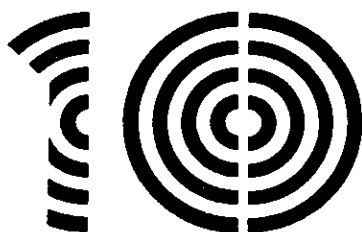




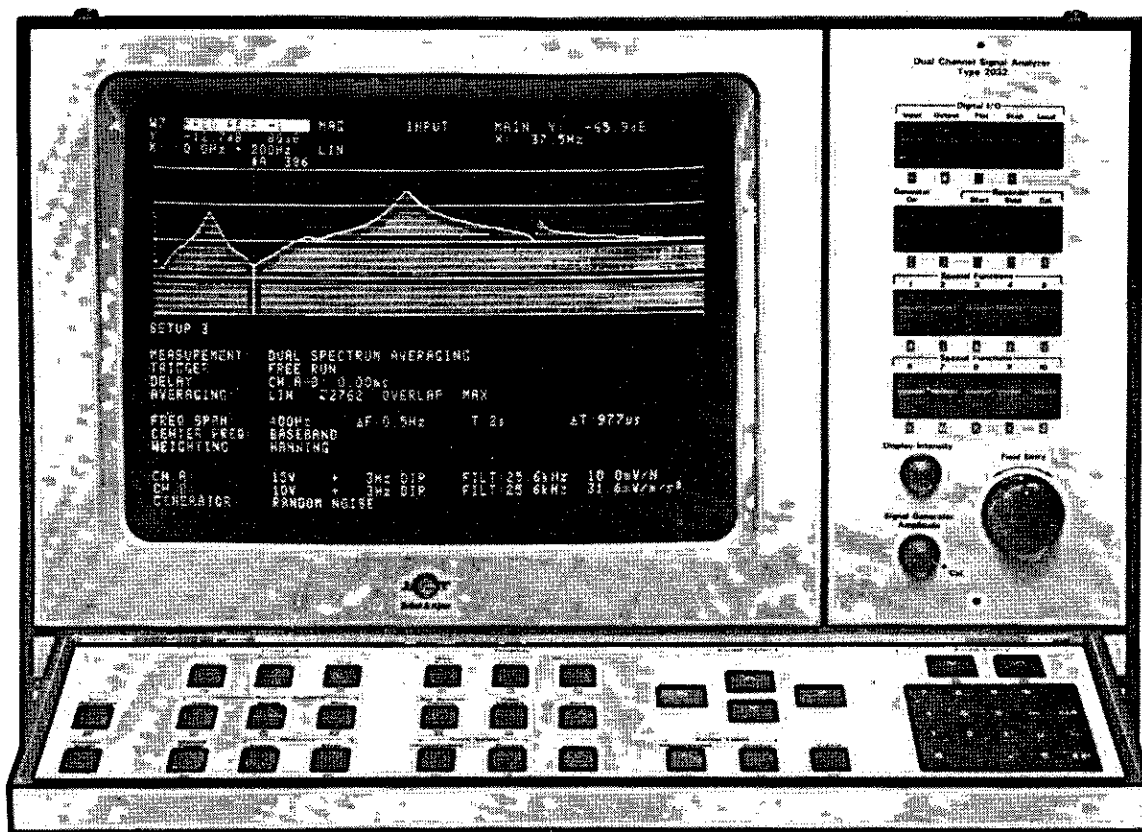
Acoustics Bulletin

July 1984 Volume 9 Number 3



INSTITUTE OF ACOUSTICS

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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.

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Presidents Letter

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Dear Member,

Writing this note shortly after taking my first Council Meeting as President, several points come to mind. One is the length of the meeting, which went on for over three and a half hours! Your Council members work hard. In addition to Council, each member is expected to serve on at least one of the Institute's Committees, where they may be joined by other members of the Institute who are not on Council. Prior experience gained through Committee membership is very useful for those who feel that they are able to make a contribution to the Institute through later election to Council. Committee experience often starts at Group and Branch level, which is where all members have an opportunity to demonstrate their involvement with the Institute.

An important item discussed at Council was progress in our approaches to the Engineering Council and the Privy Council. First the bad news. Sir Neville Leigh, Secretary to the Privy Council, made it clear to us that a petition for a Charter would be premature at this early point of our existence. We are shelving the matter for another 10-20 years! There is better news from the Engineering Council. Contact has been very positive and Council of the IOA agreed to proceed with an application to become a nominated body of the Engineering Council. Success in this will mean that corporate members of the Institute who have acceptable qualifications and experience will be able to obtain recognised status (ie Chartered Engineer, Technician Engineer or Engineering Technician) through membership of our own Institute, rather than through membership of an Engineering Institution.

We are aware that not all our members are in a position to benefit from this, perhaps because the subject of their initial qualification and their subsequent experience does not bring them into the category of 'engineer'. However, their interests are not being overlooked by the Institute, which has been a member of the Council of Science and Technology Institutes (CSTI) for several years. The CSTI does not yet have the clout of the Engineering Council, but your Council feels that its aims are relevant to the IOA. In particular, the aim of enhancement of the role of professional scientists and technologists will be of benefit to all of us.

The next major event in the Institute's Calendar is the Autumn Meeting at Windermere early in November. Previous meetings at Windermere have been a great success, both technically and socially. Do not miss this one!

Yours sincerely,

Geoff Leventhall

Bearing Vibration Research in RHP

F P Wardle, S J Lacey and C P/R Emblen

Although this subject has been researched for more than a quarter of a century the difficulties in characterising both the vibration and its sources have meant that the work has been practically biased with individual manufacturers developing their own empirical correlations between cause and effect. By far the greatest effort was expended during the fifties and sixties in an attempt to develop quiet running rolling bearings for the rapidly expanding electric motor market. During this time considerable progress was made in understanding the causes of vibration and in developing test equipment, standards and specifications. These successfully defined quiet running and provided tests which could be used for inspection purposes. However they only applied to the more commonly used sizes of single row radial and angular contact ball bearings operating under light load, moderate speed conditions.

DURING the seventies, it was increasingly realised that the vibration testing of rolling bearings was also an effective method of quality control; so much so that it is now generally accepted that quiet running is synonymous with quality and even bearings used in noisy environments are often subject to some form of vibration test. The association of quality with quiet running is not unfounded. For example, the fatigue life of bearings is known to improve with the finish of the rolling surfaces; similarly, the geometrical accuracy of machine tool bearings is known to influence workpiece form and finish whilst for high speed applications, bearings may scuff unless rolling surfaces are manufactured to high standards. The same factors influence bearing vibration levels and so vibration testing can be quick, simple and effective as a method of gauging this aspect of quality.

TEST EQUIPMENT

The requirement for quiet running bearings and the need to achieve consistently high quality has influenced research and development in RHP. The quality requirement has affected the range of bearing types and sizes to which vibration testing is applied. RHP manufacture a wide range of ball and roller bearings on a batch production basis and bearings from 10 mm to more than 200 mm bore, roller, single and double row ball types can all be tested. The condition of general bearing types can be determined from just two vibration tests, one a simple two-parameter test for quality control and the other a more searching four-

parameter test for bearings used in quiet running applications. These tests are described in the following sections.

Peak Counter

The peak counter is designed to pick out the sources of vibration which have a detrimental effect on the bearing's functional performance, namely contamination, discrete damage and excessive roughness of the rolling surfaces. It is therefore an ideal test for quality control.

The bearing is mounted on a low vibration spindle (Figure 1) and run under controlled conditions of load, speed and lubrication. Radial acceleration is recorded at a point on the bearing's

outer ring and band pass filtered to remove vibration below 300 Hz and above 10 kHz. The latter is a practical limit imposed by the response of the measuring system whereas the former is to remove vibration associated with geometrical inaccuracies of the test spindle. Two parameters are monitored: RMS acceleration and the number of vibration peaks exceeding a preset threshold in a given period of time. From practical tests a threshold of $4 \times$ the RMS acceleration level has been found to give optimum discrimination. Peak counting picks out the high amplitude, short duration vibration pulses produced by localised damage and contamination whereas RMS acceleration enables bearings with rough or even extensively contaminated rolling surfaces to be identified. Accept/reject quality limits have been determined for both peak count and RMS acceleration parameters for a wide range of bearing sizes.

Quiet Running Analyser

The procedure and quality limits defined in the American Military Specification MIL-B-17931D (Ships) form the basis of the vibration test used by RHP for checking bearings used in quiet running applications. The lubricated test bearing is mounted on a precision, quiet running spindle rotating at 1800 rpm and subjected to a specified level of load. Radial velocity is measured at a point on the bearing's outer ring and recorded in the three frequency bands: 50–300, 300–1800, 1800–10,000 Hz.

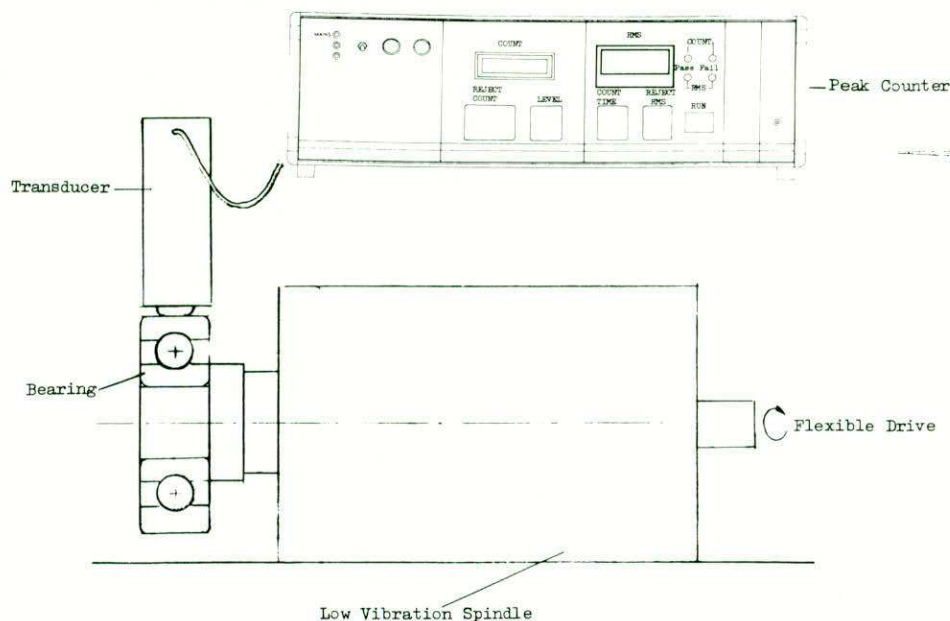


Figure 1 Peak Counter Test

This test is combined with peak counting to define a quiet running bearing, free from damage and contamination. In addition to satisfying a peak count limit the bearing must meet RMS velocity limits in all three frequency bands.

Single row radial and angular contact ball bearings are tested under axial load, the level of which must be sufficient to ensure firm rolling contact of all balls. Inadequate test load enables some balls to intermittently skid and roll and the bearing produces high and erratic vibration levels.

Roller and double row bearings are not covered by widely accepted vibration test specifications yet they are used in a number of quiet running applications. Both bearing types are tested under radial load and in this situation only a few rolling elements are in firm contact with both raceways. Repeatability is therefore the main factor influencing the test arrangement. A stable test configuration is achieved by applying the radial test load through two flexible pads separated by an arc of 30° . Only a light load (25% of the thrust load required for the same diameter ball bearing) is necessary to ensure stable motion of the rolling elements and cage. Positioning the transducer centrally between the pads ensures that vibration generated by the loaded rolling elements is recorded and also gives optimum repeatability.

The RHP quiet running analyser (Figure 2) is fully automatic and capable of testing all bearing types. The design incorporates a hydrostatic spindle having a negligible vibration level, radial and axial loading mechanisms and an isolated drive system.

Other Test Equipment

Other forms of noise or vibration testing are used within RHP but these are dedicated to special bearing designs. For example, sound pressure level is used to measure the noise produced by automotive clutch bearings. The test bearing is placed in an anechoic chamber and run on a precision spindle under a light axial load at a speed of 1800 rpm. A microphone positioned 75–100 mm from the bearing and 45° off the bearing's axis measures bearing generated sound which is filtered with an 'A' weighting and displayed in terms of RMS sound pressure level. The test is a useful comparator for quality control but does not offer any advantage over vibration measurement.

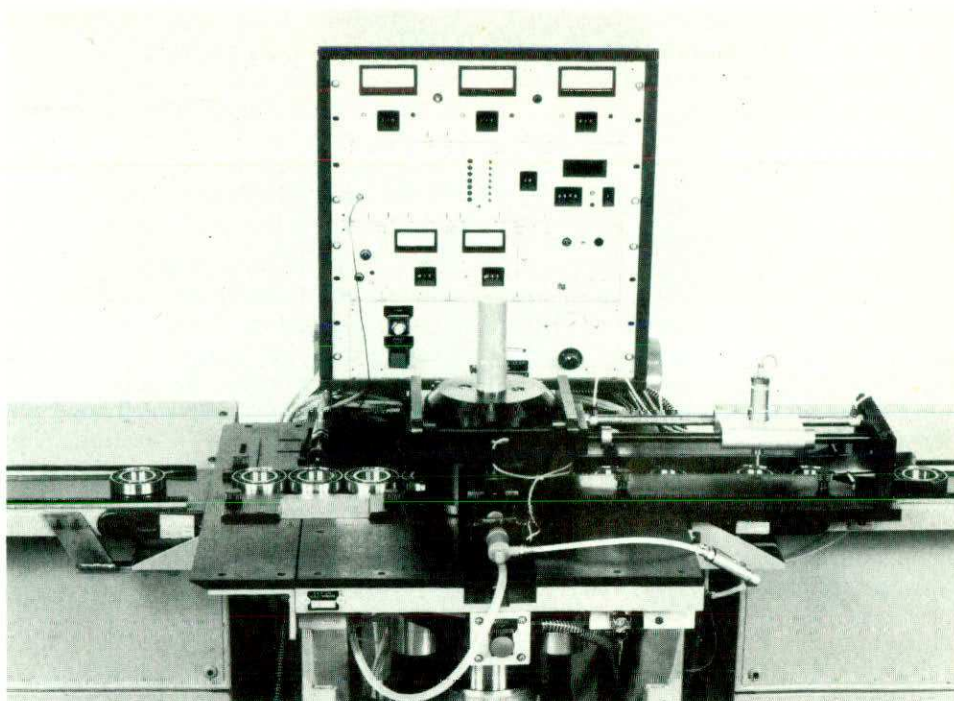


Figure 2 RHP Quiet Running Analyser

SOURCES OF VIBRATION

Bearing test conditions used on the peak counter and quiet running analyser are representative of those occurring in electric motors and many other categories of quiet running machinery. Experience has shown that the various

sources of vibration occurring in a bearing on test broadly correlate with those occurring in bearings fitted to machines. This is important to bearing manufacturers because it means that quiet running bearings can be identified from test measurements.

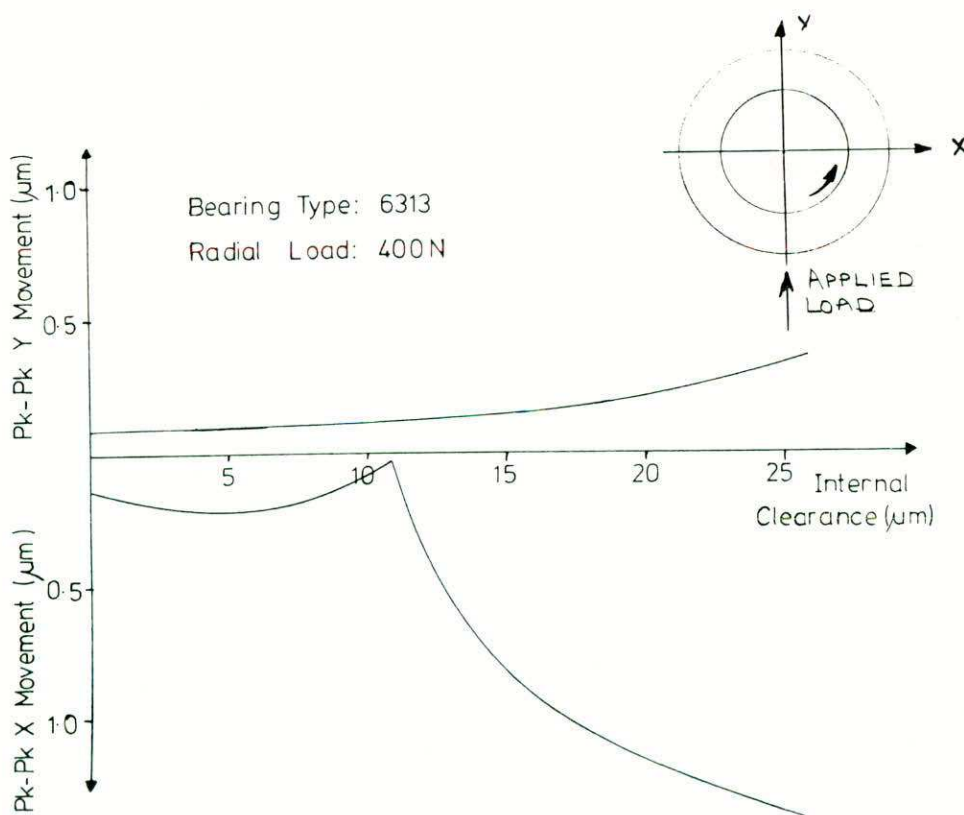


Figure 3 Variable compliance vibration vs internal clearance

Under test conditions using the Peak Counter and the Quiet Running Analyser three main sources of vibration have been identified.

Variable Compliance

This occurs under radial or misaligning loads, it is an inherent feature of rolling bearings and it is completely independent of quality. Radial or misaligning loads are supported by a few rolling elements confined to a narrow region and the radial position of the inner ring with respect to the outer ring depends on the elastic deflections at the rolling element-raceway contacts. As the bearing rotates, individual ball loads and hence elastic deflections change to produce a relative movement between inner and outer rings. The movement takes the form of a locus which under radial load is two-dimensional and contained in a radial plane whilst under misalignment it is three-dimensional. The movement is also periodic with a base frequency equal to the rate at which rolling elements pass

through the load zone. Frequency analysis of the movement yields the base frequency and a series of harmonics. For a single row radial ball bearing with an inner ring speed of 1800 rpm a typical ball pass rate is 100 Hz and significant harmonics to more than 500 Hz can be generated.

Theoretical models have been developed and these show variable compliance vibration levels to depend mostly on the number of rolling elements supporting the applied load. The greater the number of loaded elements, the less the vibration. For radially loaded or misaligned bearings 'running clearance' determines the extent of the load region and hence, in general, variable compliance increases with clearance (Figure 3). A distinction is made between 'running clearance' and radial internal clearance (RIC). For a bearing fitted to a machine the former is normally less than the RIC owing to a differential thermal expansion and interference fit of the rings. There are particular combinations of

load and clearance which produce low variable compliance vibration contrary to the general trend but this is a point of interest rather than of practical use.

Variable compliance vibration levels can exceed those produced by roughness and waviness of the rolling surfaces. However, in applications where vibration is critical it can be reduced to a negligible level by using ball bearings with the correct level of axial preload.

Distributed Surface Features

For axially loaded ball bearings operating under moderate speeds the form and finish of the critical rolling surfaces are generally the largest source of noise and vibration. In this article these are termed distributed surface features. It is convenient to consider them in terms of wavelength compared with the width of the rolling element-raceway contacts. Surface features of wavelength of the order of the contact width or less are termed roughness whereas longer wavelength features are termed waviness (Figure 4).

Surface Roughness

Surface roughness is a significant source of vibration when its level is high compared with the lubricant film thickness generated between rolling element-raceway contacts (Figure 4). Under this condition surface asperities can break through the lubricant film and interact with the opposing surface. The resulting vibration consists of a random sequence of small impulses which excite all natural modes of the bearing and supporting structure. Natural frequencies which correlate with mean impulse rise time or mean interval between impulses are more strongly excited than others.

Surface roughness produces vibration predominantly at frequencies above 60 times the rotational speed of the bearing. Thus the high frequency part of a bearing vibration spectrum usually appears as a series of resonances. For example, Figure 5 shows the spectrum recorded at a point on a ball bearing's outer ring. High vibration levels at 2.5, 4.7 and 8.0 kHz correlate with resonant frequencies of the bearing's outer ring.

The ratio of lubricant film thickness to composite RMS surface roughness is given by $\lambda = h / \sqrt{\sigma_b^2 + \sigma_r^2}$ where h is the lubricant film thickness, σ_b is the RMS roughness of the ball and σ_r is the RMS roughness of the contacting raceway. λ is a parameter which indicates the degree of asperity interaction. If the surfaces have the same roughness

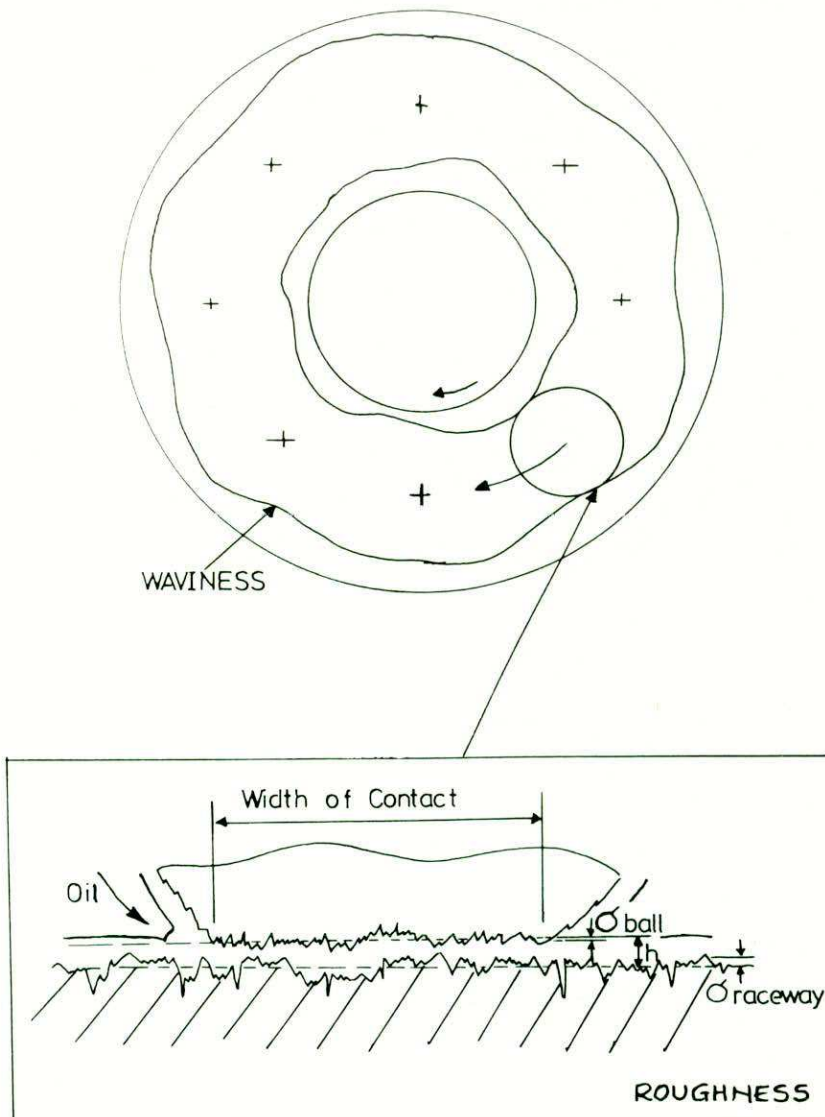
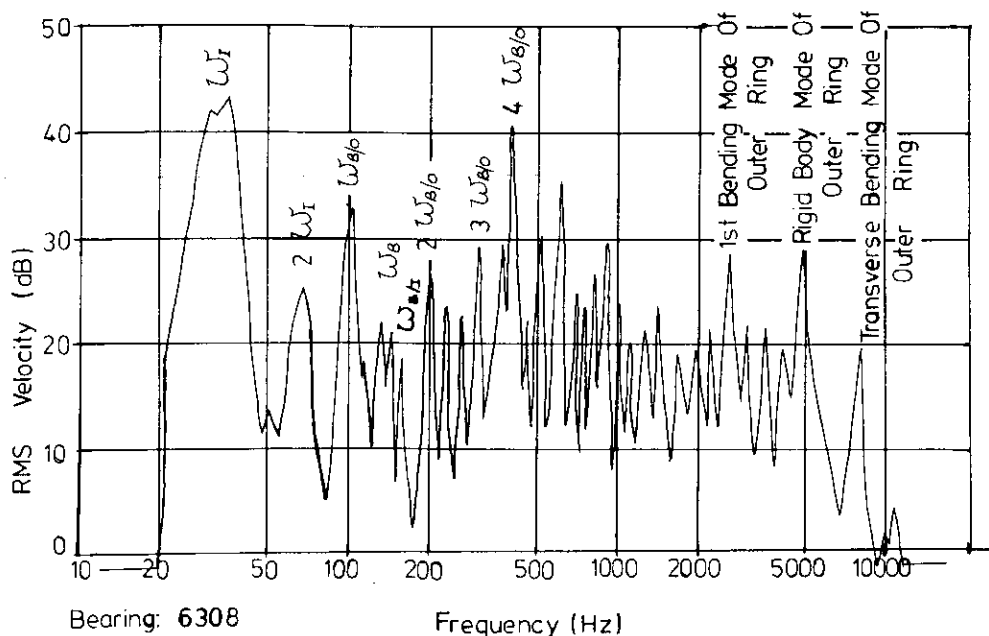


Figure 4 Waviness and roughness of rolling surfaces



Bearing: 6308
Axial Load: 260N
Speed: 1800 Rev/min

ω_I = Inner Ring Speed
 $\omega_{B/O}$ = Ball/Outer Ring Speed
 $\omega_{B/I}$ = Ball/Inner Ring Speed
 ω_B = Ball Rotational Speed

Figure 5 Typical velocity spectrum of a ball bearing

and it is assumed that the peak height of asperities is only three times the RMS level then for a typical lubricant film thickness of $0.3 \mu\text{m}$, surface finishes better than $0.05 \mu\text{m}$ are required to achieve a low incidence of asperity interaction.

Waviness

For the longer wavelength surface features, peak curvatures are low compared with that of the Hertzian contacts and rolling motion is continuous

with the rolling elements following surface contours. The relationship between surface geometry and vibration level is complex being dependent upon bearing and contact geometry as well as conditions of load and speed. Published theoretical models aimed at predicting bearing vibration levels from surface waviness measurements have only met with limited success (Reference 1). Waviness can produce vibration at frequencies up to approximately 300 times rotational speed but is

usually predominant at frequencies below 60 times rotational speed. The upper limit is attributed to the finite area of the rolling element raceway contacts which average out the shorter wavelength features. The mechanism is explained for the case of two discs in rolling contact by Gray and Johnson (Reference 2), and the arguments are supported by good correlation between predicted and measured responses. In the direction of rolling, elastic deformation at the contact averages simple harmonic waveforms over the contact width (Figure 6a). The level of attenuation increases as wavelength decreases until in the limit, for a wavelength equal to the contact width, waviness amplitudes are theoretically zero. The contact length also attenuates short wavelength surface features. Poor correlation can exist between parallel surface height profiles taken in the direction of rolling but at different points across the track (Figure 6b) and this averages measured waviness amplitudes to a low level. For typical bearing surfaces poor correlation of parallel surface height profiles only exists at the shorter wavelengths.

Discrete Defects

'Discrete defects' refers to damage and contamination of rolling surfaces. These are not inherent in the manufacturing process but can occur during the final assembly stages or when a change to the usual manufacturing route is introduced. These defects can be extremely difficult to detect by any other means yet are readily shown up by a simple vibration test performed on the finished product. They can take a variety of forms: indentation, scratches along and across the rolling surfaces, pits, debris and particles in the lubricant. Characteristically, dirt and damage produce impulsive vibration

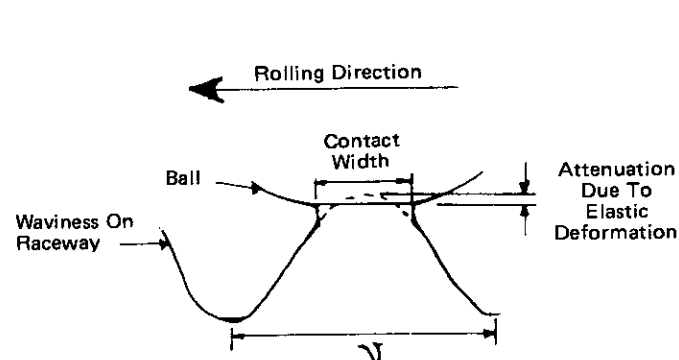


Figure 6a Effect of contact width on waviness

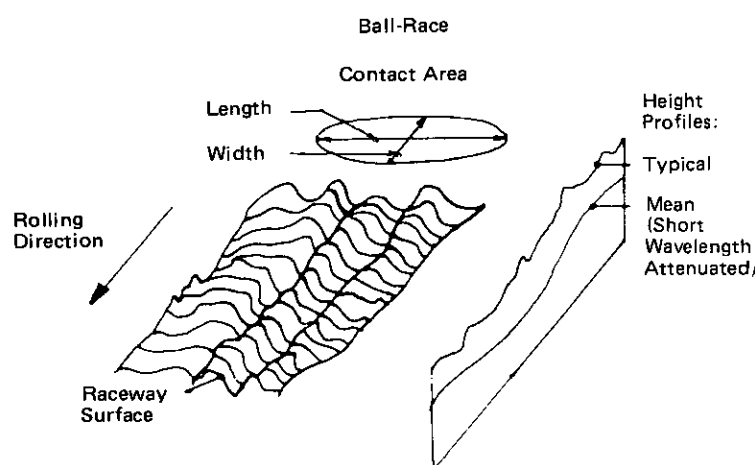


Figure 6b Effect of contact length on waviness

which has a high peak/RMS ratio (Figure 7). An exception is when a large number of defects occur. Individual vibration peaks are then not so clearly defined but the RMS vibration level is several times greater than that normally associated with a bearing in good condition.

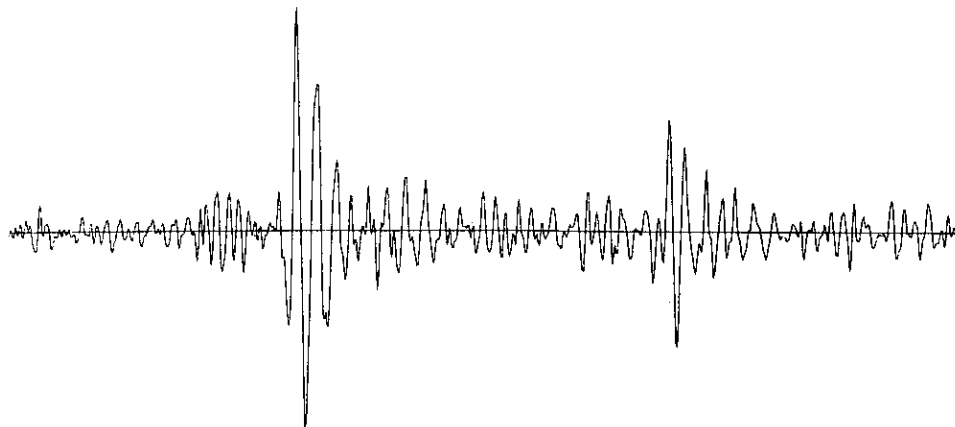


Figure 7 Vibration produced by discrete defects

A correlation between extent of damage and vibration is unnecessary. Damage should not be present so all that is needed is a vibration criterion for damage detection. During the course of determining this criterion it soon became apparent that defects were more easily detected by vibration than by other methods of inspection. Similarly, whilst determining acceptable levels of contamination, bearing vibration was again found to be a more sensitive indicator of cleanliness than existing methods of inspection.

Typical Bearing Vibration Spectrum

Although absolute vibration levels produced by rolling surface features are difficult to predict the major frequencies generated by bearings are by now well known. These relate to four base frequencies:

$$\begin{aligned} \omega_1 & \text{ (rotating ring speed, usually the inner ring)} \\ \omega_{B/I} &= \omega_1 N(1 + \gamma)/2 \text{ (ball to inner ring relative speed)} \\ \omega_{B/O} &= \omega_1 N(1 - \gamma)/2 \text{ (ball to outer ring relative speed)} \\ \omega_B &= \omega_1 d_m(1 - \gamma^2)/2D \text{ (ball rotational speed)} \end{aligned}$$

where N = number of balls, d_m is the pitch circle diameter, D is the ball diameter and $\gamma = (D \cos \alpha)/d_m$ with α = the contact angle. α is an important ball bearing parameter. It is the angle which the line through the inner and outer contacts makes with a radial plane when the bearing is subjected to

a light thrust load. Note that α is zero for radially loaded ball and roller bearings. The base frequencies and all harmonics are generally present in a bearing vibration spectrum (Figure 5). Resolution of the measuring equipment or variation in slip at rolling element-raceway contacts are the usual

factors which limit identification of high order harmonics.

MANUFACTURING CAUSES

Rolling surface form and finish required by quiet running bearings are approaching the limits which can be achieved by modern mass production machinery. To maintain these limits consistently requires a high degree of control over the manufacturing process, which for each bearing component consists of a sequence of progressively finer machining operations, starting with turning and ending with honing. Controlling both finish and form is a classical manufacturing problem within the rolling bearing industry. Essentially the parameters necessary to achieve finish are not consistent with those required to maintain good form. Thus the honing operation, whilst capable of fine finishes, can destroy the form achieved in the previous grinding operation if excessive material has to be removed. A solution is to use the grinding operation to achieve form and control the finish presented to honing so that only a minimum amount of material removal is necessary to achieve the final surface finish. Grinding is therefore the operation of central importance.

Research has so far concentrated on raceway grinding with the overall aim of achieving consistently high standards of form and finish without increasing manufacturing times. The grinding problem has been approached

from the unusual view that any surface roughness or departure from roundness of the workpiece must be produced by relative radial movement between the grinding wheel and workpiece during grinding or dresser and wheel during dressing. Vibration is therefore considered to be the main source of surface roughness and waviness. The effect of the process parameters such as, for example, wheel type and dressing condition, work and wheel speeds, machine rigidity and feed rates are interpreted in terms of their ability to amplify or average out various sources of vibration occurring during the crucial dressing and machining operations.

Grinding Machine Vibration

A typical configuration for shoe centreless grinding of a bearing's outer raceway is shown in Figure 8. Radial location of the workpiece is provided by two hard wearing 'shoes' whilst axial location and ring rotation is achieved via a magnetic faceplate. A single point diamond which rotates through an arc is used to form the required radius on the grinding wheel. This form is transferred to the bearing raceway by plunge grinding.

Two main types of vibration occur on a grinding machine. The first is forced vibration of which rotating machine elements are the main sources, ie grinding spindle and drive motor imbalance, bearings, hydraulic pumps, etc. The second is self-generated vibration which is far more dependent upon the process parameters, machine stiffness, feed rate and wheel condition. During grinding the wheel and workpiece mutually machine each other so that any relative radial movement between them not only produces poor workpiece quality but also results in deterioration of the wheel. Self-generated vibration can therefore build up within one grinding cycle or over several. Major sources of vibration are shown in Figure 8.

The two types of vibration may be categorised in terms of:

- (i) vibration, harmonic with grinding wheel speed
- (ii) vibration, inharmonic with grinding wheel speed
- (iii) vibration, harmonic with workpiece speed

Vibration, harmonic with grinding wheel speed

During dressing, vibration which is harmonic with grinding wheel speed, for example, wheel out of balance, has

a large effect on wheel form but only a small effect on workpiece quality. This is because vibration synchronous with wheel speed is transferred onto the grinding wheel during dressing and results in an integer number of waves being formed around the wheel periphery which are all in phase across the wheel width. Therefore the wheel surface although out of round runs true to the dressing diamond. Since the diamond and the workpiece are on the same slide there is no relative vibration between them so the wheel must also run true to the workpiece. Any deterioration in waviness and roughness of the workpiece should therefore be relatively small, being mostly due to the difference in contact dynamics during grinding from those during dressing.

Vibration, inharmonic with grinding wheel speed

Vibration which is inharmonic with workpiece speed also affects the wheel profile during dressing. Whereas for harmonic vibration the waves dressed into the wheel are in phase across the wheel, for inharmonic vibration the waves are now out of phase and produce a very complex wheel profile. Research has shown that inharmonic vibration has a very major effect on workpiece surface finish and it is in this area that major improvements stand to be gained.

Vibration, harmonic with workpiece speed

This category of vibration is primarily responsible for waviness formed on the workpiece. As the workpiece rotates, vibration between wheel and workpiece is in phase with the waves machined in the previous revolution and these are maintained or may even grow in amplitude whereas the effects of inharmonic vibration are averaged to a low level. The number of waves/circumference is equal to the ratio of vibration frequency/workpiece speed.

Forced vibration, such as for example, that produced by the workpiece drive or shoe location, produces waviness of an amplitude similar to that of the vibration itself. Chatter, however, which is self-excited vibration, produces waviness that builds in amplitude and does not necessarily relate to the initial excitation. Amplitudes and frequencies depend mostly on cutting conditions and the dynamic stiffness of the machine. Chatter can usually be distinguished from the effects of forced vibration mainly from wavelength. It will occur at a base frequency which falls close to a natural frequency of the machine and for most grinding machines natural frequencies are high.

FUTURE RESEARCH

Within RHP future research on bearing vibration will concentrate on the machining processes responsible for the form and finish of the rolling surfaces. The benefits associated with

increased automation provide the incentive to develop in-process monitoring for controlling the quality of bearing components and performing machine diagnostics. Present research on the ring grinding operation has successfully demonstrated that a wide range of grinding machine faults can be diagnosed from workpiece finish and roughness traces and that these faults can be detected from vibration measurements recorded during grinding or wheel dressing operations. The relatively complex analytical strategy required to diagnose a useful proportion of grinding machine faults requires far more in the way of computer resources than simply monitoring quality. In-process quality monitoring backed up by an out-of-process machine diagnostics capability therefore appears an attractive interim step towards full in-process monitoring. The work also needs to be extended into a wider range of machining operations.

ACKNOWLEDGEMENTS

The authors would like to thank RHP Divisions for supporting the investigations on which this article is based.

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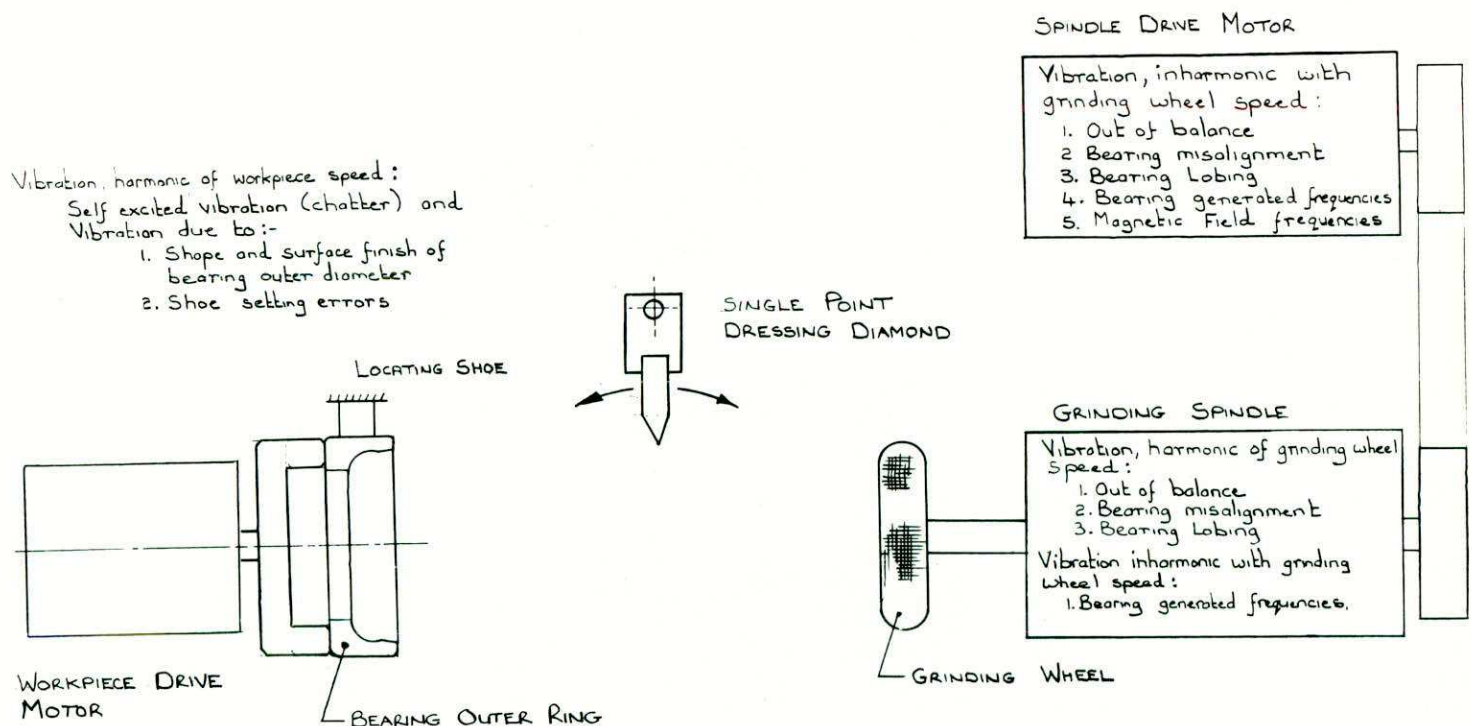


Figure 8 Typical outer race grinding configuration showing main sources of machine vibration

ACOUSTICS 84

The Institute Spring Meeting in Swansea

The 1984 Spring meeting was held in Wales for the first time in the history of the Institute. The campus of the University College of Swansea was the setting of the conference and the beautiful weather made this one of the finest sites for the series up to date. The conference was held in parallel with an international Conference on Condition Monitoring which meant that we could offer members of the IOA a wider programme of scientific topics than is usually possible. The visits, ladies' programme and social programme were all planned on a combined basis.

THREE FULL parallel sessions took place during each of the four half day sessions and a visit to a harp maker was arranged on the Wednesday afternoon. Several informal golf competitions took place spontaneously at the Langland Bay course! Because of the illness last year of Professor Skudrzyk the 1983 Rayleigh Medal Presentation and Lecture was held during the meeting. Professor Skudrzyk gave a wide ranging presentation on understanding the Dynamic Behaviour of Complex Vibrators. The 1984 Rayleigh Medal was presented to Professor J E Ffowcs Williams, Rank Professor of Acoustics in the University of Cambridge. He gave a very interesting and scientifically challenging lecture on Sources of Sound. He questioned much of the old orthodoxy of sound sources and showed how a specific sound field such as that associated with a simple source can be produced by distribution of sources at a different position. This led on naturally to a discussion of active noise cancellation. The third major plenary lecture was the first Stephens Lecture, given by Dr Edgar Shaw of the National Research Council of Canada. Dr Shaw was one of the first postgraduate students of Ray Stephens and was thus a very appropriate choice for the first lecture in the series set up by the Institute to mark the many contributions to acoustics made by Dr Stephens. Dr Shaw talked about Recent Advances in Hearing Research.

An equipment and instrument exhibition was held in the adjacent Arts Centre in collaboration with the Condition Monitoring Conference. The real ale reception on the first evening is rapidly becoming established as a tradition within the Institute. On the second evening the group from Glan Sevin moved in to take over the provision of a Welsh Night. In addition to typical Welsh fayre, we were entertained by a group of singers and clog dancers. On the Banquet Evening, a local Brass Band played during the meal and then there was a concert by the Gwalia Male

Voice Choir. The weather continued to be fine throughout the meeting and I am sure that the majority returned home with happy memories of the conference and the area. The session organisers report on their own contributions below.

1. MUSICAL ACOUSTICS

It gives me great pleasure, as retiring chairman of the Musical Acoustic Group, to be able to report an extremely lively and profitable series of sessions on our topic at the Spring Meeting of the IOA. Attendance varied from about 20 to 35 — which certainly represents our 'pro-rotta' share of the total of delegates in Swansea.

The session organiser is to be congratulated most warmly on achieving a full and varied programme. The session was typical in that, although all four papers were on one topic — in this case brass instruments — the quality of the contributions was so high that there were items of interest to all group members; it included discussions of the

psychological problems of quality assessment and some fascinating comments on the complexities of the proprioceptive and other considerations that are necessary in attempting to explain the links between the brain of a player and his instrument.

The topics then wandered all the way from woodwind instruments to a stochastic melody-generating system using a microcomputer to control an analogue synthesiser. Contributions on stringed instruments included two papers on the harp which were neatly timed to precede the visit to Merlin Madog's harp workshop and the high standard was maintained right to the end with contributions about the piano, the bowing of stringed instruments and a return to electronic sound.

Altogether this was a memorable series of meetings; it held the interest of all members of the group present, and of some welcome visitors, and amply justified the selection of an apparently diverse set of topics. Although the details may differ, and a certain amount of transformation of symbolism and terminology may be needed, nevertheless the essential problems confronting all musical acousticians are remarkably similar and we can, and did, learn a great deal from each other.

Prof Charles A Taylor

2. TRANSPORTATION NOISE

The first session was opened by Dr B M Favre who described recent research at IRT-CERNE aimed at improving the prediction of road traffic noise in urban



Dr and Mrs Stephens were present to hear Dr Edgar Shaw (right, with his wife) give the first Stephens Lecture

conditions. He discussed the noise from manoeuvring vehicles and noise propagation in the built environment. Lorry tyre noise was the subject of the second paper, by Dr P M Nelson (TRRL). The parameters affecting the production of tyre noise and the possible sources were considered. It was concluded that tyre vibration was the main noise source. Dr Ulf Sandberg (Swedish Road and Traffic Research Institute) described work carried out to measure noise from a range of cars built from 1922 to the present day. He observed a marked reduction in power train noise in cars constructed after about 1960 but little change in tyre noise although the design and construction has undergone radical changes.

Low frequency noise is often associated with a subjective vibration nuisance. Equations relating low frequency traffic noise scales to traffic variables were given by Dr D Gilbert (Imperial College). These suggest that medium and heavy commercial vehicles make major contributions to low frequency noise under interrupted flow conditions. Dr M Ringheim (KILDE) gave an assessment of the cost and effectiveness of road traffic noise control measures in the light of his experience in Norway. The control of noise from road construction sites was considered by Dr R A Hood (Travers Morgan Planning). He described the specification of noise levels to control the contractor and a method predicting noise. Problems encountered in several practical cases were discussed.

In the first paper of the second session Dr A C Pike (Westland Helicopters) discussed the need for reliability in the prediction of external noise from new helicopters at an early design stage. This is important because of the need for the machine ultimately to satisfy ICAO noise certification limits. Dr J G Walker (ISVR) outlined the methods used and the results obtained in a recent reassessment of the noise impact of helicopters operating on the Heathrow/Gatwick link. Unfortunately Dr J Lang was unable to present her paper on noise control in the Vienna subway, but a reprint of the paper is available in the Conference Proceedings.

The preliminary findings from a survey of fifty sites on vibration nuisance from road traffic were reported by Dr G R Watts (TRRL). Measurements of the vibration of windows and of the usual traffic noise indices were related to the rated vibration nuisance. The 18 hr L_{Aeq} was the best correlated measure.



Dr David Weston with the 1984 Rayleigh Medal Lecturer, Professor Shon Ffowcs Williams

Mr C G Rice (ISVR) described a laboratory study using a simulated living room environment of the annoyance caused by a combination of road traffic and aircraft noise. The results appear to favour a dominant source model rather than an energy summation model based on the total L_{Aeq} from all sources. Dr G J Raw (University of Surrey) reported interim results on a survey carried out to determine changes in noise dissatisfaction at sites where a significant reduction in road traffic noise occurred. Downward changes in noise exposure were found to produce greater increments in satisfaction than would have been predicted from data gathered from people in stable acoustic environments. Dr P J Cooper (University of Southampton) discussed the results of a site survey to investigate the influence of background noises on aircraft noise annoyance. There is some evidence to suggest that a new behavioural model of the response to aircraft noise is appropriate.

Dr David Hothersall

3. BIOLOGICAL ACOUSTICS

This was the first IOA Conference to hold a session on Biological Acoustics and we were pleased to attract such a wide range of topics. The novelty of this subject area in the proceedings was reflected in that only two of the ten papers presented were from members of the IOA, and in the relatively small numbers in the audience.

Four papers reported aspects of avian vocalisation. These included a description of vocal communication in the Little Gull with particular reference to reliability of the messages conveyed by the 'Attack Call' (Dr J Veen); a laboratory study of the directionality of sound emission from the carcass of a starling (Dr M Hunter, Dr A Kacelnik, Dr J Roberts and M Vuillermoz); the likely use of song degeneration and attenuation with transmission through the atmosphere as a measure of distance from the source (Dr P McGregor) and a study of the mechanics and energetics of sound production in birds (Dr J Brackenbury).

The physical aspects of biological acoustics were well represented by Dr H Bennet-Clark, in a most entertaining presentation which married classical horn theory with the shape of the flared burrows of mole crickets.

Background noise in the natural environment was studied by Dr G Martin and C Reading who respectively presented papers on an environmentally determined limit to useful auditory sensitivity in non-aquatic vertebrates, and practical measurement of wind noise in specific environments.

The remaining papers ranged from an experimental survey and historical review of ultrasonic calls and communication in rodents (Dr G Sales); the variation in call structure which occurs between members of the same species of frog during courtship and efficacy in attracting mates (Dr A Arak), and

measurement of the interaural intensity difference for New Zealand White rabbits as cues for direction detection of a source (Dr G Gower and Dr C Seymour).

Dr John Roberts

4. BUILDING ACOUSTICS

The sessions on Building Acoustics began with two papers on external noise. The first was given by Dr Raymond Heng of the National University of Singapore in which he described the development of a Code of Practice for control of construction noise in Singapore. The Code uses L_{eq} (5 min) as the descriptor and Dr Heng described how this choice was based on a comprehensive study of the alternatives which included measurements of noise production on site, effects on site personnel and people in the neighbourhood, laboratory studies, existing legislation in other countries and the practicability of measurement. In the following paper, Dr J W Sargent of the Building Research Establishment reported the effectiveness of the 1973 UK regulations regarding insulating dwellings against high levels of traffic noise caused by new or improved roads. Physical measurements of 150 installations together with a questionnaire survey of 900 residents showed a high level of success for the scheme with 84% of respondents considering the insulation package to be satisfactory.

The next six papers were concerned with different aspects of the transmission of sound through buildings. Mr John Miller of Bickerdike Allen Partners described some of his practice's experience with remedial work resulting from complaints of poor sound insulation in converted properties. They have found that achieving the standards set out in the UK Building Regulations provides adequate insulation for party walls and floors but that the Regulations do not cover one of the aspects of major concern in these properties, namely, impact and airborne noise from circulation areas. Practical examples were given to illustrate these points.

The development of a method for measuring sound insulation of timber frame walls in situations with a high level of background noise was described by Dr P R Wagstaff of the Université de Technologie de Compiègne, France. This work, which formed part of a Research Ministry programme, utilises a selective intensity technique and a reference signal from the input to the source to separate the transmitted sound from 'parasitic' sources. Interim

results for a scale model system show good agreement with standard methods even when the background noise is as much as 10 dB higher than the transmitted signal from the test source.

Dr Robin Mackenzie of Heriot-Watt University then reported on a lengthy and detailed study aimed at developing a simplified method for measuring sound insulation. Aspects of the procedure that were covered included the effect of source spectrum, different weightings for the source and receiving room levels, the number of positions,



At the AGM Dr Weston handed on the President's chain of office to Dr Geoff Leventhall. He also presented tankards to outgoing Council Officers Professor Brian Clarkson, Dr Roy Lawrence and Mr John Bickerdike

and the correction for room characteristics. Encouraging results have been obtained with the proposed simplified procedure. A second paper from Heriot-Watt University on the subject of sound transmission—through stud partitions—is included in the Proceedings but unfortunately its author, Mr S E Lee, was unable to present it personally at the conference.

The theoretical work being carried out at Liverpool University by Dr Yun Shen and Dr Barry Gibbs on the transmission of flexural vibration at junctions of thin rectangular plates was described in the next paper. An approximate method for calculating the displacement amplitude function as a linear combination of co-ordinate functions was given and applied to two examples, an L-combination and a series of T-combinations of plates. The practical applications of the method were discussed.

A quite different aspect of the subject of sound transmission was then con-

sidered by Mr Martin West of Salford University. His paper was concerned with the subjective performance of sound transmission and, in particular, how the spectral transmission characteristics of lightweight partitions can affect the detailed properties and therefore the intelligibility of transmitted speech. Using synthetic speech, he is investigating how the format transitional information in C-V segments is corrupted on transmission through partitions with different characteristics.

Methods of rating the physical sound insulation of walls was discussed by Mr M Wawro of Heriot-Watt University. Using the BRE data base on the sound insulation of party walls in houses built during the 1970s, Mr Wawro compared the current UK Building Regulations method of Aggregate Adverse Deviation with the rating method described in BS 5821:1980. His results showed that the two methods give closely similar results and that the BS 5821 rating can be predicted from the AAD rating with reasonable accuracy.

The third and final session was concerned with sound within rooms. Dr Bob Craik, the fourth member of Heriot-Watt University with a paper in the Building Acoustics sessions, gave an analysis of a long standing problem in measurement—the variability of sound pressure level measurements in rooms. Using the results of about 5000 sets of $1/3$ octave band measurements, he compared how well the gamma and normal distributions fitted the data and



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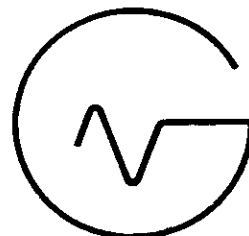
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concluded that the standard deviation and therefore the confidence interval can be predicted with a small error using the normal distribution.

Dr Murray Hodgson of Cambridge University and Dr Ralph Orlowski now of Salford University both gave papers on aspects of their work on the acoustic characteristics of factories. Dr Hodgson reviewed the theoretical and empirical methods of predicting sound propagation and reverberation time in factories and showed that the Lindquist and Jovicic-based theories agree well with each other and with the results of scale model tests of both empty and fitted cases. However, the agreement with the Friberg empirical predictions was found to be poor. The role of 1:50 scale models in predicting factory sound fields was discussed by Dr Orlowski. The tradition of many years of scale modelling of auditoria in Cambridge has been extended to factory spaces and comparisons made between the well tried 1:16 scale and 1:50 scale of three factories. Satisfactory results were reported for both sound propagation and reverberation time, the main limitation on accuracy being the scale modelling of lightweight roof structures com-

plicated by scattering from machines. This reflects lack of knowledge about the full-scale rather than the model situations.

The final paper on Building Acoustics was presented by Dr Peter Lewis of UWIST who reported the work of Dr Cyrus Chinoy and himself on computer simulation of speech transmission through buildings. The technique he described involves first analogue to digital conversion of anechoic speech, then frequency domain convolution, with the impulse response of the transmission paths and finally digital to analogue conversion of the 'transmitted' signal. A demonstration tape was played illustrating the results of simulating speech transmission through different types of walls and heard in an auditorium.

Dr Peter Lewis

5. SPECTRUM ANALYSIS AND SPEECH

The theme of the session was not strictly along the lines of its original intention but nevertheless the papers were cohesive and provided an interesting

morning. There was quite a good attendance throughout the session and the discussion at the end of each paper was lively. The paper by Professor Evans served as a nice companion to the R W B Stephens Lecture on Hearing Research in the afternoon. The papers presented were:

The Effect of an Oxygen Mask on the Spectrum of Speech, S J Elliot, ISVR, University of Southampton;

Feature Extraction for Speech Recognisers based on N-Tuple Sampling, G Tattersall, British Telecom Research Laboratories, Ipswich;

Making Helium Speech Intelligible, C C Goodyear, University of Liverpool;

Speech Recognition by Microprocessor Using Walsh Analysis and Dynamic Programming, P A Lee and J Seymour, Thames Polytechnic;

Representation of Complex Sounds at Cochlear Nerve and Cochlear Nucleus Levels, E F Evans, University of Keele; and

Fuzzy Sets and their Applications to Speech Recognition, J Dwyer and P A Lee, Polytechnic of the South Bank. □

Prof Roy Griffiths

Code and Rules of Conduct for Members of The Institute of Acoustics

In the Institute's Articles of Association there is a general requirement for members to be bound to further to the best of their abilities the aims of the Institute. The standing of the Institute is enhanced if its members are not only well qualified, but also have a professional commitment to a standard of excellence in their work and in their dealings with other people.

Council has asked the Membership Committee to provide a Code of Conduct to which all members would subscribe.

A provisional Code of Conduct has been drawn up and is given below. Any members who wish to comment on the Code should write to the Secretary.

A Code of Conduct designed to embody broad ethical principles is necessarily drawn up in general terms. Rules of Conduct set out in the following regulations indicate the manner in which members are required to conduct themselves in most situations. For situations not specifically encompassed by the Rules, the principle to be followed is that, in any conflict between a member's personal interests and those of the community, the latter should take precedence.

Code of Conduct

Every member of the Institute shall at all times so order his conduct as to uphold the dignity and reputation of his profession and to safeguard the public interest in matters of safety and health and otherwise. He shall exercise his professional skill and judgement to the best of his ability and discharge his professional responsibilities with integrity.

Rules of Conduct

In these rules 'member' means a member of any class referred to in the Bylaws and 'employer' includes 'client'. All references in the masculine gender shall apply equally to women.

1. When discharging his professional duties a member:

- a) Shall satisfy himself as to their scope, obtaining in advance any necessary clarification or confirmation and shall not accept professional obligations which he believes he has not sufficient competence or authority to perform
- b) Shall accept responsibility for all work carried out by him, or under his supervision or direction, and shall take all reasonable steps to ensure that persons working under his authority are competent to carry out the tasks assigned to them and that they accept responsibility for work done under the authority delegated to them.
- c) Shall, when asked for professional advice, give an opinion that is objective and reliable to the best of his ability.
- d) Shall, if his professional advice is not accepted, take all reasonable steps to ensure that the person who overrules or disregards his advice is aware of the possible consequences.

2. Except when legally authorised in the national or public interest, a member shall not do anything, or permit anything under his authority to be done, of which the probable and involuntary consequences would, in his professional judgement, endanger human life or safety, expose valuable property to the risk of destruction or serious damage, or needlessly pollute the environment.

3. In his work, a member shall respect all relevant laws and statutory regulations.

4. In respect of his professional relationships with employers, colleagues or clients, a member:

- a) Shall not maliciously or recklessly injure or attempt to injure, whether directly or indirectly, the professional reputation of another.
- b) Shall disclose to his client or employer any benefits or interests that he may have in any matter in which he is engaged on their behalf.
- c) Shall neither communicate to any person, nor publish any information or matter, not previously known by him or published in the public domain, which has been communicated to him in confidence by a client or employer without the express authority of that client or employer.

5. A member shall not solicit work improperly as an independent advisor or consultant, either directly or by an agent, nor shall he improperly pay any person, by commission or otherwise for the introduction of such work.

6. A member shall not be the medium of payments made on his employer's behalf unless so requested by his employer, nor shall he, in connection with work on which he is employed, place contracts or orders except with the authority of and on behalf of his employer.

7. a) A member shall be guilty of improper conduct if he is convicted of a criminal or civil offence which, in the opinion of the Council of the Institute, renders him unfit to be a member.

b) If, in the opinion of the Council of the Institute, a member is precluded from performing his professional duties in a manner consistent with the standards of his profession, as a result of having being adjudicated bankrupt or making a composition with his creditors, he may be deemed to be guilty of improper conduct.

c) Any individual whose fitness for membership is under review may, in accordance with the Articles of Association paragraph 4 (4), state his case before the Council in person or in writing and the Council's decision shall then be final.

Proceedings of the Institute of Acoustics-Abstracts

New Techniques in Sonar Transducers

International Conference organised by the Underwater Acoustics Group of The Institute of Acoustics, 5-6 September 1984 at the University of Birmingham

Reliability in Underwater Transducer Systems

D Stansfield

RAE

Underwater transducers are components in systems for converting electrical to acoustic energy, and the reliability of the system depends not only on that of the transducer itself but also on the characteristics of the overall system. In this paper the simple equivalent circuit representation of the transducer is used to discuss:

- Testing of individual transducer elements to ensure reliability at high power.
- Design of combined amplifier and transducer systems to ensure reliability.
- Safeguards against problems arising from array interactions when using arrays of closely spaced elements.

A B Wood Medal Address: Passive Sonar Arrays: Some Aspects of their Design and Calibration

M J Earwicker

AUWE, Portland

The successful design of passive sonar arrays relies on an understanding not only of the acoustics of the array itself but also of the signal and noise fields in which it works and the form of the signal processing applied to its outputs.

In reality there have to be many compromises between the purely acoustic and many practical factors, the latter being questions of mechanical strength and suitability for the environment in which the array is to work. Many of these compromises can be reached as a result of using theoretical modelling and laboratory scale experiments. However, due to the uncertainty in much of the material data the final proving of an array always requires full-scale calibration. In this paper several areas of special interest to the Author have been considered, the acoustics of the array and baffle design, the response of the array to local noise fields, array signal processing techniques and near field calibration.

Nearfield Calibration Arrays for Transducer Evaluation

A L Van Buren and L D Luker

Naval Research Laboratory, Orlando, Florida USA

The Trott nearfield calibration array (NFCAs) concept allows the farfield acoustic properties of underwater transducers to be determined in laboratory measurement facilities that are far too small for direct farfield measurements. When used as a projector, the NFCAs produces a nearly uniform plane

wave throughout a large nearfield volume close to the array. The plane wave sensitivity of a receiver can then be measured directly by placing it within the nearfield volume. When used as a receiver, the NFCAs is a plane-wave filter, ie, it measures only a single plane-wave component of the sound radiated by a projector placed within the same nearfield volume. One can obtain the entire farfield pattern by rotating the projector or receiver to be evaluated within the nearfield volume. This paper describes the theory, design, construction, and application of NFCAs. Two examples are given to illustrate the concept. One is a NFCAs that utilises only a single line of piezoceramic elements to synthesise a virtual cylindrical array surrounding the transducer. The second is a planar NFCAs that utilises piezoelectric polymer and is usable up to megahertz frequencies.

Acoustic Generation in Water by Pulsed Lasers

D A Hutchins

Queen's University, Kingston, Ontario, Canada

It is now well-established that pulsed lasers can be used to generate acoustic waves in liquids. Optical breakdown, vaporisation of the liquid surface and thermal expansion are the principle mechanisms for generation, in descending order of incident optical power density and generation efficiency. The latter mechanism is most relevant to sonar, however, in that a cylindrical source may be formed by selection of an optical wavelength that is only weakly absorbed in water.

For thermal generation in a cylindrical source by a single laser pulse, the emitted acoustic pulse is dipolar. An advantage of laser generation is that the width of this dipolar pulse may be varied either by changing the laser beam diameter, and hence the diameter of the acoustic source, or by adjusting the laser pulse length.

Experiments will be described, involving acoustic generation in water by thermal expansion in a cylindrical geometry. A comparison with theory will be presented, with an indication of the dipolar acoustic pulse widths arising from various Q-switched laser beam diameters. The frequency components emitted will also be discussed, using detection by broadband transducers.

Fibre Optic Ring Resonator Hydrophone

P Mouroulis, Canadian Instrumentation and Research Limited, Ontario, Canada

G W McMahon, Defence Research Establishment Atlantic, Dartmouth, Nova Scotia, Canada

A prototype fibre optic hydrophone is described that utilises a ring resonator

sensing element and frequency modulation of the laser diode source for signal recovery. The prototype addresses the main problems that must be faced in a field-deployable unit rather than aiming for a high performance laboratory demonstration. The sensor is connected to the input optics and electronics by an all-fibre cable link. Stable laser diode operation is achieved, without the use of an isolator, by careful reduction of feedback to the source from the resonator and the various interfaces. Likewise, no polarisation controllers are used, but adequate performance is achieved by the use of a polarisation preserving link fibre and the birefringence acquired by the coiled sensor fibre.

Details of the resonator performance are given as well as data on the hydrophone sensitivity and frequency response. The sensitivity, as expected, is limited by the source coherence length. A double cavity ring resonator sensor configuration is outlined that would increase the sensitivity and reduce the dependence on coherence length.

Metallic Glass as a Hydrophone Material

P Walmsley

dB Instrumentation Ltd

Metallic glasses are amorphous alloys of a transition metal (eg Fe, Ni, Co) with a metalloid (eg B, Si, P, C). Material characteristics include high tensile strength, favourable magnetic permeability and resistivity and low production cost. Certain compositions are also magnetostrictive and although projector applications are limited by low saturation magnetostriction, metallic glass hydrophones are potentially sensitive, geometrically flexible, robust and inexpensive.

A flexural design of metallic glass hydrophone has been built in which multiple layers of ribbon are wound and sealed over an air gap of specified dimensions. Under hydrostatic pressure, the ribbon is deflected into the air gap to create magnetic bias. Acoustic pressure causes additional small signal stress and hence an alternating flux change about this bias point which is detected as a voltage in a pick-up coil.

At low frequency the device can be analysed as a one-dimensional tension controlled membrane and equations have been derived to predict sensitivity, stress, resonant frequency and ribbon deflection. Predicted and measured results will be compared and practical problems will also be addressed. These include the ease with which ribbons may be laminated, sensitivity to external magnetic fields and housing considerations for magnetic shielding and corrosion resistance. Finally general conclusions for a metallic glass acoustic transducer will be drawn.

Invited paper: Recent developments in the USA in the application of PVF2 polymer in underwater transducers

D Ricketts

Raytheon Co, USA

Abstract not available.

A B Wood Medal Address: Envelope Statistics of Multipath Propagation in the Ocean

P N Mikhalevsky

MIT, USA

In many practical problems involving sound propagation in the ocean the received signal pressure can be modelled as a sum over many independent paths connecting the source to the receiver and this is commonly referred to as multipath propagation. It is also commonly understood that multipath generally degrades receiver performance as it causes signal energy to be spread in time due to differing path lengths and in frequency due to path to path differential doppler, or ocean dynamic induced sound speed fluctuations affecting each path differently. This paper discusses the envelope statistics of narrowband signals in three multipath regimes and the consequences for receiver performance. The three regimes are referred to as unsaturated, partially saturated, or fully saturated, as delineated by the degree of path to path phase stability. Additionally, data taken in the Arctic Ocean are shown to be in the unsaturated regime attesting to the Arctic sound channel's remarkable temporal stability at low frequencies. It should also be noted that these data were the first such calibrated coherent source data taken in the Arctic Ocean. The source was an electrically operated hydraulic piston which modulates a flexural disc radiator.

An Elementary Introduction to Finite Element Analysis

J R Dunn

University of Birmingham

This paper is intended as an introduction to the powerful technique of finite element analysis as applied to transducer structures, and demonstrates that useful programs can be run on a microcomputer, albeit with limitations on the complexity of the structure being analysed. Static and dynamic situations can be modelled, incorporating a variety of materials which may be anisotropic, but as yet neither radiation loading nor piezoelectric effects can be included. Two dimensional (plane strain or plane stress) and axisymmetric three dimensional situations are covered, and full advantage is taken of any symmetry. By restrictions on the complexity of individual programs, it has been found possible to analyse on a BBC model B microcomputer structures with up to 160 constant strain triangular elements and 100 nodes.

These programs have been applied to several problems of current interest, in particular the pressure and acceleration sensitivities of tubular PZT hydrophones, and the resonances of the heads of piston transducers and of long rectangular PZT bars of nearly square cross section.

Computation of the self and mutual Radiation Impedance between Transducers in an Array in Presence of thick Elastic Skin, using a Mixed Finite-Element Plane Waves Method
G Vanderborck, W Steichen and B Fromont
Thomson-CSF, Chemin des Travaux, 06801 Cagnes-sur-Mer Cedex France

We can predict and compute the behaviour of elementary transducers in some particular conditions (eg simple geometric shapes on rigid baffles). In a practical situation, the transducers will rarely have a simple shape and all real baffles will be non-rigid. In this case we cannot describe the behaviour when we consider the transducer, his neighbours and the thick skin. We explain this phenomenon by the fact that we cannot take into consideration the mutual radiation impedance coefficients between the different transducers in some arbitrary environment. Since one must know the impedance coefficients to be able to predict the performance of an array, in the absence of analytic solutions we developed a computer program which determines these unknown coefficients.

This program is based on a mixed physical method which divides the physical medium into two subregions. In the first region we take into account a few shear wavelengths thick of skin and consider it as an elastic medium with loss. We treat it by a three dimensional finite element method. In the second region which contains the remainder of the skin (considered as a fluid skin) and the fluid medium, we have developed the unknowns (displacements and pressure) as an infinite sum of plane waves. With this method, we obtain an impedance type boundary condition at the interface between the finite element description and the plane waves description.

Thus we have to solve a linear complex system of equations and the solutions obtained are the displacements, the stresses in the elastic skin and finally the impedance coefficients.

Comparison with the results of the literature for ideal cases shows good agreement and the interest of the method. Results are also obtained in varying different parameters such as physical and geometric properties.

Analysis of Piezoelectric Transducers Combining Finite Elements and Integral Representations

H Jensen and S Krenk

Risø National Laboratory, Roskilde, Denmark

A computer program has been developed for analysis of axisymmetric, piezoelectric transducers in contact with a large volume of fluid.

The transducer is represented by triangular ring elements with transversely isotropic, piezoelectric material properties, and mechanical as well as electrical degrees of freedom are included. The present version of the program makes use of an element with linear interpolation of displacements and electric voltage, and all stiffness and mass matrix elements are evaluated analytically. The excitation is introduced via a prescribed electrode area.

In the fluid the radiated field is produced by normal surface displacements on a circular

area surrounded by a baffle. The surface displacement is described in terms of orthogonal polynomials, and this representation leads to explicit expressions for the far-field and the field on the axis. Furthermore curvature may be included to produce focusing. The contact pressure is also expanded in terms of orthogonal polynomials, and the two polynomial expansions on the interface are connected to the element representations by least square fits.

Example problems illustrate the complicated vibration modes of flat piezoelectric cylinders with end face electrodes, and the irregularity of the surface displacement of such a transducer. Differences between the radiated field from such a piezoelectric transducer and that of a piston idealisation will also be discussed.

Design Limitations in Aluminium Shell Class IV Flextensional Transducers

J R Oswin and A G Turner

British Aerospace, Weymouth

The flextensional transducer provides an effective means of transmitting high acoustic power from a compact source at frequencies near 1 kHz. Apart from its high power capability it also offers advantages of wide band width and high efficiency. The far-field polar response is approximately omnidirectional in the plane of the ellipse while in the perpendicular plane it may be regulated by the length of stave used.

A problem in the design of flextensional transducers is the large number of variables which affect the performance in terms of frequency, power output and operating depth. An iterative design technique is needed if performance is to be optimised.

Both operating power and operating depth increase the stresses in the shells, and a compromise has to be reached between these two requirements particularly at the lower frequencies. At these frequencies, the surface area is large so hydrostatic pressure exerts a very large force which tends to elongate the major axis, so sufficient prestress must be incorporated to balance this. A 500 Hz device will require several tonnes of prestress and this makes manufacture very difficult.

The upper frequency limit is about 3 kHz; above this the device becomes very small and power is limited mainly by the volume of ceramic which can be fitted in the shell.

This paper explores the variations in performance obtained by altering dimensions and the limitations that arise.

Autumn Conference 1984

Please note that it has been necessary to alter the dates for this conference to Friday, Saturday and Sunday

2, 3 and 4 November

THE INSTITUTE OF ACOUSTICS

TENTH ANNUAL REPORT

OF THE COUNCIL 1983

The Institute of Acoustics was originally formed in order to host the 1974 International Congress on Acoustics. Now in its tenth year the Institute, a well established and steadily growing organisation, was given the opportunity by International INCE to run Internoise '83, another major international event. Internoise '83 dominated the year's activities in a number of ways. It varied the established pattern of the meetings programme in order not to syphon off resources and it placed a substantial additional burden on the Institute's administrative machinery. In the end all the effort was amply rewarded by an attendance in the region of 690 delegates with over 300 papers presented, making it one of the largest INCE conferences ever and certainly the largest outside the United States of America. Edinburgh proved to be a splendid venue, and all those who attended could not fail to be impressed by the friendly atmosphere that pervaded the whole event. Looking back it seems hard to believe that there were really so many people there! Council owes a tremendous debt of gratitude to the Organising Committee, to all members of the staff and to everyone else who worked so hard to make it the success that it undoubtedly was.

Membership of the Institute has continued to grow and at the end of the year it stood at 884 in the corporate and 356 in the non-corporate grades, representing a 9.7 per cent increase over the previous year. The Institute's publications, particularly Acoustics Bulletin, form the principal contact between the Institute and its membership and the Publications Committee has continued to develop the ways by which it disseminates information amongst the members. In education the Diploma continues its very satisfactory progress. The courses have now been running for long enough that this year has seen the first four colleges being re-approved for the next five years and another specialist module has been added to the syllabus. For the future, the Education Committee have started to investigate the viability of some form of Advanced Diploma Scheme. This investigation has been stimulated by discussions with the Association of Noise Consultants and by the Education Committee's own deliberations on the development of professional training and the pursuit of some form of charter status for the Institute and its membership.

At the end of 1983 the Branch and Group structure of the Institute consisted of 5 Specialist Groups and 6 Regional Branches with two more Branches at differing stages of development (East Midlands and Scottish). The London Evening Meetings continued to

serve the membership in London and the South East. The present network of Branches appears to be reasonably well matched to the distribution of the Institute membership. Enquiries have been made about establishing Branches in South Wales and Birmingham. At present the number of members in those areas is insufficient to support this type of development but the situation will be kept under review. The activities of the Industrial Noise Group and the Aerodynamic Noise Group have been revived to varying extents during the year. All Branches and Groups continue to manage their affairs in a businesslike manner and provide an invaluable service to the membership. Unfortunately many Branches are reporting poor support for their regular meetings. By exchanging experiences and ideas on this problem and with the co-operation of the Specialist Groups, the Branches are intent on reversing this situation in 1984.

After the optimism generated in 1982, the proposal to form some sort of successor to the Noise Advisory Council has faltered slightly. The National Society for Clean Air have spurned our approaches to them to act as co-sponsors and have decided to go their own way. However, Council is continuing to explore the possibilities for creating an effective advisory body and has re-constituted the Steering Group as a Committee of the Institute.

The Institute's relationship with other bodies is a particularly important aspect of Council's activities and this year particular attention has been paid to the question of IOA representation on British Standards Institution Committees. It is hoped that as a result of these discussions Council will in future adopt a more positive policy towards BSI matters than it does at present.

1983 has also seen the Institute's first remuneration survey. With total membership of only about a thousand members it was inevitable that when sub-divided some of the categories would have very low numbers of responses and that this might produce some unexpected results. It is Council's belief that the results are sufficiently interesting to have justified the survey and Council would like to thank all those members who contributed to its production.

With Internoise displacing the Spring Conference, the Annual General Meeting was held at the Underwater Acoustics Group meeting at Bath. At that time Dr Fahy, Dr Leventhall and Dr Mackenzie retired from Council and Dr Pretlove, Mr Rice and Dr Scholes were newly elected. During the year Professor Johns

took up a new appointment in Hong Kong and so is unable to take over the Presidency in the coming year. Council would like to thank all those who have left for all their hard work during their terms of office and to take this opportunity of recording a welcome to the new members.

STANDING COMMITTEES

The operation of the Institute is carried out by Council through the following Standing Committees: Meetings, Membership, Publications, Education and Medals and Awards. This year has also seen the Noise Group Committee added to this list.

Membership Committee

The Membership Committee met on four occasions during 1983 and considered 244 applications for membership of which 209 were successful. Details of the distribution of members in the various grades of the Institute are given in Table 1. The figures again

Grades of Membership	1982	1983	Applications in 1983	Successful Applications in 1983
Fellow	201	207	10	9
Member	634	677	103	69
Associate	301	353	128	128
Student	15	12	3	3
Total	1151	1249	244	209
Sponsor	13	15	2	2

Table 1 Details of membership

show a steady gain in membership in all grades except students. The year on year increase is 9.7% compared with 4.3% in 1981/2. Losses still continue to cause concern, amounting to 6% of the membership and in this respect a survey was conducted among lapsed members in an attempt to determine their reasons for non-renewal of membership. The principal reasons given were: fees too high 40%, no longer working in acoustics 33%, personal 20%, other 7%. Other activities of the Committee during the year were a further attempt to increase the appeal of the Institute to Sponsor Members and a revision of the bylaws to encourage membership of the Institute by those in disciplines relevant to, and associated with, acoustics. The Committee began discussions on a response to the Engineering Council's Consultative Document on *Standard and Routes to Registration* and the Institute's own approach towards Chartered Status for members.

Meetings Committee

The dominant feature of the year, and one which absorbed the majority of the time of the Committee,

was Internoise '83, the twelfth International Conference on Noise Control Engineering. Held in Edinburgh in July with the Institute as host, the event attracted almost 700 delegates from 38 countries to hear over 300 papers. Although not strictly an Institute meeting — there were very distinguished international and local organising committees which included many of our members—Internoise proved to be a very successful conference and made a significant contribution to both the finances and the prestige of the Institute. Congratulations and thanks are due to all concerned.

As a consequence of the planning and holding of Internoise, the programme of other meetings activity during the year was much reduced. There was no Spring Conference, and its position in the normal programme was occupied by the Underwater Acoustics Group Conference on Acoustics and the Sea Bed held at Bath in April. The Institute participated jointly in meetings organised by the Ultrasound Topic Group of the Hospital Physicists' Association and by the British Society of Audiology in April and May respectively, but there was no further meeting until autumn.

The remainder of the year's programme was held in London. In October, a very successful one-day meeting was held at The County Hall on Local Government Noise Problems and Construction Industry Noise, at which only 103 of the 150 applicants could be accepted as delegates due to restrictions on accommodation. In the following month, the Building Acoustics Group arranged a meeting on Studio Design for Sound and Television attended by 38 delegates and Acoustic Emission and Photoacoustic Spectroscopy attracted a similar number.

It is to be hoped that the continuing and very welcome trend being exhibited by Groups and Branches towards the hosting of one-day meetings will help to ease the sometimes frustrating and always difficult task of the Meetings Committee. The programme must reflect the requirements of members with a wide range of interests, and active participation in the arrangement of the annual programme will always be gratefully acknowledged by both the Meetings Committee and Council.

Following Geoff Leventhall's retirement from Council in April, Mike Ankers has taken over the Chairmanship of this Committee. Geoff's hard work and considerable experience contributed a great deal in this area but Mike has already proved to be a very capable successor.

Publications Committee

The Institute suffered a severe loss in May when the Advertisements Manager, Mr Roy Collins, died suddenly. Fortunately his place was immediately taken by a colleague, Mr Sydney Jary, who has now been formally approved as the new Advertisements Manager and also as Publications Adviser. Mr Jary will attend some meetings of the Committee and, as a result of his expertise, it is expected that some innovations in publishing policy will occur in the next year or two. One experimental innovation started in 1983 has been

the publication of quarter page Appointments advertisements, sent out with routine mailings at intervals of about five weeks.

A far reaching decision of the Committee, after much deliberation, has been to settle on A5 as the page size for published Proceedings. To accommodate the occasional need for A4 Meetings Handbooks it was agreed that the organisers of such meetings should also run off some A5 size copies, to be used for bound volumes of the Proceedings. It is clear that for the bound Proceedings to look professional there must be close liaison between the Meetings and Publications Committees. For this and other reasons Mrs Alison Hill has been appointed as the representative member of Publications Committee on the Meetings Committee. As from 1st January 1984 the Proceedings will be in the new format with Meetings Organisers responsible for uniform presentation and pagination. The Committee approved a suggestion that copies of the Proceedings should be provided free of charge to Colleges teaching the Diploma Course.

Acoustics Bulletin continues as the regular quarterly publication of the Institute containing news, views, current events, professional advertising and articles of general interest. Its acknowledged excellence is in no small measure due to the Editor who works long hard hours to make it a coherent whole; the Institute owes her a great deal.

Education Committee

It is pleasing to report yet another successful year with a record 204 students from 12 Colleges entering the Institute's Diploma Examinations. Twenty students who had previously gained their Diploma sat for extra Specialist Modules. The IOA prize for the best student was awarded jointly to Mr J D Wildsmith who studied at Newcastle Polytechnic and Mr R P M Bonnington who studied at Heriot-Watt University.

The Committee has started considering revisions to the Diploma syllabuses taking into account all the comments and suggestions received. It has also studied in some depth the advantages and disadvantages of distance learning systems and has given some encouragement to Colleges to develop suitable packages. At the same time the Committee is concerned to ensure that standards are not allowed to deteriorate particularly with regard to practical work. Careful consideration has been given to the entry fees for the Diploma and minor changes are being implemented to ensure the continued financial viability of the examination organisation.

The successful IOA Sixth Form Lectures are to be repeated in early 1984 at Surrey, Derby and Cardiff. The organiser is Dr R Peters and the lecturers will be Dr Peter Wells and Professor Peter Lord.

Noise Council Committee

The Steering Group formulating proposals for a new organisation to fill the gap left by the demise of the Noise Advisory Council continued its deliberations and by April their draft report had reached an

advanced stage. Because of its growing involvement with noise the National Society for Clean Air had been invited to be represented at the early meetings of the Steering Group. It was hoped that the new Noise Council would be proposed jointly by the IOA and NSCA and the proposals were worded accordingly.

Professor Lilley as Chairman of the Steering Group attended a meeting of the Council of NSCA to introduce the draft joint proposal and NSCA set up its own Steering Group to consider the matter further. IOA was not invited to be represented or even to attend as an observer on the NSCA Steering Group. This group recommended rejection of the proposal for joint sponsorship and it is understood that NSCA is setting up a 'Technical Committee' of its own to deal with noise. It has been suggested that the Institute will be invited to become an affiliated member of NSCA so that IOA members will be able to serve on the NSCA's Technical Committee. To date no such invitation has been received formally but the IOA Steering Group has already made a recommendation to Council on how to deal with this invitation, if and when it arrives.

In the meantime the IOA Steering Group has been transformed into a Standing Committee of the Institute and in this new form is continuing to investigate ways by which a viable and effective Noise Council can be formed and financed to continue the best features of the NAC.

Medals and Awards Committee

The 1982 A B Wood Medal and Prize was presented to Dr M J Buckingham at the Underwater Acoustics Group Meeting on Acoustics and the Sea-Bed in April 1983.

The recipient of the 1983 Rayleigh Medal is Professor E J Skudrzyk of the Pennsylvania State University. He was due to take possession of the Medal during Inter-noise '83, but the ceremony was postponed due to his ill health. The 1983 A B Wood Medallist is Dr P N Mikhalevsky, US Navy. The presentations of both 1983 awards are now scheduled for 1984.

The first of the Stephens Lectures is also arranged for 1984; the general guidelines for this series have now been agreed as follows: The delivery of the Stephens Lecture is intended to be an important occasion at a Meeting of the Institute of Acoustics, marked by the presentation of a scroll to the Lecturer. Although the speaker should be prominent in his field it is hoped to include some younger workers. The Lecture may concern any aspect of acoustics — technical, educational, organisational, interdisciplinary or international — but typically will cover recent developments in a particular subject. It will normally be annual and given at either the Autumn or Spring Conference.

REGIONAL BRANCHES

The Branches of the Institute have been established to further the technical and social activities of the Institute at a more local level. The liaison between the

Branches and the Meetings Committee is particularly important in extending the technical meetings programme of the Institute.

North East Branch

The first meeting of 1983 was due to be a visit to the BBC Studios at Newcastle but their commitment to making programmes for Breakfast Television forced a cancellation. Fortunately the local commercial radio station 'Metro' came to the rescue and a party of 16 enjoyed a guided tour of the studio.

At the Annual General Meeting in February, Trevor Smith stepped down as Branch Chairman after several years' service to be replaced by Chris Norris who had previously served as Secretary. The meeting, attended by a group of 12, heard that the Branch activities had been reasonably successful, a small excess of income had been achieved and it was generally thought that the outlook was optimistic.

A half-day meeting on Planning and Noise was held at Darlington Town Hall in March. An audience of 35 delegates heard presentations from Mr Atherton on experiences with environmental noise in the last ten years, from Mr Owen on a Planner's point of view and from Mr Utley of BRE on Future Developments.

In April the Civic Centre at Carlisle was the venue for another well attended meeting and again Richard Atherton took an active part. Jim Blair talked of his experiences in setting up a Noise Control Section for Glasgow City Council and B & K provided demonstrations of their latest equipment.

An interesting visit was made in May to the premises of Mr Nigel Church of Stamfordham where he carries out the business of making church organs in a converted farm near the Roman Wall. A thoroughly enjoyable evening was rounded off in the village pub.

The first meeting of the autumn was held at Newcastle Polytechnic in October when two students described their projects for the IOA Diploma examination. John Davidson described the complete calibration of a sound level meter and John Wildsmith talked about noise from a Rapid Transit System — the Newcastle Metro.

A Noise Workshop was held at Greys College, Durham, in November. A small but lively audience heard papers on noise nuisance from a gas installation, a noise consultant's practical approach to problem solving and the progress of noise abatement zones in Darlington.

The final meeting of the year in December was held in the world's only bagpipe museum, situated in the Blackgate in Newcastle. Colin Ross, a notable local piper, not only described the development of the Northumbrian small pipes, but also played them with great skill. A marvellous buffet supper was then provided by the members in a local restaurant and it was encouraging that the year ended on such a 'high note'.

North West Branch

Much of the strength of the Institute derives from the activity at Branch level, although attendance figures for Branch meetings, unfortunately, do not always reflect the amount of hard work invested in those activities. The first meeting of the year was held at Liverpool Polytechnic, partly in deference to those Branch members from Merseyside who found the trip eastwards to Salford too long or difficult. Regrettably, although an excellent two-part presentation on The Role of the Computer in Acoustics by Derek McNeil and Audible Intruder Alarms (AFA-Minerva) should have proved attractive to a wide membership, only an average turnout was achieved. This was in part due to one of the worst accidents ever on the M62 motorway which caused many hours' delay to travellers between the two conurbations.

The AGM was held in February and as intimated last year, we reluctantly accepted the resignation from the Committee of Richard Atherton, whose place as Hon Secretary is now ably filled by John Dinsdale. Following the commendably brief business meeting, Don Baines (ICL) showed us how the proliferation of (often unrelated but frequently conflicting) acoustical emission and immission 'standards' was making difficult the task of office equipment manufacturers, who say they wish to comply, but would like to know with what?

A popular visit to the acoustic laboratories of British Aerospace (Woodford) and a (regrettably) poorly attended trip to the factory of Chloride Motive Power (Swinton) took place during the summer. In September Robin Monk (AVT) spoke on The Role of the Acoustical Consultant in Noise and Vibration Problems. Equally enthusiastic, but with a different emphasis, Mike Russell (Lucas Industries) entertained us with a very professional and enjoyable exposition on Noise Control in Industry.

As usual, the Branch held its main social event in December at a hotel in Daresbury, Warrington. The principal attraction was a very funny and absorbing illustrated talk by Ralph Harrison on his hobby of canal cruising. Only occasionally was the subject of acoustics allowed to intrude on the evening, although (despite the presence of spouses and guests) it was just possible to indulge in a little shop talk. A grand opportunity to compare the experiences gained during another successful year.

East Midlands Branch

To assess the viability of an East Midlands Branch, a Steering Committee was set up in June 1982 under the guidance of Trevor Smith, Vice-President — Branches and Groups.

The inaugural meeting was held at Derby Lonsdale College, on 16 November 1982. The Speaker was Professor E J Richards of ISVR who gave an interesting and informative talk on the causes, assessment and reduction of impact generated noise in machinery. This meeting was attended by over 50 people. The Steering Committee was very encouraged by the

response and decided that there was sufficient interest in the area for the establishment of an East Midlands Branch.

A second meeting, on Noise and Hearing Impairment in the Population, was held at the M R C Institute of Hearing Research, University of Nottingham, on 16 March 1983. Surprisingly, there was a rather poor turnout for this event and it was agreed that members had missed an enjoyable and interesting evening. Professor M P Haggard opened the meeting by giving a summary of the Institute's general research programme, including the 'National Study of Hearing' — a work commissioned jointly by the Department of Health and the Medical Research Council. Dr M E Luttmann continued the talk by describing the various types of hearing loss and the relative incidence of each.

The last meeting of the year was held at Loughborough University on 22 November. Mike Ankers, Vice-President of the Institute, was guest speaker — the topic Noise and the Environmental Health Officer: 10 Years On. As Principal Environmental Health Officer with the City of Manchester, he reviewed his Authority's involvement in noise and noise control over the past 10 years, by reference to case histories.

Southern Branch

The upsurge of interest in the year's activities appears to have vindicated the earlier EGM decision that the Southern Branch should continue. The programme of meetings and visits included a full day seminar on Hearing Protection addressed by representatives of Industrial Management, Trades Unions, Insurance Companies and Consultancy Practices, and a joint meeting with the Environmental Health Officers Association addressed by Hilton Dawson on Low Frequency Noise. The latter was also announced to and attracted some attendance from members of the public. The success of this style of meeting has encouraged the inclusion of more of the same format in next year's programme.

Visits to BBC Research at Kingswood Warren, AUWE Portland and Solent Radio were well attended, the BBC visit attracting a number of members and students from NESOT.

The AGM in November saw a change of Committee membership with Ray Shack standing down as Secretary, and his succession by Frank Fahy. There are mixed feelings here, with a very warm welcome to Frank whose wealth of experience cannot fail to add strength to the Committee, but at the same time regret at the loss of Ray's membership. His efforts as Secretary over the years have been instrumental in ensuring the continued functioning of Southern Branch, and his work is warmly appreciated. Happily all is not lost — he is staying on *ex officio*.

The coming year will also see a full programme of equally wide interest and will include VTOL, ship, and Internal Combustion engine noise, architectural acoustics, the law generally and the Health and Safety

at Work Act in particular. It has to be said though that last year's upward trend in attendance will have to continue if activity at the currently planned level is to be maintained. With a theoretical Branch membership of around 280 it ought to be possible to find an average meeting attendance of 25-30. The Branch Committee will be happy to do the organising, but only the members can fill the seats.

South West Branch

At the Annual General Meeting in February of the South West Branch Mr Latham and Mr Leach resigned from the posts of Chairman and Treasurer respectively. Mr R T Vanstone was elected as Chairman with Mr Squires adding the post of Treasurer to his secretarial duties. The meeting concluded with an interesting visit to the BBC Radio and Television Studios in Plymouth.

An attendance of over 30 met in the lounge of Exeter Airport on 21 November for a joint afternoon seminar with the Institute of Environmental Health Officers. Mr Ellis, Airport Manager, Mr R Vance of Cornwall County Council and Mr M Williams of Brüel & Kjær gave papers on various aspects of Aircraft Noise.

Two other meetings, on Environmental Noise and on Blasting Vibration, originally planned for 1983, have been held over to 1984.

The greatest difficulty facing the planning of a meeting in the South West is the thinly spread distribution of members and the distances and time involved for some in reaching a suitable venue. Despite this, interest in the activities of the Institute of Acoustics remains buoyant and there are at present 59 members.

Hong Kong Branch

The first full year of the Hong Kong Branch saw several successful evening meetings with continuing interest from the media. In February and March a two-part seminar was held on Social Response of Hong Kong Residents to Noise. Recent research had suggested that HK Chinese residents could tolerate higher noise levels than persons elsewhere in the world. In the first meeting Dr A L Brown of the HK Environmental Protection Agency gave evidence to refute this; Dr N Ko of HK University replied in the second part of the seminar with a review of extensive field work and research in HK. Following these two meetings, at which press and radio were present, an interview was given to local radio by Dr Brown and the debate continued the following morning on radio's 'Open Line' with the Chairman of the Branch, Mr T K Willson. Considerable interest was generated, particularly among the medical profession.

The September meeting, on The Subjective and Objective Performance of Telephone Transmission, was presented by Mr P Berriman of HK Telephone and was followed by a field trip to HKT's Acoustics Laboratories. Mr Berriman also gave an interview to local radio. In October Dr A Kwan of HK EPA spoke on Pile Driving Noise to a meeting of 30 persons and

gave an interview to local television. Subsequently the Branch Secretary, Mr D G Lees, was interviewed on local radio in co-operation with a local contractor.

Urban Design to Reduce Traffic Noise and the Value of Acoustic Modelling Using Optical Techniques was the subject treated by Dr A L Brown of HK EPA in the last meeting of the year. Membership of the Hong Kong Branch is 45.

London Evening Meetings

The latest series of London Evening Meetings has been somewhat shorter than in earlier years with monthly meetings covering the period March to June. The style of the meeting is an informal talk followed by plenty of time for discussion, generally followed by further discussion in the Jubilee Tavern. The meeting rooms were provided at The County Hall, courtesy of the GLC. These meetings are free and open to both members and non-members of the Institute. The meetings are usually well supported with an average attendance of over twenty people.

The first talk of the last series was given by Mr Waudby of Cadbury Ltd, and was entitled The Practical Applications of Audiometry in Industry. He explained how his unit tests the hearing of every new employee of the company and how he attempts to educate people about the dangers of working in a noisy environment.

The second talk, a Survey of Vibration Nuisance from Road Traffic was given by Dr G Watts of TRRL. He described many vibration surveys past and present and also described some of his interesting experiments to try to determine whether measured vibration levels were noise induced or true ground-borne vibration.

The third talk in the series moved into the realms of the discotheque with a talk by J Bickerdike, of Leeds Polytechnic, entitled A Code of Practice to Minimise Hearing Damage Risk in Discotheques. The speaker explained the new draft code in some detail, then went on to describe some of the problems of monitoring and enforcing such a code.

The final talk of the series was given by J Simson of the GLC Scientific Services Branch and was called Automatic Noise Monitoring. Mr Simson described some of the automatic noise monitoring systems used by the GLC and others in relation to the problem of ensuring that what you have measured is what you thought it was.

No meetings have been held in the latter part of the year mainly because of difficulties in booking suitable rooms. This problem has now been resolved and a new series is currently being prepared with the assistance of an addition to the meeting organiser team, Stephen Turner of the GLC Scientific Services Branch.

GROUPS

Specialist Groups

The Institute as a whole reflects the broad span of the science of Acoustics and a number of Groups have

developed to foster closer contacts between members in the various specialisms within this multi-disciplinary subject.

Speech Group

In 1983 the Group organised three technical meetings. The first was an afternoon meeting on Speech Production, held at University College London on 28 March. Six papers were presented on a range of topics. The meeting was organised by Dr P Howell. The second meeting took place at the University of Nottingham on 15 July. Dr Q Summerfield arranged for six papers to be presented on The Perception of Speech and Related Sounds and Images. He also organised a small technical exhibition. Finally, Dr F Nolan organised a full-day meeting at the University of Cambridge on 9 December. The very full programme consisted of twelve papers on various topics in the area of Temporal Aspects of Speech.

In December Dr R Moore arranged a workshop on Speech I/O Assessment at University College, London for those members of the Group interested in the performance of speech synthesis and recognisers. After the meeting members with a particular interest in Speech I/O Assessment met and elected a Steering Committee to investigate the possible development of a Specialist Group serving this interest; at present it looks as though the outcome will be the formation of a specialist Sub-Section within the existing Speech Group.

Dr W A Ainsworth and Mr R Beresford retired from the committee at the end of 1983. Their places have been taken by Dr P Roach (University of Leeds) and Dr N M Brooke (University of Lancaster). The officers of the committee for 1984 will be Dr R K Moore (Chairman), Dr P Howell (Hon Secretary) and Mr L S Moye (Hon Treasurer). Dr Q Summerfield will continue to serve as a member of the committee.

Membership of the Speech Group has shown a sharp increase this year, and now stands at 88. It is hoped that this healthy state of affairs will continue.

Musical Acoustics Group

Unfortunately, for various reasons, the Musical Acoustics Group has been *un poco piu piano* during the past year. Early in the year, in conjunction with the AGM, we were invited to the London College of Furniture. As on previous occasions, a feast of technical expertise was on view — and was also heard. A recital of music was given by students and staff, played on instruments—violas and recorders—made by the Department of Musical Instrument Technology. We were then shown the Department's Fairlight Synthesizer and an enthusiastic demonstration of its many facilities was given by Bob Gould. Following the AGM, we were shown the 'heavy industry' of the Department in the shape of the piano hammer press. This highly specialised equipment produced the exact grading, texture and shape of the felt covering for an entire set of piano hammers.

An evening visit to the National Musical Museum, Brentford in the early autumn had to be cancelled due to lack of support. It is hoped to arrange another opportunity of seeing this unique collection of mechanically-played musical instruments in the near future. In November, a group of members was privileged to visit the Acoustical Manufacturing Company, Huntingdon, makers of the 'Quad' range of high-quality audio equipment. We were shown the manufacturing processes of the new electro-static loudspeaker as well as the construction and computer-controlled testing of the company's range of audio amplifiers. The founder of the firm, Mr Peter Walker, gave an excellent demonstration of some of the finer points of stereo reproduction, including that from the new Compact Disc. There have, unfortunately, been no major technical meetings this year, but two are planned for 1984.

The officers and committee elected at the 1983 AGM were: Chairman — Prof C A Taylor, Secretary — Dr A E Brown, Treasurer — Dr R A Smith, Committee members — Dr J M Bowsher, Dr J C Goodwin, Mr T M Pamplin. Dr Jennifer Zarek was subsequently co-opted. Group membership during the year was around 80.

Underwater Acoustics Group

During 1983 a major conference entitled Acoustics and the Sea-Bed was held at Bath University over the three days 6, 7 and 8 April. The delegates and presentations reflected the international interest and support — of the 77 authors, 53 were from abroad. The Presidential address, the A B Wood Memorial Lecture together with four invited review papers provided current perspective.

The UAG conference also played host to the Annual General Meeting of the Institute in the absence of its normal venue, the Spring Conference.

Membership of the UAG stands at 128.

Building Acoustics Group

During 1983 the Group organised a successful meeting on Studio Design for Sound and Television at Birkbeck College, London. The forty or so delegates were presented with seven papers covering several topics ranging from the problems facing outside broadcasters, to practical problems associated with the design of studio complexes and local radio Code of Practice requirements. A well illustrated talk was given on the famous Abbey Road studios and how they had altered during the last fifty years.

The main activity of the year was Internoise '83 where the building acoustics session of the Conference formed an important and well attended part of the proceedings. Many of the papers at the Conference were from European and Trans-Atlantic researchers and about 40 papers of interest to BAG members were included. Among the subjects covered were the insulation of partitions, impact noise insulation, noise in ducts, sound absorbers, sound fields in offices and factories and the scale modelling of buildings.

Membership of the Group currently stands at 333.

Industrial Noise Group

After a couple of years in the doldrums the Industrial Noise Group has had a very successful year, following the election of an active new Committee which held its first meeting in March 1983.

Rejuvenation of the Group was announced at Internoise '83 in Edinburgh, by way of a social gathering over lunch. The attendance of between 120 and 150 members, some of them no doubt enticed by the supply of free wine, set a new high standard for social meetings of the Group which must be maintained!

The first technical meeting on Noise Emission from Industrial Fans was held at ICI Welwyn Garden City in October. This was a full day's meeting, a new format for the ING, providing many opportunities for discussion and for delegates to present their own specific problems to the 'panel of experts'. The new format proved a great success, attracting 45 delegates, many of whom were practising engineers in industry. This type of meeting will therefore be maintained, since it provides the opportunity to treat subjects of general interest to a wide number of people in some depth.

As a result of the interest expressed by delegates in obtaining written versions of the material presented at this meeting, it has been decided that at all future meetings, where a Call for Papers is announced, authors will be required to submit written papers prior to the meeting.

The Aerodynamic Noise Group has been inactive for a number of years now and during 1983 it was agreed, after consultation with the Vice-President responsible for Branches and Groups, that the interests of the members of that Group could be served best through the ING as the majority of Aerodynamic Noise Group members are also members of the Industrial Noise Group.

Finally, both the membership and financial position of the Group are now buoyant, the membership having increased during the year to 380.

Aerodynamic Noise Group

See Industrial Noise Group.

ADMINISTRATION

This year the Institute's Secretary, Mrs Cathy Mackenzie, and her assistants have not only coped with their administrative functions in their usual pleasant and efficient manner but also absorbed the additional work load of running the local organisation of the Internoise Conference. Council wishes to put on record its gratitude to them for all their efforts in the management of the Institute's affairs in this particularly busy year.

THE YEAR AHEAD

After the challenging upheaval of Internoise '83 it is hoped that the coming year will see a return to the established pattern of Institute activity and that this will result in further strengthening of the Institute's broad range of activities.

Pioneers of British Acoustics

Some early Twentieth Century Acoustical Literature of the UK

The literature of present-day acoustics has become very specialised in general and even school text-books do not convey the fascination of our subject or provide the stimulation of some of the earlier books of this century. It is proposed to give a brief account of a few of these pioneer books which could be of interest to read today.

The World of Sound, written by Sir William Bragg, who with his son Sir Lawrence Bragg achieved international recognition for their work on X-rays, was Director of the Royal Institution in the 1920s. The book was published by G Bell and Sons Ltd in 1925 and it was based on six Christmas lectures given at the Royal Institution in 1919. The six chapter headings are in sequence: What is Sound, Sound in Music, Sounds of the Town, Sounds of the Country, Sounds of the Sea and Sounds in War. As exemplifying the physical and practical approach may be mentioned the last pages of the first chapter, where the use of a tuning fork as a sound source necessitates the choice of a sounding box to obtain distinct audibility. By placing various materials between the fork and the box their degrees of *transparency* to the sound could be tested. It is concluded that a pneumatic cushion is one of the best *insulators* and then the author proceeds with a practical illustration, viz, putting an *air-cushion* under your pillow when sleeping in a train. Again, in the music chapter Sir William cites the sound produced by drawing the finger-nail over ribbed silk, arising from the very rapid sequence of little pulses as the nail slips into the 'valleys' between the ridges. He then makes a delightful reference to Stevenson's *Child's Garden of Verses*:

'Whenever Auntie moves around
Her dresses make a curious sound
They trail behind her on the floor
And trundle after through the door'.

In the third chapter the Doppler effect and reverberation are carefully explained with interesting applications. In the case of the latter he quotes Darwin who writes about a Justice Fielding who was blind but on entering Darwin's room for the first time estimated correctly that its dimensions were about 22 feet long, 18 feet wide and 12 feet high. Those of us who possess sight do not usually make much use of this aural sensitivity, except perhaps in the bathroom and as the author points out the resonance can

make us feel we have passable voices — but humiliation could follow on returning to the dressing-room! Included in this chapter is a discussion on the Whispering Gallery of St Paul's Cathedral, which received an early explanation from Lord Rayleigh who also gave a demonstration of the effect in the Royal Institution (1904).

The sounds of the country provide a wide field of study which in the case of bird and insects received considerable impetus with the development of the tape recorder. This aspect of the subject has already been dealt with in a previous issue of the Bulletin in describing the work of W H Thorpe. It must suffice here to mention again the acoustical skill of a blind individual, a certain Mr Wilkinson of Leeds, who is described as having the expertise to interpret differences in natural sounds, such as that of the rustlings of different types of trees in a wood or of the same tree at different times of the year, that the sound of blackbirds could indicate the proximity of a hedge while that of larks reveals the close existence of meadows. The 'murmuring' of the bubbling brook emphasises the importance of bursting bubbles as sources of sound. The author draws attention to the fact that the sources in the brook only exist where the water appears white, which is the indicator of the presence of air bubbles. A mass of air-bubbles can also provide an acoustic absorbing medium which is illustrated by noting the damping effect of foam on a tumbler of beer when the glass is tapped in contrast to the resonant sound obtained in the absence of foam (or liquid). The ocean itself is an ideal acoustic propagating medium, particularly at low frequencies. The sea creatures are generally quiet in their movements except in some localised areas where biological creatures, such as snapping shrimps, are present in great numbers. As described in the book, fish cannot or do not listen for sounds but detect pressure changes around them by means of a pair of 'pits' in the skin on the two sides of the head. A particular change of pressure

will differentiate whether the passage is past another fish or past a rock.

As regards the last chapter it is appropriate to mention that Sir William was a Director of Research for the Admiralty during World War I, which indicates his first-hand knowledge of the subject in writing this chapter. This is largely of interest in describing the earlier applications of direction finding of military objectives and the remote sensing of submarines by microphones and hydrophones respectively. It is also of physical interest, again due to Rayleigh, to read of the design of a fog-horn to spread sound over a wide sea-surface. Contrary to first thoughts the mouth of the horn should be wide in the *vertical* plane and narrow in the horizontal. □

RWBS

BRE Defect Action Sheets

The BRE Housing Defects Prevention Unit, based at Garston, is issuing a series of Defect Action Sheets, among the most recent of which are two of potential interest to acoustics workers. The series, launched in 1982, is intended 'to remind and inform designers and site supervisory staff of ways of avoiding some of the most troublesome defects which have beset Local Authority housing in recent years'. DAS 45 is entitled *Intermediate timber floors in converted dwellings — sound insulation* and looks at the problems and remedial work associated with unacceptable sound transmission through floors which are required to act as separating floors in dwellings converted to multiple occupancy. DAS 46, *Masonry walls: chasing*, concerned primarily with the reduced strength of walls where chasing has been incorrectly carried out, is also of importance from the point of view of impaired sound insulation in separating walls. Further DASs of possible acoustical interest will be published in due course.

Local Authority acousticians may find that the nominated contact point in their Authority can provide them with copies of relevant DASs; alternatively copies of DASs or of the cumulative index may be obtained direct from the DPU. DASs are obtainable in the private sector only on annual subscription. For all further details contact: Housing Defects Prevention Unit, Building Research Station, Garston, Watford WD2 7JR. Tel: Garston (0923) 674040. □

IOA Education Committee

Colleges offering a course in preparation for the Institute's Diploma in Acoustics and Noise Control are required to present after five years a course review describing the College's experience at running the course, highlighting any changes that have occurred in the staff and equipment resource position. This year only one College came under scrutiny, Leeds Polytechnic. On this occasion the Committee's consideration of the review document was coupled with a request from Sheffield City Polytechnic to be recognised as a centre. Following visits to both Colleges the Committee decided that, exceptionally, both institutions should be allowed to offer the course, but for student intakes in alternating years only. The position is subject to automatic review after Leeds Polytechnic has received its 1987 intake, or earlier if the position regarding resources has been found to change significantly in the meantime. Next year the courses at Tottenham, Derby and Bristol are listed for review.

The first updating exercise for the syllabus content of the Diploma is well in hand. Draft syllabi have been prepared and approved by the Committee for circulation for comment among participating Colleges. Subject to discussion of the response from the Colleges it is hoped that the new syllabi will be offered to students in September 1985. It is a creditable reflection of the care taken by members of the original Diploma Working Party that most of the proposed changes are ones of emphasis only, together with some additional elements that reflect present-day trends in the subject. The Committee would like to make it known that it is always open to individual Members to put forward their own views on the content and organisation of the Diploma examination, particularly in view of the fact that passing the Diploma satisfies the academic requirements for Corporate Membership.

The Committee is pleased to record that the total number of candidates taking this year's examination was again in excess of two hundred and a small increase on the 1983 number. It is encouraging to find that the expected levelling off in demand has not yet occurred. The routine administration of the Diploma is now eased by the arrival of the Institute's micro-computer. Although this is very much a time for acquiring experience in these

things it is already clear that the work of registering candidates for the five hundred written papers taken at the twelve centres has been facilitated. There is evidence that Colleges find the more detailed statistics now made available when the results are announced, mark distribution lists for each subject for each college and so forth, are a valuable aid to planning teaching programmes, a factor which takes on particular importance where external examinations are involved. The computerisation of the administration will make the preparation of these statistics considerably easier.

The Sixth Form Lectures were again arranged for the end of 1983. Professor Peter Lord again spoke on the title 'From Digits to Music' and Dr Peter Wells spoke on 'Ultrasonics and Medicine'. This time the venues were Cardiff, Guildford and Ewell and reports have been received that the lectures again attracted an enthusiastic response. Continuing the policy for the time being of holding the lectures at centres where, through its membership, the Institute already has a significant presence, the centres selected for Christmas 1984 are Liverpool, Manchester and Newcastle.

Changes in membership of the Committee have been announced to Council and will become effective at the Committee's November meeting. Dr B J Smith has retired from the position of Chairman which he has held (including Chairmanship of the former Diploma Advisory Board) since 1978. Dr Smith's enthusiasm and administrative skills will be missed; he is taking up a post with Her Majesty's Inspectorate and this places certain, although gratifyingly incomplete, contractual restrictions on the extent to which he is able to participate actively in Institute policy making. Roy Lawrence has become the new Chairman and Bryan Oakes of Newcastle Polytechnic the Vice-Chairman. It has been agreed that in future the membership of the Committee will be strengthened by the addition of the Diploma specialist papers.

The Committee is always pleased to receive observations from the membership regarding ways in which the Institute's involvement in the field of acoustics education may be improved. □

R Lawrence

NEW ELECTIONS

At its meeting on 31 May 1984, Council approved the following elections to corporate and non-corporate membership of the Institute of Acoustics.

Member

H R Chan	R K McLaughlin
P J Crank	H F D Mui
S Daniel	M J Newman
P S Fisher	B G Olding
S K Hassan	A P Salkield
N I Haverson	D E Sherwin
M O M Ho	J N Smith
G M Holmes	K E Thomas
P T Larkin	L C Willis
Y K Leow	

Associate

J M Bairds	S W Kwan
D W Barbour	P K Lau
L C Barker	W J Legassick
R D Broomfield	W H Leung
M E Brownjohn	R D Logie
C M Butterfield	B McKell
M C Cattley	D B Maher
K K Chan	S N Pan
K W Chan	J A Parish
K K Choi	D J Parker
G Cole	T Parkin
J L Cook	J A Pickard
M Durkin	P M Robson
A J Edmunds	P A Rolando
H W Fan	T P Rowe
R W E Farr	G Seiffert
E J Fordham	C S Shau
A G Fuller	A Short
C H Fung	K H Tang
W S Fung	M Taylor
J E Gledhill	P M Taylor
M R Harrison	D R Tinker
G E Hassall	K K Tsang
G C Hill	N F Wan
P Hodgson	A Watson
P J Hubbard	C J Wood
C Joslin	H L Yim
G M Joy	W A Zawistowicz
S J Joyce	

Student

A M Duffield	J A Sidwell
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BRANCH AND GROUP NEWS

East Midlands Branch

The Branch AGM was held on 23 February. The Chairman, Mr J Savidge, gave a brief description of the past year's activities; this was followed by the election of members to serve on Committee. The existing committee was re-elected with the exception of Mr M Dearden who reluctantly resigned. The vacant position was filled by Mr P Jones.

The meeting continued with an introductory talk and tour given by Mr P Jones and colleagues at British Gypsum's Research and Development Department at East Leake, Loughborough.

In his introductory talk on the work of British Gypsum in the field of sound insulation, Phil Jones outlined the laboratory facilities which include reverberation suites for sound insulation measurements on walls and floors, a flanking transmission chamber and a 200 m³ reverberation room.

Before the laboratory was commissioned all work took place at external laboratories, which caused delays in research and development projects. The facility has proved its worth and has been in constant use for sixteen years. Work is undertaken for the whole of the BPB Industries Group of which British Gypsum is the largest company. In addition, fee paying work in the laboratory and field is accepted.

He explained how two basic elements, plasterboard and glass fibre, can be used to advantage in lightweight constructions to achieve much higher levels of sound insulation than would be predicted from the partition mass alone. Applications were described in the areas of partitioning, timber/steel framed housing, industrial buildings, cinema conversion and in the refurbishment of more traditionally constructed buildings. Reference was made to flanking transmission control which is often the major problem when designing for sound insulation.

A tour of the laboratory was given by Paul Royle who described how sophisticated remedial treatment to the laboratories has been incorporated over the years to improve on the original design and thus allow the true performance of the composite lightweight structures to be determined.

Bob Meer demonstrated the new test equipment for which he is developing fully automatic computer controlled procedures for measuring airborne and

impact sound insulation and absorption coefficients.

The evening's proceedings were well attended by approximately 20 individuals overall with representatives from as far afield as London (London Borough of Southwark).

P E Jones

On 16 May, 25 members and guests of the East Midlands Branch met at Rolls-Royce Limited, Hucknall, for a talk by M J T Smith, Head of Noise Technology, on *Aircraft Noise Control — Progress and Prospects*.

The illustrated talk was on the lines of that given by Mr Smith to the Royal Aeronautical Society in London on 2 February, and examined aircraft noise control since the introduction of the jet engine as a power plant some 25 years ago.

During this period of time the scheduled airline jet fleet has increased exponentially to its present level of some 6000 aircraft, but a 20 dB reduction from the levels of the original pure jet has resulted in a 40% reduction in NNI areas at Heathrow.

The stage has now been reached where the existing type of jet engines cannot practicably be quietened any more, and engines incorporating new noise technology need to be introduced. Research, however, is on the decline in the face of economic pressures and the 1990s are predicted as bringing about a resurgence of aircraft noise problems.

Repeated flight testing for certification is extremely costly and is being replaced more and more by the use of ground based data. Such data is obtained at the Hucknall complex on Rolls-Royce's open air testing facility.

Following the talk a visit was made to this testing facility which has a rotatable single pillar structure together with arrangements for a polar or linear array of microphones.

Currently the RB211-535E4 engine, which is being installed in the Boeing 757, is being tested.

G Yates

North West Branch

The North West Branch enjoyed a particularly pleasant technical visit to ICL Limited at their premises in West Gorton, Manchester on 12 April, to learn more of the main frame systems development division of this large British-based computer manufacturer.

The members present were allowed to view the Pegasus computer, the only remaining working example of its type, manufactured in 1959, exported to Sweden and then returned to the company's premises through the good offices of the Science Museum and the University of London. The machine is considered to be part of the ancestry of ICL computers because, through a merger in 1963, the manufacturer, Ferranti Computers became part of ICT, which was itself one of the constituent companies of ICL at its formation in 1968.

The visit then continued with a demonstration of the Perg scientific workstation, and link up between main frame computers in the computer hall and other main frame computers within other divisions and countries where ICL have premises. The highlight of the evening was an opportunity to view the acoustic laboratory from where Don Baines has for many years made contributions to the world of acoustics and also upheld his position as an acoustical ambassador for his employers. Subjects discussed during this latter part of the visit were the design of the anechoic chamber constructed within the premises, noise levels associated with the products manufactured by the company, the methods of acoustical testing of such equipment, and the general principles of computer aided design.

The Branch is indebted to Don Baines, a founder member of the North West Branch, for this opportunity to view the working operations of Britain's major computer manufacturer and those members lucky enough to have the use of one of ICL's products now understand hopefully a little more of the background to the manufacture.

J A Dinsdale

On Thursday 10 May a small party of NW Branch members visited Barratts of Manchester Ltd, where the manufacture and repair of brass musical instruments was the subject of acoustical interest. On arrival, the members who attended were met in the showroom by Alison Barratt and shown a range of instruments either made by Barratts or distributed by them, consisting of bugles and trumpets.

After this brief introduction the party was escorted by Mr Daniels of the Company into the workshop, where he explained the various processes in transforming a sheet of brass cut out from a template into a finished instrument. Mr Daniels then gave a practical

demonstration of craftsmanship by showing the party how a flat piece of brass was turned into a bell and tube of a horn.

The cleaning, polishing and electroplating of the instruments was then described and shown and members who attended now understand more of the considerable engineering skills required to assist the talented performer in achieving an acoustically pleasing result.

The Company were thanked for their hospitality and this first North West Branch Meeting featuring 'Musical Acoustics' will be followed by others if future support and interest is shown by members.

W A Baines

Southern Branch

The Annual General Meeting in December re-elected Ian Sharland as Chairman and Geoff Charnley as Honorary Treasurer; Frank Fahy succeeded Ray Shack as Honorary Secretary. The AGM was followed by a lecture on *Active Noise Attenuators* by Dr Peter Chatterton. Peter Sutton addressed the January meeting on *Hearing Protectors and Legislation*, and provided a very thought provoking evening. The problem of communication between designers and consultants was the subject of a lecture at Portsmouth by Dr Sebastian Lera. The year's programme was completed in March when Mike Shelton of ISVR revealed some of the acoustical and related deficiencies of local school buildings uncovered by his recent extensive survey.

The Committee was sad to receive notice of resignation from Peter Sutton who is retiring from professional acoustics, and the chairman wrote to express gratitude for services rendered to the Branch.

The provisional programme for the rest of 1984 will be found on the inside rear cover. Of particular interest to IOA members in general will be a visit to Vosper Thornycroft (UK) Ltd (Shipbuilders) on 12 September 1984. A conducted tour of the Hong Kong ferries will be followed by lunch provided by VT; in the afternoon presentations on the subject of noise and vibration control in ships will be made by a member of VT staff and an acoustic consultant. Numbers are limited and applications must reach Dr F J Fahy, ISVR, Southampton University, by 12 August.

F J Fahy

Scottish Branch

The embryonic Scottish Branch has now held its first three meetings. It has been encouraging to see the enthusiastic support given by Scottish members and their as yet non-member colleagues by their participation in preparing the ground for establishing the viability of a Local Branch in Scotland.

As a matter of policy, the Steering Committee decided to alternate meeting venues between the west coast (Glasgow) and the east coast (Edinburgh). A further decision made was to hold afternoon meetings to allow participants to return home without the need for an overnight stay.

The aims of these meetings are twofold:

- (i) to present specialist subject areas in simple terms for the benefit of generalists and other specialists;
- (ii) to give acousticians an opportunity to meet colleagues in an informal environment.

These aims have been met thanks to the contributions of Bill McTaggart (B&K), Meetings Organiser; Bill Lawrie (Glasgow College of Technology), Local Organiser for Glasgow events; and Dr Robert Craik (Heriot-Watt University), Local Organiser for Edinburgh events.

The first Scottish Branch meeting, on Industrial Noise, was held on 22 February 1984 at Glasgow. Two interesting papers were given: *An insight into Industrial Noise — a health and safety viewpoint*, by Brian Ross (Health and Safety Executive); and *A Consultant's approach to the control of noise and vibration in the industrial environment*, by Dr Sandy Petrie (Paisley College of Technology). This meeting proved to be on a particularly popular subject, being attended by about 40 people and generating much discussion.

The second meeting, Statistical Energy Analysis — is it different?, was held on 18 April at Edinburgh. Statistical Energy Analysis is a framework of analysis which is becoming increasingly used for problems such as sound transmission through buildings, ships, aircraft and other complex systems. The aim of this meeting was to present an outline of general ideas and applications and show that the concepts are similar to those found in many other fields of acoustics. Dr Robert Craik (Heriot-Watt University) spoke on *Introduction to Statistical Energy Analysis* and John McColl (YARD Ltd) on *Applying Statistical Energy Analysis*. About 20 people attended this meeting.

The third meeting, on Speech Processing, was held on 30 May at Glasgow. This meeting was intended to give an overview of this fast-developing field and to indicate ways ahead for speech acoustics/information technology research. Three papers were given, by Dr Howard Latham (YARD Ltd) on *Man/Machine Communication by Voice*; by Robert Johnstone (Glasgow University) on *Speech Recognition Applications*; and by Dr Simon Garrod (Glasgow University) on *Natural Language Processing*. About 20 people attended this meeting, with much interest being shown in the automatic speech recognition demonstration.

A fourth meeting, including the AGM and an opportunity for discussions over drinks afterwards, is planned for Wednesday 26 September 1984, 2.00 – 5.00 pm, at Heriot-Watt University, Edinburgh. The topic will be Noise and Vibration of Rotating Machinery; further details of this meeting, to which all are welcome, should be addressed to the meeting organiser, Dr S J Yang, Electrical Engineering Dept, Heriot-Watt University, Mountbatten Building, 31–35 Grassmarket, Edinburgh EH1 2HT (Tel. 031-225 8432 Ext 108).

It is intended that the AGM should discuss the viability of establishing a local Branch in Scotland and consider an approach to Council for formal approval of the Branch.

Howard Latham

Musical Acoustics Group

The major recent activity has been the Musical Acoustics sessions at the Spring Conference in Swansea. These are reported elsewhere, but the Group's thanks are due to Bernard Richardson for arranging such a comprehensive series of papers (requiring full-time attendance with only one coffee-break!) Also arranged as part of the musical offering at the Conference was a visit to Merlin Madog, a harp maker. Here, in the village of Pontycymer, we saw the variety and craftsmanship associated with the folk instrument of Wales. We saw harps amazing both in simplicity and complexity, culminating in the chromatic triple harp whose playing technique is a unique craft in itself. Not to be missed was the electronically amplified 'rock harp' designed for a pop group. Unfortunately, Merlin had no harpist present to play the instruments, but his vivid description of his work was a recital in itself.

In May, a visit was arranged to the Musical Museum at Brentford. Here we were taken on a tour of the collection of mechanically-played instruments having its nucleus in the piano collection of the museum's founder, Frank Holland. The process of mechanical reproduction — usually from a perforated paper roll — was demonstrated in its various forms ranging from the simple Pianola (dynamics and speed controlled by the operator) to the reproducing pianos which duplicated the performance of a famous artist. Hence we heard Paderewski playing Chopin and six anonymous hands performing Rimsky-Korsakov. The amazing secrecy surrounding the recording of the famous pianist's performance as well as the amazing incompatibility of rival firms' reproducing systems was pointed out to us. (Video is simple compared to this!) As a digression from paper-roll played instruments we then heard a 'barrel piano'. This was the old-time street piano, often mis-called 'barrel organ' and very familiar to some members on the streets of London and provincial towns. Then followed a genuine barrel organ, reproduction again taking place from a pinned rotating barrel. Reverting once more to the paper roll, a church-sized pipe organ was demonstrated, in this case emphasising the wayward personality that complicated mechanical devices seem to have. We next heard an Orchestrion, a 'portmanteau' instrument combining a pipe organ, a piano and various percussion instruments — and, strangest of all, the 'Violano Virtuoso' featuring a small piano and a mechanically-played violin. Four small rotating wheels did duty for the bow together with electrically-operated finger-stopping and vibrato. Our tour finished with a demonstration of a cinema-organ — the 'mighty Wurlitzer' formerly at the Regal, Kingston-on-Thames. This also could be mechanically played via a unique roll-playing machine.

This was a fascinating display of the mechanical ingenuity employed for the reproduction of music before the perfecting of the art of sound recording. With the rapid development of the latter, mechanically-played instruments went into sharp decline; finally home entertainment has rendered the Super Cinema with its Wurlitzer redundant.

For those who could not be with us on this occasion, the Museum is well worth a visit.

The Group, in conjunction with the Electro-Acoustic Music Association of Great Britain (EMAS) and the Institute of Musical Instrument Technology, is organising a one-day meeting on Electro-Acoustics and Music on 5 October 1984. This will take place at the London College of Furniture, Commercial Road, London E1.

Edgar Brown

Speech Group

A meeting on 'Aspects of Voice' was held on April 25 and 26 1984 at the University of Newcastle upon Tyne. There were twenty attenders at this meeting, a number of them resident. Perhaps distance, date and the interdisciplinary nature of the meeting kept this figure low. However, those who did attend found the occasion stimulating. As convenor, I feel the trouble taken to

organise a meeting of this kind is worthwhile, since it would be to the benefit of both the Speech Group and the Institute to have a wide spectrum of interested people in our specialist group. (Four new members, and one further seeking Institute membership, on this occasion reflect that the interest in speech comes from several disciplines.)

The first session, on Wednesday evening, consisted of two demonstrations, 'Fibre-optic observation of the Vocal folds' given by Mr A Welch, of the Royal Victoria Infirmary, Newcastle-upon-Tyne, and the other a psycho-acoustic experiment supervised by Ms M A Shirt of the University of Leeds. The second day took the more conventional meeting form, consisting of five papers on various aspects of the topic 'Voice'. □

R Beresford

Wave Propagation and Scattering

This conference was organised by The Institute of Mathematics and its Applications, with Dr Barry Uscinski playing the leading role. It took place on 5th and 6th April 1984 in the pleasant surroundings of Robinson College, University of Cambridge. There were some 110 participants, whose interests ranged through astrophysics, geophysics, radio wave and optical propagation, communications engineering and ocean acoustics. Attendance was virtually restricted to workers in or from the United Kingdom, and provided a good opportunity for people from different fields to meet others having common interests. Some perspective can be added by showing next how this meeting is related to two others.

The original concept of an IMA meeting split rather neatly, with two quite disparate fission fragments. The meeting under report concerned itself with propagation, but without restriction on the wave type or the medium. Thus it covered a spread of disciplines, in electromagnetics running from light to radar and radio waves, and with mechanical waves mainly represented by ocean acoustics. The medium ranged from liquid crystals, in the safety of the laboratory, to the great outdoors, with ice sheets, oceans, land surface, atmosphere and interstellar space. It is remarkable that similar concepts and methods can be used across this wide spectrum of scales. In addition we can look forward next year to the other fission product, an IMA meeting on all aspects of theoretical acoustics, led by Professor Shôn Ffowes Williams.

In 1983 the writer attended in Rome a NATO Workshop on Hybrid Formulation of Wave Propagation and Scattering, directed by Professor Leo Felsen. This, like the Cambridge meeting, was interdisciplinary. If the papers and the participants are as thoroughly mixed as the disciplines the result can be very stimulating, and in fact both meetings were very successful. But the differences in scope were greater than might be thought from the similarity in titles. Thus in Rome there were really the two separate subjects of wave propagation and of scattering or reflection from finite targets, and the meeting compared the wave approach and the ray approach to these two subjects. In Cambridge there was basically just the one subject: wave propagation through random media as affected by scattering and diffraction, including studies of the resulting variability.

Concentrating now on Cambridge, the introductory keynote address was delivered by B J Uscinski. Important theoretical and experimental developments have taken place in recent years, and workers in the UK have been at the forefront of these advances. It is now possible to give a better description of the statistical nature of the scattered wave field, for example the probability density of intensity fluctuations. In experimental work there have been improvements in instrumentation and, especially, in digital recording and processing: the subject is healthy and growing.

The rest of the first day was occupied by eight papers classified as Mathematical

Theory. M Berry discussed short waves and the important role of ray caustics or singularities, with a treatment using catastrophe theory. J H Hannay continued this theme on natural focussing regions, with descriptions in terms of wave front correlation functions. E Jakeman described multiscale systems, ie those having important spectral components over a wide range of scales, and drew on Benoit Mandelbrot's fractal concepts. C Macaskill dealt with the second moment equation, which concerns the coherence of the wave field and allows estimation of the spectrum of phase fluctuations, and in particular he extended the methods which cope with a medium such as an ocean waveguide which can channel sound. B J Uscinski considered the fourth moment equation, necessary for the

spectrum of intensity fluctuations but more difficult to work with, and reported progress using a multiple convolution approach. R Buckley and D Roberts used a Fokker-Planck equation for the problem of the random phase screen. K Ouchi introduced us to the intricacies and relevant problems in synthetic aperture radar imaging of the sea surface. R H Clarke put forward some simple formulae describing laser beam propagation through the atmosphere.

The second day's menu comprised eleven papers classified as Experimental. The first four described scintillation and the effects of interstellar propagation, fascinating for a worker in acoustics — or any other branch of physics, with authors P J Duffet Smith, F G Smith, N C Wright, A Hewish, and

B J Rickett. We then heard about major experiments in ocean acoustics from T E Ewart, on the optics of various media from E Jakeman, and on radio waves in ice from M Walford. J C Dainty and D Newman showed us how to detect a phase grating hidden within a diffusing medium. C J Oliver described a new model for non-Rayleigh scattering, together with its application to experimental data on radar clutter. The conference ended with two further papers on radar returns from the ocean surface, including some beautiful illustrations; authors K D Ward, S Rotherham and J T Macklin.

The Proceedings of the Conference are to be published by Oxford University Press. □

D E Weston

Standards

The following developments have been noted from the British Standards Institution over the six-month period January — June 1984. BSI publications are available by post from: BSI, Sales Department, Linford Wood, Milton Keynes MK14 6LE (Tel: 0908 320066).

New British Standards

BS 5944: Measurement of airborne noise from hydraulic fluid power systems and components

BS 5944: Part 4: 1984 Method of determining sound power levels from valves controlling flow and pressure. Describes procedures for the determination of sound power levels of a hydraulic fluid power valve under controlled conditions of installation and operation, suitable for providing a basis for comparing the noise levels of valves. No current standard is superseded.

BS 6083: Hearing aids

BS 6083: Part 0: 1984 (= IEC 118-0). Methods for measurement of electroacoustical characteristics. Describes the measurement of physical performance characteristics of air-conduction hearing aids based on a free-field technique and measured with an ear simulator. Supersedes BS 3171: 1968.

BS 6083: Part 5: 1984 (= IEC 118-5). Specification for dimensions of the nipple and sealing device for insert earphones. Specifies those dimensions which are essential in order to ensure the interchangeability of insert earphones as used with earmoulds or other attachments to the ear. No current standard is superseded.

BS 6083: Part 11: 1984 (= IEC 118-11). Specification for symbols and other markings on hearing aids and related equipment. Specifies symbols and other markings for the switches and controls on hearing aids and related equipment for the benefit of users and those involved in the fitting of such equipment. Supersedes BS 3942: 1965.

BS 6344: Industrial hearing protectors
BS 6344: Part 1: 1983 Specification for ear muffs. Specifies constructional and performance requirements with methods of test and marking requirements for ear muffs to be used in industry. No current standard is superseded.

British Standards Withdrawn

3171: 1968 Methods of test of air conduction hearing aids *Superseded by BS 6083: Part 0: 1984.*

3942: 1965 Marking of control settings on hearing aids *Superseded by BS 6083: Part 11: 1984.*

Drafts for Public Comment

84/20434 DC BS 6083 Hearing aids Part 1. 1984 Method of measurement of characteristics of hearing aids with induction pick-up coil input (Revision of BS 6083: Part 1: 1981) (IEC 118-1: 1983)

84/20460 DC BS 6083 Hearing aids. Part 3. 1984 Methods of measurement of electro-acoustical characteristics of hearing aid equipment not entirely worn on the listener. (Revision of BS 6083: Part 3: 1981)

84/20636 DC BS 6083 Hearing aids Part 2. Methods of measurement of electro-acoustical characteristics of hearing aids with automatic gain control circuits. (Revision of BS 6083: Part 2: 1981) (IEC 118-2: 1983)

83/30601 DC Specification for 'sound calibrators' (IEC 29C (Secretariat) 47)

83/30602 DC Specification for 'immittance audiometers' (IEC 29C (Secretariat) 46)

84/72812 DC Method of calibration of vibration and shock pickups (ISO/DIS 5347)

International New Work (ISO)

Measurement of airborne noise emitted by liquid pumps. Will give procedures for measuring and reporting noise emissions of pumps, based on measurement procedures in ISO 3744.

Vibration and shock — Vocabulary. Will revise ISO 2041 to include additional terms.

Mechanical vibration of machines with operating speeds from 10 to 200 revolutions per second — Basis for specifying evaluation standards. Will revise ISO 2372 to take account of current practice. □

B C Grover

Material for the October issue of Acoustics Bulletin should reach Mrs F A Hill at 25 Elm Drive, St Albans, Herts AL4 0EJ, no later than Thursday 23 August.

Impulsive Noise

Its Measurement, Assessment and Reduction

Industrial Noise Group Meeting, 22 March 1984

This meeting, held at the National Coal Board's Bretby Conference Centre and organised by the Industrial Noise Group, covered various aspects of Impulsive Noise. Forty-five delegates attended and listened to six technical papers on a variety of subjects. It was noticeable that whilst there is increasing understanding of the mechanisms which generate impact and impulse noise it is clear that the techniques of actually reducing it, at source or otherwise, still elude us.

THE MORNING SESSION of three papers started with a presentation by John Kuehn of Brüel and Kjær who reviewed the applicable Standards for instruments measuring impulsive noise. After defining impulsive noise generally as 'noise produced by the sudden expansion of gases' or 'noise produced by impacts between hard objects', he described the general acceptance, in the UK at least, of 'A-weighted' Leq as the appropriate measurement for evaluating the hazard to hearing from it. The descriptors were shown to be different outside the UK, with West Germany recommending the use of 'impulse derived Leq' which can penalise impulse noise by up to 16 dB, and the situation in the USA being rather confused with a variety of conflicting proposals currently under consideration. The subject then turned to the current and proposed Standard for 'Impulse Grade Integrating' instrumentation suitable for measuring this type of noise. Of greatest significance to the UK is the new IEC Standard, currently nearing completion, for such equipment. The Standard follows the form of IEC 651 (Sound Level Meters) by proposing four classes of instrument with types 1 and 2 being suitable for measuring impulsive noise correctly, and only type 1 being sufficiently accurate for measurements of very short duration noise in free-field environments.

The paper concluded with the suggestions for a new International Standard (perhaps in line with BS 6402) for personal dose meters and a reminder to users of some older types of 'precision grade' sound level meters that their detectors may well be inadequate for measuring certain types of impulsive noise such as piling and hammering — a point which is considered increasingly important as Leq becomes more widely adopted as the appropriate

noise descriptor both in UK and in International Standards.

The second paper on controlling, at source, machinery noise, or more particularly power press noise, was given by Gordon Stimpson of the ISVR. The paper's first part concentrated upon general 'energy balance equations' where input energy of the form of an impact in a machine may be transformed into useful work; and into energy dissipated in the machine structure; energy escaping into the ground; and finally energy radiating from the machine as noise. The paper briefly described the theory of altering each term in the energy balance equation in order to influence and reduce the amount of unwanted noise.

The second part of the paper dealt with the possibilities for reducing the noise generated by power presses. This work, which is being carried out at the ISVR under an industrial research contract, has identified the benefit of smoothing the unloading of the power press structure at the moment of workpiece fracture. This is done by using progressive shearing techniques to avoid a sudden fracture of the workpiece; or by using smaller punch to die clearances or by damping the machine to inhibit structural springback. The damping concept was suggested as particularly encouraging, such as incorporating hydraulic rams located between press bed and slide on small 'C-frame' presses.

For large straight-sided four column presses, damping by means of infilling the columns with a suitable material is also suggested. Work carried out on a one-third scale model of a 200 tonne press showed that noise reductions, using sand as a damping medium, of up to 9 dB(A) are possible.

The last paper of the morning session was given by Mike Forrest of APRE

Farnborough on the subject of the effects of gunfire noise on hearing. The methods of describing the noise level of gunfire by means of 'A and B durations' was explained. 'B-duration' is the more common measure and may be defined as the time period over which the pressure is within 20 dB of its peak value.

Current limits to gunfire noise exposure are based mainly upon 'acceptable' temporary threshold shifts rather than on any assessments of the longer term permanent threshold shifts and deafness risks. There is however reasonable correlation between these criteria and typical Leq limits for industrial noise. The problems of instrumentation to measure gunfire noise were raised, in particular the problems of dynamic range and the need for transducers to cope with pressure up to 50 kPa. Even with the correct instrumentation, it is vital when measuring gunfire noise, to orientate the transducer correctly so that the shock wave front impinges on the surface only at grazing incidence. This obviously poses practical problems of measurement when ground reflections and reflections off other nearby surfaces have to be contended with.

The reduction of gunfire noise at source by means of silencing was explained as being of very limited application and possibly confined to small arms only where some loss in rifle/handgun performance would be acceptable. It was therefore necessary to rely upon ear muffs or plugs as protection against high levels of noise. Reference was made to ear muffs incorporating orifices which in theory attenuate only when large acoustic pressures are incident at the ear, and the paper concluded with the comment that the full ear muff attenuation was only going to be achieved in practice if the muff or plug fits correctly, is compatible with other equipment, such as helmets, and is sufficiently durable in service.

After the buffet lunch, the afternoon papers commenced with a presentation by Raymond Heng of Sheffield and Singapore Universities on the use of 5 minutes dB(A) Leq as a descriptor of Construction Noise.

This paper summarised work undertaken in advance of the proposed Singapore Code of Practice on Noise from Construction and Demolition Sites, and is particularly interesting in the light of the revision to the UK's own BS 5228 which is currently under way. The original reason put forward

for proposing a 5 minute Leq was that of difficulty in monitoring over longer periods such as 12 hours as recommended in BS 5228. Concern was also expressed over building contractors using noisy equipment for short periods only, and that the 12 hour Leq measurement might not adequately reflect the community annoyance from such operations.

A laboratory study was undertaken using a large number of subjects, who were exposed to a range of noises including typical construction noise. The results showed that 5 minute Leq's of noise at 60 dB(A) were 'disturbing' to subjects and that this response increased to 'annoyance' at a level of 65 dB(A).

The paper concluded with a recommendation that a 5 minute Leq of 70 dB(A) should perhaps be considered as the upper acceptable limit for construction noise.

The penultimate paper by David Hughes of the North Staffordshire Polytechnic addressed the meeting to the interesting problems of noise generated by rock impacts on 'particulate screening systems'. For those of us who were not familiar with the theory behind how rock screens work, and how they are designed, the brief explanation of the basic principles was very interesting.

The work is as yet only at an early stage; however, the noise associated with the process is caused either by rock to rock impacts, or rock to screen impacts. The noise generating mechanisms are: rigid body radiation; aerodynamic noise; surface acceleration; structure ringing; and material fracture. However it is the first of these, the rigid body radiation noise associated with elastic deformation of material, which usually dominates the other four mechanisms, and it is this aspect which was further investigated by experimentation in the laboratory.

Initial results of the experimental work have shown similar level pressure peaks when rock samples fall onto a screen from a fixed height, whether they impact on an edge or a corner (impact on a flat surface is rare). Peak pressures of 120 dB with durations of 0.5 m seconds have been measured at 300 mm from the points of impact on the screen surface. The experimental and theoretical work on this subject continues.

The final paper of the day was given by Ian Carr and Malcom Smith of the ISVR on the subject of noise from a drop hammer. Of the characteristic mechanisms of noise generated by drop hammers, the predominant contributions were shown to be 'acceleration noise' and 'ringing noise'.

Acceleration noise occurs only during the actual impact and is caused by rapid accelerations of the impacting bodies. It emanates from the 'tup' and 'upper die' regions of the hammer. Ringing noise emanates from all components of the hammer as the vibrations from the impact zone are transmitted throughout the machine. Ringing noise tends to be the dominant source in drop hammers.

Experimental work was carried out on a one-third scale model of a Massey Marathon One tonne drop stamp. The contributions of both acceleration and ringing noise were determined indirectly from accelerometer measurements of surface velocity of components together with estimates of radiation efficiencies. The resulting

noise level total determined in this way was compared with actual noise measurements of the hammer with good correlation.

To consider reducing noise from drop hammers, another scale model was built with the anvil enclosed in a thin aluminium walled box containing sand, and the poppet system replaced with a simple bolting system. This treatment proved very effective in reducing ringing noise but left acceleration noise unattenuated. Such measures as have since been tried for reducing acceleration noise have proved to be fragile, susceptible to damage, and of limited success in reducing this noise. Because of this difficulty overall noise reductions achieved to date have been limited to 3 dB.

The day ended with tea followed by the Industrial Noise Group's AGM, copies of the minutes of which are available on request. □

Andrew Corkill

COURSES

Noise and Vibration — Measurement and Control is a 3-day short course to be held at Cranfield Institute of Technology from 3 to 5 October 1984. Designed to cater for engineers, technicians and safety officers whose work may involve them in problems of industrial noise and vibration, the course provides an introduction to the subject with particular emphasis on measurement and analysis techniques, correct use of instrumentation and the interpretation of results. Legal and social obligations and maximum permissible levels will be outlined, and basic techniques for noise and vibration control will be discussed. Course members will be able to obtain first-hand experience in the use of instrumentation. For further details contact: Andy Tomlinson, Signal Processing and Applications Group, Cranfield Institute of Technology, Cranfield, Bedford MK43 0AL. Tel: Bedford (0234) 752769.

The Centre for Extension Studies at Loughborough University of Technology is to run a seminar and a short course on industrial noise. The seminar, on *Curbing Industrial Noise — Management — Responsibilities —*

Worker Risks, on 12 November 1984, will seek to clarify management responsibilities to reduce noisy working environments and will look at the risks to workers from exposure to high noise levels over a period of time, at noise legislation, and at case studies in economic noise control. The course, from 13 to 16 November, will discuss in detail the principles of noise control and show how control principles are applied in practice. Contact: Mrs S M Withers, Centre for Extension Studies, University of Technology, Loughborough, Leics LE11 3TU.

The current programme of short courses to be held at ISVR is as follows: Sept 10-14, Industrial Audiology and Hearing Conservation; 17-21, Technical Audiology; 17-21, Advanced Noise and Vibration — Part I; 24-28, Advanced Noise and Vibration — Part II. March 25-29 1985, Instrumentation and Measurement Techniques for Vibration Control; 25-29, Engine Noise and Vibration Control. April 22-26 1985, Clinical Audiology; 22-26, Environmental Health Officers' Course. Further details of these courses from Dr J G Walker or Mrs M Strickland, ISVR, The University, Southampton SO9 5NH. Tel: 0703-559122 ext. 2310. □

Police Applications of Speech and Tape Recording Analysis

Birbeck College, 13-14 March 1984

A wide and stimulating range of topics was discussed at this conference. The enthusiasm of the participants and the apparent widespread interest in the subject however were inconsistent with the disappointingly small attendance. Perhaps wider publicity and better timing (for example, in the academic vacation period) would have attracted more than the 30 or so people who turned up to hear 12 papers and to investigate the mini-exhibition.

The subjects of the presentations fell into three broad areas. The first was that of enhancing audio tapes to improve their intelligibility. Although a number of papers touched on this subject, only two were devoted entirely to enhancement techniques. In the opening paper of the conference Roger Woods described the operational requirements and procedures of the FBI and the value of audio tape evidence, while James Paul explained the principles of adaptive digital filters and in particular the real-time equipment he has designed. Nick Courtis followed on, describing the use of an array processor with a computer system to provide real time capability while retaining the flexibility of software based techniques.

The second area dealt with the examination of tapes and the presentation of evidence obtained from them. The enormous versatility of computer processing was described by Robin Pape, who gave examples of examination and display techniques currently in use or under development. David Dean outlined what might be termed the final step in the process, the procedures to be followed and the pitfalls to be avoided when preparing exhibits and giving evidence at a court of law. Brian Klepper, who presented his own paper

as well as three papers written by colleagues, gave an account of the common degradations suffered by tape recordings, and went on to mention enhancement techniques and the various strategies adopted to obtain good transcripts. He followed with an account of authentication methods, but admitted in the discussion that the occurrence of non-obvious sinister interference was quite rare. The possibility was raised by Ian Raven that the need for authentication might be completely removed by ensuring that all recordings were coded, but it was frustrating that he was prevented from giving a fuller technical description of the proposed technique.

The third area was concerned with the general problem of identification. In four of the papers the object of interest was the human speaker, but Brian Klepper described an investigation in which an attempt was made to identify a handgun whose firing had been recorded on tape. In this particular case it turned out not to be possible. In his final presentation, he put forward the proposition that the proper selection of a set of natural speech features should enable a speaker to be identified from a population. However, the prospect of an operationally useful system still seemed remote. The apparently self-evident hypothesis that phoneticians are better than non-expert listeners at recognising speakers was subject to considerable doubt, based on the results of a pilot study conducted by Marion Shirt. This line of thought was carried further by Steve Lewis, in his paper on the underlying philosophy of speaker identification, who made the point that the concept of 'identity' was ill-defined and misunderstood, and that considerable difficulties were associated with the presentation of reliable and helpful evidence. The final paper, presented by John Bridle, described a thought-provoking concept of using speech synthesis by rule as the basis of a semi-automatic technique for recognising a talker.

In the general discussion following the formal sessions, the main debate centred on the relative merits of processing using specialised hardware or general purpose computers. The real-time capability and ease-of-use of the former were compared with the flexibility of the latter. It was conceivable

that the introduction of micro-processor based hardware and optimised, user-friendly computer software was causing the two types of equipment to converge.

The interest and value of the conference had been considerably enhanced by the mini-exhibition. A wide range of equipment was on display, in particular a variety of types of audio tape recorders and players, from the simplest and cheapest desktop and pocket machines to special-purpose units of many kinds. Measuring gear was on show, ranging from simple sound meters to micro-based spectrum analysers, as well as tape processing and analysis equipment.

In summary, the meeting was judged a success by those present but more thought must be given about potential participants, time and venue, before a second conference on this subject is organised. □

B J Blain

The Bulletin of the Australian Acoustical Society

The Australian Acoustical Society are pleased to report the success of their 'new look' Bulletin. The Bulletin has always sought to include technical papers in addition to Society news and notes, but the 'new look' involved a major change in the appearance and presentation of the publication along with an increase in the proportion of technical matter included. Consulting editors were appointed in eight subject areas and it is planned to have regular special issues devoted to specific subject areas, starting in late 1984. These changes have been well accepted, as is indicated by the continuous flow of contributed papers and articles and the continued support of the advertisers.

Distribution is primarily to members of the Australian Acoustical Society but the number of subscriptions from organisations and libraries both within Australia and around the world is increasing. The cost, for three issues, is 24 Australian dollars per annum, inclusive of surface mail charge; airmail is available at current rates of around 3 Australian dollars per issue. Technical papers, news and notes are welcome and the address for subscriptions and contributions is: Bulletin of the Australian Acoustical Society, C/o School of Physics, University of New South Wales, PO Box 1, Kensington, NSW, Australia 2033. □

RNID Journal

After two years without a journal, the RNID have just launched 'Soundbarrier'. This new journal, which will be on a free postal distribution basis, will seek to interest all who are associated in any way with hearing impairment, and the RNID aim to make it widely read by the general public as well in the future. If you wish to be added to the mailing list for Soundbarrier, please contact the RNID at 105 Gower Street, London WC1E 6AH. □

New Products

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

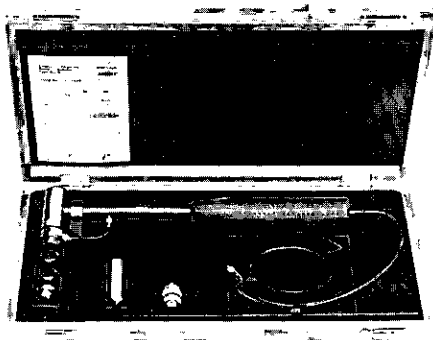
Random Noise Generator — CEL 213

The CEL 213 Random Noise Generator is a compact portable instrument employing a digital random noise generator. When used in conjunction with a CEL 160/2B Graphic Recorder and CEL 196 Automatic Third Octave Filters the Reverberation Time Calculation software will allow automatic control of the source noise and filters.

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Further details from CEL Instruments Ltd, 35 Bury Mead Road, Hitchin, Herts, SG5 1RT. Tel: 0462 52731.

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

Precision Octave Analyser CRL 2.37

The Cirrus CRL 2.37 Grade Convertible Analyser is a self-contained octave analyser and sound level meter. The 10 octaves from 31.5 Hz to 16 kHz can be used unweighted or weighted by the 'A' or 'C' curve over a range from 20 to 154 dB. The max hold function can be used on all three response speeds, Slow, Fast and Impulse. The meter is dual scaled with 34 dB linear mirror scale and a 1 to 50 vibration scale. Input units include Ceramic, Electret and Air Condenser Microphones, also Velocity and Acceleration pick-ups to measure vibration. The basic price of the CRL 2.37 is £475.

Audiometer Calibration Coupler CC 182A

Cirrus Research have produced a new coupler to provide an inexpensive means of calibrating an audiometer. The CC 182A coupler incorporates its own microphone and is terminated in the Cirrus L3M system connector. In use, the earphone of the audiometer to be calibrated is placed on the 6 cc cavity of the CC 182A and the CC 182A plugged into any L3M system sound level meter. The CC 182A is priced at £202.

Further details from Cirrus Research Ltd, 1-2 York Place, Scarborough, North Yorkshire YO11 2NP. Tel: 0723 371441.

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Further details from Castle Associates Ltd, Salter Road, Cayton Low Road Industrial Estate, Scarborough YO11 3UZ. Tel: 0723 584250. □

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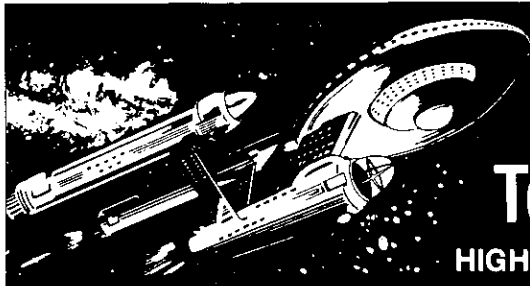
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Institute of Acoustics

Meetings

1984

September	M	Auditory Communications in Difficult Environments	Southampton
5 — 6 September	UAG	New Techniques in Sonar Transducers	Univ of Birmingham
5 — 6 September	M	Local Government Noise Problems	Birmingham
12 September	SB	Visit to Vosper Thornycroft (UK) Ltd	Cosham
20 September	NWB	Noise from Building Services (in conjunction with BAG and ING)	Univ of Salford
October	NWB	Technical Visit to UKAEA, Risley	Risley
4 October	YHB	Dedicated Noise Instrumentation (Bruel & Kjaer (UK) Ltd)	Leeds
5 October	MAG	Electro-acoustics and Music	London College of Furniture
11 October	SB	Visit to Ricardo	Shoreham-by-Sea
24 October	SB	Public meeting: The Law of Nuisance. Followed by an open forum	Southampton Civic Centre
November	YHB	Urban Transportation Noise	Leeds
2 — 4 November	M	Autumn Conference. Sessions on: Building Insulation and Privacy; Speech; Ship and Diesel Engine Noise	Windermere
7 November	M	Combustion Generated Noise and its Suppression	British Gas, Solihull
15 November	SB	Tour of ISVR, Pub meal, AGM and Film Evening	Southampton
27 — 28 November	M	Computers and Microprocessors in Acoustics	London
December	SB	STOL and Heliport Noise	Univ of Southampton
13 — 14 December	UAG	Underwater Acoustic Calibration and Measurements	Bracknell

1985

25 — 29 March	M	Colour in Information Technology. Joint with Institution of Electronic and Radio Engineers	Univ of Surrey
15 — 17 April	M	Acoustics 85. Sessions on Aircraft Noise and Railway Noise; Structural Dynamics; Noise induced Hearing Loss; Instrumentation; Open Session; Poster Session; Exhibition	Univ of York

Key:

M = Meetings Committee Programme
 BAG = Building Acoustics Group
 ING = Industrial Noise Group
 MAG = Musical Acoustics Group
 SG = Speech Group
 UAG = Underwater Acoustics Group

LEM = London Evening Meeting
 EMB = East Midlands Branch
 NEB = North East Branch
 NWB = North West Branch
 SB = Southern Branch
 SWB = South West Branch
 YHB = Yorkshire and Humberside Branch

Further details from:

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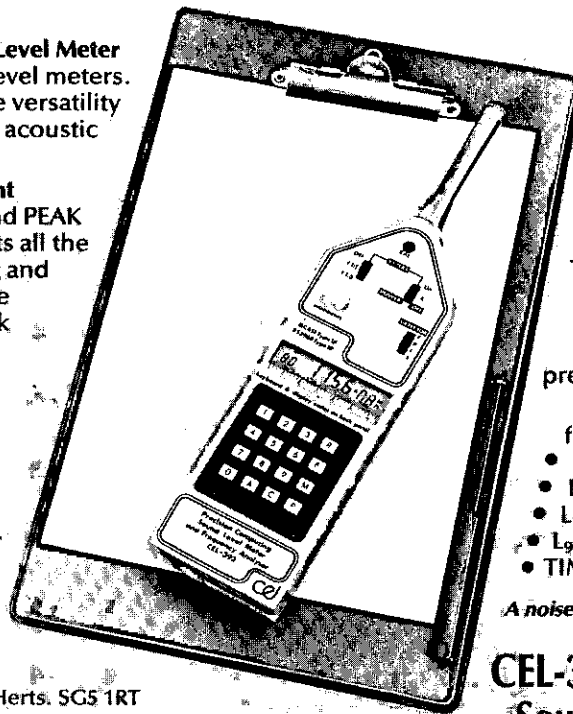
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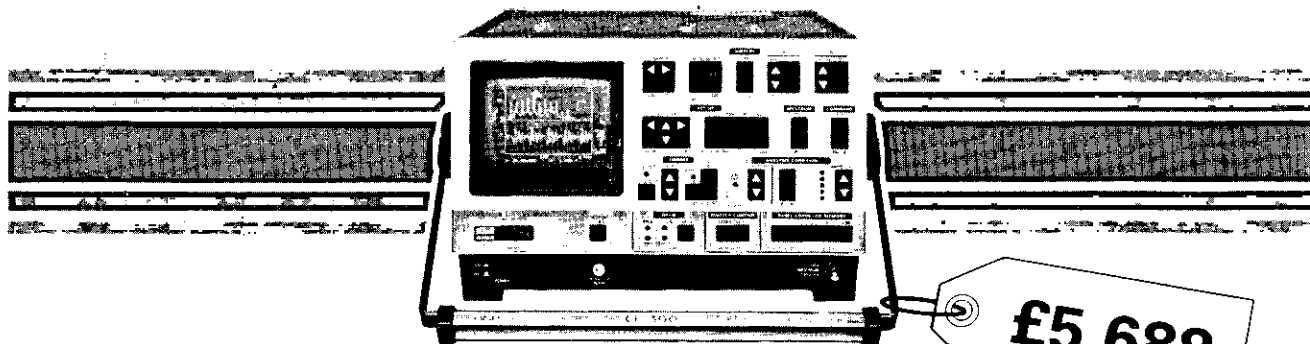
- SPL
- L_{eq}
- L_{10}
- L_{90}
- MAX
- L_{AX}
- L_{50}
- L_{TM}
- TIME (elapsed, real, period and delay.)

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