of an Institute devoted to studying all aspects of this subject. Now, however, eighty per cent of the annual budget of 2½ million pounds is non-UGC funds, and is made up of many grants from industry and government. This money is brought in by the efforts of many staff members'.

Professor Richards concluded that ISVR is now a major department in the University and a significant contributor to the reputation of the University.

The highlight of the evening was the toe-tapping variety entertainment, organised by chairperson, Pat Davies, compered by Max Wells and including the Frequency Shifters, a lively musical group featuring Jeremy Nedwell on french horn, Tony Lawther on guitar, Ken Brown on clarinet, Peter Watkinson on cornet, Maurice Petyt on trombone, Colin Ryde on drums, Frank Fahy on 'funny' instrument, Rob Drew on electric piano, Ed Kruzins on banjo, Tim Lewers on guitar, and Bob White on trombone.

Sharing the limelight beautifully in their turquoise costumes with cerise bands were the lovely ISVR Decibells, who included Sue Cunningham, Sue Hall, Karen Pedley, Elaine Service, Jane Tout, Angela Barks, Pat Davies and Wendy Thomas. A hilarious poetry recital with sound effects was given by Chris and Kirsten Pickering, Dr Roger Thornton cut Maureen Strickland in half during his magic act, and Tony Lawther captivated the audience with his specially devised ISVR song, complete with slides portraying department personalities. Grand finale to a memorable evening was the cutting of the ISVR birthday cake, with many wishes for a bright future. □

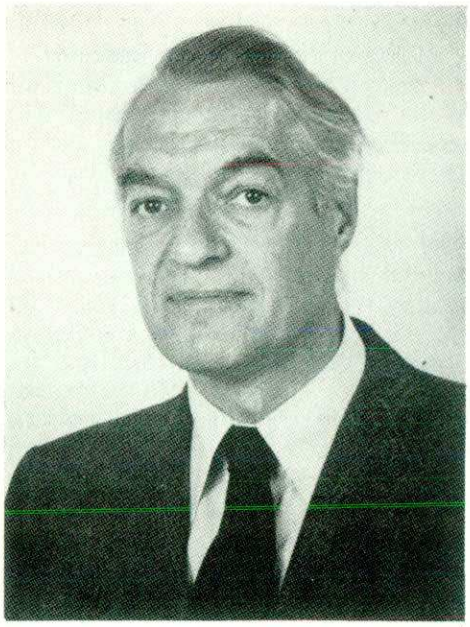
Barbara Large

Tony Lawther on guitar

Professor E J Richards, founder of ISVR, recalling early days in ISVR

Winding up a lively rendition of 'When the Saints go marching in' are some of ISVR's Frequency Shifters

Vocal entertainment by the lovely Decibells



Presidents Letter

Dear Member,

There has been no Council Meeting since my last letter was written, and so I wish to make just a few remarks on technical meetings. The Inter-Noise Meeting in Edinburgh has now taken place, a major enterprise and a great success with around 700 participants. I am sure there were great sighs of relief from the Organising Committee and the Headquarters Staff, and we certainly owe them a debt of gratitude. I will say no more to avoid spoiling better accounts elsewhere.

This summer has also seen the 11th International Congress on Acoustics in Paris, together with satellite meetings elsewhere. The attendance was a few hundred greater than at Edinburgh, but of course this is for a meeting which only occurs every three years and covers all branches of acoustics.

As far as I personally am concerned this spate of large International Meetings is to be followed by a much smaller Conference in Rome. Noting the weather this summer this all means that I am beginning to associate acoustics with high temperatures. But then it is rather appropriate to get a warm feeling when I think about acoustics.

Yours sincerely,

David Weston

Acoustics at AIRO

A J Jones FIOA and C Schofield MIOA

For nearly twenty-five years the AIRO acoustics laboratory has been involved in the evaluation of the acoustic characteristics of all types of materials and equipment, with particular reference to the construction industry. In addition to certification work, a number of studies have been undertaken into new building techniques. The results of these studies and the very existence of the considerable data base which has been accumulated over the years provide valuable design guidance for the future.

The Development of the Laboratory

IN PARALLEL with the inauguration in 1958 of the Acoustical Investigation & Research Organisation Ltd (AIRO) as one of the United Kingdom's first independent consultancy firms to be established for the sole purpose of practical investigation and research into all aspects of noise problems, the design of the company's acoustic laboratory was being undertaken with the co-operation of the National Physical Laboratory and Building Research Station. The new laboratory was duly opened in October 1959 and was widely hailed as the first commercial facility in this country to bring under one roof all the special equipment and techniques necessary for acoustic measurements of every description.

At that time the laboratory consisted of four experimental chambers and an underground duct, which can be used as a low frequency standing wave tube, in addition to the control room which housed the instrumentation for measurement and analysis purposes. One of these chambers is a 200 m³ reverberation room, especially designed to exhibit long reverberation times and diffuse sound fields by virtue of its irregular reflective surfaces and suspended diffuser panels. This room was designed to be used in its own right for measurements of sound absorption of materials and sound power spectra of noise sources of various types, whilst it could also be used in conjunction with other rooms to form transmission suites for the measurement of sound insulation. The building's distinctive gantry, which can be seen in Figure 1, carries a crane which is used for the installation of floor structures in the aperture between the upper source chamber and the reverberation chamber below, to enable impact and airborne sound transmission testing on specimens, whilst a similar aperture between the adjacent ground floor source and reverberation chambers provides the facility for airborne insulation measurements on partitions and other separating structures such as windows and doors.

Since the prime objective of a laboratory of this type is the direct and accurate measurement of sound under controlled conditions, the building design incorporated measures to enhance the signal to noise ratio by minimising the ingress of extraneous external noise and reducing flanking transmission between the rooms. For example, the reverberation chamber comprises a massive structure built within and mechanically isolated from the main outer building shell, which is itself of substantial construction. The fourth chamber was the anechoic room, also mechanically isolated from the external building envelope, but in this case lined internally with up to 760 mm thick acoustically absorbent material to provide a reflection free environment over a wide frequency range for investigations of the directivity of noise sources and for the measurement and calibration of loudspeakers and microphones. An air handling system was also included in the design of this facility enabling air to be ducted via the anechoic and reverberation chamber to permit assessments of various elements in ventilation systems.

Such was the response to the services offered by this new research station that by 1963 it was becoming clear that the facilities should be extended in order to reduce the waiting time for testing work. This was also the time of considerable public debate on the subject of noise with the publication of the Wilson report. It was with this background that in May 1965 the extension to the laboratory was opened, virtually doubling the original capacity with the addition of two new transmission suites employing a common source room, one with a fully isolated 225 m³ reverberation chamber as the receiving room and the other with a partially isolated 100 m³ receiving room. The advent of high velocity ventilation systems in new buildings prompted the replacement of the original fan system in 1976 by higher duty air handling plant bringing the laboratory to its present capability. The floor plan of the extended laboratory is shown in Figure 2.

The daily work at the laboratory involves the measurement of the acoustic characteristics of a wide variety of materials and equipment and, as can be imagined, over the nearly quarter of a century of operation a considerable amount of acoustic

Figure 1 The AIRO acoustics laboratory, Hemel Hempstead

data has been amassed. This covers both product certification data and development research work undertaken for a diverse range of clients, and because the confidential relationship between the laboratory and its clients is of paramount importance it is not possible to divulge the results of specific tests. However, it is possible to provide an overview of some of the studies undertaken and to present statistical summaries which can be of valuable practical use.

Taking as a theme the increasing use of lightweight elements in buildings which has occurred over the last twenty years or so, examples of studies and assessments of sound insulation have been selected to illustrate something of the work performed at AIRO's laboratory.

Empirical Mass Law

The large base of test data on sound insulation of a wide range of partitions, windows and other types of separating structure could obviously act as the basis for a whole range of empirical mass law formulae which, unlike a detailed mathematical calculation procedure, would provide a reasonable and quick estimate of a partition's sound insulating properties. As an initial exercise, the results of some ninety recent individual tests on double leaf partitions of various types have been compiled and analysed. All these tests were conducted to provide the Sound Reduction Index over the frequency range of 100 to 3150 Hz in accordance with BS 2750:1980 (part 3) and the results rated using the procedures given in BS 5821:1980 so as to obtain the Weighted Sound Reduction Index, R_w.

Figure 3 shows a lightweight stud partition being erected in the aperture between the source and receiving chambers in preparation for a sound insulation measurement. The types of partition included in this study cover double windows, thermal double glazing with and without secondary windows, double and triple leaf partitions in various materials such as plasterboard, chipboard, metal etc, composite double skin partitions and blockwork walls. It can, therefore, be expected that the results of a linear regression of R_w against the logarithm of the product of overall mass per unit area and cavity width would provide a prediction formula which can find practical application for a wide range

Figure 3 Installation of a lightweight partition in a transmission suite test aperture

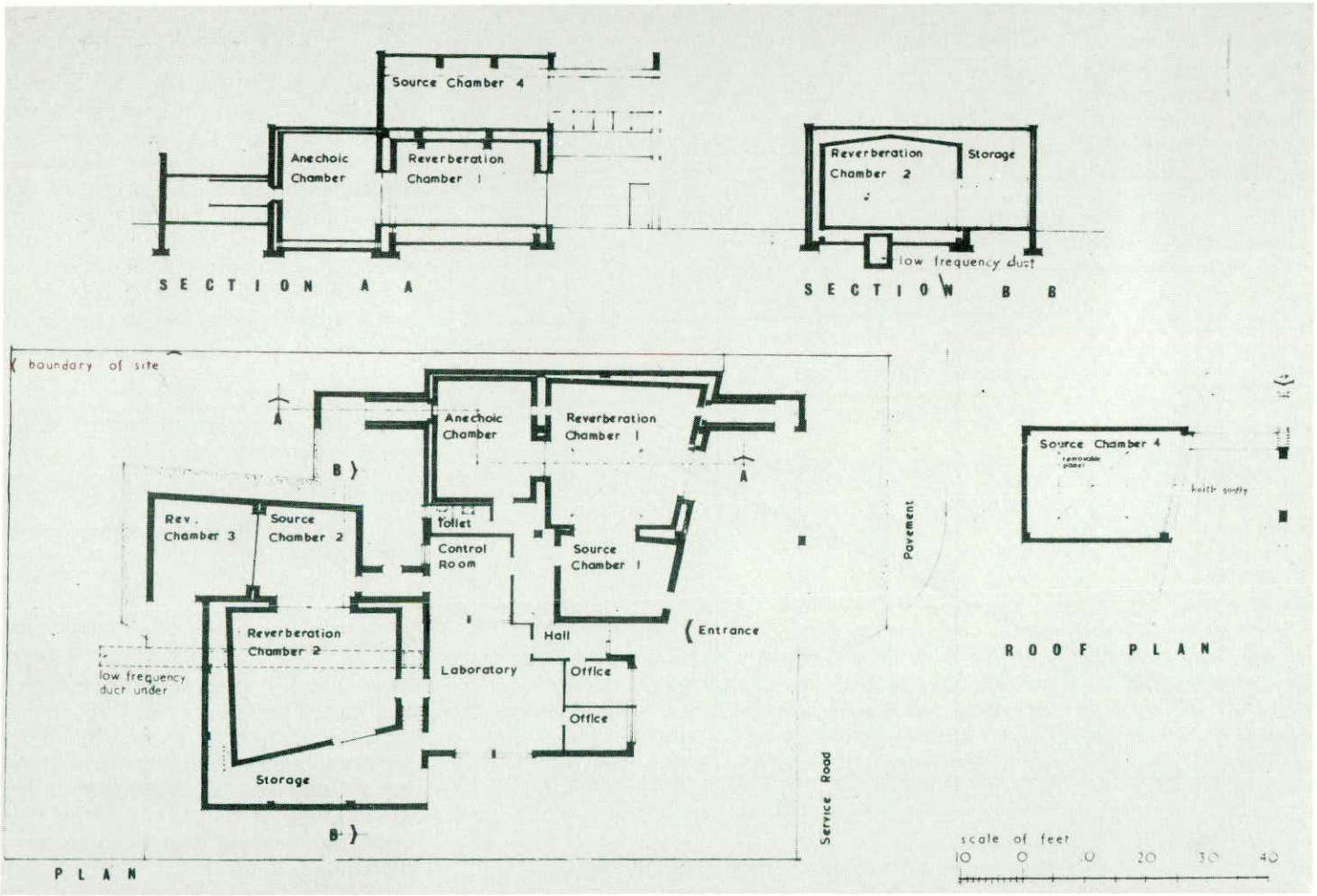


Figure 2 Floor plan of the AIRO acoustics laboratory

of two leaf partitions. This regression analysis provides the following relationship with a correlation coefficient of 0.81:

$$R_w = 12 \log (m.d) + 3$$

where m is the total mass per unit area of the main leaves of the partition in kg/m² and d is the cavity width between the outer leaves in mm. This relationship is shown graphically in Figure 4. One factor which is clearly related to the variance observed in these measurements is the absorption contained within the cavity. For example a typical double leaf partition with an 'm.d' of 3300 gives an estimated R_w of 45, but with an empty cavity the measured result might be of the order of 43 whilst a porous type absorption material in the cavity might give rise to a measured value of around 47. Factors such as these are deserving of further detailed analysis, but in the mean time the AIRO simple mass law for double leaf partitions can provide a reasonable estimate of a partition's inherent insulating potential.

Sound Insulation Between Rooms with a Common Suspended Ceiling

Of course this mass law is based upon data in which flanking transmission is, for practical purposes, absent. In a finished building the effects of flanking transmission can be of major significance and in this area too the laboratory can be used to quantify the problem. For example, the small transmission suite at the rear of the laboratory has been used for the purpose of measuring the sound insulation of flanking constructions through the construction of an enclosed void along the continuous wall of the suite. The flanking construction under test is built in the void aperture with the associated partition in the normal test aperture. This particular arrangement has been used to check the effects on sound insulation of particular combinations of dividing walls and flanking wall and the limiting performance of various ceiling designs when used in conjunction with a substantial wall in the normal aperture.

The study of sound insulation between rooms with the increasingly frequent common suspended ceiling was taken further in an investigation for the Property Services Agency of the Department of the Environment. Two measurement facilities were employed for this study, the first being a specially constructed pair of rooms separated by a 215 mm brick wall, except for the space to be used as the void, at the Princes Risborough laboratory of BRE. The second facility was AIRO's vertical transmission suite. Measurements in both cases were made over the frequency range of 100 to 3150 Hz in accordance with BS 2750:1956; at Princes Risborough the room to room normalised level difference was measured with a number of suspended proprietary ceilings arranged to have a perfect seal with the partition head, while at AIRO the ceilings were suspended in the test aperture, taking care to avoid perimeter gaps, for measurements of Sound Reduction Index. Of the 42 ceilings subjected to tests for horizontal transmission, 34 were tested for vertical transmission, with weights ranging from 0.8 to 34 kg/m². The mean values of Sound Reduction Index (V) ranged from 12.1 to 32.8 dB whilst the equivalent range of room to room normalised level difference (H) was 22.5 to 46.5 dB. It may be observed that the total range of 24 dB for the horizontal transmission tests was only marginally greater than that of 21 dB for the vertical tests giving an indication that the suspended ceilings acted more like a double leaf partition than two partitions separated by a large void. Taking the 34 pairs of results from horizontal and vertical transmission tests, the following relationship was found, with a correlation coefficient of 0.92:-

$$H = 1.1\ V + 12.8\ dB$$

where H is the mean value of room to room normalised level difference (100 – 3150 Hz) and V is the mean value of Sound Reduction Index. The low V factor confirms the earlier impression that the suspended ceiling behaves more like a double leaf structure than two separate partitions. Updating the results in terms of BS 5821:1980 gave the following relationship between the room to room weighted normalised level difference $D_{nT,w}$ and weighted Sound Reduction Index R_w with a correlation coefficient of 0.90:

$$D_{nT,w} = R_w + 13.5$$

whilst the mass law for the vertical transmission tests was found to be:

$$R_w = 9.5 \log(m) + 14$$

where m is the superficial density of the ceiling in kg/m².

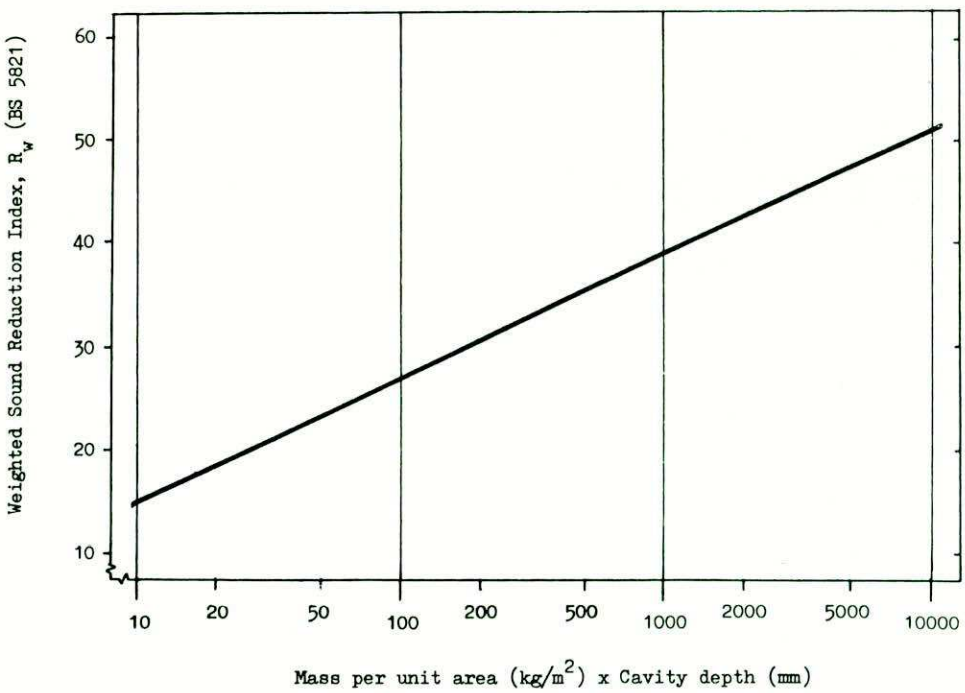


Figure 4 The AIRO simple mass law for sound insulation of double leaf partitions

Raised Access Flooring

Now that the suspended ceiling is an established feature of many new buildings, it is interesting to note the recent growth in use of the raised access flooring systems which offer a similar risk of flanking transmissions, this time under rather than over the separating partition. Recently a special test facility was built around one of the laboratory transmission suite apertures so as to provide two adjacent rooms

separated by a substantial partition with a rectangular aperture 350mm deep at floor level, as illustrated in Figure 5. Floor systems were installed spanning below the partition, and sealed to its underside such that measurements of room to room weighted normalised level difference could be carried out. For the specific floors considered to date these measurements have ranged from just below 40 to in excess of 50 and it is hoped that in due course a more detailed mathematical analysis will be undertaken to provide further valuable design guidance.

Other sound insulation studies undertaken at the laboratory have included the development of high performance lightweight composite laminated partitions for use as bulkheads in passenger ships and a study of the importance of the various parameters of the isolating medium in floating floor systems for use in both timber and concrete floors in dwellings.

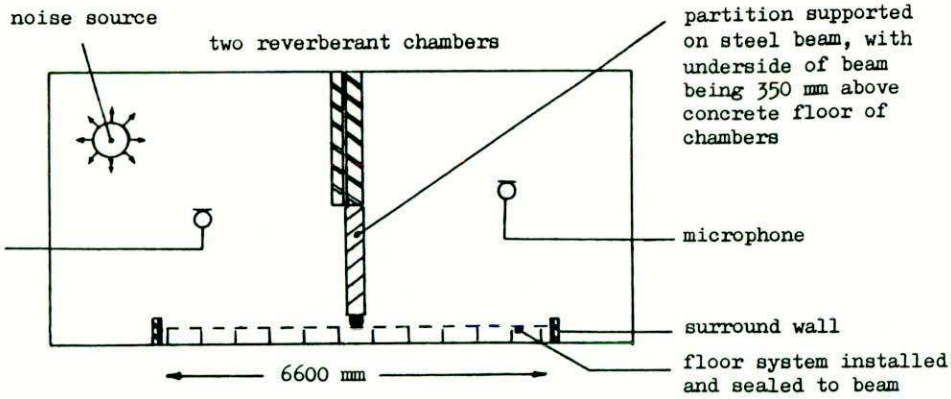


Figure 5 Schematic illustration of the access floor testing arrangement

Concluding Remarks

It is hoped that this summary of some of the work conducted at AIRO's acoustic laboratory shows the value of being able to measure the characteristics of materials under controlled conditions. Just as techniques have changed in the building industry over the past 25 years and brought their attendant acoustic problems so they will again over the next 25 years, and it seems likely that as many new research and development topics will be initiated as have been seen in AIRO's history to date.□

CITATIONS

RAYLEIGH MEDAL FOR 1984

Professor J E Ffowcs Williams

John Ffowcs Williams was Spitfire Memorial Scholar to Southampton University, receiving his BSc in 1958 and PhD in 1960. The period 1960-1962 was spent at the National Physical Laboratory, and 1962-1964 with Bolt Beranek and Newman. He then moved to Imperial College, eventually becoming Rolls-Royce Professor of Theoretical Acoustics. Since 1972 he has been Rank Professor of Engineering (Acoustics) at Cambridge University and is a Professional Fellow of Emmanuel College.

His field is acoustics linked to fluid mechanics. The fluid under consideration has sometimes been air and sometimes water, and other wave motions as well as sound have been treated. But his main contributions have been to the understanding of the aerodynamic generation of sound, investigating analytically the roles of turbulence and of boundary layers. His work has not been restricted to the realms of theory but has extended to the highly practical and highly important question of what to do about jet noise. As some evidence for this, he has acted as Executive Consultant to Rolls-Royce, and chaired the ARC Noise Research Committee for several years.

As implied above, a second interest lies in underwater acoustics. Some of the same problems, such as flow noise, reappear, but there are also new ones such as bubble radiation.

Shôn has published a large number of influential research and review papers. Added to this is the making of a film on aerodynamic sound, and co-authorship of a recent book on *Sources of Sound*. The chronicle of his energy, leadership and achievement is still far from complete: Organiser of the Institute's 1978 Spring Conference, Chairman of a consultancy firm, and recipient of the 1978 AIAA Aeroacoustics Medal.

For his distinguished and effective work in acoustics, including studies of jet and propeller noise, the Institute of Acoustics awards Professor J E Ffowcs Williams its Rayleigh Medal.

TYNDALL MEDAL

Professor R G White

Professor White received his professional training at the Royal Aircraft Establishment, Farnborough, where he was a member of the Instrument Division. In 1967 he joined the Institute of Sound and Vibration Research as a Research Fellow working on the development and assessment of a new transient method of vibration measurement. This work led to the award of a PhD in 1970 by the University of Southampton. In 1970 he was appointed Lecturer in Structural Dynamics.

Professor White developed the swept sine technique for structural vibration measurement and the associated on-line computer methods for analysis. More recently he has developed techniques for the identification of the vibration characteristics of structures

from acceleration data. A new experimental method to measure the power flow through structures has been developed. He has worked on vibration isolation systems and is now an acknowledged expert on experimental analysis of structural dynamics of fibre reinforced plastic plates. This has included studies of the natural frequencies, methods of increasing the damping, and the fatigue of composite structures. He has developed ultrasonic and

acoustic emission methods of detecting internal damage in these composites.

He is a very enthusiastic and effective teacher and is much in demand as a supervisor of undergraduate and postgraduate research projects. He has been invited regularly to give lectures on short courses run by Cranfield Institute of Technology, IBM, Plessey and Sperry. He is a member of the British Standards Committee on Shock and Vibration and a Vibration Consultant to the UNESCO (in this latter capacity he has made several extended visits to the Polytechnic at Bucharest to help in the building up of a Vibrations laboratory and a teaching course in the subject). He has been involved in many vibration consulting projects for industry, in particular the ship and aircraft construction companies. He has recently been made a visiting scientist at R A E Farnborough.

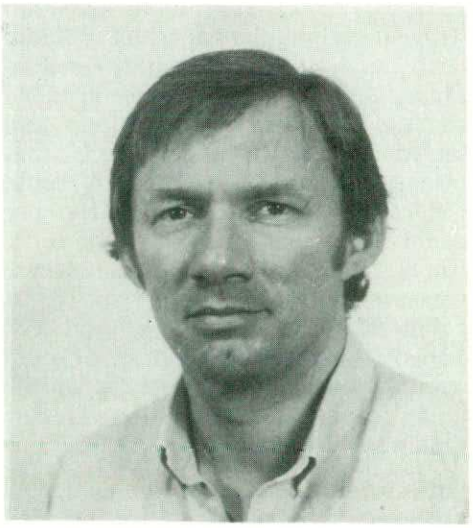
In 1982 he was appointed Director of the Institute of Sound and Vibration Research and in 1983 he became the Professor of Vibration Studies in succession to Professor B L Clarkson. Thus he is now in charge of the largest research centre in acoustics in the world. The award of the Tyndall Medal is a fitting recognition of the many contributions which Professor White has made to the broad field of acoustics.

A B WOOD MEDAL AND PRIZE FOR 1984

M J Earwicker

Martin Earwicker graduated in physics from the University of Surrey at Guildford. He joined the Admiralty Underwater Weapons Establishment at Portland in 1970, and is now a Senior Principal Scientific Officer. During his time at AUWE he has specialised in underwater acoustics and related problems.

His interests have centred around underwater acoustic transducers, including baffles and arrays. His research area covers the theoretical, experimental and material development necessary for high performance. The work on techniques for prediction of farfield beam patterns from measurement of nearfield data is particularly noteworthy, being not only a significant piece of theoretical acoustics, but also a topic which he carried right through to the development of practical methods. Martin's efforts have also extended to signal processing and systems considerations.



Despite the need to lead a large group of people, he has maintained his own strong personal contribution. Thus he has written a large number of papers, but only a proportion of these have been for the open literature.

Martin has also been active in the affairs of the Institute, on the Committee of the Underwater Acoustics Group and in Meetings organisation. But it is for his distinguished work on all aspects of underwater acoustics transducers and fields that the Institute of Acoustics presents M J Earwicker with the A B Wood Medal and Prize.□

Musical Acoustics Information Service

A project which has been in progress for some years at the University of Surrey under the direction of J M Bowsher has now been completed. As a result it is possible to offer a comprehensively-classified literature search service in the field of musical instrument acoustics. A store of over 2 600 references to publications exists, both on conventional index cards and on hand-notched punched cards. Both these indices will be kept up to date. About 200 key-words have been allotted, and by using these singly or in combination entries on any desired topic can be located. In addition, entries are classified by author and date of publication in the customary way, so that contributions by specified authors, or by any author during a specified period, can be found.

Enquiries should be directed in the first instance to F J Dibdin, 16 Winchester Drive, Chichester, West Sussex, PO19 4DE, telephone Chichester (0243) 781964 (day or evening). It will be necessary to make a small charge to cover the expenses of operating the service, and this will obviously depend upon the number of entries involved.□

J M Bowsher

Remuneration Survey

Response to the survey was much higher than anticipated, with well over 400 forms returned. This unfortunately prolonged the coding and verification of the data and work on statistical analysis has only just started. It is hoped to include a full report on the results of the survey in the next issue of the Bulletin.□

J Hyde
M Blackaller

Inter-Noise '83

Inter-Noise 83 had its origins in a chance conversation with Professor Fritz Ingerslev at Inter-Noise 79 in Warsaw. Fritz Ingerslev mentioned that a European venue for 1983 was being sought by International INCE. A complication was that the ICA was to be held in Paris in July, at dates not then known, and Inter-Noise would have to take place either consecutively with the ICA or with maximum time difference, in view of the large distances which some delegates would travel. An offer to investigate the possibility of holding Inter-Noise 83 in the UK was received with encouragement, but there was an important obstacle to be overcome. A prerequisite is that the body representing acoustical interests in the host country must be a member of International INCE. The Institute of Acoustics was not a member. In fact, Council of the IOA had previously turned down suggestions that the IOA should join International INCE. However, the possibility of holding Inter-Noise 83 in the UK swung opinion in favour of membership and this obstacle was removed.

The next development was at the IOA Spring Meeting at Bedford College in 1980. Fritz Ingerslev, as Chairman of International INCE, addressed the meeting about I/INCE and also gave the go-ahead for the IOA to organise Inter-Noise 83. Fritz also expressed a preference that the meeting should not be held in London.

Council appointed a small steering committee to consider alternative locations. A number of possibilities were investigated and, at one stage, about twelve locations were listed. However some of these turned out to be unsuitable, whilst others were already booked, and the choice finally focused upon Edinburgh. Here we had a good choice of lecture rooms and other conference facilities, sufficient hotel accommodation for the large number of delegates expected, an attractive location and the Institute's office on the spot. Therefore Edinburgh was chosen as the location for Inter-Noise 83 and the detailed planning commenced in the middle of 1981.

The organising committee held meetings every few months for the next two years, whilst a great deal of work was also done by individual committee members, particularly in arranging the programme (Ken Ratcliffe) and in editing the Proceedings (Roy Lawrence). Meanwhile, the office staff worked through mountains of publicity leaflets, distributing them to all corners of the world. The publicity was greatly assisted by about 5000 address labels sent to us from INCE-USA and by insertions in Brüel & Kjaer's circulars.

The programme began to take shape as the last date for submission of abstracts was reached, going through a number of modifications and juggling of rooms until the final form crystallised shortly before the Conference opened.

Delegate numbers outstripped our most optimistic estimates with a final total of nearly 700 delegates from 38 countries and about 200 accompanying persons. The delegates distributed themselves amongst several parallel sessions to listen to nearly 300 papers, whilst their accompanying persons went on a series of day trips.

The Conference was opened by the Lord Provost of Edinburgh who entered the hall preceded by a piper. The opening session was notable for the informality and humour of the speakers, the Lord Provost, Professor Richards and Professor Ingerslev. This set the tone of a friendly, informal conference with an active social side.

The Organisers(1): Members of the Organising Committee with the Lord Provost of Edinburgh welcome delegates to Inter-Noise 83 at the opening ceremony

The Lord Provost invited delegates to a Civic Reception in the evening of the opening day. The Assembly Rooms echoed to the sound of hundreds of individual conversations until a beautiful display of Scottish Dancing took delegates' attention.

There were three plenary session at which eminent speakers were invited to address all the delegates. Michael Griffin gave a review of the effects of vibration on humans, F Ingemansson recounted some of his personal experiences in acoustical consultancy and Harold Marshall described his approach to the acoustical design of concert halls and related this to recent research developments in this field. It is not easy, at a conference of this size and covering so

The Organisers (2): Roy Lawrence with Ruth Hampton (left) and Cathy Mackenzie. Together they were responsible for a great deal of the behind-the-scenes administrative work before, during and after the Conference

many nationalities and specialist disciplines, for any speaker to make his or her presentation acceptable to all, but these three speakers nevertheless succeeded admirably in keeping their audiences interested and we thank them for their contributions. One disappointment was that illness prevented Eugen Skudrzyk's attendance so that the presentation of the 1983 Rayleigh Medal and Medal Lecture had to be postponed to another occasion.

Otherwise, the Conference proceeded with remarkably few obvious crises, as most difficulties were anticipated or rapidly dealt with by the efficient registration staff.

Social Programme

A busy programme had been arranged by Cooks for those accompanying delegates to the Conference, and many delegates themselves were sorely tempted by tours of the Trossachs, a whisky distillery and Edinburgh itself. The warm, sunny weather which encouraged delegates to stand around outside the conference rooms and make new acquaintances while discussing the papers, also contributed to the success of the tours which were much appreciated.

A substantial number of delegates stayed for the Closing Reception, the sign of a successful conference. The final contribution to the closing session was the introduction of the next Inter-Noise which is to be held in Honolulu, 3rd–5th December, 1984. Bill Lang, Chairman of the Organising Committee, showed slides of the location, turning our thoughts from Inter-Noise '83, which was about to close, to the future, represented by Inter-Noise '84.

Dr H G Leventhall

TECHNICAL SESSIONS

Effects of Industrial Vibration on Man

Ten papers were presented in this session with topics extending from the effects of hand-held tool vibration to vibration in vehicles and buildings. The influence of gloves and seats on the transmission of vibration to the body was covered and two papers were concerned with laboratory experimentation. Authors came from Japan, Denmark and the United States in addition to the United Kingdom.

A paper by O'Connor and Frood discussed the various factors which affect the measurement of tool vibration. Some of the problems were illustrated with experimental data obtained by a 'round-robin' test in which the vibration of a tool was measured in different laboratories. Rasmussen and Rasmussen presented data on hand impedance and the power transmitted to the hand-arm system. Voss presented data which predicted the transmissibility of various gloves. He concluded that attenuation of vibration at frequencies above 60 to 80 Hz is possible. Hilyard and Collier were concerned with models for predicting seat transmissibility — particularly the response of foams.

A paper by Guignard was not included in the proceedings but was available after the presentation. The author discussed the possible mechanisms whereby whole-body vibration may affect human performance. Two experiments by Hiramatsu and Griffin investigated the use of magnitude estimation as a means of determining the subjective severity of motions whose amplitudes varied with time.

Stayner presented data on tractor vibration and the ranking of vibration severity by tractor drivers. He concluded that a modification to a tractor successfully improved ride and could also increase productivity. A paper by McNulty, Douglas, Hilyard and Collier was concerned with the evaluation of vibration in earth moving vehicles. They concluded that the vibration was in excess of values considered allowable in the appropriate ISO standard. Measures of both seat and human body impedance were presented in a paper by Fairley and Griffin. They showed how seat transmissibility depended on body impedance and how useful predictions could be made from impedance measurements. The final paper, by Irwin was not presented. It addressed the question of a combined index for noise and vibration in buildings.

M J Griffin

Occupational Noise

There were thirteen papers in this session which was well attended and, being a new topic for Inter-Noise, perhaps indicates a need to consider it as a regular event for future conferences.

The first paper by Dr Alice Suter gave a critical review of the outlook for occupational noise regulations and hearing conservation in the US. As an ex-employee of both EPA and OSHA, Dr Suter is ideally suited to comment on these topics. She pointed out a number of current and future problems, which in the main are of an administrative and political nature. Two papers were presented on occupational noise control and the costs involved in Denmark, which painted a more successful and hopeful picture for the future of industrial noise in that country. Perhaps the most controversial paper of the session was given by Mr Peter Sutton, who argued most strongly and cogently against the draft EEC Directive proposal for an industrial noise limit of 85 dB(A) L_{Aeq} with monitoring audiometry also being mandatory at that noise level. Not unnaturally this paper produced some considerable and heated discussion. At the very least his presentation should make those in the field review the existing data and their ideas on the subject very carefully.

Four papers were given on the evaluation of hearing protectors. These included the field measurement of attenuation of earmuffs for industrial impact noise, the noise dose measurements on shipyard workers, and preliminary results of a Nordic round robin test on hearing protectors employing measurement procedures similar to those in the new ISO 4869 and ISO/DIS 6290 standards. The fourth paper by Dr Elliott Berger reviewed previous and new data concerning the evaluation of protectors by nine different laboratories following the same US standard procedure ASA SDTI-1975. He concluded that factors such as subject selection, sample selection, fitting techniques, sizing technique and duration of use could all materially affect the results obtained. He counselled caution in the use of such data in deriving single figure attenuation ratings, such as the Noise Reduction

Rating, which many buyers of protectors use as their sole purchasing criterion.

Papers were also presented on different techniques for evaluating individual and group noise exposure levels, and computer-based serial measurement and analysis of hearing thresholds in the industrial context.

A Martin

Structural Response and Vibration Analysis

Study of the conference proceedings will show that this session contained ten papers which ranged in content from structural dynamics to the effects of vibration on man in buildings.

The session opened with the paper of Mr Ranky and Prof Clarkson which summarised some work carried out at the ISVR on the analysis of spacecraft structures using Statistical Energy Analysis. This type of approach requires a mixture of theoretical and experimental studies; approximate estimations of structural responses are made, for example, using some measured loss factor data. The work illustrated the fact that although we are now in the age of high computer technology with powerful numerical analysis methods, less rigorous methods still have an important place in engineering design. This theme ran through the paper presented by Dr Pinnington who showed how power flow techniques may be used to assess the relative contributions of mechanical and acoustical transmission paths, in machine-isolator-substructure systems. Power flow is the unifying concept in this situation which also offers the only method of comparing the structural responses induced as various wave types in the machinery seating.

Coupled system power flow measurement methods were well illustrated via study of a machine on a stiffened substructure. The case of point excitation of a large plate had been examined by Mr Lee who presented analyses which showed how power levels varied as a function of distance from the source and postulated areas within which response level measurement transducers should be confined. Extension of frequency response and related techniques to more practical diesel engine installations in ships was covered in the paper of Dr Plunt who outlined the Nordic Cooperative Project. This work has already been reported upon in part at earlier Inter-Noise meetings — but formed a very useful review of the shipboard problem and modelling techniques. The final report on this project is awaited with interest. Dr Kinns is active in the shipboard noise and vibration field and he highlighted the need for very simple excitation techniques for frequency response measurements in ships in areas which are relatively inaccessible and preclude use of conventional exciters. A repeated impact exciter has been developed for use in such situations and care had been taken to examine possible sources of error in dynamic measurements such as the contact stiffness problem. The works of Y-ARD were further described in the following paper by Dr Kinns, Mr McColl and Dr McKinstey, who gave the presentation, which highlighted the variability of results which can be obtained in repeated measurements on machines over a long period and discussed the approach to estimating the significance of the variations observed.

Vibration testing and analyses are of course only carried out with the objective of eventual vibration or noise control. Dr Cuschieri illustrated the approach to radiated noise prediction using structural response methods which may often be used in very simplified form but which have a good basis in theory. As well as the industrial machinery problem, ie punch presses etc which have been the subject of much scrutiny via this approach and the Richards Energy Accountancy Equation, Dr Cuschieri spoke of the analysis of piston slap generated vibration and noise in internal combustion engines. The acoustic radiation from structures of a very different type was described by Mr Jakobsen who outlined very practical measures which he had applied for the reduction of brake squeal from railway wheels. Dynamic absorbers (vibration neutralisers) and damping treatments have been applied to wheels and because of the nature of wheel cross-sectioned profiles practical means of applying constrained layer damping treatments have to be simple and, of course, robust. The paper of Dr Capponi concerned the rail/wheel interaction which generates vibration in the track and tunnel walls of underground train systems. The effects of parameters such as track bed type and train speed were presented but it had been found that vehicle suspension system condition could be a dominant factor in vibration production and good maintenance schedules must be implemented as an essential part of the vibration control procedure. The impact of noise on man in the form of pass-by noise, squeal etc from trains is perhaps obvious but the vibration problem can be very complex. Prof Grootenhuis illustrated the effects of ground vibration by considering the transmission of such vibrations into buildings via foundations with the attendant need for simple prediction methods and knowledge of amplification factors. Vibration in buildings can cause damage and discomfort. Criteria for the former were presented which indicate the likelihood of damage occurring, as also were perception curves. The need for experimental data concerning structural Q factors and mobilities if predictions are to be made was stressed.

The session was very useful in bringing together a range of vibration topics and it highlighted the fact that if

Members of the Organising Committee with the Lord Provost of Edinburgh at the Civic Reception

structural designers are to make dynamic predictions then simple, well founded design procedures are required. The power flow concept is particularly useful in this context. There will always be the need for experimental data, however, and vibration test techniques for field use must be simple and of proven accuracy. Finally, if vibration control procedures are to be attempted for practical structural systems, and this is particularly true for additive damping techniques, very often practical, effective methods can be adopted by experiment, perhaps coupled with simple theoretical assessment, without the need to carry out computer-based studies except perhaps for parameter sensitivity examination.

R G White

Machine Noise and Vibration

This topic was one of the longest in the Conference and covered a wide variety of subjects.

Dr P Bruel opened the session with a provocative paper on whether we are right to use a single value of L_{eq} for all industries as a measure of industrial noise hearing damage risk. Using a pair of sound level meters to produce charts of maximum sound levels and L_{eq} simultaneously for various industries he showed that in industries working with hard materials peak levels were 30 to 50 dB above L_{eq}, but in industries working with softer materials such as wood peak levels were 20 to 25 dB above L_{eq}. He postulated that it is the short duration peak noise levels which cause hearing damage; therefore, the L_{eq} limits should be set differently for different industries to take account of the different peak/L_{eq} ratios.

G Stimpson presented two papers on the work being done at ISVR and CETIM on punch press noise, one describing the effect of dampers to reduce the noise generated by the spring back of the pressframe which occurs as the material is sheared. Hydraulic damping offers the most promise, an 'active' system being desirable to overcome the accuracy of setting up required with a passive system. G Stimpson's second presentation described studies of a scale model of a 200 Tonne power press which showed that model results could be scaled to full size and thus allow the model to be used to quantify the sources and develop noise control techniques.

Hodgson described work at North Carolina State University on the acoustic intensity radiated by a punch press. He had used coherence techniques to assess the contribution of various parts of the press structure to the total noise and also carried out finite element analyses to indicate which parts had the greatest vibration energy. His results indicated that press response was more stiffness controlled than mass controlled.

Cuschieri described work on adaptive vibration cancellation systems for short duration pulse inputs. He showed that the performance of an active system is critical to the timing of the initial and cancelling pulses, the distance between the application points of the initial and cancelling pulses and the exact matching of the pulse spectra.

The punch press and drop hammer theme continued with papers by Seidel, Kloth and Wischmann from the University of Hannover. Seidel discussed an active cancellation system designed to change the force time diagram as the punch breaks through, spreading the energy release over a longer period than normal; 8 to 10 dB(AI) reduction was claimed to be possible. Kloth described work on a scale model drop hammer and particularly the cases of off-centre blows and die-to-die impacts which are the loudest elements of the drop forging process. Wischmann had measured the noise of 36 forging presses in normal operating conditions and showed how sound power level varied with nominal force. He also assessed the effect of noise control activities such as partial enclosure of the clutch and brake system which can give around 10 dB reduction of sound power level. He pointed out, once again, that the L_{eq} in a forge is usually over 90 dB(A) even when the forging presses are not in operation.

Asztely introduced a small type of machine, the hand-held impact drill, and described the problems of measurement of noise from such machines when more sound power was emitted from the concrete block or wall into which the machine was drilling than from the machine itself. He suggested that the machine sound power should be measured when drilling into a concrete block acoustically shielded by a vibration isolated layer of chipboard.

The remaining three papers on the first day made an abrupt change of subject matter to fan related topics.

Maling described a fan system noise prediction technique for computer frames based on experimental results of the attenuation of 'gates' of circuit cards. The prediction of the aerodynamic performance of a laminar flow disc fan was described by Merry. These fans do not follow fan laws. Some noise measurements of laminar flow fans were also presented showing them to be appreciably quieter than conventional centrifugal fans of comparable aerodynamic output. Work at NASA on large variable pitch and variable speed fans 12.2 m in diameter in the NASA Ames wind tunnel was on a completely different scale. Soderman presented a formula derived from practical measurements for calculation of the sound power of these larger fans, taking into account pitch angle changes, and showed how this could be used to optimise the operation of the wind tunnel. At a given mass flow rate the least noise at the lowest energy cost is produced by running the fans at low speed and high blade pitch.

Thursday's papers covered a wider range of topics. The paper given by Bernard and Badie concentrated on the performance of an anechoic termination for a test rig for circulation pump noise measurement, showing such a device to be effective acoustically but refusing to reveal details of its construction for patent reasons. Holmberg described a technique for prediction of the noise radiated during the compaction process which is involved in the manufacture of concrete building components. He had constructed a mathematical model of the wave propagation in liquid concrete and for the mobility of the steel mould, from which the radiated noise could be calculated.

Elegant mechanical engineering solutions to the problem of making nails quietly were shown in Nielson's paper. He had replaced the conventional impact mechanisms with more gradually applied rolling action forces to give a noise reduction of 17 dB(A) at the operator's position, coupled with much increased production rates, lower energy consumption, greater tool life and high product quality. Customer surveys showed that the factors which affected the profitability of the operation of the machine were far more important than the low noise output.

Noise from cooling air jets with rectangular slit openings was described by Larsen. He had investigated the

effect of various cross sectional geometries on radiated sound power. Moore described attempts at reducing the noise from milling operations on awkwardly shaped components by using irregular cutter spacing. As is often the case some redistribution of energy within the frequency spectrum was possible but little change in overall level. The problems of providing simulated loads for measurement of machine tool noise have exercised the minds of many. Gargano, Berolini and Cassin have used a modified automotive disc brake with claimed success. They did not, however, say whether they had a cure for the well known problem of disc brake squeal should it occur! A cooling water film is not used to cure brake squeal but is an effective cure for stone saw blade noise according to Shaw. Unfortunately the method has not yet found a commercial application.

Wood and Thornton showed how the acoustic insulation of thermal lagging could be improved by the addition of a heavy, limp outer layer to provide increased high frequency attenuation from such sources as valves, pumps and turbines.

The manufacturing processes involved in modern micro-electronics plants are very susceptible to the floor vibration induced by movement of personnel and by ventilation systems. Gordon and Ungar described the development of floor vibration criteria and the way in which special buildings are designed to meet the criteria.

In Hungary new laws for machinery noise emission are in preparation and the paper by Augusztinowicz discussed the background to proposed regulations.

Large industrial gearboxes are often noisy. Nilssen showed how they could be made quieter by the redesign of the upper part of the housing incorporating double skin construction, vibration isolation and panel absorbers. Ecology is not without its noise problems! Collecting old bottles for recycling sounds laudible but annoys the neighbours. Irmer's paper described this problem and some solutions, amongst other noise problems relating to the collection of refuse.

The last part of the marathon session on machinery noise control concentrated on enclosure design. Yasuda concentrated on a mathematical analysis of the problem of panel attachment to the enclosure frame. Thompson's enclosures were room sized and he discussed alternative ways of better predicting sound pressure level distribution in enclosures which do not conform to classical Sabine concepts. The image source method seemed to come out best, provided enough images were considered. Jonasson concentrated on an assessment of various practical methods of measuring small enclosure performance whilst Oldham wound up the session by looking at simplified and apparently successful methods of predicting the performance of small enclosures.

A H Middleton

to serve improvement notices where he considered that there was a risk to the health of employees by excessive noise. By contrast, the approach in Denmark, described by Knud Skovgaard, was the voluntary labelling of machines to show their noise output. It is hoped that market pressures will then encourage the development of quieter machinery.

At the early design stages, lack of data often compels noise control engineers to resort to empirical formulae to estimate the noise from an item of plant. The unreliability of this approach was apparent from a paper by H J Eun of Korea, describing a large set of measurements of machine sound power levels. The range of sound powers from similar machines was remarkable — the less powerful machines not necessarily being the quieter.

Brüel & Kjær, who in addition assisted the Institute with publicity for the Conference, were among over twenty firms participating in the Exhibition

Diagnostics, including Monitoring

This session, which was organised by Dr R A Collacott, was ably chaired by George Maling who stepped into the breach at short notice. Papers presented in the session may be found in the Conference Proceedings.

Noise in Industry, including Planning

The scene fo: this topic was set by Hugo Verhas of Belgium, who argued that quiet was a natural state, stolen by industrialists, whom he likened to burglars. He argued that not only should noise control be designed early in any project, but noise control engineers should look for alternative processes which could be quieter. B E Miles of the UK Health and Safety Executive came along in his role of the policeman to explain that he was able

Because noise control of open-air installations can be expensive, a method for making accurate calculations of neighbourhood noise is of great importance. K J Marsh of the UK described the new CONCAWE method, and this paper was followed by C A Neirop of Holland, Jorgen Jakobsen of Denmark and Paul Teordorescu of Switzerland describing the methods used in their own countries. The four were later seen earnestly comparing techniques, which illustrates one of the great benefits of an international conference.

Sound does, of course, have its uses and two of these were presented. Richard Harris of the UK gave us some valuable information on the selection and specification of audible alarm

signals, whilst in a paper by G Reethof we heard of a technique for using acoustic energy to agglomerate the fine ash from a boiler.

Dust-laden gases pose a problem in the design of duct silencers, where dust can settle out and reduce both the gas-flow and the attenuation. U Z Kurze of West Germany described several solutions, including one which works more effectively when contaminated.

A number of interesting case-studies of noise control projects were presented by Ekstrom, Elvhammer, and McQueen from Sweden, and Schuller of The Netherlands, ranging from small workshops to steelmaking and a very large covered shipyard. The approach was to use good, conventional techniques, but speakers stressed the need for a thorough initial analysis to gain an understanding of the major noise sources. They also suggested modifications to processes which can lead to substantial noise reductions. Peizi Li, at Southampton, in describing the performance of various types of air-jet nozzles, took this a stage further by illustrating that a well-designed quieter nozzle can be more effective than a noisy type.

In conclusion, the papers showed that industrial noise control practice is consolidating on the existing foundations, with a steady refinement of techniques. Perhaps the most important lesson is that innovative thinking can lead not only to reduced noise, but also to greater efficiency which will eventually repay the effort required.

K R Tompsett

Noise Control in Buildings and Building Services

Whether audience size is necessarily a pointer to quality of papers and presentation is perhaps arguable, but if it is, the session must have been very highly rated since the room allocated initially was filled to standing room only during the first morning. Robin Mackenzie and his local organisers are to be thanked for effecting the subsequent change to a larger theatre with minimum disruption and apparently no lost audience.

The first eight papers were generally concerned with partition insulation. J W Sargent opened with an account of BRE's survey of customer satisfaction with some of the 30,000 installations carried out under the Noise Insulation Regulations. Two further papers, one from Cambridge and Edinburgh (L J Lee and R K Mackenzie) and one from Belgium (A Cops) gave good illustration of how measurement of partition performance can be simplified, in the one case by measurement of dB(A) and in the other by intensity techniques. A similar theme was covered in the paper by H R Stoll and M Leutwiler from Berne.

Some indication of how different test methods could produce significantly different results for building facade performance was given in the paper by R Schumacher and F P Mechel (Stuttgart), while J D Quirt of NRC Ottawa discussed some of the practical difficulties in getting an accurate representation of SPL immediately outside the facade. From the same organisation J S Bradley reported on a survey of the correlation between aggregate adverse deviation and subjective assessments of party walls. Some very interesting results showing the improvement in overall building transmission loss using flexibly mounted lightweight floors were presented by W F Landheer of the Ijsselmeer Development Authority.

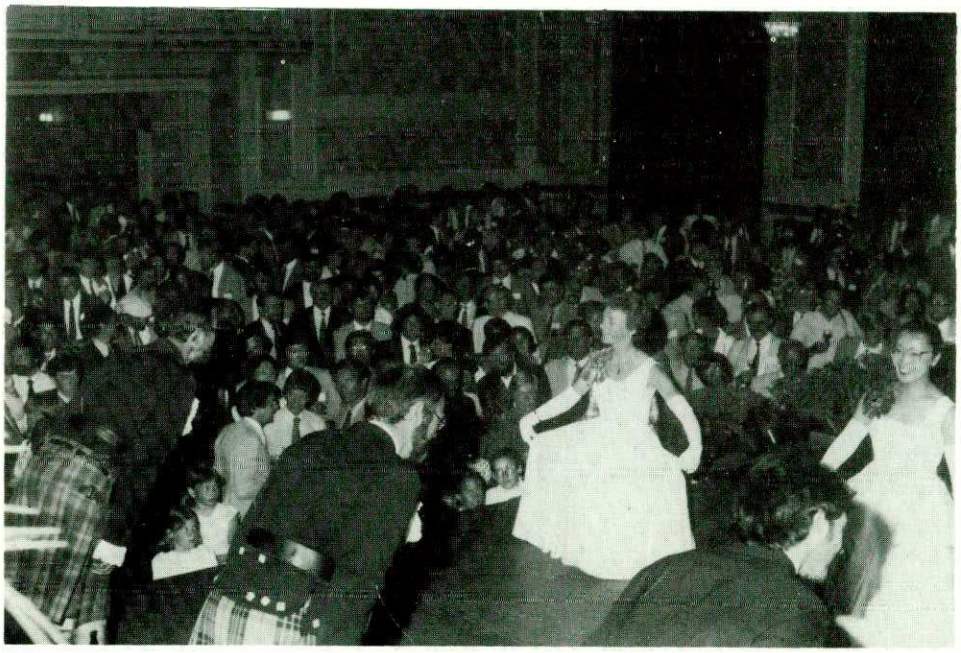
The second group of papers dealt with the general field of sound and its attenuation in pipes and ducts. The first two were linked, giving a summary of work carried out on noise break-out and break-in through the walls of ventilation ducting. I L Ver covered the US work on the theoretical side, while Alan Fry outlined the experimental facility at Colchester and presented some test results.

A new Swedish attenuator utilising 'bars' of sound absorbing material was introduced by N A Nilsson, and a new German facility for measuring attenuator performance with airflow was described in the paper by F P Mechel *et al.*

An interesting development in the field of attenuation of fluid borne noise was outline by J Mantel, and the paper on measurement of transfer matrices of duct elements by M Nishimura *et al* of the Takasago Technical Institute closed the section.

The final group of ten papers was devoted to room acoustics and the control thereof. Robert Craik opened with a report of the encouraging results being produced by the work at Herriot-Watt on the use of scale models for predicting noise transmission in buildings. Murray Hodgson brought us up to date on his work at Cambridge on the accurate prediction of noise behaviour in factory spaces, and G Benedetto of Turin reported on a computer simulation of the performance of barriers used in conjunction with absorptive treatment in similar spaces. J H van den Berg of the Dutch Labour Inspectorate then presented his results from using absorptive treatment in large shipbuilding halls.

On specific treatment for room correction, Goran Karfalk showed some performance figures for Swedish designed diagon absorbers combining good wide band performance with a specific low frequency peak. In similar vein, A Nilsson of the Danish Acoustical Institute reported the results of work on combining perforate and membrane absorption.



Scottish dancers performed at the Civic Reception for the delegates — a few of whom may be seen in the background

A general outline of applications for conventional perforate absorbers was given by T J Schultz of Boston USA and Maa Dah-You of the Peking Institute of Acoustics explained how micro perforation of panels could produce broad band absorption without necessarily using a porous infill behind.

C L Dym from the University of Massachusetts spoke on the use of modelling techniques for optimising the cost-effectiveness of sandwich panels and E Uchino from Hiroshima presented a statistical method of subtracting background from an environmental noise signal.

A wide range indeed, and one to which this short summary can hardly do justice. The wealth of detail covered though is all to be found in the published proceedings, and these must rate as one of the year's best buys in acoustic literature.

I Sharland

Opencast Mining and Quarrying

Geoff Kerry of Salford University reported that the response of a building to a variety of quarry blasts has been studied over a two year period. Results indicated large variability in response to air overpressure compared with groundborne vibrations, and the author suggested that this should be taken into account when complaints of excessive vibrations were made by occupants.

Chris Waites (co-author with D J Saunders) of Salford University described a ray tracing technique to predict the propagation of sound levels from quarry blast. Field trials indicated that surface wind velocity could reasonably account for variation in peak sound pressure level on many occasions, but there were some days when more detailed meteorological information would be needed.

Ken Broadhurst of Rock Environmental Ltd emphasised the need for caution when noise and vibration limits were set for blasting operations. Account should be taken of the type and duration of the activity, the cost of implementing restrictions, as well as measured air overpressure and vibration levels.

Target levels currently considered by various organisations were discussed.

Harry Slyper, of University College Cardiff, discussed the application of standard acoustic barrier attenuation calculations in blasting. His experiments indicated that the calculations could be used for approximate predictions.

John Kuehn of Brüel and Kjaer (UK) Ltd talked about the requirements for low frequency performance of microphones or other forms of pressure transducer (eg hydrophone) in the overpressure measurement. He showed the variation in commercially available low frequency systems and possible discrepancies resulting from use of instrument systems with unknown or inadequate low frequency response.

Jack W Reed of Sandia National Laboratories, Albuquerque, New Mexico discussed the results of large numbers of tests carried out for the purpose of studying propagation characteristics of explosions buried in the ground. He showed the effect of overburden and the crater shape, and that predictions of overpressure at distances up to 1 km were in good agreement with measured values, but at longer distances atmospheric conditions had to be taken into account. He stressed the need for a careful watch on atmospheric conditions, especially with large explosives which could affect distant communities.

Guy O Stevin of Acoustics Laboratory, STFT/CT of Brussels, Belgium found his paper included in this section. He spoke of the use of Sound Exposure Level (A weighted) in the evaluation of hazard to hearing caused by firing of firearms, eg rifles and pistols. He compared results obtained by using SEL with results according to CHABA and Pfander. He concluded by strongly recommending the SEL.

J Kuehn

Ship and Offshore Noise and Vibration

This session could conceivably be subdivided into three further areas, namely Offshore Installations; Ships; and Materials. The specific inclusion of Offshore Installations as a topic at Inter-Noise was particularly appropriate with Scotland's close association with the offshore industry. The papers were presented by representatives of the three main European countries having an interest in the North West European Continental Shelf, namely the United Kingdom, Norway and the Netherlands. In the UK the Offshore Industry is one of the few activities covered by mandatory legal requirements on noise and vibration levels, Norway has draft regulations due to come into force from this year and the Netherlands, whilst having no specific regulation, has produced guidelines outlining noise limits for offshore installations.

The three papers discussed the prediction, measurement and control of noise and vibration on fixed gas and oil production platforms and mobile drilling units. They highlighted the problems of high equipment density and integral living accommodation, including noise build-up in enclosed modular spaces and structure borne noise prediction and control.

A truly international group of delegates enjoying the Reception

The fourth paper in this sub-session described the assessment of alarm and public address systems on these installations. Good alarm and PA coverage in a hazardous environment is essential; however, mandatory requirements are general in nature. The paper reviewed acceptability criteria and in particular discussed a method for evaluating the coverage and effectiveness on existing installations. High background noise levels and the effect of high reverberation on articulation were the main problems encountered. All papers in this sub-session were well attended and provoked lively discussions which continued outside the allotted time.

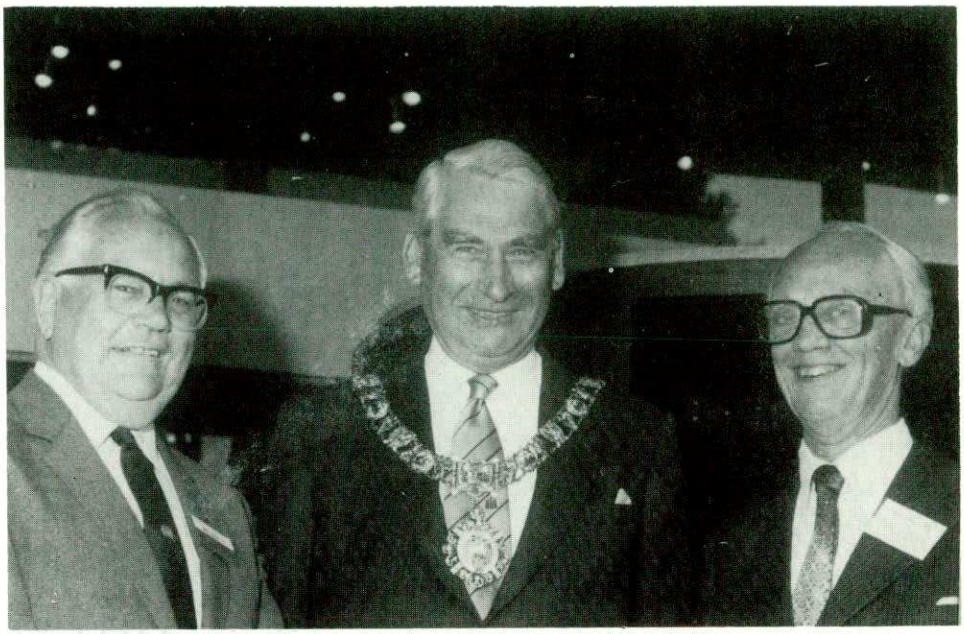
The sub-session I have loosely described as 'Ships' covered a wide range of topics. The first paper addressed the problem of noise generated by thrusters on dynamically positioned vessels affecting the hydroacoustic positioning reference system. The results of model tests were presented and provided a means of predicting signal-to-noise levels and hence optimising transducer locations and thruster operating procedures. The second paper also concerned noise from thrusters, but this time in the context of the effects on accommodation spaces on offshore support vessels. These vessels have been developed with accommodation forward and maintain station by means of bow thrusters; this has led to increasing noise problems. The paper described a wide range of noise control measures applied to such vessels to minimise noise levels.

Next a problem of engine generated noise entering the water via a ship's hull was described. Resiliently mounting the engine would have been an expensive solution and, since the noise spectrum was dominated by a single frequency a dynamic absorber was considered. A scale model was used to test the theoretical design and a full scale prototype then developed. A useful insertion loss was obtained when installed on the ship's engine. The following paper described the use of air injection in propeller ducts to reduce cavitation and hence noise in the ship's accommodation areas and to reduce interference with echo sounders.

The next paper described an empirical procedure for determining pressure pulse generation and propagation from cavitating propellers. Experiments in a model cavitation tunnel were compared with full scale measurements on a trawler to verify the technique.

The final paper in this sub-session concerned the noise exposure of engine room personnel. Measurements using dosimeters were compared with calculated exposure levels based on area noise levels and work patterns and it was concluded that either method could be used to assess personnel exposure.

Again, many of the papers were controversial and aroused much discussion.



Left to right: Prof E J Richards, Chairman of the Organising Committee, the Lord Provost of Edinburgh and Professor Fritz Ingerslev, at whose instigation the Edinburgh Inter-Noise was organised

The final sub-session comprised three papers concerning the application of damping compounds. The first paper described the application of constrained viscoelastic damping to structure borne noise problems on a range of ships and complementary laboratory tests of the damping systems.

The second paper considered the optimisation of unconstrained damping layer thickness over the surface of a plate. The results showed that considerable improvements in system loss factor could be obtained by optimising distribution of the damping layer and identified areas where damping treatment was most effective.

The final paper described an application of the Raleigh-Ritz method to describe the behaviour of constrained layer viscoelastic damping applied to plates. This method has considerable advantages over finite element methods and was successfully tested against other researchers' experimental data.

As always discussion centred on the theoretical and laboratory results versus the number of dB's obtained in practice. The session as a whole proved most interesting and it was a pleasure to have been involved in its organisation. Thanks are due to all the authors and delegates who contributed to the discussion and to my colleague Richard Davies who chaired the majority of the session.

C J Manning

Transportation Noise

17 papers were presented of which 4 were invited. Many were concerned with noise impact and the overall flavour was inevitably similar to that of the community noise session. Most papers involved road vehicle and traffic noise although railways, trams and helicopters were also represented.

Many authors dealt with the forecasting of noise levels and community reaction. Kurra (Turkey) described research in Istanbul, Hothersall (Bradford University) presented an unproved method for taking reflections into account when predicting traffic noise levels and Backteman (Sweden) examined moped noise emissions. Moehler and Knall (Germany) outlined a large scale social survey of responses to railway and road traffic noise. Buna (Hungary) reviewed the state of the art in traffic noise prediction and considered that the best possible accuracy is ± 2 dB(A). Ritterstädt (Germany) examined the relationships between traffic noise parameters and distance from the road. Cohn and Bowlby

(USA) described the use of computer graphics and Abdel Alim (Egypt) discussed consideration of traffic noise in town planning in Alexandria.

Vehicle noise generation mechanisms were investigated by De Brabander (Belgium) who had experimented with motorway surface treatments and Suzuki *et al* (Japan) who compared noise generated by different types. Lamure (France) examined the relationship between noise reduction and energy saving, concluding that these are not necessarily correlated.

Two papers described actions to reduce road vehicle noise or its effects. Klemper presented impressive results of a German programme to silence a range of diesel engined vehicles. Production vehicles are expected to be commercially available in the near future. Solberg (Norway) evaluated the performance of traffic noise barriers and soundproofing in an ongoing social survey.

Four papers addressed noise problems of rail vehicles. Riemans (Netherlands) compared noise outputs from six different types of tramcars. Kumagi *et al* (Japan) reported a laboratory study of subjective response to noise caused by rail joints. Van Rangelrooij (Netherlands) described locomotive driver cab noise reductions of 10 dB achieved by noise and vibration control treatments. Garbell (USA) presented a case history of railway noise control using barriers and sound insulation.

In a lone paper on aircraft noise Ollerhead (Loughborough University) addressed the problem of noise scaling for helicopter noise certification concluding that EPNL is a suitable measure.

The session attracted considerable audience interest although the limited time available for presentations prevented serious discussion. However, with a parallel session on community noise it seems a pity that this one could not have included more papers on noise control and less on impact evaluation.

J B Ollerhead

Community Noise

This was the longest running session with 15 invited and 28 contributed papers programmed in six half-day subsessions throughout the conference. Approximately half the papers were concerned with the effects of aircraft noise and about a quarter were devoted to the assessment of community noise in general.

Smith (Rolls-Royce) opened the topic of aircraft noise by stating that aircraft noise control presently costs around 1 billion $US per year and suggested that we have gone beyond the point of diminishing returns. With a few exceptions, other papers on the topic described various national and local attempts to evaluate and reduce the impact of aircraft nose on local communities. Gummlich (Germany) and Bragdon (USA) reviewed airport noise abatement practice in their countries, the former restricting himself to general aviation. Zoric (Jugoslavia) described the use of vegetation belts and home insulation to reduce noise impact at Belgrade airport and Rechnagel (Denmark) discussed the home insulation grant system at Kastrup Airport, Copenhagen, pointing out that a survey of its effectiveness will be published in two years' time.

Social survey methods and results were dealt with by Brooker (CAA) who emphasised the methodological difficulties of discriminating between the effects of noise levels and number of events on annoyance reactions and Taylor (Canada) who reanalysed earlier survey results to show that noise sensitivity and speech interference are the most significant of several intervening factors which influence annoyance responses.

Zoric described a study of general aviation noise impact at Bovec in the Julian Alps.

Meecham's paper on the effects of jet noise on mortality rates at Los Angeles Airport attracted some critical remarks from the audience.

Assessment of airport noise impact for planning purposes was considered in papers presented by Stubbs (Bickerdike, Allen) and Browdler (Sandy Brown Associates) and the associated problem of estimating community noise exposure levels concerned several authors. Walker (ISVR) presented data showing that noise level due to ground operations decays at 12 dB per doubling of distance. Svane (Denmark) described a simplified method for predicting light aircraft noise and his colleague Plousing addressed himself to the ground roll contour. Neubauer (Germany) showed high-speed Schlieren film to support theoretical considerations of propeller noise radiation. De Belder (Belgium) reviewed noise measurements carried out at Brussels Airport.

Identification of aircraft from noise measurements was discussed in papers by Yamada *et al* (Japan) and Hess (Denmark). Van Deventer (Netherlands) addressed himself to noise aspects of ultralight and model aircraft. Finally Ms Roxner (Israel) described methods for generating realistic sound in aircraft flight simulators.

Moving away from aircraft noise specifically, the problem of relating noise exposure and human reaction variables in social surveys was examined by several authors. Fields (USA) pointed out that community differences contribute to overall variations in annoyance responses, Guski (Germany) described first steps taken to adopt quietness (rather than noisiness, etc) as an index of environmental quality, Hall (Canada) investigated the use of 'time-above' measures to predict speech interferences caused by transportation noises but concluded that these offer no significant improvement over conventional noise measures. Scheumer and Mrs. Scheumer-Kohrs drew attention to the role of noise sensitivity and window opening habits on acceptance of road and rail noise. The utility of L_{eq} as a predictor of noise annoyance was re-examined in papers presented by Berry (NPL) and Mrs Kuwano (Japan) and Martin reviewed the various methods used to measure and describe community noise in Germany.

Deva-Aditya presented Vulkan's paper on the GLC's attempts to exercise control over lorry noise by traffic management schemes and Hood (Travers Morgan) suggested that housing turnover rates may provide a more reliable indication of traffic noise impact than self-reported annoyance/dissatisfaction. Kasta (Germany) presented results which indicate that traffic noise annoyance is independent of distance from the road (when noise level is controlled) thus suggesting that non-acoustical factors such as dust, fumes, vehicle lights, etc do not influence annoyance. Abdel Ahmi (Egypt) also described a study of road traffic noise.

Other papers in this session were devoted to noise control in industrial plants (Jensen, USA) and window air-conditioning units (Strumpf, Israel), a noise appraisal of a river estuary (Kirk, Carrick, DC), a financial incentive scheme for the adoption of quieter equipment (Eggink, Netherlands) noise evaluation in broadcast listening (Ebata *et al*, Japan) and noise prediction by scale model techniques (Yamashita, Japan).

Overall the sessions on community noise were reasonably well-supported with audiences in the range 40 to 80 (although not perhaps enough to justify allocating the largest available lecture room to the topic). There is no doubt that lively discussions would have followed many papers if more time had been available.

J B Ollerhead

Impact Noise Insulation Testing

The session on Impact Noise Insulation Testing contained ten papers. This session was the outcome of a special seminar on the subject held in Copenhagen in February 1982, where the question was raised: 'Do test results obtained by means of the ISO Tapping Machine actually give a correct scaling of the impact sound insulation properties of all types of floor construction, ie a scaling which corresponds to subjective judgements?' This question seems to be particularly relevant with regard to lightweight constructions and wood-joist floors.

Although the papers presented at Inter-Noise did not solve the problems, they provoked considerable discussion and indicated along which paths further work should be directed.

It may be concluded that the session was very successful and that a satisfactory answer to the question cited above may well be within reach in a foreseeable future.

J T Broch

Diesel Engine and Vehicle Noise and Vibration

The papers in this session covered three broad aspects of noise and vibration control in the specialised field of diesel engines and vehicles, these being measurement techniques, prediction methods and the means of control.

Vibration measurement techniques using non-contact methods were described in papers by Halliwell, who dealt with the use of lasers, and by Maeda who used electromagnetic detectors. Russell's paper on the measurement of combustion noise described a combustion noise meter from which the contribution of combustion noise to the total engine can be determined. The paper by Kojima and Fukuda described a technique using a single combustion pulse to study the transmission path of vibration through an engine structure and hence to determine the relationship between combustion and total noise.

Prediction methods relating to exhaust noise and pulsive flow in straight pipes were dealt with in the papers by Ferrari and Okda.

Papers by Astrup, Beards, Caspar and Tandarn covered a number of aspects of noise control including applications to cars, buses and motorcycles using a variety of techniques such as improved exhaust silencing, reduced vibration of air cooling fins, frictional damping applied to steel sumps and total engine encapsulation.

It is particularly encouraging that practical new techniques are continuing to be developed, leading to improved methods of measurement of noise and vibration many of which can be applied outside the field of engine development.

This session was clearly very specialised but attracted from twenty to thirty delegates throughout.

K Ratcliffe

Low Frequency Noise: Occurrence and Effects

This session was concerned mainly with the subjective aspects of low frequency noise, ie perception, loudness, annoyance and other psychological or physiological effects. Fifteen papers were presented, including seven from Japan, four from Scandinavia and the remaining four from the United Kingdom, France and Germany. These numbers are an indication of how activity in low frequency noise has become centred in certain parts of the world. The frequency range covered included not only what is known as 'infrasound' but also the low frequency part of audible sound.

The technical aspects of low frequency noise and its control are becoming more clearly understood. For example, low frequency noise at 10 Hz from an induced draft fan was reduced by 18 dB using a reactive silencer about 6.5 m long and 14 m diameter. Investigation of axial flow flans has shown that low frequency noise is produced by rotating stall of the blades. This effect was reduced by careful design of the geometry of the input housing.

Common low frequency noise sources include ground-borne vibration from underground trains and exhaust pulsations from heavy vehicles. The ground-borne vibration from trains usually peaks in the 63 Hz octave band and a limiting criterion for vibration velocity in this band of 50 dB re 5×10^{-5} m/s was suggested. Work on modelling road vehicle/building interaction has shown that it is possible to estimate internal noise in buildings from a knowledge of the engine parameters and the building construction.

Problems arise from reflections from nearby surfaces eg 5 m away, and it has been found that, for outdoor measurements, the microphone should be near to the ground for best results.

The subjective effects of infrasound and low frequency noise are gradually being clarified. Perception occurs both directly and from secondary radiation (eg rattling of doors and windows). Side effects of direct perception include insomnia, increased heart rate and a feeling of pressure on the head.

Annoyance and loudness of low frequency noise is under investigation in several laboratories and the following facts have emerged. There appears to be a heightened sensitivity in the region of 40 Hz. The bunching together of equal loudness contours continues into the lowest frequencies investigated, eg at 8 Hz the range from 20 phon to 80 phon is covered with a level change of about 15 dB. The annoyance rating also rises more rapidly at low frequencies.

For neurosensory deaf subjects, the perception threshold is at about 30–40 dB above that of subjects with normal hearing in the frequency range involved.

Experiments with deaf people and analysis of the individual perception threshold microstructure lead to a better understanding of the hearing process. For low pressure levels, the sensory organ of low frequency noise is the cochlea. At higher levels, low frequencies are also felt through vibration of other parts of the body; this is the ordinary process for deaf people. The semicircular canals are not sensitive to low frequency noise.

Physiological changes have been monitored under the influence of infrasound and low frequency noise. Heart and respiratory rates can be affected by low frequency noise; the effect can be enhanced by the presence of audible sound, and the relationship with low frequency noise is not always significant. Infrasound at moderate levels causes a reduction of wakefulness but the higher levels (20–30 dB above

threshold) may enhance wakefulness by vibration sensations in the body.

In real situations, when the low frequency noise stimulus is combined with other audible and non-audible stimuli (vibration, etc), the effect depends on the masking or synergy effects between stimuli, and on the primary and secondary tasks of the subject (Sandberg, Benton). Whereas high levels of noise or vibration increase performance, high levels of infrasound impair performance; but noise and infrasound interact. The combination of high-level infrasound and low-level noise has a highly significant negative effect, but increasing noise eliminates this effect. This effect can be of primary importance for driving conditions, where it is recommended that quietening of vehicles should not lead to unbalanced spectra.

In conclusion, although many results require further developments, this session has brought interesting new material for a better understanding of perception, the hearing process, and the effects of low frequency noise, whether or not combined with other stimuli.

H G Leventhall
B M Favre

George Maling of I/INCE receives an appropriate token of appreciation for his work from Geoff Leventhall at the closing ceremony

Instrumentation and Measurement

With 32 papers the Instrumentation and Measurement section of the conference was one of the largest sessions, showing the increased interest in measuring techniques that has accompanied the considerable capabilities of modern electronic techniques. Over one third of the papers were concerned with intensity and sound power measurement, showing how rapidly intensity measurement has become established as a useful tool. Dosemeters and impulsive measurements were discussed and there were several papers describing the use of multiple-microphone techniques. Finally there were a number of papers concerned with statistical measurements, and in other presentations some novel measurement methods and techniques were described.

S J Flockton

Active Noise Reduction

Although 'anti-noise' has been featured at earlier meetings, the sessions at the Edinburgh Conference represented a major increase in interest in this area, with seventeen papers presented on a wide range of different aspects of the technique. One of the main features of the sessions was the emergence into public view of the achievements of synchronous adaptive waveform cancellation, a technique pioneered at Essex University. A total of six papers were given which described applications of this technique to fields such as selectively cancelling headphones, cancellation in vehicle cabs, and active vibration mounts. A paper by M D Croker described experience of using the Essex system to silence the exhaust of a seventeen-litre turbo-charged diesel engine.

Significant progress was reported by Warnaka *et al* on cancellation in spatial regions, including important results on cancellation in a reverberant environment, and successful reduction of noise intrusion into a fuselage model was also described.

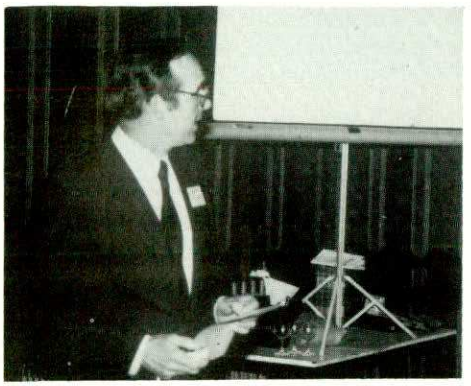
Jessel outlined basic theoretical results relevant to active noise reduction, and Tichy and Warnaka presented theoretical data on the sound field associated with loudspeakers mounted in ducts, taking into account the presence of evanescent modes. Trinder and Nelson described experimental results which were complementary to this theoretical work. The latter authors also reported work on the virtual earth (tight-coupled monopole) duct noise attenuation system, as did Hong *et al*.

The approach of Guicking *et al* concentrated on the absorption of sound in rooms, using wall-mounted loudspeakers, and they reported measurements using an impedance tube. Kim *et al* reported results on a system for reducing noise pick-up by a microphone on a noisy environment.

Mazzanti and Piraux described anechoic chamber experiments on the use of microphone arrays to reduce noise in spatial regions.

The only vibration reduction work reported in these sessions was that of Smith and Chaplin. The paper highlighted the novel characteristics which the Essex system imparts to active engine mounts, and the potential influence of these characteristics on future vehicle design.

G B B Chaplin



Bill Lang turns delegates' thoughts ahead to Inter-Noise 84, in Hawaii

Outdoor Noise Propagation

Fourteen papers were presented at this Session, which was organised by Dr S I Hayek. The papers were well attended by about fifty delegates. Details of the papers can be found by consulting the Conference Proceedings. □

Speech Production

Speech Group Meeting, 28 March 1983

Five papers were presented at this half-day meeting held in the Department of Phonetics and Linguistics, University College London. About fifty people attended.

Paul Warren (Department of Linguistics, University of Cambridge) presented a paper where he compared two accounts of lexical ambiguity; the accounts considered are those in which prosodic cues play a role in disambiguating such utterances and parsing strategies that do not attribute prosodic cues such a role. Warren argued for a theory where prosodic cues play a role in disambiguating utterances.

Helen Petrie and Brian Butterworth (Department of Psychology, University College London) reported preliminary data on the semantic units for planning speech. They examined a dual-task methodology to investigate this question rather than (as is usual) look at pauses.

The next paper concerned delayed auditory feedback, DAF, (Howell and Archer, Department of Psychology, University College London). When feedback is altered by, among other things, delaying it, speech control suffers. Traditionally these findings have been interpreted as support for the view that the process of speech production involves feedback monitoring. It is also known that individuals differ in their susceptibility to the effects of DAF. Howell and Archer presented data showing that susceptibility is determined by how loud the delayed signal is (whether level changes are brought about by electronic amplification or by the subject raising her voice). They also showed that the effects apparently do not depend on the delayed signal being used for feedback control because similar effects that occur with delayed speech occur when a non-speech sound is substituted for delayed speech.

Leman then described and demonstrated several systems designed to improve the intelligibility of speech in auditoria.

Fourcin and Rosen (Department of Phonetics, University College London) described two aspects of work on vocal fold activity. The first aspect (in collaboration with Berry and Noscoe) concerned X-ray photographs of the vocal cords with very short duration flashes. This 'freezes' the vocal folds at any stage in the cycle they go through during speech activity. The second aspect concerned changes in vocal fold activity when totally deaf people have some of their ability to hear this activity restored by an electrical implant.

The final paper was by Henton (University of Oxford). She reported her own acoustic data on the vowels of received pronunciation and compared them with data that has been reported by others. □

P Howell

Speech I/O Assessment

The Speech Group is to hold a workshop on 1 December 1983, to discuss procedures for establishing techniques and standards for performance assessment of systems of man-machine communication by speech. Anyone interested in further information should contact the Secretary of Speech Group:

Dr R K Moore
RSRE
St Andrew's Road
Malvern
WR14 3PS
Tel: 06845 2733 Ext. 2951.

NEW ELECTIONS

The following elections to corporate and non-corporate membership of the Institute of Acoustics have been approved by Council.

Fellow

M A Breazeale	P Brooker	J W R Griffiths

Member

M S Adams	M N W Austin	D P Ayyappan	P W Barnett
D L Bell	I F Bennett	R P M Bonnington	R Bussell
C C Buxton	I J Campbell	I W Campbell	A C Conrad
W A Francey	K B A Ginn	J E T Griffiths	J O Hetherington
P A James	K W Keay	A J Kirk	J R Jackson
D J Mackenzie	R D Mole	R L Pope	S W Lui
A G Sotiropoulou	G Taylor	F G Thompson	J A Shillinglaw
R F Towers	H F Ward	M F Yuen	

Associate

G S Badwal	J M Bairds	D E Barke	T J Bassett
A R Baxandall	K I Beever	H Behnam	D L Bell
T A Bennett	K Bock	S J Bone	R P M Bonnington
M P Bowery	W J Briggs	P H Brown	D Cairns
C J Chan	P A Christopher	V G Cole	C T E Corcoran
P P Cosgrove	P Cunning	C Daines	J M Davies
P M R Davies	J Davison	M A Din	M D Dixon
D B Dobbs	M Doran	R D Evans	E Flint
A J Franks	C Frier	S G Gardner	D H Gibson
R J Gilbert	J A Gillard	G P Goodwin	R G H Greenaway
L Griffiths	J Groombridge	A A Hall	D R Hall
L D Hall	C D Harland	N I Haverson	P R Hebron
A M Higgins	A Hill	G M Holmes	PA James
C S Johnson	C O Jones	R Jones	A H Kershaw
N H Kitchin	J Lawton	J P Lee	K S Lee
P Leeman	P Lewins	R Limb	F J Lobnitz
P J Long	S S Lowe	P J Lycett	J McNally
A C McWillie	J Magrath	K Malcolm	G C Martin
P J Mawdsley	F R Miles	K T Moss	S C Mountfield
G A Murray	P Myers	G L Newcombe	J Norrish
R Norton	F O'Grady	W B Oliphant	M G Patrick
H A-S Rahi	I M Read	C J Reed	G A Renton
H J E Robinson	D F Rothwell	M E Round	L D Russell
A G Sawyer	M Serridge	J J L Slane	D G Smiley
I P Smith	R J Smyth	T P Smyth	J G Staunton
C D Stirling	S Unwin	J H Urmson	C G Ward
R Waterhouse	J Westmoreland	D G Yarr	

Student

C J Peters

BRANCH AND GROUP NEWS

Industrial Noise Group

To publicise the proposed future meetings of the Industrial Noise Group which is now once again an active Group of the Institute, the Committee arranged a free buffet lunch which was held during Inter-Noise '83 at Edinburgh. Estimates of the numbers who attended varied between 120 and 150 people, but by all accounts it was one of the more popular 'Sessions' of the conference.

The Industrial Noise Group meets on October 20th at ICI, Welwyn Garden City to hear presentations by a number of speakers (Messrs R Taylor, S Mather and M Ankers amongst others) on the subject of 'Noise Emission from Industrial Fans'. Meetings scheduled for 1984 are likely to cover such subjects as 'Noise from Gas Venting', 'Noise from Refrigeration Equipment' and perhaps 'Maintenance and Cleaning of Noise Control Equipment'.

The Committee of the Industrial Noise Group feels that each Group Meeting should generally last one complete day and cover one particular and specific theme only. Presentations by four to seven speakers are followed by ample time for questions, 'workshops' and specific problem-solving discussions. The Committee sense that this is the meeting format that most ING members like.

Further details of meetings will appear in due course in the IOA Bulletin and general mailings to the membership. In the meantime please contact Andrew Corkill — Tel: Welwyn Garden 23400 Ext. 7386 if any information is needed.

Speech Group

Fifteen devotees resolutely ignored the counter-attractions of swimming and sunbathing and competing meetings in Paris and Toulouse to drag themselves to Nottingham on 15 July to attend a meeting on 'The perception of speech and related sounds and images'. A diverse but satisfactorily coherent group of papers were presented by Bill Ainsworth (*Production and perception of vowels*), Richard Whorwood (*Speech masking in telecommunications*), David Graddol (*Perception of voice pitch*), Matthew McGrath (*Audio-visual asynchrony and lip-reading*), Julius Guzy (*Preliminaries for image-processing of spectrograms*), and Michael Brooke (*Computer synthesis of talking faces*).

A meeting on 'Temporal Aspects of Speech' is to be held on 9 December at Cambridge University.

Hong Kong Branch

The Institute's first overseas Branch has been thriving since its Inaugural Meeting on 23 July 1983. A series of technical evening meetings was embarked upon in November 1983, all meetings so far having been attended by at least 20 people; the circulation list includes 78 interested parties, one third of whom are Members of the IOA.

The Hong Kong media were very interested in the establishment of the Branch and a press release and interview were given to the local radio station by the Chairman Mr Terry Willson and the Secretary, Mr D G Lees. The press were also in attendance at a two-part seminar considering the

Social Response of Hong Kong Residents to Noise. Earlier research had suggested that Hong Kong residents can tolerate higher levels of noise than persons living elsewhere in the world. Dr L A Brown, Senior Environmental Protection Officer at the Hong Kong EPA, criticised the validity of the conclusion of this work; Dr N Ko of the Hong Kong University replied to him and reviewed extensive field work and research he has carried out in H K. The open discussions following each part of this seminar were at times lively and heated, with opinions voiced as to whether apparent variations in response were due to measurement technique, physiological differences or cultural background. Taped interviews were given to the press and the discussion continued the following morning on the local radio 'phone-in' programme, a good indicator of the interest generated.

An Autumn series of Evening Meetings is now organised and includes the Branch's first field trip, to HK Telephone, and a social function in December. A monthly newletter is circulated.

The Branch extends its thanks to the Commissioner for Environmental Protection, EPA, and the Vice-Chancellor, HK University, who have lent invaluable support to the new Branch by providing venues.

North West Branch

The Role of the Acoustic Consultant — Noise and Vibration Problems with reference to Offshore Installations was the topic discussed by Dr R Monk of Acoustic and Vibration Technology at the September meeting of the North West Branch. On Thursday 17 November Mr M Russell of Lucas Industries Noise Centre will talk on *Noise and Vibration Control in Industry with reference to Case Histories.* The meeting will be held in the Bridge Room in the Maxwell Building of the University of Salford, starting at 6.30 p.m.

Proposed events for 1984 include a visit to a musical instrument repairer and retailer, where the more pleasing aspects of acoustics may be appreciated.

Yorkshire and Humberside Branch

The **AGM** and social evening will be held on Thursday 15 December at Leeds Polytechnic. □

Diploma in Acoustics and Noise Control 1983

Titles of Project Reports

North East Surrey College of Technology

An assessment of the acoustic performance of the Connaught Theatre, Worthing
An acoustic assessment of the Civic Hall in Wandsworth Town Hall Complex
An investigation of noise and vibration in television studios
Honor Oak Community Hall — results of an acoustic survey
An investigation into the problem of speech clarity in the Great Hall at Kensington and Chelsea Town Hall Complex
A study of compressor noise
An assessment of the acoustics of the Great Hall at Kensington Town Hall
An investigation into a simplified sound intensity meter for use in noise source location
An investigation examining the sound emission from a Philips (HR 1170) food mixer
Investigation into noise produced by a spindle moulder machine
Recommendations to optimise the acoustic quality of the proposed social psychology laboratories at the Open University
Wind-induced noise levels experienced by motorcyclists due to wearing crash helmets
A comparison of predicted and measured traffic noise levels for non-free flowing conditions
A study of noise problems associated with a sawdust extraction plant of a woodworking factory situated adjacent to a residential property
Noise exposure in a wood-working machine shop
Measurement and evaluation of vibration transmitted to the human hand/arm system
Investigation into the acoustic properties of a facade using British Standard BS 2750
Household noise sources
W G Grace Community Centre acoustic problems
The proposed Forest Hill Bus Terminal — results of an acoustic survey

Liverpool Polytechnic

Vibration hazards associated with the use of horticultural machinery
The reverberation time of coupled spaces
Investigation of airborne sound transmission
An investigation into the sound insulation performance of a timber frame party wall construction
An assessment of the value of predicting sound pressure levels resulting from the proposed operation of an industrial unit
An investigation into noise levels and associated problems in local authority day nursery centres
An investigation into tractor cab noise
Land use planning and noise conditions
An investigation into the effectiveness of sound absorbent hoods in the control of reverberant sound
An investigation into the use of a non-standard reverberant chamber for measurement of sound absorption coefficients
Attenuation of road traffic noise by screens of various profiles
The prediction of the Equivalent Continuous Sound Level around a railway line
Procedures of prediction and control of noise emission from clay pigeon shooting grounds
A study of the sound propagating from a factory building within the boundary of Blackpool

Newcastle Polytechnic

An investigation of the acoustic performance of the Videotone Model GB3 loudspeaker
Does the notional background level suggested in BS 4142 represent actual measured background levels?
The measurement of the sound absorption coefficient of celtic tiles by two methods
Noise from boiler room of Newcastle Polytechnic
Report on the performance of an impulse precision sound level meter
Amplified music — enjoyable but hazardous
The effects of boiler house noise on Newcastle Polytechnic classrooms
An investigation into noise from road breakers
The control of noise and vibration problems associated with building services engineering
Comparison of predicted road traffic noise against measured values
An investigation into speech intelligibility in a municipal and a school swimming pool
The exposure of employees to amplified music — hearing risks and methods of control
Discotheque noise survey — Newcastle upon Tyne
An investigation into the effectiveness of noise control measures recommended for housing development at Moorland Court, Bedlington
Assessment of the environmental impact with reference to noise of a dairy industry in a mixed light industrial/residential area
A Study of noise levels arising from the operation of the Tyne and Wear Metro Railway system
The attenuation of model aircraft noise

Cornwall Technical College

Construction site noise
An investigation of noise levels inside passenger motor vehicles with particular reference to M G sports cars
Noise from household appliances
Assessment of blasting nuisance: a case study
The identification of noise sources in a slaughter-house and the investigation and evaluation of carcase saw noise as a hazard to hearing
Consideration of residential development on land adjoining a motorway
Simplified prediction of 'A' weighted indoor sound levels from broad band external sources

Bristol Polytechic

Cold forming drop stamps noise control project
A survey of noise levels and noise control provisions at Keriman & Taylor Ltd
An investigation into noise complaints from extended use of mechanical office
Fan noise from a factory complex — investigation assessment and control
Investigation of a planning application for a small woodworking and aluminium window manufacturing business in a predominently residential area
Assessment and control of noise from refrigeration units in a retail food premises
To consider the environmental impact of establishing a light industrial workshop in a residential area and to recommend noise control measures
An assessment of the noise impact resulting from coal recovery operations in the Somerset Coalfield.
Investigation into noise nuisance from a timber shredding machine
Assessment of noise at a dairy

Tottenham College of Technology

Road Traffic noise
Loudspeaker communication systems
Let or hindrance
Noise from Kart racing
Road traffic noise
Evironmental impact of Heliport
Computer program for L_{eq} L_{Ax}
Noise from Kart racing
Assessment of noise
Noise due to proposed STOL airport
Disco noise
Railway noise in a proposed residential development

Derby Lonsdale College of Higher Education

A study to assess the effectiveness of earth bunds as noise control measures at Birmingham (Elmden) Airport
Detonators — a hearing hazard?
Microlight noise. A consideration
The problem of military aircraft noise in relation to housing
The emission of amplified sound from shop premises
Noise in the home from external sources

Colchester Institute of Higher Education

The insulation properties of an acoustic door
Silencing a compressor in an automobile workshop
A study of airborne sound insulation
Developing a computer program for duct breakout noise
Codes of Practice on noise 1982 — an appraisal
An investigation into noise nuisance from a Go-Kart track
The elusive 'hum'
Development of an inexpensive desk-top acoustic unit for teleconferencing
An automatic test system for measuring the transmission performance of telephones
An investigation into noise exposure in a flour mill
Comparison of predicted and tested sound power of aerofoil fans
The performance of silencers on aerofoil fans
Amplified music and noise nuisance

Heriot-Watt University

Factors in the assessment of a small radio talks studio
Applications of scale models to building acoustics
Sound insulation of floor covering
Coupling loss factors between floors and columns
The case of a noise nuisance at prize Bingo arcade, 14 Friars St, Stirling
Reverberation time and electroacoustics aids in small halls
Report on stock car racing — Newtongrange

In case you didn't hear . . .

The allocation of Ministerial responsibilities in the **Department of Transport**, taking account of the transfer from the Department of Trade of all the civil aviation and shipping and marine responsibilities, was announced earlier this year. The Secretary of State, who has overall responsibility for policy and management of the Department, will be assisted by Minister of State Mrs Lynda Chalker and Parliamentary Under Secretary of State David Mitchell. Railways, ports, shipping and marine, aviation and road freight are among the areas of responsibility of David Mitchell whilst roads, road safety, local public transport and rural transport, vehicle standards and licensing, are included under Lynda Chalker's direction.

CEL Instruments Ltd have relocated within Hitchin to premises that provide a new calibration and standards laboratory and a conference facility which will be used for CEL Training Seminars. The new address is: CEL Instruments Ltd, 35 Bury Mead Road, Hitchin, Herts SG5 1RT. Telephone (unchanged): 0462 52731.

AIRO, the Acoustical Investigation & Research Organisation Ltd, this year celebrates its silver jubilee, having been incorporated as one of the first acoustics consultancy firms in Great Britain in 1958. Any IOA Member who finds himself in the Hemel Hempstead area is welcome to visit the AIRO laboratory off Maylands Avenue to discuss the Company's aspirations for the next quarter century over a celebratory cup of cheer!

David Lees, the Secretary to the Hong Kong Branch of the IOA, has left W S Atkins to become Resident Associate, E R L Asia (Ltd) in Hong Kong.

And finally . . . **Grootenhuis Allaway Associates** were recently employed to quieten things down between a South London Social Club and the Church next door. Following consultations and the construction of a lightweight soundproofed partition wall between the two buildings, the priest at St Thomas the Apostle church in Nunhead reported a great improvement. 'It is miles better,' he said. 'Before, you could not use both buildings at once. The Social Club have Bingo on a Thursday night, and during Mass you could hear the numbers being called. . . .' □

Diploma Titles continued

Coventry (Lanchester) Polytechnic

A comparison of two methods for measuring road traffic noise
A study of noise associated with the operation of six internal combustion engine (diesel) test cells
The control of community noise using Section 58 of The Control of Pollution Act 1974
Industrial noise affecting residential dwellings — a case study
Noise from piling operations
Objective and subjective measurements of vibration in houses adjacent to railways in Rugby
The assessment of impulsive noise affecting a residential area: a case study

Ulster Polytechnic

An investigation of helicopter noise in Bessbrook
An assessment of noise problems within a small Local Authority abattoir
An investigation of vibration levels at 30 Clarendon St, Londonderry
The noise nuisance potential of an induced draught water cooling tower and methods used to reduce noise
An investigation of noise from pneumatic drills and problems associated with their use in urban commercial districts
An investigation of the acoustics of Carnmoney Church Hall
A comparison of simplified methods of measurement of airborne sound insulation in partitions with the method of BS 2750: Part 4: 1980
Noise control in Planning
Noise measurement and sound reduction techniques for a metal finishing machine
Noise nuisance from an industrial air blower
The exposure of employed persons to noise at Down District Council's refuse disposal tip
An investigation of traffic noise levels by direct measurement and prediction
Noise in a milk bottling plant

Any enquiry concerning these projects should be addressed to The Secretary, Institute of Acoustics, 25 Chambers Street, Edinburgh EH1 1HU. □

11th ICA, Paris

THE ELEVENTH International Congress on Acoustics was held in a very hot and sticky Paris from the 19th to the 27th July 1983. Following the formal opening of the Congress (by Madame le Secrétaire d'Etat auprès du Premier Ministre Chargé de l'Environnement et de la Qualité de la Vie) in the main lecture theatre of the Sorbonne, the sessions were held in the Hotel Sofitel, a modern hotel on the south-west boundary of the City of Paris. This provided a sufficiency of rooms close enough to each other for participants to be able to swap from one to another of up to twelve simultaneous sessions during the four-minute break between papers, without having to sprint all the way. One of the rooms had particularly comfortable deep seating and, in the subdued lighting required for slides, many of the audience seemed to have difficulty keeping their eyes open during the presentations immediately after lunch!

The avowed intention of the Congress (as stated in the Programme) was not only to provide a periodic review of the state of research in various fields, but also to promote cross-communication between researchers in different fields of acoustics. These different fields were grouped as follows: physical acoustics; physio- and psycho-acoustics; oral communication; shocks, vibrations and solid-state acoustics; measurements, transducers and electroacoustics; applied acoustics; musical acoustics; more general topics, eg history, regulation, education etc. Additional specialist symposia were held, prior to the main Congress, on acoustic radiation from vibrating structures (at Lyon) and on phonetic encoding and decoding of speech (at Toulouse). One of the most daunting aspects of the Congress was, on arrival, to be presented with a shoulder bag containing the eight volumes of Proceedings, each volume containing about 400 pages, and the Programme detailing the whereabouts of the seven hundred-odd presentations. It took most people half a day's solid study to find their way round the schedule.

It is always very difficult to pick out for mention specific talks or topics from a meeting as large as this, for one person only sees and attends a small fraction of the whole; I can therefore select for mention only those items that were of greatest interest to me. The first of these was a demonstration of auditory illusions that formed the last section of the opening ceremony. This was billed as a demonstration of some techniques of contemporary music and I (and I'm sure many others) groaned inwardly when the topic was announced. I could not have been more wrong. We were treated to a fascinating series of examples of ways in which the ear may be deceived and puzzled, analogous to the deception of the eye by the drawings of Escher.

The other topic that caught my interest was that of recent progress and future trends in electroacoustic transducers. This was the subject of one of the General Lectures, and there was also a Structured Session on fibre-optic acoustic detectors. It seems very probable that a revolution in transducers is on its way, with the ability to fabricate entire transducers, sensor element, conditioning amplifier and, if required, analogue-to-digital converter all on a single chip, while fibre-optic transducers offer excellent discrimination against interfering electromagnetic fields, together with ruggedness, and geometric versatility.

The social programme included a most enjoyable recital of organ music of the sixteenth and seventeenth centuries at the Church of St Germain des Prés and a conference dinner held on board a boat on the Seine. A number of technical visits to acoustics laboratories of various organisations were arranged, mostly to places in or around Paris, though one was to the Speech Processing Laboratory of CNET at Lannion in Brittany (transport for this was by air, rather than by coach as for the other visits).

I am sure the eleven hundred-odd other participants in the Congress found it, as I did, a very interesting and worthwhile event to attend. Undoubtedly its very breadth, and duration, caused some organisational problems, but of course this very breadth is one of its valuable advantages. The extent to which the French Government supported the event was very noticeable. The Patron of the Congress was the President, M Mitterand; eight Ministers or Secretaries of State were the 'Comité d'Honneur' and five Ministries contributed to the cost of organisation. I'm now beginning to plan how to get to the twelfth Congress in Canada in 1986. □

Stuart Flockton

London Evening Meetings

Code of Practice for Discotheques

At the third meeting of the present series, John Bickerdike told us about the proposed new Code of Practice for Discos. The Code covers three main areas:

(1) To provide sound level limits;

(2) To provide guidance on the lay-out of premises and the positioning of equipment;

(3) The provision of information to attenders.

The contents of the Code were described in some detail including the available options for enforcement. A draft version of the Code was circulated last year and the comments are now being digested. John estimates that compliance with the proposed Code would mean that the average dose for attenders would drop by 3 dB(A) with some from the top end of the exposure range reducing by 10 dB(A).

There then followed a very lively discussion over a wide range of topics including: gunshots; the effect of beer in microphones; the tendency of members of the human race to self-destruct; and what exactly is temporary threshold shift. A new record was set up for LEMs with at one time during the discussion six people talking at once. However, the Chairman remained fully in control and the meeting was subsequently closed to permit thirsts to be quenched.

Stephen Turner

Automatic Monitoring

In the last session of this series John Simson talked about some of the Greater London Council's experiences with automatic monitoring of environmental noise. Anyone who has had a tape recording made for them by someone else will know how difficult it can be to identify the noise sources that have been recorded; Level Recorder traces on their own can add a new dimension to guessing games! However, if we are to carry out long-term monitoring exercises to build up an accurate picture of the exposure to complex sources such as airports and helicopter routes, we must develop automatic data collection systems if the labour element is not to make the exercise prohibitively expensive.

The GLC have adopted such techniques and have now monitored aircraft noise in the west of London for a number of years and have established a fairly high degree of reliability. The system employed is a level activated data logger which records the time of triggering and samples the noise level for each event. Spurious events can subsequently be excluded from the analysis by examining the timing and duration of the logged events in relation to the operational constraints placed on aircraft by air traffic control procedures.

This equipment has also been used to monitor helicopter noise but, because the levels fluctuate a lot more due to less predictable operating procedures and because the signal to noise ratios are generally poorer, the reliability of identification is not as good as for their fixed wing counterparts. These problems have caused the GLC to investigate, in collaboration with certain University departments, more sophisticated ways of identifying sources. John's intention is to produce an instrument that would be attached to a sound level meter which would perform a cepstral analysis, compare the results with stored discriminant factors and provide in real time a classification of the source type. The sources that are being actively considered are aircraft, helicopters, trains and road traffic.

The meeting was well attended and I am sure that everyone there enjoyed the insight into the development of such a device and that, like me, they are eagerly awaiting the delivery of the prototype so that we can ask John to do another talk to demonstrate it. □

Robert Hill

Book Reviews

Environmental Health Procedures

W H Bassett, DMA, FIEH, FRSH

H K Lewis & Co Ltd, London
266 pp £13.00

The author is coeditor of Clay's Handbook of Environmental Health, which was reviewed in the Bulletin of July 1982 and to which this book forms a companion volume. The emphasis is here upon law and legislative procedures, rather than the practice of environmental health and this is accomplished by the adoption of apparently simple flow charts. It is no easy task to reduce the requirements of Acts and Regulations to a readily-understood diagrammatic representation, but Mr Bassett has achieved a high standard of clarity and succinctness.

The steps to be followed in each of a hundred or so procedures under Public Health Acts, Clean Air Acts, Control of Pollution Act, Housing Acts, Food and Drugs Act etc are detailed. The list of these procedures is comprehensive but not exhaustive — to make it so would be an impossibility. The accompanying text is restricted to short explanatory passages, being brief résumés of the relevant legislation. Cross references to the 'parent' volume are included and thus the work may be seen to be a valuable addition to the library shelves of the practising environmental health officer and perhaps also to professionals working in related fields.

There is little for acousticians, however, less than 20 pages being devoted to the law of environmental noise. Regrettably, there are some small errors in this part which could be misleading; the use of ie instead of eg implies that notices served in respect of noise construction sites etc will normally include a noise emission standard (certainly not the case); or that a notice served to abate a noise nuisance should not require a compliance period of less than the time allowed for an appeal against it to be lodged with the Court (a negation of the facility to act quickly). Such errors do not greatly detract from the usefulness of the publication, which, together with the proposed updating supplements, will be of great value to environmental health officers. □

M S Ankers

New Products

Submissions for inclusion in this section should be sent direct to J W Sargent, Building Research Establishment, Garston, Watford WD2 7JR.

A New Interface for the CEL Level Recorder

CEL Engineers have in conjunction with the British Steel Corporation, Swindon Laboratories, developed the necessary software to allow the CEL 160 Graphic Level Recorder to be interfaced to the B & K Third Octave Real Time Analyser. This will realise a low cost system for providing full annotated hard copy results from the analyser. Exchange program chips are available free of charge, from CEL Instruments, for existing users of their equipment, whilst all future productions will include this software package as standard.

CEL 193/3 Sound Level Meter obtains Intrinsic Safety Approval

The CEL 193 Precision Integrating Impulse Sound Level Meter has been granted certification by BASEEFA for use in explosion hazard zones up to Class IIc. This represents the first integrating instrument to obtain approval and will allow noise deafness risk measurements to be made in the mining and petrochemical industries. Approval has been granted in conjunction with the CEL 178 Octave Filter hence allowing full frequency analysis work also to be undertaken. Certification has been granted under the terms of the article of the Council Director of the EEC of 18 December 1975 (76/117/EEC) allowing the certification to be accepted throughout the Community.

Enhanced Real Time Zoom Capability in FFT Analysis

A new software package has been developed for the CF-300 that provides for a real-time zoom function. This is housed on a retrofittable board and will allow continual zooming of dynamic signal with an expansion factor of 128 to give a resolution better than 1 Hz across a 20 kHz frequency span. When used in conjunction with the post analysis store a continually rotating time frame can be assembled which can be triggered at any time and thereby provide a pictorial pre-event waterfall display. Further details from Computer Engineering Ltd, 35 Bury Mead Road, Hitchin, Hertfordshire SG5 1RT. Tel: 0462 52731.

Human Environment Measurements

Brüel & Kjær (UK) Ltd have just produced a 24-page colour illustrated brochure describing *Human Environment Measurements.*

This is intended to help Safety Officers and Administrative staff in factories, warehouses and offices to prepare for the problems which will be facing them when proposed new legislation comes into force in the near future, and the brochure is issued free upon application.

One of the biggest problems once legislation has taken place will be finding the best way to deal with excessive noise which endangers hearing and the brochure deals very fully with that subject in 17 of its 24 pages.

The brochure also deals with the investigation of vibration problems which can adversely affect work people, illumination contrast measurements which can be used to ensure better optical working conditions and a unique

NON-INSTITUTE MEETINGS

1983

15–20 December. *Sixth IFTOMM Congress on Theory of Machines and Mechanisms.* New Delhi, India. Contact: Department of Mechanical Engineering, Indian Institute of Technology, New Delhi 110016 India.

1984

12–13 January. *Design against Wind-induced Failure.* Bristol. Contact: Judy Vare, Conf Sec, PO Box 63, Guildford, Surrey GU2 5BH.

2 February. *Anti-Sound.* A Review Lecture by Prof J E Ffowcs Williams. The Royal Society, London. Contact: Miss C A Johnson, The Royal Society, 6 Carlton House Terrace, London SW1Y 5AG.

19–21 March. *IEEE International Conference on Acoustics, Speech and Signal Processing.* San Diego, California. Contact: Mr S S Viglione, Interstate Electronics, 707 East Vermont Avenue, Anaheim CA 92805, USA.

21–23 March. *2nd International Symposium on the Performance of Computer-Communications Systems.* Zurich. Contact: I B M, Zurich Research Laboratory, Saumerstrasse 4, CH — 8803 RUSCHLIKON, Switzerland.

27–30 March. *75th AES Convention.* Paris. Contact: Ms T K S Bakker, c/o Polygram B V, PO Box 23, 3740 AA Baarn, Holland.

5–6 April. *SEECO 84 — Dynamics in Automotive Engineering.* Contact: SEE, Owles Hall, Buntingford, Herts SG9 9PL.

9–13 April. *2nd International Conference on Recent Advances in Structural Dynamics.* Southampton. Contact: Dr M Petyt, ISVR, The University, Southampton SO9 5NH.

13–17 June. *Principles of Sonar Systems Engineering.* Course presented by the Continuing Education Institute with Linköping Institute of Technology, Sweden. Zandvoort, The Netherlands. Contact: Course Registration Office, Continuing Education Institute-Europe, Anita Hull, Gustav Adolfsgatan 9, S-582 20 Linköping, Sweden.

18–22 June. *Waves in fluid-filled tubes.* (Euromech). Rimini, Italy. Contact: Professor F Mainardi, Università di Bologna, Piazza di Parta S Donato 5, 40127 Bologna, Italy.

measuring system that can be used to assess the likely thermal comfort of work people situated in any given environment and taking into consideration the clothing they wear and the work that they do.

Further details from Brüel & Kjær (UK) Ltd, Cross Lances Road, Hounslow, TW3 2AE. Tel: 01-570 7774.

A Waterfall Display for FFT Analysers

The Spectral Dynamics SD348 Waterfall Display is compatible with the SD345 and SD375 FFT Analysers via the IEEE 488 Digital Interface. It is ideal for highlighting signal amplitutde/frequency changes in 3-D. The versatile SD348 data acquisition modes and flexible non-destructive data viewing selections are significant instrumentation advancements in manipulating stored processed data without the use of an external computer. Further details from Scientific—Atlanta, Spectral Dynamics Division, 25 Bury Mead Road, Hitchin, Herts, SG5 1RT. Tel: Hitchin 31101.

Metrosoft

Metrosonics Inc have recently produced Metrosoft software which makes possible the transfer of noise exposure data from db-301 Metrologgers to popular personal computers. Summary time histories and exposure data are displayed and are available on hard copy; graphs can be plotted in condensed and detailed format. All data is stored on floppy discs, saving filing space. The package also contains sophisticated archiving and search routines. Further details from Barry G Watkins, 12 Boxwood Road, Upper Tean, Stoke-on-Trent. Tel: 053872 3537/2952. □

Material for the January issue of Acoustics Bulletin should reach Mrs F A Hill at 25 Elm Drive, St Albans, Herts AL4 0EJ, no later than Friday 25 November.

HSE Campaign on Deafness caused by Noise at Work

The Health and Safety Executive are conducting a publicity campaign this Autumn to raise awareness of the need to take action to prevent noise at work causing hearing damage, and the various forms that this action can take.

This awareness campaign is to be launched on 26 October, when John Gummer MP and Mr Terry Scott are expected to join Dr John Cullen, the new Chairman of the Health and Safety Commission, in introducing it to the media. The aim is to make people more aware that noise at work can be harmful and that it need not cost a fortune to tackle it. Publicity of various kinds includes a booklet describing actual cases where noise was reduced. Emphasis will be laid on the need for a sensible and balanced approach to be taken towards noise reduction where the cost is reasonable, and use of ear protection where necessary. □

Institute of Acoustics Meetings

1983

2 November	IMech	Practical Use of Active Noise and Vibration Control.	London
7 November	BAG	Studio Design for Radio and Television	London
December	M	Sonic Emission	Chelsea College, London
9 December	SG	Temporal Factors in Speech	University of Cambridge

1984

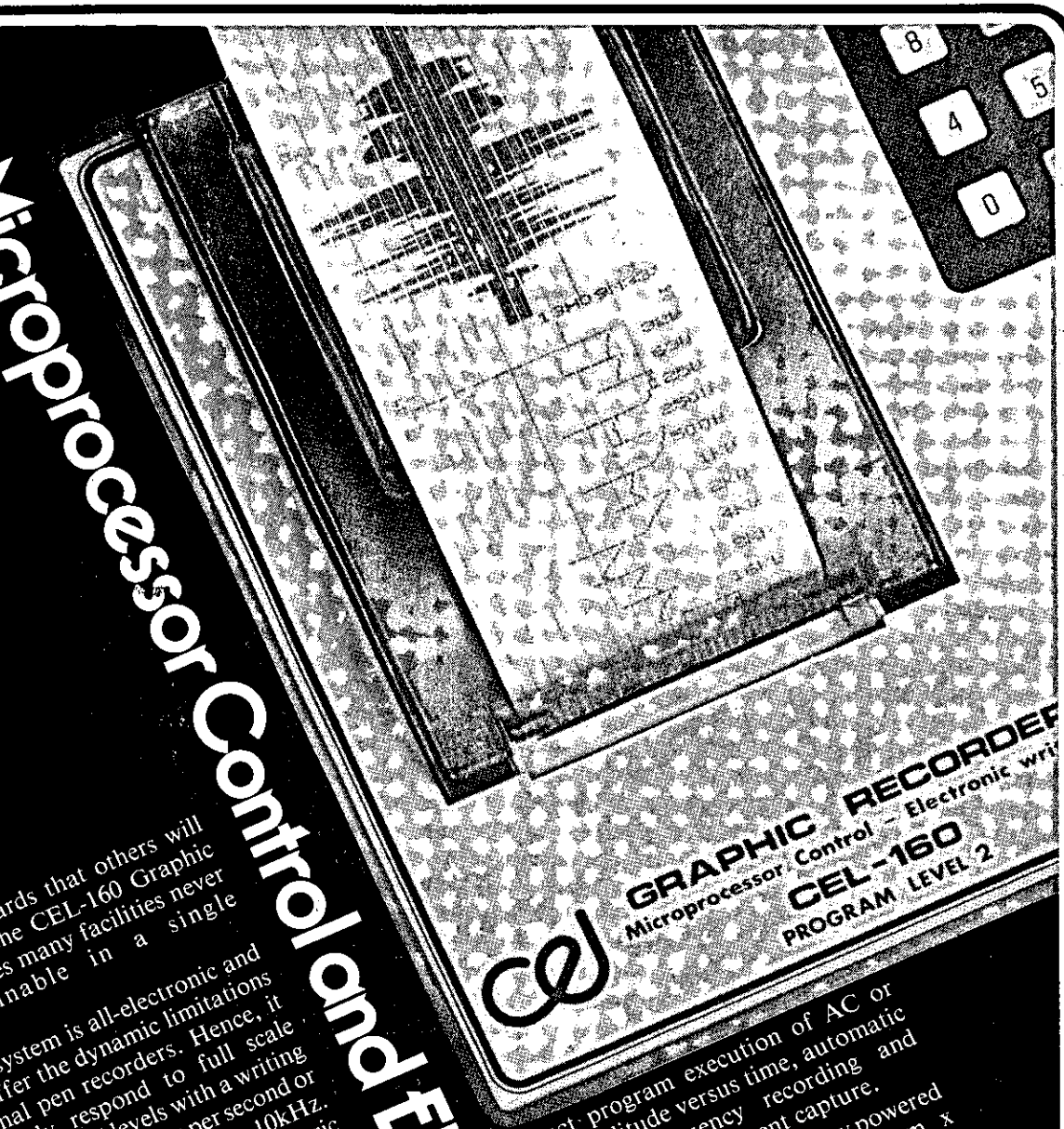
22–24 February	IEE	Secure Communications Systems	London
13–14 March	M	Speech and Audio Tape Analysis for Police Use	Birkbeck College, London
10–12 April	M	**Acoustics 84—Spring Meeting**	**Swansea**
5–7 June	IMech	Vehicle Noise and Vibration	London
4–6 November	M	Autumn Conference	Windermere

Key:

M = Meetings Committee Programme
SG = Speech Group
BAG = Building Acoustics Group
IEE = Joint meeting with The Institution of Electrical Engineers
IMech = Joint meeting with The Institution of Mechanical Engineers

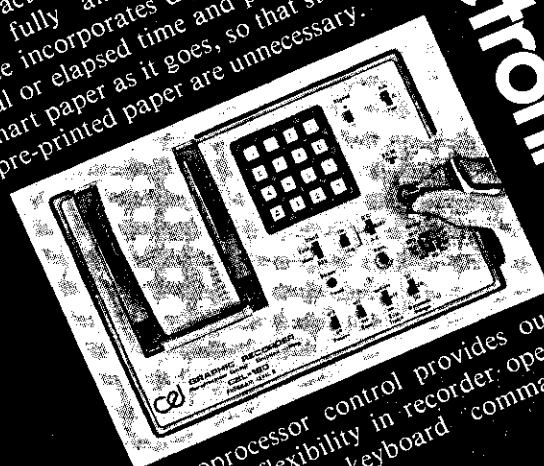
Further details from:
Institute of Acoustics
25 Chambers Street
Edinburgh EH1 1HU

Microprocessor Control and Electronic Writing



Setting new standards that others will have to follow, the CEL-160 Graphic Recorder features many facilities never before obtainable in a single instrument.

The writing system is all-electronic and does not suffer the dynamic limitations of traditional pen recorders. Hence, it can accurately respond to full scale deflection for RMS levels with a writing speed of 10000 millimetres per second or write actual waveforms up to 10kHz. The fully annotated alpha-numeric trace incorporates digital recording of real or elapsed time and prints its own chart paper as it goes, so that stocks of pre-printed paper are unnecessary.



Microprocessor control provides outstanding flexibility in recorder operations. Simple keyboard commands instruct program execution of AC or RMS amplitude versus time, automatic hard-copy frequency recording and automatic transient event capture.

This revolutionary new battery powered instrument measures only 275mm x 195mm x 130mm and weighs just 3 kg making it ideal for on-site or laboratory applications. Full details of this exciting new development are available from:

Computer Engineering Limited
Wallace Way, Hitchin, Herts, SG4 0SE
Tel: Hitchin (0462) 52731/3.
Telex: 826615.

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