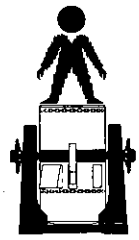
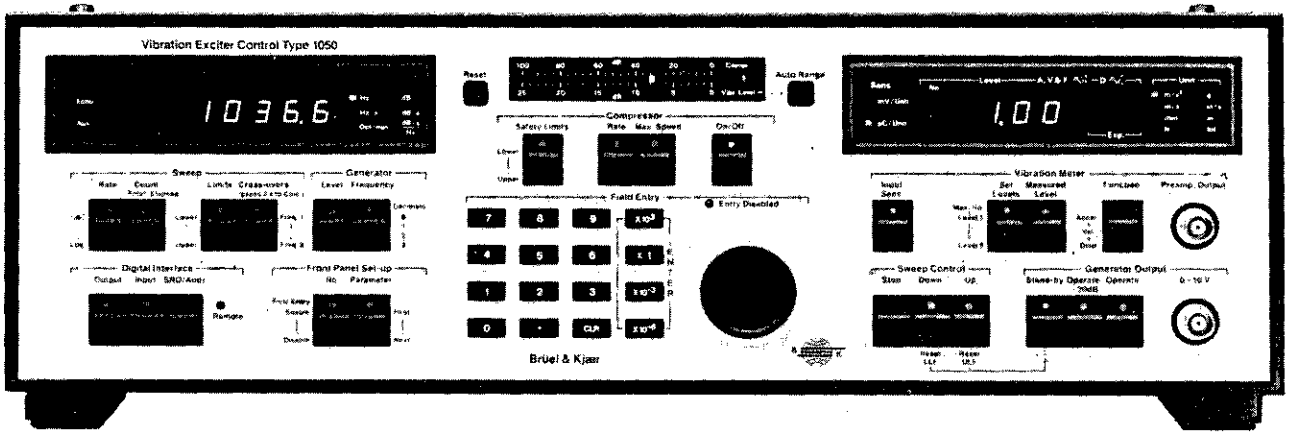
# Acoustics Bulletin

July 1986 Volume 11 Number 3

INSTITUTE OF ACOUSTICS



# VIBRATION TESTING?
# – THIS'LL SHAKE YOU!




## IT'S OUR NEW TYPE 1050 VIBRATION EXCITER CONTROL

### THE CULMINATION OF SPECIALISATION AND A REVELATION IN DEDICATION

The 1050 is a highly advanced instrument in which the 40 years experience we've gained by specialising in environmental measuring equipment has been dedicated to the improvement and simplification of procedures for controlling vibration testing. Here are some of its main features:

- ★ Digital signal generation at frequencies of 1Hz/10kHz with 1.19mHz resolution but with the good old analogue "feel".
- ★ Keyboard and thumbwheel controls for precise direct entry of test parameters.
- ★ User friendly IEEE488 and IEC compatible digital interface for remote control.
- ★ Constant levels of acceleration, velocity, displacement or force. 100dB compressor range.
- ★ 9 selectable vibration levels enabling complex test programmes to be performed.
- ★ Direct setting and automatic calculation of crossover frequencies when required.
- ★ Provision for connecting other instruments to facilitate resonance dwell tests, swept narrow band random noise tests, signal filtering and multi-point test control.

The 1050 is a worthy new member of our internationlly known "family" of equipment specifically designed for vibration testing. This includes vibration exciters ranging from small bench types to large floor models with force ratings up to 1780N. Also sine-generators, power amplifiers and a range of transducers second to none anywhere in the world. Further information is available free.

**Brüel & Kjær**

In the United Kingdom Bruel & Kjaer (UK) Ltd., 92 Uxbridge Road, Harrow, Middlesex HA3 6BZ
Telephone: 01-954 2366 Tlx: 934150 BK UK G Fax: 01-954 9504

# Acoustics Bulletin

**Editor:**
F A Hill

**Associate Editors:**
S J Flockton
A J Pretlove
J W Sargent
R W B Stephens

**Advertising enquiries to:**
Sydney Jary Ltd
28 Southway
Carshalton Beeches
Surrey SM5 4HW
Telephone: 01-642 5775

**Contributions and letters to:**
Editor, IOA Bulletin
25 Elm Drive
St Albans
Herts AL4 0EJ

**Books for review to:**
S J Flockton
Physics Department
Chelsea College
Pulton Place
London SW6

**Published by:**
The Institute of Acoustics
25 Chambers Street
Edinburgh EH1 1HU
Telephone: 031 225 2143





Single copy £5.00

Annual subscription (4 issues) £18.00

ISSN: 0308-437X





**July 1986** **Volume 11** **Number 3**


**Contents** **Page**



*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.*

# Sponsor Members

Admiralty Research Establishment
Portland, Dorset

Brüel & Kjær (UK) Ltd
Hounslow, Middlesex

Sandy Brown Associates
London

Burgess Manning Ltd
Ware, Herts

Lucas CEL Instruments Ltd
Hitchin, Herts

dB Instrumentation Ltd
Aldershot

Fokker B V
Schiphol-Oost, The Netherlands

GenRad Ltd
Maidenhead, Berks

Greater London Council
The County Hall, London

Hann Tucker Associates
Woking, Surrey

Isophon Ltd
Gillingham, Kent

Masscomp UK Ltd
Reading

Moniton Technic Ltd
Basingstoke, Hants

Monitor Acoustic Control Ltd
Glasgow

Morison & Miller Engineering Ltd
Glasgow

Scientific Atlanta
Hitchin, Herts

Stancold Acoustics
Bristol

# Presidents Letter



*Dear Fellow Member,*

*As Geoff Leventhall predicted in his last President's Letter, there is a new photograph on this page. Aesthetically speaking, I am sure that it is not an improvement. I hope that I shall be able to live up to the standards set by the previous Presidents of the Institute during my tenure of office.*

*The Officers and the Council of the Institute can only attend to its smooth running. However, the success of the IOA as a 'learned society' must depend on the participation of the membership through specialist Groups and local Branches in engendering ideas for and organizing meetings for the dissemination of knowledge.*

*As Geoff mentioned in his last letter to us all, the Institute has initiated a number of new developments some of which are still in the pipeline. We do need participation and support from all concerned to continue to flourish.*

*Yours sincerely,*

Orhan Berktay

# ACOUSTICS '86

## SPRING CONFERENCE AND EXHIBITION

### Held at University of Salford

*The 1986 Spring Conference and Exhibition took place at the University of Salford from 7 to 10 April and was attended by over 150 delegates. It was a first class meeting both in terms of the technical presentations and the social events and was complemented by the official opening of the new laboratories in the Department of Applied Acoustics.*

SALFORD in the Spring may not be everyone's idea of a perfect venue for an annual meeting — it is no Cambridge or Bath. And yet the Spring Conference at Salford proved to be very fruitful and enjoyable for all those who attended.

There appear to be three main reasons for this success and it is worth dwelling briefly on each.

Undoubtedly the first and most important factor was the quality of the technical programme and one has to thank the session organizers and session chairman for ensuring this quality. A German professor remarked, quite voluntarily, that he considered the standard of papers to be very high, which was indeed a valued compliment. A full report by each session chairman is presented later.

The second reason is that it was evident that Salford is a centre of learning in Acoustics; not just because it has acoustic test facilities but because it has a body of enthusiastic students who were keen to help in any way they could to ensure the success of the conference. It was heartening to hear later how much they appreciated the lectures and speeches by eminent acousticians whose names they were familiar with from textbooks or acoustical equipment. It is, of course, a cliché to say that they are the acousticians of tomorrow but this is nevertheless true and we must continue to encourage them.

The third reason for success was the quality of the conference facilities provided by the University. Salford has an unashamedly modern technological image where interfacing with industry is of prime importance. It has recognized the importance of good hospitality and this was reflected in the high standard set in both catering and accommodation.

The manufacturers' exhibition, which was held adjacent to the conference centre, attracted most of the delegates to its stands. On show were the latest developments from Industrial Acoustics Company, Hakuto, Brüel & Kjær, Cirrus Research, Kemo, Scientific Atlanta, Gracey and Associates and Computer Engineering Limited. There were also displays by the Manchester Area Council for Clean Air and Noise Control and the University of Salford Industrial Centre.

A special feature of this conference was the reception held in the Department of Applied Acoustics to mark the opening of the new laboratories. Delegates, members of the University and friends were addressed by the Vice-Chancellor, Professor John Ashworth, who invited Dr Per Brüel to perform the opening ceremony. The wine flowed freely throughout the reception and guests were able to sample red or white in either a reverberant or anechoic environment.

### TECHNICAL SUMMARY

The Rayleigh Medal Lecture, presented by Professor E J Richards OBE, was an excellent review of ten years of research work into the generation and control of noise at its source. Professor Richards hopes that the fruits of this work will pass into the curricula of engineering courses so that the design of quieter machinery will become standard engineering practice.

The R W B Stephens lecture was presented by Professor Heinrich Kuttruff who described old and new ideas about concert hall acoustics. Professor Kuttruff put into perspective those old ideas which still have currency and the new ideas which are showing promise such as the importance of early lateral reflections for creating spatial impression in auditoria. However, he concluded that the traditional concert halls which are rectangular and narrow in shape are unsurpassed in an acoustics respect — this is perhaps bad news for ambitious and innovative architects.

The A B Wood Medal Lecture, presented by Dr P D Thorne, was an excellent exposition of how the movement of underwater sediments can be monitored using acoustic techniques.

#### Environmental Noise 1

Snow on the Pennines prevented David Oldham from presenting his paper which was due to open the session but a more distant traveller, Bela Buna from the Institute for Transport Sciences in Budapest, stepped in bravely at the last minute to give a paper on the prediction of road construction noise in which he


*Delegates in a packed conference hall hear Dr Ray Stephens offer a vote of thanks to the 1986 Stephens Lecturer, Professor Kuttruff*

compared measured values of $L_{Aeq}$ with those predicted by various models, including his own theoretical model and the TRRL method.

Khadim Jraiw then described the work he has been doing at the University of Bath on the estimation and modelling of traffic noise in urban and suburban areas, with special emphasis on non-freely flowing traffic.

The topic then switched from noise to vibration, as Greg Watts from TRRL reported on further developments from

*Professor Peter Lord with Professor Heinrich Kuttruff*

a previous survey (TRRL Laboratory Report LR1119) which had examined nuisance caused by traffic induced vibrations in dwellings. The present study concentrated on ground-borne vibrations and in particular on the role of road surface irregularities of various kinds including joints in concrete road surfaces.

In a particularly well prepared and clearly presented paper, Linda Duckworth, an EHO with the Bolton Metropolitan Borough Council, showed how a postal survey could be used in assessing the impact of road and rail noise on a small housing development. The paper also provided some interesting insights into the ways in which an Environmental Health Department could influence a development at the planning stage.

The paper by Graham Coleman of the Institute of Occupational Medicine (NCB) dealt with a problem which has received relatively little attention, that of designing industrial auditory warning signals to minimize neighbourhood noise nuisance.

The session concluded with David Oldham of the Department of Building Science, University of Sheffield, who had eventually defeated the elements and was able to describe the work which he and M M Radwan have been doing on a computer model, based on the ray tracing technique, used to study noise propagation in city streets.

**Bernard F Berry**

### Underwater Acoustics

After an absence of some while, Underwater Acoustics returned to the Spring Meeting. It was my pleasure to act as technical organizer for three sessions which attracted a worthwhile following and resulted in some excellent and varied material. The sessions were organized around a central theme of High Resolution Sonar and Acoustic Imaging, with the addition of a 'catch-all' topic — Latest Developments in Underwater Acoustics — to solicit a medley of contributions appropriate to a general meeting.

The opening session collected together several papers on the latest array signal processing, and our only two offerings on imaging techniques. The signal processing papers concentrated on the advanced algorithms for adaptive processing which are being developed to improve the accuracy and resolution of extracting bearing information from sound arriving at an array. It was interesting to hear how these techniques are being investigated for source location in nuclear reactors. The imaging papers also concerned algorithms of one form or another, the first to allow self-focusing when no *a priori* knowledge is available of the object plane distance, and the second to greatly improve axial resolution of acoustic holographic systems.

The first session was followed admirably by the 1986 A B Wood Medal Lecture, by Dr P D Thorne of IOS, Bidston Observatory. Dr Thorne has been developing a technique for monitoring the transport of sediments by analysing the noise generated in collisions between the moving particles. The technique shows good agreement with past methods, offers a number of observations which were previously unobtainable, and is non-invasive. You could say that we may be advised to listen carefully for further movements in this area!

The technical sessions resumed with the second underwater session, with topics associated in some way with the ocean medium or its effects. The first of these addressed the fluctuations in amplitude and phase caused by random events within the bulk of the medium, whereas another described a technique for simulating effects due to the sea-surface boundary. A third paper, by past-medal winner Dr M J Buckingham, described how measurements made on the ambient noise field could reveal information on the sound speed within the sea floor sediment. The remaining papers discussed, on the one hand the importance of unwanted motions on towed arrays for synthetic aperture sonars, and on the other, a technique for exploiting target motion — an advanced, within-pulse Doppler scanning processor.

Our third session amounted to a two-horse race, with three papers each from the Marine Laboratory, DAFS, Aberdeen and Loughborough University. All the papers presented were notable for their engineering content, and many delegates I am sure will benefit from the techniques described. It was interesting to see the extent to which engineering is applied to fisheries research, and the co-operation with Government and Industry achieved at Loughborough. These subjects concluded the underwater acoustics sessions, which on reflection, may be said to have arrived at a fishy end, miles from the sea!

**L W Lipscombe**

### Open Session

I imagine the idea of the open session is to mop up some of the odds and ends, and the five lectures of this session certainly covered decidedly unrelated fields, from voice reproduction through to nervous system responses to noise stimulae via rectangular attenuators, boundary layer absorption to high amplitude sound fields and a probe microphone working on optical principles.

The first lecture by Christine H Shadle from Southampton University concerned itself with modelling the reproduction of sounds produced by the combination of larynx cavity, roof cavity, and more especially the outlet arrangement in the region of the teeth and lips. An exceedingly simple model was constructed to which mathematical analysis could be applied, and on which a range of experiments was conducted. The basic format of the model was a simple organ pipe tube, but with an induct orifice and downstream obstacle interacting with turbulence produced from the orifice. Conclusive correlation was indicated between the measured peaky sounds generated and the predicted curves.

The next paper by F B Shenoda and H Selim, presented by H Selim, was a little difficult to understand until clarification of the test piece during question time, and concerned rectangular duct attenuation when lined with a wall

lining shaped progressively from zero in a horn-like manner to full duct cross-section. The shape chosen — parabolic — lent itself to mathematical analysis and the paper concerned itself with agreement between experiments and analysis. The usefulness for the complication involved was not apparent.

Alan Cummings' paper on the response of perforated liners subject to turbulent boundary layers and, at the same time, high amplitude non-harmonic sound fields, was very clearly presented for what is obviously a fairly heavy subject. He cross-referenced back to a simple single orifice on a cavity resonator when excited by a combination of acoustic signal and high duct flow velocities. Exceedingly good agreement was demonstrated between the measured cavity pressures and the predictions from a lumped constant cavity model, and also a finite difference model.

The next speaker, Dr R Ohba, was from Japan, but is currently working at UMIST. He presented a most interesting paper on a microphone employing fibre optics and laser interferometry to measure the traditional diaphragm displacements of the microphone. It had been contrived for measurements within the vocal tracts, where the complete elimination of electric wiring is to be preferred and a hostile damp environment needs to be conquered.

The last lecture in this morning's session was from S Mantysalo from Finland. She presented a paper on the direct detection of nervous system response to combinations of distracting pulses when carrying out traditional test tasks, such as accounting and reading.

**Alan Fry**

### Room Acoustics

The session on room acoustics contained sufficiently substantial new material which left one with the pleasant sensation that the same old furrow was not being ploughed yet again.

M Barron, with his usual skill, discussed those considerations which have importance for speech in theatres. His ideas followed along similar lines to those he has been presenting for auditoria for a number of years now. The data which were discussed and on which his considerations were based were obtained from an extensive objective study of 12 British theatres and a complementary subjective study of three of them. The distillation of the data from the survey led to the conclusion that six influences, including for example, speaker orientation and sound power, needed to be considered in order to predict speech intelligibility.

K Hojbjerg of Brüel and Kjær discussed 2 channel analysis as a means of objectively analysing room acoustics. With this technique he was able to show that it is easy to obtain clarity, point of gravity time, signal to noise ratio, reverberation time and EDT. One was left with the impression that it was so simple to extract information regarding reverberation from various stages of sound decay one wondered if the IBA really understood what they were asking for when setting limits of accuracy on RT in TV and sound studios.


*The Industrial Centre of the University of Salford prepared a display for the Conference Exhibition*

There was a minor panic when J Miller of Bickerdike Allan Partners discovered his slides were still in his bedroom, but fortunately D Templeton of Building Design Partnership was able to step in and give his paper thus merely changing the programme order. Templeton then described the architectural and structural work as well as acoustic criteria which underpinned the refurbishment of the Albert Hall in Bolton Town Hall, destroyed by fire in 1981. The presentation showed the painstaking work which had gone into restoring the building to its original Victorian glory and yet involving major alterations which had satisfied the requirements of chamber orchestra concerts, ballroom dancing, banquets and fashion shows.

J Miller then returned to the lecture theatre to describe his firm's work on the Orchestra Rehearsal and Recording Hall of the Academy of Performing Arts. Emphasis was laid on the variable acoustics of the hall which had to provide flexibility of reverberation time over a range of 1.5 to 2.5 seconds, making the room suitable for both recording and rehearsal of orchestral music. The lecturer described in detail, with the aid of excellent slides, how the requirements have been achieved using a system of absorber boxes and mechanical flaps on the side walls of the hall. He reported that on the whole the clients were well satisfied with the result.

There was further discussion on the problems associated with studio design in Mr T L Redman's paper in which he described the work of Sound Research Laboratories in providing acoustic consultancy in the extension of Central Television facilities at their Birmingham Studios. There were major problems concerning sound intrusion and transmission, particularly in the case of the Music Studio which sits on top of a car park and is beneath the main plant room. Mr Redman showed in a convincing manner how these problems had been overcome in considerable detail.

**P Lord**

### Building Acoustics 1

The first session clearly demonstrated that continued advances are being made in the apparently mature area of Building Acoustics. Robin Mackenzie began the session with a discussion of progress towards a rapid test method for airborne sound insulation in buildings. Work at Heriot-Watt University is contributing with others to development of an International Standard method. Confidence levels of a dB or two appear likely. Interestingly electronics are not being used to accommodate all the

variables; it is proposed in unfurnished rooms to use an absorbent pack (1 m x 0.5 m x 0.3 m) in order to control the reverberation time. The following two papers each dealt with recently introduced sophisticated measurement techniques. K B Ginn from Brüel and Kjær discussed in-situ measurement of sound insulation using a sound intensity probe. The method has the distinct advantage that transmission through components of the wall can be measured individually. However in discussion following the paper the question was raised of implied normal radiation from the wall into the receiving room, which would not apply to coincidence radiation. No doubt we shall hear more of this. From sound intensity we passed to time delay spectrometry: Mr Whittaker of Munro Associates, London, reported on its use for loudspeaker and absorption measurement, through not as yet successfully for sound insulation.

The high point of the morning was the paper from Professor Mechel (Fraunhofer Institut für Bauphysik, Stuttgart) on sound insulation by absorber barriers. Typically a length of absorber is used to fill a ceiling void above a partition when airtight construction (say for fire reasons) is not acceptable. A fully comprehensive theory was presented and shown to match measured values convincingly. The results are also relevant to more mundane situations such as cable ducts which are stuffed with absorbent; the very poor isolation due to the absorber at low frequencies is a potential problem. Mrs Rasmussen then described results of extensive measurements on sound insulation for hermetically sealed double and triple glazing conducted at the Danish Acoustical Institute; asymmetrical constructions, including gas filling of only one cavity in triple glazing, prove to be the most effective. In place of J Belza, who did not manage to attend the conference, a Salford University Final Year student, R Maxwell, bravely stepped in with a paper on Active Noise Control using digital filters that have a time varying frequency response. This terminated a varied and stimulating session.

**Michael Barron**

**Environmental Noise 2**

This session was primarily designed to explore the effects which national legislation and EEC directives have on the control of equipment noise. Although at first sight this may not seem a particularly dynamic subject, it is one that our profession will increasingly have to concern itself with in the future. It is therefore important that the implications are discussed in open forum. Indeed, the interest that was evoked during the discussions was such that the Meetings Committee of the Institute should perhaps consider organizing a whole-day meeting on this topic.

The first paper, entitled *Barriers to trade and how to remove them* was presented by M Hayter from the DTI. He very eloquently put forward, from a mechanical engineer's point of view, examples of how conflicts between the different bodies arose and how long they could take to rectify. It might well be that the delays introduced by official procedures, inadvertent or otherwise, could in themselves act as a spur to producers of machinery to spend their time reducing noise levels rather than negotiating more amenable legislation. The second paper, *EEC Directives — the view of an approved body,* was given by R H Clough from Wimpey Laboratories Ltd. Dealing with experiences based on type testing measurements of the noise emissions from construction machinery, the presentation provided a logical sequel to the official framework outlined in the first paper. One of the major problems faced by those who carry out such tests is the ambiguity or lack of guidance provided by the accrediting bodies. R F Higginson, from the National Physical Laboratory, addressed this issue in the next paper on *Quality control in acoustic testing.* He replied that rigorous specification of the procedure to be followed in every case is not always possible, particularly in the formative stages where feedback of the problems encountered by the approved testing laboratories is essential. He then very concisely and clearly outlined the factors which NAMAS takes into account when assessing the competence of laboratories for accreditation. The issue which raised most interest was that of the competence of the staff who would be undertaking the testing. This very point was also raised by B F Berry from NPL, when he presented his paper entitled *A survey of local authority noise measurements.* Information on how local authority scientific and technical staff undertake measurements of environmental noise in pursuance of their various obligations revealed interesting differences in approach. Whilst the final analysis of the data will be awaited with interest, the need for specialist post-experience and short training courses for staff was highlighted. It was suggested that the Institute might take more interest in the sponsorship of such an activity, particularly as statutory obligations are likely to be more rigorously enforced in the future.

The latter part of the session was concerned with annoyance due to environmental noise, and two papers were presented. The first was by J G Walker from ISVR, who reported on *The influence of residual noise on community disturbance from aircraft noise around Glasgow Airport.* The magnitude and costs involved in carrying out viable social surveys was evident, as well as the scope that is possible when multi-national co-operation is obtained. In this case, similar studies were carried out in France and The Netherlands, and the combined results were discussed. Interesting conclusions were that annoyance due to aircraft noise is unaffected by background noise, and that the Guttman Annoyance Scale (GAS) can be replaced by simpler scales without any loss of precision. The final paper, by I J Anani from the South Bank Polytechnic, concerned the *Control of noise from heavy goods vehicles.* Particular reference was made to the use of 'hush kits' and their possible introduction as a means of reducing such noise within large city boundaries during the night-time period.

**C G Rice**

**Building Acoustics 2**

The second session on Building Acoustics, chaired by Dr A J Jones (AIRO), continued the interest in sound insulation which had been shown in the first. The initial presentation dealt with various aspects of The Building Regulations. Dr L Fothergill (Building Research Station) kicked off by explaining the legislative and technical philosophy behind the recently re-vamped sound insulation requirements presented in Approved Document E. Mr J Miller (Bickerdike Allen Partners) followed with general applause for the advice given in the Approved Document but argued that architects needed wider guidance on acoustic design. He described the manual of domestic noise control currently being prepared for CIRIA for this purpose. Mr S Maslivec (Bolton Metropolitan Borough Council) highlighted an area of particular concern, that of sound insulation of properties converted into multi-tenanted units which can by-pass the requirements of The Building Regulations. Local authorities' powers to exercise

control through the planning consent procedures and field test results of improvement schemes were described.

Moving away from the specifics of The Building Regulations but nonetheless on a very pertinent topic, Dr R J M Craik (Heriot-Watt University) described the results of a study into the effects of workmanship, ie anything that can't be explained, on sound transmission. Using a structure-borne method, a standard deviation of the order of 2 dB was found in the performance of nominally identical constructions. A joint paper by D W Templeton (BDP Acoustics Unit) and P E Jones (British Gypsum Ltd) described the acoustic design of a new multi-screen cinema complex, emphasizing the high standard of insulation achieved. Mr D I Evans (Heriot-Watt University) reported on a study whose objective was to establish the low frequency limit to which statistical energy analysis can be considered a reliable predictive tool for sound transmission through buildings. The final paper of the session was presented by Dr B M Gibbs (Liverpool University) in which he discussed the results of an experimental investigation of the vibration response of connected rectangular plates which was thought to correlate well enough with theory based only on bending vibration. This latter assertion initiated a lively discussion involving several of our esteemed overseas delegates. Indeed the discussion on each of the papers provided pertinent observations on what had proved to be a very interesting session.

**Tony Jones**

**Industrial Noise**

This session was quite well attended and provided six papers on various aspects of Industrial Noise. (It is regrettable, however, that more papers were not forthcoming from members of the Group which is by far the largest within the Institute. Indeed, if there is not a more active part played by Group members both in supporting technical meetings and in forming an effective committee, then the Group may well become dormant again as it did in the early 1980s).

C G Rice opened the morning with a paper which suitably bridged the earlier Environmental and Industrial noise sessions. Recent laboratory and field studies have more accurately defined the factors which affect the annoyance of combinations of noise sources. Rather than using the 'dominant source' annoyance response, a more accurate parameter is the 'total' response. In view of the fact that this 'total' response can be below 'source specific' responses, particularly where intermittent or impulsive noise sources are concerned, this could have important implications regarding planning criteria.

G J Stimpson used an energy balance assessment, combining SEA and energy accountancy ideas, to predict the noise radiation from built up machinery structures. Generally good agreement was obtained both for a two-plate structure and for a scale model of a punch press. The techniques are especially useful for assessing the effects of modifying or optimizing noise radiation from existing systems, but as always their effectiveness is limited by the accuracy to which the coupling loss factors and radiation efficiencies can be evaluated.

The damping of a plate by attaching an auxiliary plate to it and thus trapping a thin layer of air, 'squeeze-film damping', was described by L C Chow. The damping mechanism was described for a thin air layer and for an oil filled layer, where additional damping could be achieved by artificially increasing the viscosity losses.

D N Lewis presented two case studies of factory noise propagation modelling. In each case the prediction techniques, which were limited to overall dB(A) assessments at various positions, used empirically derived values for reverberation time and sound decay with distance. Predicted noise levels, both before and after incorporation of noise reduction measures, were accurate to approximately 2 dB(A) for these geometrically relatively simple buildings.

The problems of predicting sound radiation from buildings were outlined by D J Oldham. In particular he described the difficulties of predicting sound fields within factory spaces, the problems of predicting the behaviour of actual building elements having these sound fields incident upon them, and the effects of ground cover on the propagation of sound from these extended sources. A useful discussion took place on the proposed programme of research covering these three areas.

J S B Mather presented a paper on the design of a low noise cooling fan and on the design of a cooling system test rig. The modular rig can be built up to study the effects of radiators, distorted airflow and of both axial and mixed flow fan designs. Fan tip clearance can be accurately varied and the effects of changing speed, throttle and blade pitch can be assessed during running.

**S C Bennett**

**TECHNICAL VISITS, AGM AND ACCOMPANYING DELEGATES PROGRAMME**

Two technical visits were arranged. One was to the research laboratories of the UKAEA at Risley to see the numerous ways in which acoustic techniques are being developed and tested to enhance reactor operational safety. The recent disaster in the USSR emphasizes the vital importance of these types of monitoring and test procedures.

The other visit was to the studios of Granada Television. This provided at least one delegate with the opportunity to realize a lifetime ambition — namely, to walk down Coronation Street and be


*We are assured this really was part of a technical visit!*

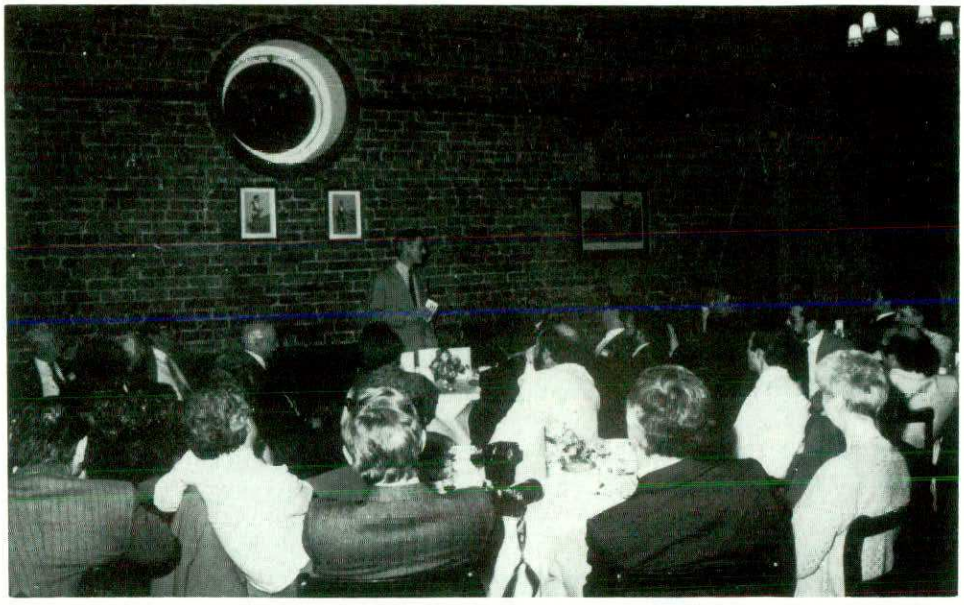
photographed outside the Rovers Return!

The afternoon was concluded with the Annual General Meeting of the Institute at which Honorary Fellowships were awarded to Dr Chester McKinney and Dr Per Brüel.

The accompanying delegates programme started with a full day visit to Chester with the opportunity of combining sightseeing with shopping in the historic 'rows'. The second day was spent at the award winning Styal Mill in Cheshire which is an eighteenth century cotton mill recently restored to full working order, including the noise!

**SOCIAL PROGRAMME**

The entertainment on the first two evenings was provided by two superb groups of jazz musicians, one modern and the other traditional. On the second evening delegates may have recognized The Ged Hone Big Four who played so well at last year's autumn conference. The highlight of both evenings was the student extravaganza in which a song and dance act was performed by the unforgettable 'Nearly Sisters', three female undergraduate students on the Electroacoustics course at Salford.



*Brian Trueman was the very entertaining guest speaker at the Annual Dinner*

Wearing true 'cabaret' costume they sang in close harmony but with mild irreverence about a member of the academic staff!

The annual dinner was held at The Hunting Lodge, Adlington Hall which is in the heart of rural Cheshire although only 20 minutes drive away from the University campus. After a splendid meal, the outgoing President, Geoff Leventhall, paid tribute to the many members who had supported him during his term of office and in particular to David Weston, the immediate Past President, who was retiring from Council. Professor Orhan Berktay was then inaugurated and received, on behalf of the Institute, a block and gavel. This was a gift from the Department of Applied Acoustics at Salford which had been crafted by Ralph Harrison, a past Council member and Treasurer.

Delegates then settled down to listen to an entertaining talk given by the guest speaker, Brian Trueman, a broadcaster on technical affairs but currently contributing to the 'Danger Mouse' series on TV.

**Geoff Kerry and Raf Orlowski**

*Orhan Berktay receives the President's Medal from outgoing President Geoff Leventhall — and also accepts from former President Peter Lord, of Salford University, the means of keeping Council and the Membership in order: a new gavel and block*

## Acoustics '86: the Students Report

**The Official Report**

On behalf of the Salford University Acoustics Society we would like to thank the Institute of Acoustics for inviting our members to the recent Spring conference, held at the University of Salford. We enjoyed the conference immensely and appreciated the kind hospitality extended to us by the committee.

The conference provided a unique opportunity for members of the society to meet prominent members of the

acoustics world. The lectures and exhibition provided a diverse view of the acoustics field and were an ideal supplement to our Electroacoustics degree course material. The students who attended the conference found delegates easy to approach and willing to talk about all aspects of their work.

The conference proved to be a tremendous success; especially for the acoustics society. We received several pledges of support in the form of guest lecturers and industrial visits, for which we would like to show our appreciation. We shall be contacting all those delegates, who kindly offered us their expertise and services, during the summer or at the beginning of the next academic year.

*Delegates and members of the University listening to Dr Per Brüel at the opening ceremony for the new test facilities*

During the conference, we received enquiries from other universities about our activities with a view to their establishing similar societies. As we would like to see more student involvement in the Institute of Acoustics, we are most willing to offer advice and the benefit of our experience to anyone interested in forming a society.

Dr Chivers of Surrey University suggested the organization of a junior conference to be attended by students and young graduates of acoustics. The society is extremely enthusiastic about this idea and is keen to help in the organization. Informal discussion with members of the IOA council yielded support and encouragement for such a conference. We therefore urge members of the Institute who have contact with any young acousticians to get in touch with either Dr Chivers or us if they wish to see a junior conference materialize. We would also welcome any support for this venture from distinguished members of the profession.

As an extension of this we would also like to see a junior session included at future Institute conferences. Salford University feels that it has already set a precedent when the Institute allowed a Salford Electroacoustics undergraduate to present a paper at the spring conference this year.

Once again the students who attended the spring conference would like to express their gratitude for being invited. We hope that every other delegate found the conference as fulfilling as we did and that our exhibitionism did not discredit us!

**Keith Harris (Chairman), Nicola Haywood (Secretary)**

**The Unofficial Report**

For those who spent the winter months in hibernation or who have not yet ventured further into this edition of Bulletin, the Spring Conference 1986 was held at the University of Salford. A perfect opportunity was thus provided for the students in the Department of Applied Acoustics to experience their first Institute conference at first hand on home territory.

A group of the final year students (having recently founded the first student Acoustics Society and become members of the Institute) were persuaded (bribed/blackmailed) into helping out with the smooth running of the week's events. In this way we were able to glean a 'backstage' view of the conference which added to the novelty of the event.

For those who agreed to help, the first major task was to take a crash course in the operation of slide projectors. This included hints on how to put the handful of slides, thrust upon you two minutes before the session was due to begin, into the correct order and the right way up. Then it was a matter of keeping your fingers crossed that it would not be *this* lecture that the projector bulb would decide life wasn't worth living any more. For those not having the chance to have fun with the slide carousels, the job of bell ringing between sessions was available, bringing memories of being junior school bell monitor to the fore!

The first morning went quite smoothly with interesting and informative lectures to attend and not too many temperamental slide projectors to cope with.

In the afternoon, New and Old Ideas in Concert Hall Acoustics were presented by Professor H Kuttruff to a capacity audience. Afterwards everyone made their way 'en masse' by car, bicycle or on foot (no, the Brüel and Kjær jet was not used at this point) over to the Brindley building to attempt to witness the opening of the new Acoustics Laboratories by Dr Per Brüel. For those who didn't manage to get in to the opening ceremony, a chance was available afterwards to view the new facilities while, at the same time, attempting to persuade the ladies serving the wine that yes, you were driving and maybe a third glass of wine was not a wise idea.

And so to the evening's entertainment . . . having attempted to guess exactly what *was* in the consommé being served at dinner and later suddenly discovering that the liqueurs had to be paid for, it was time to retire to the lounge and be serenaded by the Ged Hone Big Four (well at least the bass player was a big chap!) and experience the long awaited 'student extravaganza'. This was, by popular demand, a repeat performance of the night before though this time the girls wore hats! For those reading this who did not attend, the performance was a rendition of the Andrews sisters' Boogie Woogie Bugle Boy but suitably rewritten for the occasion (to Raf Orlowski's embarrassment!) Having

*A source of noise intrusion to delegates too deeply immersed in their sessions — the handbell rung by the students between sessions*

been together as students on the Acoustics course at Salford for four years, they were re-christened 'The Nearly Sisters' though visually, they did not leave 'nearly' as much to the imagination as the Andrews sisters ever did!

Wednesday provided more technical sessions with more opportunities of finding useful resemblances with degree work. In the evening delegates and a few of the students travelled to the sixteenth century Adlington Hall in the heart of rural Cheshire for the Annual Dinner. Afterwards, we were all highly entertained by Mr Brian Trueman, lately of Danger Mouse fame, who amused everyone with his after dinner speech.

Thursday dawned and with it the last of the technical sessions and, sadly, the end of Acoustics '86.

For those of us attending a conference for the first time it was a marvellous experience. While being in a superbly social atmosphere, we were able to meet acoustic engineers from all over the country, working in wide ranging fields and presenting new ideas and viewpoints. At the same time, it was an excellent opportunity for many people to learn about the Department of Applied Acoustics at Salford and its students and we look forward to further contact with these and other acousticians through the students' Acoustics Society.

We are all now looking forward to further Institute events, assuming, that is, that the time spent at the conference was not detrimental to our degree work and that we will be let loose onto the world of Acoustics in the Summer (watch out!).□

**Susie Williams (Liason Secretary)**

# Letter from the Chairman of the Meetings Committee

We asked for your suggestions, and we got them! Our request for ideas for the 1986/87 meetings programme produced a good (and almost entirely constructive) response, with over 50 completed questionnaires containing dozens of offers to arrange meetings and/or to present specific papers. Several came from members overseas and I was particularly pleased to see this evidence of their enthusiasm for the Institute, distances notwithstanding. It isn't possible to acknowledge all submissions, hence this open letter of thanks to all who have contributed so far.

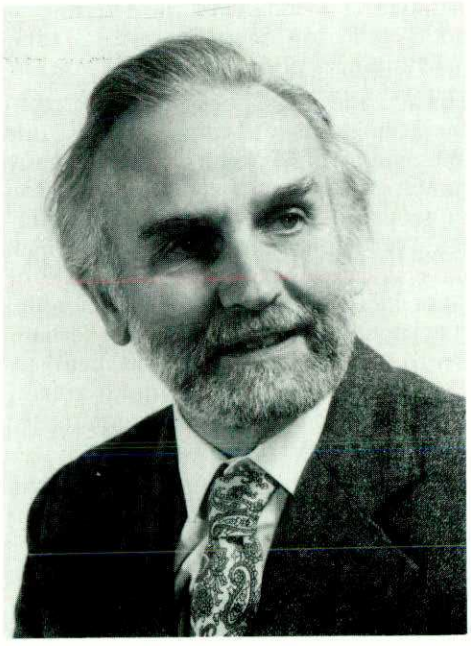
It is taking some time to collate the replies and to arrange contact with individuals via the Committee members, so if you have not heard, don't despair. There is sufficient material for several one- and two-day meetings on topics as diverse as the law of noise and underwater telemetry, finite element analysis and professional negligence. We can't have too much of a good thing, however, so those of you who have been meaning to find a stamp for the envelope into which you have put your completed questionnaire please take advantage of the reduced postage rate and send it in.

Thanks.□

**Mike Ankers, Vice-President, Chairman of Meetings Committee**

# Professor Peter Fellgett FRS

As briefly reported in the last issue of the Acoustics Bulletin, Peter Fellgett, a Fellow of the Institute of Acoustics, has recently been elected a Fellow of the Royal Society. He entered Cambridge University in 1940 and remained there until 1959, with a short intermission at the Lick Observatory of the University of California in 1951-52. He then joined the staff of the Royal Observatory at Edinburgh where he worked on the development of the 'Galaxy' automatic measuring machine. At about this time he was elected a Fellow of the Royal Society of Edinburgh. Peter Fellgett moved to his present job as Professor of Cybernetics in the University of Reading in 1965. Clearly, much of his work has been concerned with Astronomy and particularly with the securing of information, its processing and its application. The same kinds of skill are of course relevant to Acoustics and Professor Fellgett has had a long-standing interest in audio. As early as the 1940s he had experimented with motional-feedback loudspeakers, moving-coil pickup cartridges and exalted-carrier detectors, all ideas which have since been re-invented as 'new'. These interests came together with his interest in information and human senses in the Ambisonic technology for



surround reproduction of sound. His current work related to audio concerns the development of a high-order quantitative soundfield microphone, and the recovery of material from early recordings.

We congratulate Peter Fellgett on his election and hope that he will have many more years of fruitful scientific endeavour in Acoustics.□

# INSTITUTE OF ACOUSTICS COUNCIL 1986-87

**President**
Prof H O Berktay, FIOA

**President-Elect**
Mr C G Rice, FIOA

**Immediate Past President**
Dr H G Leventhall, FIOA

**Vice-Presidents**
Mr M S Ankers, MIOA
Dr J N Holmes, FIOA
Mr G Kerry, FIOA

**Hon Treasurer**
Dr G M Jackson, MIOA

**Hon Secretary**
Mr R C Hill, MIOA

**Ordinary Members**
Dr W A Ainsworth, FIOA
Mr B F Berry, MIOA
Dr T I Hempstock, FIOA
Dr D C Hothersall, FIOA
Prof J B Large, FIOA
Mr J Mills, MIOA
Mr R B Mitson, FIOA
Prof J A Powell, FIOA
Dr J P Roberts, MIOA

# CITATIONS

## RAYLEIGH MEDAL 1986
### Professor Elfyn John Richards

Professor Elfyn Richards studied mathematics at the Universities of Wales and Cambridge but chose aeronautics as the field in which to start his remarkable career. He worked at the National Physical Laboratory before and during the Second World War.

With the war over he became assistant chief designer at Vickers-Armstrong and in this capacity was responsible for the aerodynamic design of such famous early postwar aircraft as the Viscount and Valiant. During this period he realized that the increased power of the new jet engines would cause problems of noise and fatigue for years to come. He also became aware of the work being done at the NASA Langley Laboratory on propeller noise and transmission loss which at that time had no equivalent in this country.

In 1950 he left industry and moved to Southampton University, becoming the founding head of the Department of Aeronautics and Astronautics. As he had to build the Department up almost from scratch he was able to establish in which areas the major thrust was to be and he chose aircraft noise. During this early period experimental work was carried out relating to Lighthill's eighth power law for jet noise, and supersonic jet screech became understood. Many other problems were studied and reported, including boundary layer noise, structural damping, acoustic fatigue of structures, community reaction around airports, helicopter blade slap and fan noise. The success of such research projects as these led inevitably to the expansion of the Department's interests into other, non-aviation, aspects of noise and vibration. Topics as diverse as hearing damage risk, diesel engine design and room acoustics were tackled. In the early 1960s, after a long campaign on the part of Professor Richards, the University created a separate Institute of Sound and Vibration Research.

Professor Richards' achievements in his long association with the ISVR would alone be enough to place him at the forefront of the development of acoustics research and teaching over the last 25 years, for it was his vision and energy that were responsible for the unique blending of a University Department with government and industry as sources of financial support and research interest. The same foresight and effort led also to the founding of one of the most successful journals in the field, the Journal of Sound and Vibration, as a medium for reporting the research findings. However, Southampton was not to be the only University to benefit from Professor Richard's enthusiasm. In his decade as Vice-Chancellor of Loughborough University of Technology he was instrumental in enhancing the activities of another major acoustic research and teaching institution.

His activities have not been restricted to the academic world alone and his time and energy have been given to many matters of importance to the profession of acoustics. He was involved in the formation of the earlier societies which have since evolved into the Institute of Acoustics. Of the many other examples that could be included it is perhaps worth drawing attention to his membership of the Wilson Committee and chairmanship of the steering committee of the Noise Advisory Council.

Professor Richards returned to ISVR in 1975, to a research chair. His love for personal research having survived the years of administrative effort, he has since set about identifying and investigating the basic causes of noise in machinery.

Elfyn Richards' undoubted flair for detecting, and successfully developing, untapped or neglected areas of acoustical research, has led to a varied and fruitful career. Much of the success of the Departments he has headed and of the individual staff and students who have passed through them may be attributed directly to him.

In recognition of this extraordinarily varied contribution to the research, education and literature of many aspects of acoustics, the Institute of Acoustics takes great pleasure in presenting Professor Elfyn Richards with the Rayleigh Gold Medal for 1986.

## TYNDALL MEDAL 1986
### Jeff G Charles

Jeff Charles was educated at Kingston Grammar School, and graduated in physics at Durham University in 1962. His first appointment was at the Electrical Research Association, where he carried out a 3-year study into the fundamental cause of transformer noise. He then moved to the Acoustics Department of C A Parsons in Newcastle-upon-Tyne, where he studied the measurement and reduction of noise from large power transformers, electric

motors and generators, and eventually led the noise group. At the same time he carried out acoustic consultancy at International Research and Development Company Limited on various topics including domestic gas burners and motor vehicle passby tests. During this period he received further academic training at ISVR, where in 1967 he was awarded an MSc in Advanced Acoustics.

After seven years with C A Parsons he left to take up general acoustic consultancy at the Wolfson Unit for Noise and Vibration Control at Southampton. In the 18 months he spent at ISVR, he completed more than 20 separate consultancy projects on subjects as varied as footbridge noise, noise from a hydroelectric power station, a brewery, an aluminium extrusion press, as well as

the environmental impact of road traffic and industrial developments.

In late 1973 he joined Dr William Allen's science-based architectural practice and became partner in charge of acoustics in 1977. At Bickerdike Allen Partners he has supervised over 400 commissions, and has personally reported on more than 150 projects. The scope of his work has remained as broad as ever, ranging from plant noise control to the design of stages for optimum musical performance. He has carried out numerous studies connected with the acoustics of performing spaces, for example at St George's Theatre Islington, a Victorian church converted into a Shakespearean theatre, and at the Central Hall at the University of York, where the programme of acoustic improvements was successfully completed early in 1985. Recent studies of interior acoustics have included a Palace in Indonesia, a Moslem Centre in London, a library in Cambridge, a new museum in London, and a number of office developments.

One current project offering considerable challenge is the commissioning and tuning of the new Academy for Performing Arts in Hong Kong, where numerous performance, teaching and recording spaces are all sensitive to the high prevailing noise levels, and where acoustic conditions must meet the highest standards of international performance.

Another important aspect of his work has been the presentation of expert testimony at Planning Inquiries concerning developments near railways, roads, industry and airports. He gave evidence at Inquiries relating to proposals to site London's third airport at Stansted, and to the building of a STOLport in London's docklands.

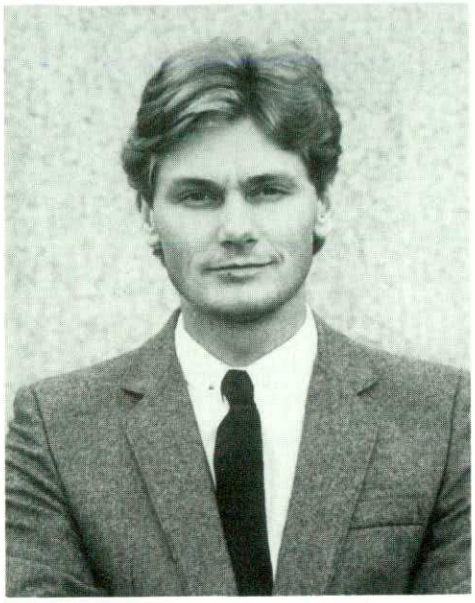
Within the IOA Jeff Charles has served as an Associate Editor of Acoustics Bulletin, and on the Meetings Committee. He was also a joint founder of the Institute's Southern Branch and London Evening Meetings.

The Institute of Acoustics is delighted to be able to award Jeff Charles the 1986 Tyndall Medal for his contribution, through his consultancy work, to the practical application of acoustics.

## A B WOOD MEDAL & PRIZE 1986

### Peter D Thorne

Peter Thorne's career in underwater acoustics was launched from the firm base of a first class degree in Physics obtained at the University of York. After completing a post-graduate course in Education at Chester he joined the Physics Department of the University of Bath to carry out research towards a PhD. This study consisted of the development of a non-linear parametric system which was employed to measure the frequency dependence of normal incidence acoustic backscatter



from a randomly rough surface. A theoretical expression was also obtained for the backscattered intensity which compared favourably with the collected data. This work subsequently focused upon the range dependence of the backscattering coefficient and a number of comparisons between the measured and computed values have been conducted.

In 1980 Dr Thorne was appointed by the Institute of Oceangraphic Sciences to investigate the applications of acoustic techniques for sediment transport research. A principal component of his time since then has been devoted to the development of a passive acoustic system to monitor the bedload transport of gravel by detecting the acoustic noise generated by the inter-particle collisions of mobile material. Laboratory measurements were conducted to investigate the physical parameters which govern this acoustic noise, and a theoretical explanation of the results based upon rigid body radiation has been adopted. Marine feasibility studies of the technique have been successfully conducted, and show that continuous high temporal resolution estimates of sediment transport rates can be obtained using a passive acoustic approach. This novel technique has been utilized to obtain a detailed understanding of the relationship between course sediment movement and the turbulent flow conditions controlling the transport.

Recently time has been spent on the use of the intensity and doppler shift of the accoustic backscattered signal from suspended solid particles, to estimate the flux of sediments in suspension.

In 1982 Peter Thorne received the Deryck Chesterman Memorial Medal, awarded to outstanding postgraduate students in the University of Bath's School of Physics. He has published papers on transducer design, laboratory applications of the parametric array, rough surface scattering, acoustic applications in sediment transport, and the relationship of fluid dynamics to the mobility of seabed gravels.

For his varied and substantial contributions to research in these fields the Institute of Acoustics presents Peter Thorne with the 1986 A B Wood Medal and Prize.

## HONORARY FELLOW OF THE INSTITUTE OF ACOUSTICS

### Dr Per Brüel

Dr Per Brüel's enthusiasm for acoustics was awakened by his teacher when he attended the technical high school in his teens. From there he went to The Technical University of Copenhagen where he met Vigo Kjær who was to become his lifelong business associate.

Development of the Brüel & Kjær instruments started during the second world war, in particular that of the frequency analysers and the well known standing wave apparatus which can be seen in every self-respecting acoustics laboratory.

In 1944 having left Denmark and joined what can best be described as a Danish Colony in Gothenburg, Sweden, he became Principal of the Acoustics Laboratory at Chalmers Technical University as well as Lecturer and

Associate Professor in that Institute. From 1942 he was a member of the Board of Directors of Brüel and Kjær A/S but it was not until about 1948 that Britain became aware of Per Brüel's existence when he appeared at the doors of such organizations as Metropolitan Vickers (now GEC) in Trafford Park, Manchester, on a motor bike with the instruments for sale precariously balanced in the side car.

A hobby pursued by a successful businessman is always interesting because it often tells us a great deal about the man behind the hobby and Per Brüel's is no exception. Flying is his part-time pursuit but taken to a highly professional level, such that he received the Danish Aviation Cup in 1981. He had already served in 1962 as President of the Civil Aviation Council and, from 1967, as Vice-President of the Fédération Aéronautique Internationale.

Per Brüel has had two books published on acoustic measurements and room acoustics and is well known for his lectures in which he usually manages to introduce thought provoking ideas.

The Institute of Acoustics presented him with the Rayleigh Gold Medal in 1974. In 1982 he was awarded the Silver Medal of the Acoustical Society of America and today the Institute of Acoustics is delighted to be able to honour him again by making him an Honorary Fellow.

### HONORARY FELLOW OF THE INSTITUTE OF ACOUSTICS

#### Chester M McKinney

Chester M McKinney comes from Austin, Texas. He has had a long-term association with the University of Texas at Austin, receiving his MA there in 1947 and his PhD in 1950. In particular he started at the Applied Research Laboratories of the University in 1946 (as its first graduate student employee) and has continued to the present date. He guided the scientific and economic fortunes of the Laboratories as Director from 1965 to 1980, ie for a large fraction of the total existence of ARL.

Two periods of absence should be recorded: the first running from 1950 to 1953 when he was Associate Professor of Physics at Texas Technological College. The second is especially apposite here, since he was Liaison Scientist at the Office of Naval Research in London from 1983 to 1984. It only takes one year to turn a Texan into a Briton and a European!

Chester's researches have included radar, reflecting his service as a radar

officer in the Second World War. But his main technical interests lie in underwater acoustics and sonar, centring around all the manifold problems of making and using high-resolution sonars. Thus his work has covered studies of transducers, and studies of scattering from targets of various shapes as well as scattering from the sea bottom. His written output in these areas has managed to continue despite all his administrative duties.

He has been deeply involved in the activities of the Acoustical Society of America, serving in many ways, most recently as Vice-President. At the time of writing he is a candidate for President Elect. Many Government Advisory Groups have had the benefit of his time.

Perhaps the history above does paint the entirely correct picture of a productive scientist and administrator, but it is also essential to round it out by referring to his friendly and hospitable personality, which makes contacts with him and his family so pleasurable. Chester is already a Fellow of the Institute of Acoustics; he is ideally qualified to become an Honorary Fellow, and in this capacity we will be very well represented by him in the United States.□

## Sponsor Members of The Institute of Acoustics

The Membership Committee of The Institute of Acoustics has recently reviewed the fee structure and benefits applying to Sponsor Members of the Institute. This fee structure has now been simplified and updated to allow for inflation and to reflect the better service we hope to offer Sponsors. The new fee is £400, but 'small' firms or consultancies, ie those having 15 or fewer employees in total, may pay a reduced rate of £200.

Benefits of Sponsor Membership are given below. Anyone interested in becoming a Sponsor Member should apply in the first instance to Mrs Cathy Mackenzie at IOA Headquarters in Edinburgh.

10% discount at exhibitions.

10% discount for advertising.

25% discount on advertising/technical mailings to members.

Employees of Sponsor Organizations attending Institute Meetings are charged at ¾ the rate appropriate to that employee, ie Members at ¾ of the Member rate and non-Members at ¾ of the non-Member rate. 'Small' firms may send one representative to meetings at the discounted rate; 'large' firms may send three represenatives.

'Small' firms receive one free copy of Acoustics Bulletin; 'large' firms receive three free copies.

A list of Sponsor Members is prominently displayed in 26pt type at every IOA main meeting.

A list of Sponsor Members will appear with greater prominence in the updated Professional Register.

A list of Sponsor Members together with one line descriptions of their activities will appear in every part of the Proceedings of the Institute.

Sponsor Members are represented on Council by a Vice-President, the Chairman of the Membership Committee.

Sponsor Members will be invited to provide an occasional feature describing their products and/or activities for publication in Acoustics Bulletin.□

# Sound Intensity


## F J Fahy
## ISVR, Southampton



*Sound Intensity is increasingly recognized as an important field of acoustic measurement, yet remains something of a mystery to many acousticians. Frank Fahy has been actively involved in making the techniques of sound intensity measurement available and he here provides the historical and technical background to the subject.*


THE INSTANTANEOUS SOUND INTENSITY at a point in a sound field is the instantaneous rate of flow of sound energy per unit surface area, the elemental area being so oriented that it lies perpendicular to the instantaneous particle velocity vector. An alternative, and more explanatory term for this quantity is 'sound power flux density'. The transported sound energy exists in two forms: kinetic energy of fluid motion, and potential energy of volumetric deformation of fluid elements. Theoretical consideration of the fluid mechanics of energy transport in a non-flowing fluid shows that sound intensity is given by the product of sound pressure (a directionless, scalar quantity) and particle velocity (a directed, vector quantity); it is, therefore, a directed quantity and is expressed as a vector, having both magnitude and direction. In most practical sound fields comprising waves of many frequencies travelling in many directions, the particle velocity vector, and hence also the intensity vector, vary continuously in magnitude and direction. Consequently it is customary to use the term 'sound intensity' to mean the time-averaged vector quantity which, in a temporally stationary (steady) sound field, has a constant magnitude and direction in any given frequency band.

The measurement of sound pressure alone, by means of a single pressure microphone, tells us nothing about the direction of energy flow. Sound intensity bears a simple relationship to sound pressure only under a very small number of special conditions, which is why it is necessary to employ expensive special purpose test facilities, together with approximate empirical formulae, to be able to infer sound power from measurements of sound pressure. Also, since pressure is a non-directional quantity, it is impossible to distinguish between the contributions of the tested source and other simultaneously operating extraneous sources. This constitutes a very severe limitation on the practical utility of sound pressure measurement techniques for the in-situ determination of source sound power. In contrast, measurements of sound intensity may, in principle, be made with a suitable instrument anywhere in a sound field, irrespective of the measurement environment and the proximity of source or reflecting surfaces, subject, of course, to the constraint of experimental error. The recent development of reliable techniques and instruments for the direct and accurate measurement of sound intensity has revolutionized the process of identifying and quantifying noise sources. The three main areas of measurement to which intensity brings the greatest benefit are:

(a) determination of the sound power of large and complex source systems which cannot be installed and operated in special purpose acoustic test facilities;

(b) the determination of the sound power of an individual source, or part thereof, in the presence of noise generated by other sources;

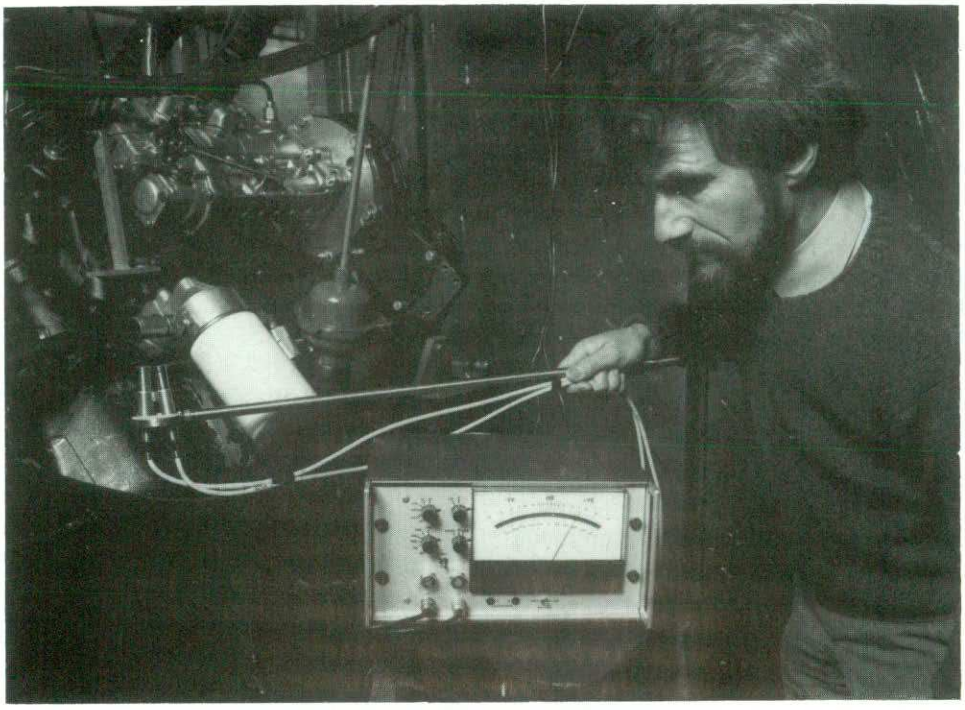
(c) the placing in rank order of the various regions of a distributed source.

Although the technical advantages offered by intensity measurement, in comparison with pressure measurement, are considerable it is the economic benefits which are of the greater significance: in particular, the capability which it affords for making sound power determinations in non-ideal environments, such as factory shop floors, production line quality control booths, or performance test installations. Another benefit provided by reliable indication of the relative importance of the various areas, or components, of a complex source, is that an order of priority for the application of noise reduction procedures can readily be established.

Given range and number of the advantages afforded by the availability of intensity measuring instruments it is remarkable that they were not developed a long time ago: in fact, the history of the subject is rather intriguing. Just over fifty years ago, in 1932, Harry Olson of RCA Laboratories was awarded a US patent for his 'System responsive to the energy flow of sound waves': forty-three years later, in 1975, Olson published what appears to be his next, and indeed, final statement on the subject (1), alas still not accompanied by experimental validation of the theoretical claims. During this long interval of time, sporadic attempts were made to develop practical measurement systems with varying degrees of success. In 1941, Clapp and Firestone of the University of Michigan constructed a system comprising two crystal pressure microphones in combination with a ribbon velocity microphone which performed well in an impedance tube up to 2000 Hz but less well in a reverberant room (which is no surprise to us today): temperature instability and ribbon resonance compromised its performance. Two years later R H Bolt and A A Petrouskas described a technique for rapid impedance measurement using two microphones, which contained all the ingredients of an intensity measurement system. In 1955, S Baker reported on a wattmeter based upon a combination of a hot wire anemometer, for particle velocity measurement, and a pressure microphone. The sensitivity of this device to extraneous air movement, together with the need for a steady air supply, ill suited it to practical field use. At about this time Ted Schultz published the results of his research into intensity measurement performed at MIT. He made a thorough investigation of the performance of his back-to-back double electrostatic microphone probe, and raised fundamental doubts about the use of intensity measurement to simplify experimental determinations of the sound power radiated into reverberant enclosures: we can today confirm his reservations as being well-founded. Schultz was perhaps the first fully to appreciate the very high quality of transducer and circuit phase matching necessary to ensure accurate measurement, especially in highly reactive fields. As he ruefully described many years later, the strangeness and unexpected form of the results obtained in a marble box disconcerted investigator and sponsor alike, with the result that the project was discontinued.

This, perhaps, is a suitable point at which to refer to a very strange feature of the development of our understanding of energy flow in sound fields; a feature which appears at this distance of time to have compounded the experimental difficulties produced by the shortcomings of the current transducers and electronic circuitry. During all the years which passed between Olson's first and last publications on the subject, there appeared in the scientific literature very little theoretical in-

vestigation of the forms of sound energy flux fields. In the Journal of the Acoustical Society of America I have found only one such analysis (2), namely that of Enns and Firestone published in 1942, no doubt stimulated by the parallel development and application of a measuring device: the intensity fields of pistons, monopoles and dipoles are analysed therein. Stenzel, in Germany, published an analysis of piston near fields (hard work without a computer!), including some treatment of energy flow, and that seems to be about all. The incredible feature of this story is that all the ingredients of energy flux analysis were being churned out by anyone who produced theoretical expressions for pressure, or velocity potential, fields: they just didn't seem interested in energy flow. Perhaps some light can be shed on this mystery by the cryptic statement by Philip Morse in the second edition of his excellent book *Vibration and Sound*, published in 1948, that 'unfortunately (or fortunately perhaps) we seldom measure sound intensity . . .'. How many researchers, I wonder, calculated, or measured, the sound intensity vector distribution in an interference field and decided to suppress the unpalatable results?



*The author using the ISVR sound intensity meter*

The stage for the next scene in the sound intensity saga is set in South Africa in the first half of the 1970s, where J F Burger, B G van Zyl, and co-workers in Pretoria, set their sights on the determination of sound power using intensity measurements made with a combination of pressure and velocity microphones: they also investigated the errors associated with discrete point sampling of the sound field. They did not initially choose to follow the lead given by Olson and use the difference between the outputs of two nominally identical pressure microphones to infer the particle velocity, a technique which they eventually came to favour, and which they implemented in what was probably the first reliable, wide-band sound intensity meter for field measurement.

We have arrived at the time of Olson's second paper. The mid-seventies saw the first stirrings of a revolutionary development in methods of acoustic measurement, fuelled by the parallel growth in the availability and versatility of integrated circuit devices, and the digital filters and dual channel DFT analysers which were based on them. At last the bogey of filter mismatch, which had frustrated intensity seekers for so long, was defeated; in analogue circuitry the introduction of switched capacitor filters solved the problem, and with digital filters the problem simply ceased to exist (except of course in the anti-aliassing front end filters). Analogue intensity meters were constructed in France, Germany, Switzerland, Yugoslavia and Great Britain, inter alia; measurements made in the field on real complex sources in non-ideal environments, in these countries and also in the Netherlands with the South African meter, demonstrated that the potential advantages of intensity measurement could be substantially realized.

Also in the mid-seventies there occurred a very important advance in the theory and practice of sound intensity measurement in which I was fortunate enough to play a part. In July 1975 I formally wrote down, in preparation for supervision of an undergraduate project, the expression for time-dependent intensity based on the finite difference approximation for particle velocity. I realized that the four resulting terms could, in the case of stationary signals, be reduced to one; and, even more importantly, that the frequency domain form consisted simply of the imaginary part of the cross spectral density function. The simplicity and potential of this formulation astounded me; the implication was that anyone with two phase-matched pressure microphones and a dual channel frequency analyser was the proud possessor of an intensity measurement system — although he didn't know it at the time! Subseqently A S Miller in his final year undergraduate project in 1975, became probably the first person to apply this new result, which has since become the basis for the intensity software packages provided with DFT analysers. Subsequent important refinements in relation to the reduction of errors associated with inter-channel phase differences, together with the development of in-duct, plane wave applications, were introduced by various researchers, in particular J Y Chung in the USA.

In the early eighties it was the turn of the instrument manufacturers to exploit the results of basic research. Sadly, British manufacturers failed to appreciate the potential market for a simple, portable instrument — and we're still waiting! Apart from the introduction of a large, sophisticated system based on digital filters, which has been widely used now for about three years, and the implementation of the cross spectral techniques on DFT analysers, the most interesting development work has concerned transducer and probe principles and configurations. The face-to-face condenser microphone configuration minimizes adverse probe diffraction effects, thereby maximizing the working frequency range. The more recent introduction of a probe in which the particle velocity is transduced by an ultrasonic wave process in principle extends the low frequency limit, otherwise imposed by dual pressure microphone phase match, down to zero. Research is currently in progress to develop probes

suitable for in-situ measurements in ducts carrying low speed airflow.

The most widespread application in sound intensity measurement is likely always to be in the determination of the sound power levels of sources, principally for regulatory and commercial purposes: an ISO working group is currently drafting a standard for this purpose. Sound power is determined by defining a measurement surface which encloses the source of interest, and effectively integrating over that surface the component of sound intensity normal to it, by means of either discrete point sampling or continuous sweeping. As already mentioned, sound intensity measurement provides a powerful means of discriminating against noise generated by sources other than that under investigation, and therefore allows sound power determinations to be performed in-situ under a wide range of operation conditions. There are limits, however, to the degree of discrimination achievable in practice, for which there are two main reasons.

Any intensity measurement system will register a value even when the actual particle velocity is zero, or when it is wholly in-quadrature with the pressure (zero intensity). This value, which will increase with sound pressure, is known as the 'residual intensity'; its origin lies primarily in the failure of any system to transduce the required acoustical quantities with complete fidelity. In practice this means that there is a kind of minimum 'signal-to-noise' ratio for which high measurement accuracy may be expected; the relevant quantity is the decibel difference between the Sound Pressure Level and the Sound Intensity Component Level indicated at a measurement point (the pressure-intensity index) and the upper limit for high accuracy is about 15 dB. Origins of high values include strong standing wave components in enclosures, high ratios of multiply-reflected to directly-radiated field components, and alignment of the probe at a large angle to the local intensity vector. The second reason why discrimination is limited is that it is produced only by the process of integration over the measurement surface, because an intensity meter cannot discriminate between contributions from different sources at any individual field point. Therefore both the source under investigation and all sources of extraneous noise must be sufficiently steady during the total measurement period for discrimination to be effective. This is a limitation which is being given careful attention by the ISO working group.

One of the dreams of people such as myself in the early days of development of intensity measurement techniques was that we would ultimately be in a position to scan a probe over the surface of a complex source and announce 'Voilà! There is your source'. What we had not anticipated (not having previously done the sums) was that sound fields close to vibrating surfaces exhibit circulatory patterns of energy flow, some regions apparently radiating energy, and others apparently absorbing energy: this feature is most strongly evident with tonal sources, or very narrow band analysis. The nett radiated power is given by the difference between the outward-going and inward-going powers, which may be small, and therefore poorly estimated. Such circulatory patterns of energy flow are restricted to the nearfield of radiators, and are not found at distances of more than 10-20 cm from most sources; however, by measuring at larger distances of 50-100 cm to avoid such complications, some degree of spatial resolution of 'the source' is sacrificed. Even so, it is certainly possible to rank order regions of broad band sources, such as automotive engines, and complex plant and production machinery, with a sufficiently high degree of confidence to justify the conclusions as a basis for noise control strategies.

Circulatory patterns of sound energy flow are characteristic of two- and three-dimensional interference fields, as indicated by Schultz *et al* (3). They can lead to serious misinterpretations of intensity measurements made close to reflecting surfaces, particularly if an insufficient density of measurement points is employed, because sound energy will seem to emanate from some regions, and to be absorbed by others. One practical application in which this problem arises is in the use of intensity measurement to diagnose and quantify flanking transmission in buildings, in which the circulating intensity produced by the principal transmitting surface may be erroneously attributed to another innocent surface. In spite of some practical difficulties, numerous measurements of transmission loss of partitions using direct determination of the radiated sound power have demonstrated that the receiving room can be dispensed with, provided that extraneous noise is not too severe. Unfortunately, an intensity meter cannot distinguish incident from incident intensity, and, as yet, we have not found a practical way of dispensing with the source room in transmission testing. A significant advantage afforded by the intensity-based technique is that the various components of a complex partition can readily be rank ordered, which is very difficult to achieve (by masking) with the conventional method. Sound intensity scans have been found extremely effective in the detection and location of sound leaks in door seals, windows, etc.

Another potentially valuable application of intensity measurement is to the determination of the sound absorption properties of materials, particularly in-situ, where the standard techniques fail because of the presence of extraneous absorption by other bodies. For instance, the sound energy absorbed by one seat in an auditorium has been evaluated by integrating the intensity over an enveloping surface; also, the effectiveness of studio absorbers has been investigated under operational conditions. Although some limited success has been achieved, experience with attempts to supplement conventional methods with an intensity-based technique has, so far, been somewhat disappointing, in that the uncertainty of determination is rather high. There are good theoretical reasons for this situation which are partly connected with the pressure-intensity index mentioned previously.

One area of acoustic measurement which is still the subject of considerable contention is the evaluation of the sound power generated by air-moving devices, and of the performance of associated in-duct attenuators. A major technical factor behind the disagreements is that the proposed methods involve the arrangement of special test conditions so that sound powers can be inferred from measurements of sound pressure (the old problem). The development of a system for making direct intensity measurements in flow, under operational conditions, could be of considerable technical, economic and contractual importance: such a system is at present under development at the ISVR, Southampton University.

Among the more recent interests in the field of sound intensity theory and measurement is the question of the practical usefulness of the concept and experimental determination of complex intensity, which incorporates both the 'real' intensity, as described above, and the 'imaginary' intensity which quantifies the local oscillatory flow of energy in interference fields. It seems that this quantity may find a use in the quantification of the degree of reactivity of intensity fields, which has a bearing on the accuracy of measurement, and the

physical interpretation, of intensity fields.

Sound intensity measurement is now firmly established as a major weapon in the armoury of the noise control engineer. Future developments are likely to lie primarily in the area of refinement of the measurement procedures and improvements in the quantification and minimization of measurement uncertainty. Of course, one of the most important tasks now facing us is to agree on an international standard for instruments and systems for the measurement of sound intensity. This work is currently being tackled by an IEC working party under the capable chairmanship of Dr M Delany of the National Physical Laboratory.□

**References**


1. H Olson (1975) J Audio Eng Soc *22*, 321-328. *Acoustic Wattmeter.*

2. J H Enns and F A Firestone (1942). J Acoust Soc Am *13*, 24-31. *Sound power density fields.*

3. T J Schultz, P W Smith and C I Malme (1975). J Acoust Soc Am *57*(6), Pt 1, 2163-1268. *Measurement of acoustic intensity in reactive sound fields.*


# Non-Destructive Testing

Three events relating to non-destructive testing have been announced. **Mathematical Modelling in Non-Destructive Testing** is the title of a conference to be held on 2 — 3 September 1986 at Jesus College, Cambridge, by the Institute of Mathematics and its Applications in association with the British Institute of Non-Destructive Testing. The aim of this conference will be to present a range of subjects which are topical and provide good grounds for theoretical development. The majority of the papers will be in ultrasonics, but other non-destructive evaluation techniques will be covered. Details may be obtained from: The IMA, Maitland House, Warrior Square, Southend-on-Sea, Essex SS1 2JY.

**Non-Destructive Examination** will be the subject of Session 3, on 23 September 1986, of Analyticon, to be held at the Commonwealth Institute. The Session, to be chaired by Dr L J Bond, will look at non-destructive testing techniques for materials characterization applied to plastics, metals, ceramics, composites and biological material. For details contact Beverly Humphrey, Scientific Symposia Ltd, 33 — 35 Bowling Green Lane, London EC1R 0DA.

Papers are invited on all topics of non-destructive testing, including novel applications of existing techniques and the development of new methods of testing and material evaluation, for the **4th European Conference on Non-Destructive Testing** which will take place at the new Queen Elizabeth Conference Centre in Westminster from 13 to 18 September 1987. The Conference is the fourth in a series of triennial conferences and is being organized on behalf of the European Council for Non-Destructive Testing by the British Institute of Non-Destructive Testing. Further information is available from: Conference Associates NDT, 27A Medway Street, Westminster, London SW1P 2BD.□

# Calls for Papers

**Current Research in Ultrasonics and Physical Acoustics**

One-day meeting of the joint IOA/IoP Physical Acoustics Group, 25 September 1986 at University College London

Papers are invited on current research on any topic in ultrasonics and physical acoustics. Papers to be given by research students would be most welcome.

Meeting Organizer: Dr L J Bond
Department of Mechanical Engineering, University College London
Torrington Place, London WC1E 7JE
(Titles of papers by 31 July. Abstracts by 10 September)

**Noise and Vibration in the Aircraft and Spacecraft Industry**

Joint meeting of the Industrial Noise Group and East Midlands Branch, 29 October 1986 at Birmingham International Airport

Meeting Organizer: Mr Stuart Bennett MIOA,
National Coal Board, Mining Research and Development Establishment,
Ashby Road, Stanhope Bretby, Burton-on-Trent, Staffs
(200 word abstracts by 15 August)

**Sound Insulation of Buildings and Building Elements**

In collaboration with the Building Research Establishment, 4 December 1986 at the Building Research Station, Garston, Watford

Meeting Organizer: Dr L C Fothergill MIOA, BRS, Garston,
Watford, Herts WD2 7JR
(200 word abstracts by 31 August)

## *Advanced Diploma in Diagnostic Engineering*

A new concept in developing diagnostic skills is to be launched through the introduction of an advanced diploma available to both members and non-members of the Institution of Diagnostic Engineers. A planning meeting to prepare the syllabus was held in June in Birmingham. Anyone interested in further details should contact Dr Ralph A Collacott, Institution of Diagnostic Engineers, 3 Wycliffe Street, Leicester LE1 5LR.□

# Proceedings of The Institute of Acoustics-Abstracts

# Materials for Musical Instruments

## One-day conference organized by the Musical Acoustics Group at the London College of Furniture, London, on 20 March 1986

**The Effect of Material in Brass Instruments: a Review**

**R Smith**
**Richard Smith (Musical Instruments) Ltd, London**

The contribution to musical quality made by the walls of brass instruments has been widely discussed by experimenters and musicians for over a century. Several experiments ignore small changes in bore shape and the effect of a change in weight and balance on the player's judgement. Using a specially prepared set of interchangeable trombone bells, several workers were able to perform different measurements of their vibrational and acoustical characteristics. The results indicate that the bell thickness, and to a lesser extent the other material parameters, do have a significant effect on the sound spectra measured at the player's ear position due to some radiation from the material itself. However, under controlled blindfold conditions, players seem unable to distinguish between thick and thin materials.

**Practical Observations on the Acoustic Properties of Materials used in Organ Building**

**P Collins**
**Organ Builder, Redbourn, Herts**

The return to the classical principles of organ building in the last thirty-five years has emphasized the attention to detail essential in the choice of materials necessary for a truly musical instrument. The various metals and species of wood used in pipe construction must be supported in their choice by suitably constructed casework and framing. The effect of such acoustically sympathetic surroundings is of great importance. Also important is the quietening of parts of the organ that should not be heard — for instance, the wind supply. The builder can put his distinctive stamp on an instrument by the materials he uses.

**Spruce for Soundboards: Elastic Constants and Microstructure**

**J Woodhouse**
**University Engineering Department, Cambridge**

The usual theoretical model for the elasticity of wood regards the material as orthotropic, described by nine independent elastic constants (each with a corresponding damping constant). Measurements of all eighteen of these constants are needed for a serious study of musical instrument wood. The various possible approaches to such measurements are reviewed. It is then suggested that this difficult measurement problem might be simplified somewhat by modelling the microstructure of the wood to provide inter-relations between the constants. Such microstructure modelling, particularly as applied to softwoods which have rather simple structure, dates back to 1928, but is still an active area of research.

**Wood for the Guitar**

**B E Richardson**
**Department of Physics, University College, Cardiff**

One of the most difficult aspects of the guitar maker's art is learning to accommodate variations in the material properties of the woods used in an instrument's construction. Most makers adopt traditional rules for the selection of wood species and cutting methods. These rules ensure the choice of wood with consistent characteristics, allowing makers to construct instruments of an even tone with a minimum of design modifications. However, the acoustical reasons for their choice are not always clear. This paper presents measurements of the mechanical properties of some standard and some non-standard woods destined for use in guitars. These experiments demonstrate that a much broader selection of materials produces perfectly adequate results. With a better understanding of the quantitative relationships between wood properties, construction and final tone quality, non-traditional materials could be used commercially.

**Materials and Acoustics: A Guitar Maker's View**

**P Fischer**
**West End Studio, Chipping Norton, Oxon**

With the craft and art of instrument making being passed from one generation to the next, mainly through the apprenticeship system, the maker's approach to his work has a practical bias. His understanding of acoustics is developed through a thorough knowledge of and familiarity with the materials he uses, which is a long process. In this paper, the author will present his understanding of the luthier's craft based on his 25 years of experience as a professional guitar maker. The results of recent work with new and exotic species of wood for the classical guitar will also be described.

---

# Recent Developments in the Active Control of Noise and Vibration

## 25 March 1986 at ISVR, Southampton

**An Overall Perspective of Active Noise Control: the Balance between Theoretical and Practical Research**

**M A Swinbanks**
**MAS Research Ltd, Cambridge**

Abstract not available.

**Ten Years of Synchronous Cancellation in Active Control**

**M Trinder**
**University of Essex**

Abstract not available.

**Novel Applications of Active Control Techniques**

**C F Ross**
**Topexpress Ltd, Cambridge**

Abstract not available.

**An Adaptive Algorithm for Multichannel Active Control**

**S J Elliott and P A Nelson**
**ISVR, University of Southampton**

Abstract not available.

**The Implementation of Active Noise Control Systems using Digital Signal Processing Techniques**

**R R Leitch and M O Tokhi**
**Department of Electrical and Electronic Engineering, Heriot-Watt University, Edinburgh**

The recent advances in semiconductor technology have produced extremely fast, dedicated digital signal processing devices capable of implementing, in real time, control algorithms of significant complexity. In active noise control systems this facility allows the substitution of controller complexity for the geometric complexity of the acoustic arrangement, resulting in a number of significant advantages. This requires a careful study of the structure of active noise control systems from a control engineering perspective and a clear classification of the characteristics of the acoustic sources, each of which leads to a different control solution. In this paper an analysis of suitable control structures employed in active noise control systems is given leading to a design methodology for broadband noise emanating from a compact (point) source. Based on this method, a control algorithm is developed and implemented in a dedicated signal processing device. The performance of the system is investigated using a synthetic broadband source and verified by application to the attenuation of the exhaust noise of a 125 cc

motorcycle. A frequency independent controller (constant gain) is also implemented and experimental results are presented. The advantages of control system design methods are demonstrated by comparing the experimental results for the two cases. Furthermore, the approach provides the basis for the development of adaptive active noise control systems capable of adjusting their performance as operating conditions change.

**Development of a Prototype Exhaust Noise Cancellation System for Commercial Vehicle Applications**

**H Corr**
**University of Essex**

Active noise control is now acknowledged as being a viable alternative to passive silencers for the reduction of high intensity low frequency exhaust noise. The active system is potentially smaller and lighter and unlike the passive low frequency silencer does not introduce any back pressure. To date patented synchronous active systems have successfully been applied to stationary engines running at relatively constant speeds.

The paper describes the application of active noise control to the exhaust noise of a 350 HP Foden heavy goods vehicle. The active control system must, by necessity, respond to the rapidly changing noise fields produced by the tractor unit under varying speed and load conditions encountered when being typically driven.

Aspects of the signal processing hardware and software are described along with the necessary actuators required to give global cancellation. The performance of the commissioned system is then discussed and conclusions drawn.

**Active Noise Cancellation: a Feasibility Study**

**J Vandenhout, P Sas and R Snoeys**
**Katholieke Universiteit, Leuven**

Active noise cancellation, using anti-sources which are properly dephased towards the original noise source, is a relatively new and promising noise reduction technique. Much has been published on the theoretical background of the method, but little is known about real life applications.

The aim of the work described in the presented paper is therefore a feasibility study, using an experimental approach. First some of the principles of active noise cancellation are highlighted, using simple point source configurations, as well as a simplified acoustical radiation model. In a following part of the paper the findings from this theoretical work are tested with loudspeaker configurations. This leads to the more realistic applications on plate-like structures, in ducts and at the ear, using headphones.

From the experiments on active noise reduction on platelike structures, it can be stated that the quality of the loudspeakers used is very important. In laboratory conditions attenuators of 10 dB are obtained on a vibrating aluminum plate at the first resonance frequency. Real life applications are possible, but not yet operational, due to annoying higher order harmonics.

Concerning work in ducts, applications are very possible, yielding attenuations of 10 to 15 dB. In this field, as well as in the field of active noise cancellation at the ear, the results are certainly promising.

**The Active Control of Crankshaft Vibration and Bearing Distortion**

**R Holmes**
**University of Southampton**

Abstract not available.

**Computer Simulation in Active Noise Control**

**P Sjösten and P Eriksson**
**Dept of Building Acoustics, Chalmers University of Technology, Gothenburg, Sweden**

The application of active noise cancellation in real systems is an intricate problem that requires a thorough investigation of the properties of the acoustic or vibration field as well as the effectiveness of the control system. Specifically, when using digital adaptive filters, the filter structure has to be considered in order to obtain fast convergence and low residual error.

With a computer it is possible to perform simulation tests, where a given filter structure is adapted to a measured acoustic transfer function. This technique allows a direct comparison of the convergence speed as well as residual error for different filter types.

This paper discusses a computer simulation procedure and also demonstrates the results from a comparison between a conventional FIR filter and a linear, frequency domain interpolating filter.

# Ultrasonic Scattering and Attenuation in Solids

## Physical Acoustics Group Meeting, 27 February 1986

THIS MEETING of the Physical Acoustics Group, held at IoP headquarters in London, was intended to cover recent developments in our understanding of the generation, propagation and attenuation of acoustic waves. Certainly it fulfilled its promise and we were treated to papers which ranged from the subsonic extremes of earthquakes to acoustic studies at microwave frequencies and beyond.

The morning session was dedicated to acoustic propagation in composite materials and to the investigation of microstructure, an area of much current interest and application. The meeting had as its first speaker Professor John Willis of the University of Bath who took the audience by the hand through the mathematical theory of composites to usable expressions for attenuation and elastic dispersion. It is to his credit that even his use of Green's functions sounded natural and even easy. Dr L Scudder then described the industrially important work carried out at AERE Harwell with his colleague Dr R Smith on ultrasonic studies of microstructures, where semi-automated analysis of the data from a wide range of metal alloys enables the various scattering mechanisms to be identified.

Stuart Crampin of the British Geological Survey at Edinburgh and Dr J A Hudson of the University of Cambridge then gave two fascinating papers on the propagation of elastic waves in cracked or flawed material and the implications for seismology. It was noted that in materials with the aligned flaws typical of many parts of the Earth's crust, the two shear polarizations will propagate at different velocities. Recent seismological techniques which enable changes in polarization as well as the arrival times of shear waves to be detected, show that much information on the propagation path can be obtained. In some cases it is possible to detect the build-up of stress along the propagation path as cracks close.

After lunch Dr L Dissado and Professor R Hill of the University of London described their important work on structural relaxation in disordered systems. Their research group has been at the forefront of attempts to explain why a wide range of dielectric and elastic relaxation phenomena in polymers and other disordered materials show a related form which can readily be described by a few simple parameters, a form which is now widely referred to as the 'Universal' response function. The relaxation losses in these materials can be very different from the classical form for relaxation peaks associated with the name of Debye. After reviewing the problem Dr Dissado and Professor Hill described their current ideas on intra- and inter-cluster exchange in which the scaling behaviour of the structure determines the parameters describing the relaxation losses. Dr Almond from the University of Bath then described his work on electric and elastic relaxation in ionic conductors, where he had found the 'Universal' response function useful in describing his data. There were significant differences in the forms of the electric and dielectric response however, which are as yet not described by theory. It was clear from the papers and the lively discussions that followed that the study of disordered systems will be with us for some time, and that although advances are being made, the problem of deriving the parameters of the 'Universal' response from knowledge of the structure is far from resolved.

The theme of relaxation losses was continued by Dr King of the University of Nottingham, who spoke on their studies of chromium impurities in gallium arsenide. Although it was shown that the elastic losses in this system cannot be described by the theories of previous workers, it was interesting to note that the formula of Debye rather than the general 'Universal' response function still holds sway in describing this dilute system. The last paper on relaxation was that of W E Al-Naser, R A R Hassan, and Dr Niblett of the University of Kent. Mr Al-Naser described work on the Bordoni peaks found in polycrystalline aluminium and on the identification of the mechanisms responsible.

After tea Dr G A D Briggs of the University of Oxford gave an excellent review of the measurements which are possible with the now well established techniques of acoustic microscopy. Special emphasis was given to the measurement of thin films, the properties of implanted layers, and the detection of small cracks.

Throughout the day, from the first papers on composite materials to the last paper on the heat pulses generated in thin metallic films using nanosecond electrical excitation by Dr M Wybourne of GEC, the meeting was marked not only by the high quality of the papers but particularly by the lively discussions that followed.□

**P J King**

# Materials for Musical Instruments

ON THURSDAY 20 March, some thirty members of the Musical Acoustics Group met at the London College of Furniture. Five papers were presented, three concerning stringed instruments (guitar, violin) and two wind instruments (organ, brass). We were fortunate in having contributions from two frontrank craftsmen, Peter Collins (organ builder) and Paul Fischer (guitar maker).

The first paper was from Richard Smith, who, in addition to being a physicist, has been engaged for many years in brass instrument design and manufacture. He reviewed the research undertaken to try to ascertain the musical influence of the material of a brass instrument. He highlighted the sharp — and sometimes acrimonious — differences of opinion, ranging from that of the scientist who insists that the wall material has no effect at all, to that of the player who equally insists that the 'magic' of a good instrument lies in the precise composition of its metal. The latter view may sometimes be fostered by manufacturers eager to sell their 'unique' product. Dr Smith observed that the instrument's bore — a truly vital determinant of tone quality — could indeed vary with the material used. The varying springiness of the material could lead to nominally identical bores — produced on the same mandrel — actually being different. From experiments with interchangeable trombone bells it was concluded that wall vibration does have an influence on the sound spectrum at the player's ear position. However, blindfold playing tests indicated that players could not unequivocally detect this; in one case a copper bell of particularly attractive appearance only acquired magical properties when the blindfold was removed.

The next contributor was Jim Woodhouse of the University of Cambridge. Of the influence of his chosen material — Spruce for Soundboards — on the musical properties of a violin, guitar or piano, there was no doubt. The difficulties of identifying and then measuring the significant elastic properties of wood were outlined. The size of the specimen — not too large, not too small — has to be considered in relation to the variability of material properties as has the requirement of simplicity of specimen shape. Resonance methods, with appropriate loading of the specimen, seem to offer the greatest possibilities for the economical measurement of a full set of elastic and damping constants. The possibilities and drawbacks of ultrasonic testing methods were also outlined. The paper ended with a description of the microstructure of wood — the cell structure and differentiation by annual rings — and its relationship to the macroscopically-observed elastic constants.

Peter Collins adopted the craftsman's viewpoint that the correct choice of materials is essential in the harmonious construction of a harmonious instrument. He illustrated his paper with numerous slides of organs *in situ*, some of which were first-rate examples of his own work. He took the view that the material of the pipework of an organ self-evidently *did* influence the tone quality. Moreover, the material and construction of the casework surrounding the pipes was extremely influential in modifying and projecting the sound. Using the right material to dampen the mechanical noises of the organ was also a point of good design.

After lunch we returned to wood, this time with reference to the guitar. Bernard Richardson (University College Cardiff) emphasized the conservatism of guitar makers in selecting materials for their instruments. The choice of spruce for the soundboard has sound acoustical justification, but materials and designs for other parts of the instrument are often the subject of only haphazard experiment. Dr Richardson reported measurements on spruce for the soundboard and on various other woods for the back and sides of the guitar — alternatives to the highly-prized and now scarce Brazilian rosewood. He mentioned the development of a numerical model of the guitar enabling instruments to be 'designed' from an effectively infinite supply of differing 'woods'.

Paul Fischer followed up this contribution with a description of his own experiments in the use of different materials in guitar construction. Systematic and controlled departures from the traditional materials and methods had given some excellent, but at the same time different and unfamiliar results. The acceptance of such departures from the traditional design of course depends on the willingness of musicians to make use of new tonal concepts and possibilities.

The discussion which followed threw into sharp relief the differences of opinion on how far the material of an instrument *does* influence its tone. In the case of stringed instruments there was the semblance of harmony, but discord appeared whenever wind instruments were mentioned. The view of the largely scientific audience was that the influence of material was generally overstated. In one respect the makers of wind instruments *were* right: the material used encourages the appropriate manipulation of critical regions of the instrument (eg the lips of an organ pipe) in a way that best produces the tone sought after. The need for selective assembly of the parts of a well-known make of plastic recorder showed the critical nature of the construction process. The group secretary had tantalizingly billed the session as one for riding 'musical hobbyhorses' — those curious creatures cross-bred from half-truth and anecdote — which seem to populate the musical scene. Quite a respectable number of these creatures were paraded (does the air *really* spiral up the organ pipes in an anti-clockwise direction in a certain northern cathedral city?) usually showing that the instrument makers often have a grain of truth in what they say. Life though might be a bit easier for them if they would occasionally enlist the musical scientists to help their pet hobbyhorse over a difficult jump.□

Edgar Brown

# One Day Conference on the Improvement of Sound Insulation in Existing Buildings, 19 February 1986

THIS was a most successful conference by any of the usual criteria; a large number of contributors, an attendance of 130, an audience which remained to the end and left with a sense of satisfaction.

The Conference was chaired by Professor Peter Lord in his usual friendly and discursive manner, which contributed greatly to an ambience which encouraged participation from the floor and a wide ranging discussion.

Each session was opened by two general papers and then by a specialist topic: in the morning on improvement of sound insulation of walls and in the afternoon on improvement of sound insulation of floors.

The morning session was opened by Dr G Jackson (Atkins R & D) who reviewed the principles and practice of noise insulation. He was followed by S Rintoul (London Borough of Lewisham) who discussed the economic constraints existing on improving sound insulation and the possible legal remedies for noise nuisance. These were followed by J Mathys (MAA), Professor F Mechel (Fraunhofer-Institut für Bauphysik) and J Miller (Bickerdike Allen Partners) who considered sound insulation improvements achieved by the lining of walls with plasterboard and thermal insulants.

The afternoon session was opened by P Allaway (Grootenhuis Allaway Associates) speaking on acoustic privacy in offices — real and imagined — and Mr Middleton on behalf of J Blair (City of Glasgow District Council) desribed experience of extensive sound testing by 'enforcement officers' and their attempts to utilize the provisions of current legislation.

R Alphey (Building Research Station), T Curson and J Morrison (London Borough of Southwark) and A Jones (AIRO) described case studies of the improvement of sound insulation of floors. Topics included improvement by modifications to the under ceiling, enhancing the surface of the floor and treatment of the cavity.

H Ertel (Fraunhofer-Institut für Bauphysik) reported on transmission of impact noise from staircases and access ways in muliple occupancy dwellings, and methods for its reduction. The Conference ended with a paper by R Mackenzie (Department of Building, Heriot-Watt University) on the relative significance of system mass, resonance and resilience on the transmission of impact noise.

This conference was sufficiently successful for the Institute to be considering a follow-up meeting, probably for the Autumn in the Building Centre, London.□

John Roberts

# THE INSTITUTE OF ACOUSTICS TWELFTH ANNUAL REPORT OF THE COUNCIL 1985

During the last year the Institute of Acoustics has continued to grow in size and stature. Membership levels have risen by 5% from 1284 to 1345 during the year and further details relating to the individual grades of membership are given in Table 1. Council has continued its negotiations with the Engineering Council and an assessment visit was made to Headquarters by that body in August. There appears to be every sign that before long the Institute will have an acknowledged route by which members of the Institute will be able to qualify for Chartered Status.

Dissemination of technical information amongst its members is a vital role for any professional Institution and through its Meetings Committee the Institute aims not only to arrange a programme of relevant and interesting meetings but also to ensure that, wherever practicable, sufficient income is thereby generated to cover the individual meeting costs and to provide a substantial proportion of the Institute's revenue. Overall the past year's programme has been satisfactory although the success of individual meetings remains somewhat variable.

The development of a formal meetings policy was implemented by Council in the early part of the year, with the aim of more clearly involving members in the arrangement and running of meetings at both Group and Branch level. The Meetings Committee and Council, swayed by arguments about self-determination and autonomy, accepted the view that members should be positively encouraged to sponsor meetings which more precisely meet their particular needs and interests. However, with a few notable exceptions, this objective is proving elusive.

A number of very good Meetings and Conferences covering many different topics have been held at a range of venues throughout the country even if the attendances have not always been as high as the organizers would have liked. The central feature in the Meetings Programme was, as usual, the Spring Conference which was held in the excellent surroundings of York University. It is a matter of great concern to Council that even the centrepiece of the Institute's Meetings Programme is dogged by poor attendances. All members of the Institute are urged to try to attend as many meetings as possible and in particular to make a concerted effort to get to the Spring or Autumn Conferences.

The Annual General Meeting was held at the York Conference. At that time Mr John Mills and Dr Peter Chatterton were elected to serve on Council and a warm welcome is extended to the new members. Concerning the Officers of the Council Dr Roy Lawrence relinquished the post of Honorary Treasurer and was replaced by Mr Ralph Harrison. Unfortunately, Ralph Harrison resigned from Council in the course of the year and has been replaced by another newcomer, Dr Geoff Jackson. Mr Geoff Kerry took over from Mr Trevor Smith as Vice-President with special responsibility for Groups and Branches. Council are delighted that Roy Lawrence will continue to be involved with the running of the Institute in his capacity as Editor of the Proceedings but Trevor Smith will be sorely missed. The present strength of the Group and Branch network within the Institute is largely due to the latter's commitment to the principle and his capacity for hard work. Council is extremely grateful to him for all his efforts.

The active participation of Groups and Branches in the Institute's affairs has continued during the past year to the benefit of all members. This applies particularly to their role as organizers of meetings. The Underwater Acoustics Group hosted successful meetings on scattering phenomena during April and array signal processing in December while the Hong Kong Branch was involved in the organization of the Second Pacific Regional Acoustics Conference (WESTPAC II). The Yorkshire and Humberside Branch hosted the 1985 Spring Conference at York and the North West Branch is actively involved in the organization of the 1986 Spring Conference at Salford in collaboration with the Underwater Acoustics Group, Building Acoustics Group and Industrial Noise Group. Although the new joint IOA/IoP Physical Acoustics Group has yet to be formally approved by either Institute it has run a number of successful meetings. There is, however, some doubt concerning the level of interest in this area amongst the membership of the IOA and it has proved difficult to find any IOA members prepared to serve on the Group Committee.

At the local level all Branches have reported difficulties in attracting members to meetings. Nevertheless, most have run a successful series of meetings, visits and discussions which have been well received by those members attending. The activities of the London Evening Meetings have been suspended pending the outcome of the abolition of the Greater London Council. However, the formation of a London Area Branch is being discussed. Individual Group activities have continued, but generally at a lower level than in the previous year. It is, however, difficult to estimate the level of activity accurately over a single year since some groups prefer to run large meetings at longer intervals.

Following discussions with the Committee of the Underwater Acoustics Group, practical amendments have been incorporated into the general Group and Branch constitution, which is now considered acceptable by all parties. Additional discussions between the Honorary Treasurer and representatives of Groups and Branches have taken place. These should lead to a simplification of some of the accounting procedures. The annual meeting of Group and Branch representatives, which forms a vital link with Council, was held this year in conjunction with the September meeting of the Meetings Committee. This allowed the representatives to attend both meetings and it is recommended that this practice should be continued.

This year has seen the publication of Volume 6 of the Proceedings of the Institute, appearing for the first time in the new format. It is hoped that this venture will in the course of time prove to have been worthwhile. The Diploma course and examination continues to provide the educational backbone of the Institute. The revision of the Syllabus has now been completed and some of the earliest establishments to offer the course have now been reapproved for a further period of five years. New colleges are still being approved to run courses and arrangements have been finalized to introduce a Distance Learning Scheme using video recorded tutorial material.

It has for many years been the aim of the Institute to be involved in establishing a worthwhile successor to the Noise Advisory Council. There have been many disappointments in the past but this year there have been signs that all the discussions have begun to bear fruit. It has been agreed that a joint Noise Council is to be set up in collaboration with the Institution of Environmental Health Officers and the Institution of Occupational Safety and Health. It is anticipated at this stage that a launch meeting will take place early in 1986.

## STANDING COMMITTEES

The operation of the Institute is guided by Council through the following Standing Committees: Membership, Meetings, Publications, Education, Noise Council, Medals and Awards and a newly constituted Finance Committee.

### Membership Committee

The Membership Committee met on four occasions during 1985 and considered 77 applications for corporate membership of which 48 were successful. Table 1 gives the detailed distribution of applications and rejections as well as the present and 1984 totals across all grades of membership.

The Committee has consolidated the work started last year on the admission of our Corporate Members to Chartered Status through one of the main Engineering Institutes. The Membership Committee Chairman discussed our existing membership arrangements with the Nominations Committee of the Engineering Council during their appraisal visit to Headquarters in August 1985. As a result of those discussions, the application form has been redesigned to help us identify those applicants who are already or who wish to become Chartered and to forward their names to a new Committee (provisionally called the Registration Committee) which will handle such matters.

The more stringent criteria announced last year regarding post-qualification experience are now being implemented and many more potential Members are having to wait for a year or two building up relevant experience before their Corporate status can be conferred. This raising of our standards is undoubtedly one of the features which should help us gain admission to the list of Recognized Bodies of the Engineering Council.

The Committee has also looked at the benefits we offer to our Sponsor Members. We gain a lot from our Sponsors and it has been felt for some time that we should give them more in return. The Committee drew up a list of benefits which it considered the Institute should offer and this was accepted (with slight modifications) by Council at its meeting of the 12 December 1985. The list of benefits will appear in Acoustics Bulletin and all present Sponsor Members have been circulated with the information.

*Table 1 Details of Institute Membership*

| Grade | 1984 | 1985 | Applications in 1985 | Successful Applications in 1985 |
|---|---|---|---|---|
| Fellow | 214 | 211 | 9 | 6 |
| Member | 711 | 735 | 68 | 42 |
| Associate | 344 | 383 | 108 | 108 |
| Student | 15 | 16 | 7 | 7 |
| **Total** | **1284** | **1345** | **192** | **163** |
| Sponsors | 16 | 17 | 1 | 1 |

### Meetings Committee

During 1985 Meetings Committee has worked not only to arrange the year's conferences and more specialized meetings but also to catalyse the production of successful future programmes of Institute meetings.

The main meeting of the year is the Spring Conference which in 1985 was held at the University of York. The opportunity to gather together, to exchange greetings and information, and to perform in a holistic way as an association of members should not be missed. York in the spring is beautiful, the venue was excellent, the quality of the submitted papers was more than adequate, the presence of so many well-respected and notable acousticians was extremely stimulating and the weather held out. Why then did so few (only 140) members make the attempt to attend? Only ten per cent of our corporate members came, many of them involved either as contributors or as officers of the Institute.

There has been much subsequent heart-searching and analysis and the only firm conclusions reached have been that we do not invest enough time in our Institute, that we do not sell ourselves effectively and

that experience in the running of meetings needs to be shared more widely. It is also an inescapable fact that there is less money around than there used to be, but this should only mean that we must fight harder for our proper share, as individual members, as members of Council and as an Institute.

On the other hand there were a number of successful meetings. Auditorium Acoustics at Cambridge attracted 50 delegates in February and in the next month a meeting in Birmingham on Local Government Noise Problems was extremely well attended by Environmental Health Officers as well as other practitioners. The topic of Barriers for Noise Control, in October, was successful. The Underwater Acoustics Group organized two major meetings during the year, with the Group's usual high level of presentation and with consequent large attendances including many delegates from overseas. Scattering Phenomena in Underwater Acoustics attracted 85 delegates over two days in April to listen to 30 papers and this was followed in December by a further two-day meeting at Loughborough on Array Signal Processing at which 25 papers were presented.

The Autumn Conference at Windermere on the theme of Reproduced Sound was a huge success. It demonstrated clearly both that there are still untapped areas in which acoustics is practised but is often not recognized as such, and that Dr Roy Lawrence has a unique talent for finding such areas, for developing a strategic marketing technique and for exploiting such situations with a combination of sheer hard work and sound entrepreneurial flair. Attendance was around 150 to hear 43 papers covering a very wide range of topics.

It is not possible in this report to do more than select some of the many meetings held during the year under the banner of the Institute. Groups, Branches and organizers of main meetings all played their part in filling our programme, and Council's sincere thanks are extended to all who contributed. Thanks must also go to Mrs Cathy Mackenzie for her organizational skills and to her staff, without whom none of this would happen at all.

**Publications Committee**

The Proceedings of the Institute have now appeared in their new and attractive format with Volume 6 (for 1984) priced at £107. The Committee encourages members of the Institute to consider purchase of the Proceedings on behalf of their employers or institutions. It is expected that Volume 7 (for 1985) will be available for purchase in April 1986.

The Chairman together with the Bulletin Editor and Advertisement Manager have been commissioned to conduct a policy review of Acoustics Bulletin during 1986. This review is to consider the quality and cost of printing and to assess the technical balance and amount of written matter. The Committee has expressed the view that the number of technical (not academic) articles might be increased. Advertising, both in Acoustics Bulletin and in the monthly Recruitment Bulletin, has shown a marked increase during 1986. This is a considerable help in the funding of Acoustics Bulletin and we extend our thanks to the Advertisement Manager, Mr Sydney Jary, for his hard work on our behalf.

The Committee has also reviewed certain publicity documents used by the Institute. These are a descriptive leaflet for the Institute and a pamphlet on Education in Acoustics. These documents will be re-issued during 1986 in their updated form.

During the year the Committee has welcomed two new members: Mr John Sargent from the Building Research Establishment (who has been an Associate Editor for Acoustics Bulletin for some years) and Mr John Tyler, a private consultant, formerly employed by the Transport and Road Research Laboratory.

**Education Committee**

During 1985 the Education Committee, under the Chairmanship of Dr Roy Lawrence, has been almost exclusively concerned with matters relating to the conduct of the Institute's Diploma. The first syllabus revision has been completed and brought into operation in time for the 1986 examinations. Improved guidelines for the conduct of the Diploma Project exercise have been agreed and implemented.

One hundred and eighty candidates, a reduction of 47 on the previous year, took all or part of the 1985 Diploma examinations. This reduction meant that the Institute's income from this source was significantly less than had been anticipated. The overall pass rate was broadly as in previous years and resulted in 103 candidates being awarded the Diploma and 14 candidates being awarded Endorsement Certificates to Diplomas already held. The Instrumentation paper was offered for the first time in 1985 and the results in this examination were encouraging. Mr M Saunders from Tottenham College of Technology was awarded the Institute Prize for the best all-round performance in the 1985 examinations. Mr T Parkin of Leeds Polytechnic was awarded the 1984 ANC Prize.

South Bank Polytechnic were approved as a centre preparing Diploma students: Bristol Polytechnic, Derbyshire College of Higher Education and Tottenham College of Technology were reapproved unconditionally for a period of five years. The biennial Course Representatives' meeting was held in November, allowing an opportunity for views on the future development of the Diploma to be aired.

Arrangements were finalized for the introduction of the Institute's Distance Learning Scheme which involves tutored video instruction material which has been produced by Heriot-Watt University and will be used by the Institute under licence. The intention is that this scheme will be introduced in a pilot form in 1986.

Outside the Institute the Committee has been represented on a working party considering the establishment of an appropriate form of training and assessment for industrial audiometricians.

### Noise Council Committee

The Noise Council Committee took a major step forward during 1985 through the establishment of close working relationships with the Institution of Environmental Health Officers, followed by similar co-operation with the Institution of Occupational Safety and Health. A very satisfactory result has been the establishment of a joint Noise Council, bringing together the three major professional bodies in the UK concerned with noise.

Preliminary plans have been made for a launch meeting of the Noise Council in the House of Lords, sponsored by Lord Nathan, to be held in March 1986. The first publication of the Noise Council, dealing with aspects of noise legislation, is to be prepared for the launch meeting.

Co-operation with other concerned professional bodies has overcome many of the difficulties we have had over the past few years in seeking the best way forward for the Noise Council. This does mean that the Noise Council is no longer a committee of the IOA alone, but what we have (willingly) given up in control has been more than compensated for by the influx of new Noise Council members, new ideas and fresh enthusiasms.

### Medals and Awards Committee

This was a year in which presentations to overseas acousticians figured largely in our medal awards. The Rayleigh Medal was awarded to Professor Peter Westervelt from Brown University, Providence, Rhode Island, and was presented to him at the Spring Conference in York. On the same occasion Professor Leif Bjørno of the Technical University of Denmark gave the second Stephens Lecture, maintaining the high standard which had been set in the first lecture of this series. We were also happy at this Conference to welcome two distinguished persons to Honorary Fellowship of our Institute: Professor Sir Brian Pippard FRS and Professor Charles A Taylor. The AB Wood Medal was presented to Dr Timothy Stanton of the University of Wisconsin at the Underwater Acoustics Group Meeting at Portland in April. All the lectures were well presented and attracted keen audiences.

## REGIONAL BRANCHES

The Branches of the Institute of Acoustics 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

Six meetings have been held during the year, two of these being joint meetings with adjoining branches. The first of these was with the Yorkshire and Humberside Branch at the Town Hall, Darlington, but unfortunately the attendance was very poor. The second, at the Civic Centre in Carlisle, in conjunction with the Scottish Branch, was more successful with an attendance of about 20. The Oriental Music evening in May provided an intriguing, if noisy, introduction to Indian culture, and was followed by the more Western activity of sampling a good selection of cheese and wine.

In October, Newcastle General Hospital was the venue for what could be described as a revealing talk on Medical Ultrasonics which included demonstrations of the latest developments. The November meeting was held at Newcastle Polytechnic, consisting of a talk on vibration aspects of motor vehicles, followed by a visit to the laboratory where several demonstrations were set up.

*Table 2 Branch Membership*

| | |
|---|---|
| North East | 44 |
| Southern | 391 |
| South West | 71 |
| North West | 112 |
| Yorkshire & Humberside | 48 |
| Hong Kong | 74 |
| East Midlands | 99 |
| Scottish | 58 |

### North West Branch

There were six meetings of the Branch held during the year, producing an average attendance of just over 16 which was slightly up on 1984. The Annual General Meeting of the Branch was held in January and featured a joint presentation on Testing of Hearing Defenders by Dr Ian Hempstock and Mr Paul Clarke. In March a visit was arranged to the facilities of British Aerospace at Warton, Lancashire, followed by talks on their work by scientific and engineering staff. The next visit was to Manchester International Airport in May to view the new noise monitoring installation and aircraft handling system. The meeting in July was an illustrated talk on the selection of practical vibration transducers for industry by Mr Tom Murphy of Vibro-Meter. After the summer holiday a visit was made to the float glass plant and glass museum of Pilkington Ltd at St Helens, followed by a talk on the acoustics of glazing by Mr Cliff Inman. The vibration isolation by foundation design of large reciprocating machines was the subject of a talk by Mr Karl Pratt of Vibronoise in November.

It is estimated that the catchment area for the Branch contains 100 or more corporate members, as well as students from the University of Salford and Liverpool Polytechnic, and it is surprising that more have not attended since the formation of the Branch. All who did manage to come on the visits or to the talks expressed themselves as being satisfied with the programme and content. The Committee has been addressing itself to the problem of attracting a higher proportion of the remainder. The difficulties are not unique to this Branch; others are experiencing similar reluctance on the part of their members to allocate

time to the local activities of the Institute. To that end, the Committee appointed from its number two programme secretaries who were charged with the task of putting together a series of events over the next two years which should prove irresistible to our members. The programme has now been produced, and with sufficient advance notification and attractive packaging it is to be hoped that there will be better attendance.

To those who continue to provide support, whether from within the membership or outside it, the thanks of the Committee are extended. In particular, the provision (gratis) of meeting facilities at County Hall by the Greater Manchester Council has been much appreciated. Sadly, the abolition of the Metropolitan Councils means that we will need to seek anew for a regular (if infrequent) venue with car-parking attached. Again, the assistance of the Secretariat in Edinburgh is gratefully acknowledged: members are often unaware of the level and amount of input provided by Headquarters Staff. And last, but by no means least, we must wish farewell to Mr John Dinsdale, Hon Secretary to the Branch for the last three years and to Mr Don Baines, both of whom retire at the next AGM.

**East Midlands Branch**

The annual programme of events for 1985 included two technical visits and two evening meetings with specially invited speakers. Unfortunately, the year got off to a poor start when the first meeting scheduled for February had to be cancelled at short notice due to the illness of the speaker. The deferred AGM was held in May at the invitation of Q-STUDIOS, Queniborough, Leicester. Following the AGM, those attending experienced the 'Q-Awareness Evening' comprising a tour of the Studios which covered many aspects of video, including production in the two TV Studios, video editing, sound recording, the uses of video films in business and a demonstration of Q-video programmes.

In September, members and guests visited the Royal School for the Deaf in Derby. The Principal, Mr D Langley, explained the work of this non-maintained school, followed by a tour of the facilities. Those present were impressed and moved by the commitment of the speaker to the special educational needs of hearing impaired individuals.

Mr G H Vulkan, Assistant Head of Scientific Services at the Greater London Council, kindly agreed to speak to the Branch in December. He discussed the work and development of the noise section since its inception in 1961. Aspects highlighted included aircraft noise monitoring at Heathrow, the proposal to build a STOLport in London's Dockland area and the recent London Lorry Ban. The Branch, and indeed all those working in the field of acoustics, wish Mr Vulkan and his colleagues at the Greater London Council as well as the staff of the other Metropolitan Authorities, every success in the future following Abolition.

The year was marred in December by the resignation of Mr John Savidge, one of the instigators of the East Midlands Branch and Chairman since its inception in 1982. The Committee, on behalf of the Branch, would like to express their thanks for his valuable past service.

**Scottish Branch**

A decision was made at the 1984 Branch AGM to vary the timing and content of events in an attempt to increase the attendance at Branch meetings. To this end 1985 began with an interesting evening meeting at Strathclyde University on the subject of fluid noise. Unfortunately only 13 members attended.

In early May a half-day visit to the National Engineering Laboratory at East Kilbride was arranged by Pat McNulty. The effort and hospitality of the NEL staff was exceptional and it was rather disappointing that only 10 members were present.

The AGM on 9 October followed a successful afternoon meeting on sound insulation aspects of party walls and floors — a popular subject in Scotland. It was agreed by the 17 members attending the AGM that in view of the geographical problems facing the Branch a reduced programme should be planned for 1986. Following the acceptance of the constitution an approach will be made to the Council for formal recognition of the Scottish Branch.

**Yorkshire and Humberside Branch**

The only activity during the year has been that of hosting the Spring Conference of the Institute at York University, and thanks are due to the Committee and Branch members who helped to make this a successful event. As in the previous year there is an apparent lack of interest in the Branch's activities by the majority of its members. This has been reflected in the enthusiasm of the Committee over the past year and it has been agreed that some fairly positive action is needed to enable the Branch to continue its function. In an attempt to determine the interests of the Branch membership, the Committee sent a questionnaire to all Branch members with a reply-paid envelope to try to ensure its return. From the replies received it appears that the membership does not wish to see any major change — nor does it wish to see the Branch disappear. However, some useful information has emerged from the replies and the new Committee will take up the ideas proposed.

In the circumstances both the Chairman and Secretary felt unable to continue in office. After considerable discussion Mr David Marsh eventually agreed to become Chairman on the understanding that both the continued support of Mr John Bickerdike as past Chairman and the availability of the meeting facilities of Leeds Polytechnic could be relied on. The retiring Committee members were Mr John Charman and Mr Barry Heald and the vacancies were filled by Mr Mike Squirrell, Mr Len Bean and Dr Steve Turner.

**Southern Branch**

The Southern Branch has enjoyed a varied and interesting range of presentations during the year, and the Chairman is pleased to report that attendances have been rather larger than in recent years. In February, Dr Neil Halliwell of ISVR intrigued members with the wonders of his optional vibration measurement systems, including torsional vibration measurement on a wildly dancing, square shaft. Hopes of visiting an operational on-shore drilling rig in March, in conjunction with a lecture on their noise problems and control, were dashed by scheduling difficulties, but the lecture by Mr Colin English of Acoustic Technology Ltd contained plenty of surprises. Mr Ian Acton of ACHCU, ISVR, amused his audience in May with anecdotes based upon his experiences as an expert witness, revealing some of the secrets of court warfare and hotel bedrooms. After the summer break, Dr Raf Orlowski of Salford University explained the 'non-sabineness' of factory hall acoustics to a lively audience at Portsmouth Polytechnic, and in November a joint meeting with the Chartered Institute of Building Services Engineers in a Southampton Hotel was treated to fascinating revelations of bump and grind in building service systems by Mr Alan Fry and Mr Peter Allaway, both well-known and experienced consultants in noise and vibration control. The 1985 Annual General Meeting was postponed until 19 February 1986, in order to ensure a good attendance.

**South West Branch**

Only one meeting was held by the Branch in 1985, a highly successful joint venture with the Cornish Branch of the Institution of Environmental Health Officers. An all day Seminar on Noise and Planning was combined with the Bruël & Kjær exhibition at St Austell. Over 50 attended the meeting with papers by local government officers, a councillor and an industrialist. The meeting concluded with a lively discussion.

The problems facing the Branch are the large travelling times involved in reaching a suitable venue and the thin distribution of members in the south west. Rail travelling time from Penzance to Bristol is over four hours and only three quarters of an hour less than to London. Yet most people regard Bristol as being in the south-west! In these circumstances it is difficult to plan any type of meetings other than all-day seminars so that the effects of the time spent in travelling are minimized.

**Hong Kong Branch**

One of the problems of very remote Branches is that regular communications with the central body are made more difficult. It is known however that the Branch was involved in the organization of the Second Pacific Regional Acoustics Conference (WESTPAC II). No formal report has been received but from informal contacts it is apparent that the Branch is active and flourishing.

**London Evening Meetings**

The programme continued in January with a meeting on Sound Insulation by Mr John Miller of Bickerdike Allen Partners. He spoke about the CIRIA manual that BAP are producing on sound insulation and described some case histories of various remedial measures. The February meeting was well attended with a talk on noise and mental health by Dr Stansfeld from the Institute of Psychiatry. He outlined various laboratory experiments on the physiological effects of noise, then discussed the findings of a survey of aircraft noise and mental health. The third talk of the year was given by Mr Paul Lattimore of the Greater London Council Scientific Services Branch on the noise aspects of the GLC lorry ban, covering such aspects as the noise test procedures and the 'hush kits' available to quieten lorries. The final meeting was very well attended with over thirty people listening to Dr J J Knight of the Institute of Laryngology and Otology giving an interesting presentation on acoustics and audiology.

Although the meetings have continued to be successful, with an average attendance of over twenty people per meeting, a further series of meetings has not yet been arranged due to difficulties with accommodation. It is hoped that if the GLC's Scientific Services Branch survives in one form or another, they will continue to host further sessions of the London Evening Meetings. The Institute has asked the London Evening Meeting organizers to give consideration to the possibility of setting up a formally constituted London Branch. Discussions are continuing concerning this proposal and members will be kept fully informed of any future developments.

## 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 various specialisms within this multi-disciplinary subject.

*Table 3 Group Membership*

| | |
|---|---|
| Physical Acoustics | 68 |
| Underwater Acoustics | 128 |
| Industrial Noise | 537 |
| Speech | 95 |
| Musical Acoustics | 81 |
| Building Acoustics | 331 |

**Speech Group**

In 1985 the Group organized three technical meetings. The first was an all-day meeting, organized by Mr J S Bridle (JSRU), on the topic of stochastic optimization for perceptual interpretation. This meeting was held jointly with the British Pattern Recognition Association at University College London on 7 January. More

than 150 people attended to hear Professor G Hinton of Carnegie-Mellon University present two lectures on his 'Boltzmann Machine' approach to perceptual modelling. These were followed by six short papers, three of which were concerned with the implications of Boltzmann Machines for speech pattern processing.

The second meeting took place at the University of Lancaster on 17 April. Dr N M Brooke (Lancaster) organized a meeting on speech synthesis by rule where six papers were presented. The third meeting was a two-day mini-conference organized by Mr D W Hardcastle (Reading) and Dr G Kaye (IBM) at the IBM UK Scientific Centre in Winchester on 16-17 December which over fifty people attended. The topic for the first day was instrumentation and six papers were presented covering a range of devices and tools for measuring different aspects of speech signals. These were followed by various demonstrations and a tour of the facilities at the IBM Centre. On the second day eleven papers were given on the topic of coarticulation.

The Speech Technology Assessment Group (STAG) steering committee has continued to hold regular meetings: four during 1985. Two information/news bulletins have been released to the membership of the Speech Group; the first announced STAG's successful approach to the National Physical Laboratory with a view to involving them in a collaborative project in the field of speech technology assessment, and the second outlined recommendations for recording standards for PCM digital audio systems.

The programme of meetings for 1986 has yet to be finalized, but it is expected that in addition to the usual one-day meetings, the Group will be well represented at the Institute's Autumn Conference in Windermere.

**Musical Acoustics Group**

As shown in Table 2, Group membership stands at 81. About 13 of these are from overseas and 80% of the remainder live in areas covered by the Southern, South West and East Midlands branches, so a concentration of activity in the south is perhaps not too unfair.

Early in January, a small group of members visited the Horniman Museum at Forest Hill. Frances Palmer, keeper of musical instruments, gave an illuminating lecture on the history of the museum (established by the Victorian tea magnate) and some of the unique musical instruments in its extensive collection.

Facilities for the AGM were kindly made available by Boosey and Hawkes at their Edgware factory, and members were able to gain some impression of the variety of the firm's activity; of instruments, cases and accessories; of brass, woodwind, strings and percussion; and of precision engineering and skilled hand craft, including polishing around all those awkward valves. Sadly, even this incentive lured few to the AGM: only one non-committee member was present. Elections were therefore uncontested, and voting unanimous.

In April, a larger group visited the BBC Research Department at Kingswood Warren. Members familiar with the problems of Maida Vale 1 were able to renew acquaintance with the scale models used in acoustic testing of the studio. The technology in development and on display, especially in loudspeaker measurement, was, if possible, even more impressive than the setting; while envious glances were cast at the croquet hoops on the lawn, feelings of guilt at the sheer disrespect of listening to programmes on a battered transistor radio were inescapable.

Gracious surroundings were maintained in the summer with a visit to Finchcocks in Kent. This Georgian house, in splendid grounds, contains a fine collection of harpsichords, clavichords, chamber organs and early pianos. For once, permission to play the instruments was almost less exciting than the demonstrations; never will the Rondo alla Turka be the same without percussion built into the piano.

Members of the group had a particular interest in the Institute Autumn Conference on Reproduced Sound, but their own technical meeting takes place in March with a day on Materials for Musical Instruments at the London College of Furniture. It is hoped that this will attract a good attendance for the (brief!) AGM. Looking forward to the coming year, the 1987 Spring Conference includes a musical acoustics session and members are encouraged to start preparing their papers.

**Underwater Acoustics Group**

Two very successful conferences were held during the year. The first, on scattering phenomena in underwater acoustics, was held over the two days 2-3 April at ARE Portland, and attracted 94 delegates. Of the 22 papers presented 9 were from either Europe or North America. Dr C Sienkiewicz from the Applied Physics Laboratory, Washington University, Seattle was invited to present an overview of the outstanding problems in boundary scattering. The other papers presented covered such areas as sea bed scattering, mathematical modelling, sidescan and mapping techniques, volume effects and scattering from man-made targets.

The second conference was on array signal processing and was held at the University of Technology, Loughborough, on the 16-17 December and was attended by 85 delegates. Dr S L Marple of Schlumberger, Texas was invited to present a keynote address. This was followed by 22 papers, 8 of which were from abroad.

During the year the Underwater Acoustics Group Committee has given some consideration to the possibility of refereeing the papers submitted for publication in the proceedings of conference. Now that the Institute provides an acceptable method of referencing the papers presented at conferences, it was considered that providing a peer review service would be of benefit to the membership. However, it was felt that the added lead time involved might be too great.

Last year it was reported that the sponsoring of an author to write a book on Underwater Transducers was being pursued. Discussions are now at an advanced stage and it is expected that the work will shortly be commissioned with the actual publication scheduled for Spring 1988.

**Building Acoustics Group**

The year started with a BAG-sponsored special feature in the January edition of Acoustics Bulletin. The subjects covered in these seven articles, ranging from music teaching rooms to domestic buildings, illustrated the breadth of interests of building acousticians. This diversification was further echoed in the Auditorium Acoustics meeting held in February. A full and varied programme of ten papers, from objective measurements in Danish concert halls to computer simulation and the design of orchestra pits, was brought to a successful and practical conclusion with an evening concert in the University of Cambridge Music Room.

The Spring meeting in York had two well attended sessions dedicated to building acoustics. Ten papers were presented, including two from overseas. Subjects included the transmission loss in timber-framed building, the acoustic benefits of upholstered Church pews and the control of noise and vibration in microelectronics Clean Rooms.

**Physical Acoustics Group**

This joint group of the Institute of Acoustics and the Institute of Physics came into existence in February 1985. For some years there had been no specialist group active in the specific field of physical acoustics. This new group has evolved from an informal group which has been active in the field for some years since the old Physical Acoustics Group ceased to function and it involved mostly members of the academic physical acoustics community. The residual activity in this field within the IOA has been maintained by Dr R W B Stephens, and it is intended that the new group should complement his achievements. The group with its position as part of both the IoP and the IOA will seek to facilitate a comprehensive coverage of all aspects of physical acoustics. The lack of a specific IOA or IoP group in this field has resulted in other groups and organizations tending to provide meetings to cover aspects of this field. It is already clear that the PAG can and has held successful meetings, but it will need to demonstrate that it is capable of becoming a focus for those active in this field in the UK. It is intended that whenever possible joint meetings with other groups and organizations should be arranged. It is also clear that it will take some years for group membership levels to grow significantly from the present 140 members which are derived almost equally from the IoP and the IOA. The 1986 subscription documents were the first to include the new group and the new returns will provide some measure of interest in this field within the two Institutes.

The first meeting of the Group was on acoustic microscopy and its applications and was held on 27 February in London. About 70 people attended the meeting which reviewed the subject and in particular considered applications for these microscopes which are now available as commercial instruments from several companies. A general meeting on current research in physical acoustics was held together with the AGM at Oxford on the 26 September. A series of interesting papers were presented to a regrettably small attendance of about 25. The final meeting of the year considered remote generation and reception of ultrasound which was co-sponsored by the IoP group on ISAT. This attracted several people from Europe and one from the USA to a meeting which had a very high technical content, but only a modest total attendance of less than 40. The group was associated with a meeting on physics in medical ultrasound held in Durham on 11-12 July and organized by the IPSM.

The 1986 programme has now been prepared and will contain two topical meetings and a general meeting on current research in ultrasonics and physical acoustics which will be linked with the AGM and a visit to University College London. At present both the Chairman (Dr D P Almond) and the Secretary (Dr L J Bond) are from the IoP half and it is hoped that IOA representation can be improved on the committee. At present the committee is a steering committee as a joint constitution has yet to be agreed by the Councils of the two Institutes.

**Industrial Noise Group**

Although this Group is, in numerical terms, one of the largest in the Institute it is at present showing every sign of being one of the least active. Perhaps the subject area that it is attempting to cover is too wide to encourage enthusiastic participation or maybe the absence of significant levels of academic research in the area is to blame. Whatever the reason it is hoped that in the coming year the Group Committee will be able to stage some kind of comeback.

## ADMINISTRATION

Mrs Cathy Mackenzie and her staff at Edinburgh have continued to provide a friendly and flexible service to the Institute and its membership. It is worth noting in this context that since the Secretriat was moved to Edinburgh the Institute has nearly doubled in size, significantly increasing the administrative and accounting workload; there are more formal meetings run with higher standards of presentation; the sale of publications has increased substantially and the Diploma has expanded in numerical terms and extended in scope. All of this increased workload has been accommodated with virtually no increase in numbers. The cheerful hard work of the Headquarters Staff constitutes a valuable asset in the Institute's many varied activities. Council would like to put on record its thanks to everyone involved in this aspect of the Institute's affairs.

# IOA Branches and Groups

**East Midlands Branch**
**Chairman**
Mr F McCorry MIOA
**Treasurer**
Mr D J Snow MIOA
**Secretary**
Mr F McCorry MIOA
11 Templeman Close
Ruddington
Notts NG11 6BT

**Hong Kong Branch**
**Chairman**
Mr David Lees MIOA
**Treasurer**
Mr P Berriman MIOA
**Secretary**
Mr Aaron Lui MIOA
Flat 2
8/F 419S
Queens Road West
Hong Kong

**North East Branch**
**Chairman**
Mr N Marshall
**Treasurer**
Mr B Oakes FIOA
**Secretary**
Mr R Bainbridge MIOA
Hawthorne House
North Street
West Rainton
Co Durham DH4 6BL

**North West Branch**
**Chairman**
Mr M S Ankers MIOA
**Treasurer**
Mr G Kerry FIOA
**Secretary**
Mr C Waites MIOA
6 Wragby Close
Brandlesholme
Bury
Lancs

**Scottish Branch**
**Chairman**
Mr W McTaggart MIOA
**Treasurer**
Mr J Stirling MIOA
**Secretary**
Mr W Laurie MIOA
48 Gartcows Road
Falkirk FK1 5QT

**Southern Branch**
**Chairman**
Mr I J Sharland FIOA
**Treasurer**
Mr G R Charnley MIOA
**Secretary**
Dr F J Fahy MIOA
ISVR
University of Southampton
Southampton SO9 5NH

**South West Branch**
**Chairman**
Mr R Vanstone FIOA
**Secretary**
Mr M Squires MIOA
1 Feebers Cottage
Westwood
Broadclyst
Nr Exeter, Devon

**Yorkshire and Humberside Branch**
**Chairman**
Mr D Marsh FIOA
**Treasurer**
Mr J Tubby
**Secretary**
Mr B Anderson MIOA
East View
75 Warren Lane
Eldwick
Bingley
West Yorkshire

**Proposed London Branch**
Please contact Mr J Simson at London Scientific Services, The County Hall, London SE1 7PB

**Building Acoustics Group**
**Chairman**
Dr G M Jackson MIOA
**Treasurer**
Mr N Spring FIOA
**Secretary**
Dr L C Fothergill MIOA
Building Research Station
Garston
Watford
Herts WD2 7JR

**Industrial Noise Group**
**Chairman**
Mr S Bennett MIOA
3 Meadow Rise
Church Broughton
Derbyshire DE6 5DF

**Musical Acoustics Group**
**Chairman**
Dr A E Brown FIOA
**Treasurer**
Mr T M Pamplin MIOA
**Secretary**
Dr Jennifer Zarek MIOA
Dept of Musical Instrument Technology
London College of Furniture
41 Commercial Road
London E1

**Physical Acoustics Group**
**Chairman**
Dr D P Almond
**Treasurer**
Dr D P Almond
**Secretary**
Dr L J Bond
Department of Mechanical Engineering
University College London
Torrington Place
London WC1E 7JE

**Speech Group**
**Chairman**
Dr R K Moore MIOA
**Treasurer**
Mr L Moye
**Secretary**
Dr N M Brooke MIOA
University of Lancaster
Lancaster LA2 6HX

**Underwater Acoustics Group**
**Chairman**
Dr B V Smith MIOA
**Treasurer**
Mr J R Dunn MIOA
**Meetings Secretary**
Dr N Pace FIOA
**Secretary**
Dr L Lipscombe MIOA
Lower Noarhill Farm
Selborne
Hants GU34 3LW

# BRANCH AND GROUP NEWS

**North West Branch**

It was on a fine day in March that a small band of branch members gathered in the shadow of the cooling towers and chimney of Fiddler's Ferry power station for what turned out to be a fascinating and instructional tour. The largest of the CEGB's stations in the North Western region, its capacity of 2,000,000 kW is sufficient to meet the peak demand of both Liverpool and Manchester. On full output, about 16,000 tonnes of coal (25 train-loads) are burned on an average weekday.

We started at the beginning with the coal being delivered by rail from the coal-fields via a loop branch line to hoppers, from which it is passed by conveyor either to stock or directly to the pulverizing fuel mills. Here it is ground, mixed with preheated air and blown into the watertube boilers. The resultant steam is superheated and used to drive four 500,000 kW turbo-generators, after which it is condensed and returned to the boiler. Electricity is produced at 22,000 volts which is transformed up to 275,000 volts for distribution through the supergrid transmission system ring around Liverpool and then to the National Grid.

The cooling towers which are so much a feature of power stations serve to provide cooling water to the condensers. Water is drawn from the Mersey at a rate of 195 million litres per day and, through sprays, reduces the temperature of the recycling boiler water. About 60 million litres per day are passed to atmosphere or otherwise lost. Combustion gases are drawn though fans and up the stack, first being cleaned by ash collectors and electrostatic precipitators. Pulverized fuel ash (PFA) is removed from the EPs and sold, as is the coarse ash from each combustion chamber.

The overwhelming impression is one of sheer size. The turbine hall is a huge space, but is itself dwarfed by the cathedral-scale of the boilers themselves. Even the (very quiet) control room would accommodate a pair of semi-detached with gardens! Ear defenders and hard hats were provided for all. Noise-hazard areas were clearly identified but subjectively very few seemed to reach the magic 90 dB(A). The site itself, 405 hectares in extent, is substantially grassed and well landscaped. We were guided by Mrs Martin and Mrs James, two of a team provided by the CEGB, whose knowledgeable and efficient manner made this long afternoon both memorable and enjoyable.

**Mike Ankers**

**Visit to Agecroft Colliery**

It was the second piece of toast I choked on as the voice on the other end of the phone said 'I am sorry but we only have one guide, we will have to cancel the visit'. Several hectic phone calls later the same voice was saying 'It's OK now, we have found another guide'. My apologies to Nick Kitchin who was the only one to miss this exciting visit; we will arrange a return visit in the next few years.

After a safety demonstration we changed into our old clothes and were kitted out with a helmet, lamp and breathing mask. We set off for the cage that would transport us deep underground. Our guides Bernard, Karl and Robert showed us how to operate our lamps and explained that we were falling at about 32 ft per second. A train was waiting at the bottom which took us on a 15-minute ride towards our destination. The remainder of the journey was made on man-carrying conveyor belts and by foot.

As we moved deeper the steel arches that supported the roof became distorted; some were almost unrecognizable. There was a dramatic increase in temperature and as we approached the face through a small tunnel we were shown an area that was being ventilated to prevent spontaneous combustion. The face sloped steeply and further progress was made by holding onto the many hydraulic rams that supported the rock above. Here we met a salvage team who were trying out a new technique for supporting the roof. Further down the face we watched the huge rotary cutter and crusher making short work of extracting coal from the face. The Colliery produced 519,155 tonnes of coal last year, of which 33% supplied the industrial and household market and 67% is fed directly to Agecroft Power Station.

Dust and sweat laden we set off back, riding face down with the coal on the conveyor belts. Back on the surface we were grateful for the hot shower followed by an enjoyable buffet. The thanks of the branch were given to our hosts for their hospitality and for making our visit so enjoyable.

**Chris Waites**

Future meetings planned by the North West Branch include 'Meet the IOA' — an open invitation to acoustic undergraduates to meet members of the Institute over a pie and a pint in a local pub, in October.

## Letter from the Vice-President Groups and Branches

The lack of enthusiasm amongst branch committee members reported in my last letter has apparently spilled over into group activities. The largest group in the IOA, the Industrial Noise Group, is struggling at the moment to fill the vacancies on its committee. There are over 500 members in the group but Stewart Bennett, the Chairman, cannot find any enthusiastic help to organize its activities.

The duties of committee members are not onerous and the need to attend meetings can be drastically reduced provided communication is maintained with the Group Chairman and Secretary. If anyone is prepared to help Stewart out, perhaps organize the technical content of a meeting or a visit, please contact him on 0283 216161.

London and Home County members who attended the excellent series of London Evening Meetings will be pleased to know that there are plans to revive them with the formation of a London branch. It is intended to extend activities a little to include the odd one-day or half-day meeting but the mainstay of the proposed branch activities will be along the lines of the past early evening meetings.

Another branch in the news is the Hong Kong branch. They (ie all fourteen of them!) have just organized a successful Westpac II meeting with 100 acousticians taking part from Japan, Australia and other countries in that part of the world. Well done Hong Kong.□

**Geoff Kerry**

**Southern Branch**

The AGM of the Southern Branch was held in February. Ian Sharland was re-elected as Honorary Chairman, and Geoff Charnley and Frank Fahy continue as Hon Treasurer and Hon Secretary respectively. After a considerable number of years of valuable service to the committee, John Pollard and Andrew Blackburn stood down to make way for Brian Parker and Neil Baines to join Martin George as ordinary members. Brian works for Portsmouth City council, and Neil is a consultant with Stewart-Hughes Ltd at Chilworth Research Centre, Southampton.

Following the AGM the branch were treated to an authoritative survey of progress in the development of noise legislation with particular reference to recent EEC noise legislation by Mr Alan Dove of the DHSS; not surprisingly, this was followed by a lively discussion. In March, Mr Derek Astridge of Westland Helicopters presented a lecture on **Health monitoring of helicopters,** which impressed the audience with the enormous amount of work and testing which goes to ensure that the highest possible standards of safety are achieved.

At their recent meeting the committee agreed to co-opt Dr Phil Nelson of the ISVR, together with a representative of the newly formed Southampton University Student Acoustical Society. The latter innovation follows the lead given by the students at Salford University.□

**Frank Fahy**

## A London Branch?

One of the less well publicized results of the abolition of the GLC was that the IOA's London Evening Meetings came to an untimely end. Now that the dust has begun to settle, and at least the old GLC Noise Group continues to function as part of London Scientific Services within the London Residuary Body, it seems a good time to look again at Institute activities in the capital.

London Evening Meetings proved to be a very successful format for informal presentations and the exchange of ideas. It is now intended to start a new series in September where it is hoped to expand the programme to cover a wider range of technical interests than in previous series. This also seems to be an appropriate time to put London Evening Meetings on a more formal basis. I would therefore be very pleased to hear from anybody who would be interested in supporting a London Branch of the Institute. In addition to a new series of London Evening Meetings it should be possible to put together an interesting programme of acoustical activities.

An ad-hoc group of IOA members met in early May to look at what future activities might be fruitful. This meeting has undertaken the task of setting up the London Branch subject to the views of the IOA Council and, of course, the support of members and associates.□

**John Simson**
London Scientific Services
The County Hall
London
SE1 7PB

**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 Friday 15 August.**

# Living with Airfields, Now and in the Future

## The Airfields Environment Federation Conference

AIRPORTS are not generally popular neighbours. Ten years ago, the Aircraft Environment Federation was set up because of the frustration felt by people who apparently had no means to reduce the impact of airfields situated near their homes. Since then, the AEF has tried to draw the balance between the interests of the aviators and the needs of the environment. The approach has been to promote informed discussion of the problems that are encountered, the available scope for action and the methods available. Whilst the AEF is clearly an environmental pressure group, chiefly interested in general aviation (GA), its members are dedicated to the promotion of consultation with policy makers and enforcement bodies both nationally and locally. This conference, held at the Institution of Civil Engineers on 11 March, was an example of the conciliatory approach to achieving an improvement in environmental standards for GA.

Moyra Logan, executive secretary of the AEF, opened the conference with a paper describing the nature of problems that have been encountered at small airfields. People are fearful not only about the possibility of accidents, but also that vulnerable amenities can be threatened and that there is no recourse for action in law. Alienation results, as the threat of unacceptable changes seems to be imposed by commercial or bureaucratic authority. Fun flying and GA activities generally are seen as being elitist, causing feelings of injustice and resentment. To maintain the balance of interest, the AEF suggests that more careful planning is required in conjunction with effective regulation of flying and noise reduction at source, all within the framework of effective dialogue between aviation interests and the community. A programme of future action is suggested.

Going from the general to the particular, Peter Bryant, the County Planning Officer for West Sussex, described the success achieved at Goodwood and Shoreham. Agreements made under Section 52 of the Town and Country Planning Act have provided a good means of regulating commercial and recreational flying patterns, including the number of movements and times of operation, to maintain a fair compromise between the needs of the airfield and those of the community. Problems of monitoring the agreements showed that, despite good records being kept of business aviation, there was a serious lack of information on training flights which the operators were just as pleased to rectify as the environmentalists. Good public relations and the use of Airport Consultative Committees do reduce conflict, demonstrating how important is regular information exchange in improving mutal understanding.

The history of the development of aerodrome regulations since 1920 is not the dry legalistic topic that the title suggests, at least not the way it was told by A J O'Connor, the Director General of the Operations Division of the Civil Aviation Authority. His paper highlighted the reasons for many of the regulations which both control and protect airfield operations, and traced their development as technology advanced. Responsibilities for environmental matters were laid at the door of the Government and not the CAA which is more concerned with safety than noise. Whereas safety measures rely heavily on clear standards, albeit some of these are recognized as being arbitrary, environmental decisions seem to depend on subjective judgements of society at large, setting one set of opinions against another. These judgements may also seem arbitrary when comparing the media attention devoted to the threat of an airfield with, say, the nuisance caused by noisy motorcycles. The campaign 'It's Hell Under Helilink' against the Heathrow-Gatwick helicopter shuttle was mentioned as a case in point.

Interests of the pilots were represented by R D Campbell, chairman of the British Light Aviation Centre and an experienced pilot and pilot instructor and examiner. GA has a high value to the community in such areas as agriculture, public services such as air-ambulance and the transfer of blood and human organs for transplant, survey work, law enforcement and as a technical aid to industry. Once more the case was made for better information to the public. Private and recreational flying accounts for only 10% of GA movements so the much resented image of GA as just 'flying for fun' is a false one. The UK Aircraft Owners and Pilots Association produces regular bulletins which include reminders on noise sensitivity and other information designed to help pilots reduce the nuisance they cause. The Association would be pleased to receive any practical suggestions on other ways in which they can lessen noise grievances within the community. One sobering statistic however: the UK probably has the lowest ratio of aerodromes per head of population of any European country, only one aerodrome for every 400,000 people. In the United States there is one for every 12,000.

Noise measurement and its use for controlling the impact and nuisance caused by GA was discussed by John Simson of London Scientific Services (née the GLC Scientific Services Branch). Many people seem to think that by measuring a noise, the problem will somehow be made to go away. After a brief résumé of various noise measures available and the place of aircraft noise certification, some practical suggestions were made on the use of airport noise monitoring systems and noise limits to control nuisance. It would be wrong to assume that noise nuisance suddenly begins at a particular noise exposure value; the percentage of people expressing serious annoyance increases steadily beginning at quite low noise exposures. By the same token some people will never be annoyed however unpleasant the noise climate may seem to be.

Michael Spicer, the Parliamentary Under Secretary of State for Transport, was the last speaker. It is the Government's policy to encourage air travel but action is also being taken to deal with the noise problems. Noise is being tackled at source through the Aircraft Noise Certification Regulations; all non-certificated aircraft will be banned by January 1988, and those on the British Register ceased to operate on January 1st this year. Helicopter noise certification standards from the International Civil Aviation Authority will be adopted in the next few months. Reviews have been made of the use of $L_{eq}$ to replace the Noise and Number Index and a further study has recently been completed on aircraft noise and sleep disturbance. The Minister has direct responsibility for noise control and sees wide consultation as a key part of the decision making process.

The conference concluded with workshops and a panel discussion. Copies of the full Proceedings including the questions, workshop sessions and panel discussion which closed the conference can be purchased from the AEF (Telephone 01-378 6766).□

# ANC REPORT

SINCE last year's report, the Association of Noise Consultants has celebrated its first thirteen years of progress, and continues to represent the independent noise consultants with currently twenty-two member firms. The recent AGM concentrated on many problem matters, such as the frustration caused by inconsistent attitudes of local authority officers in adjoining boroughs (consultants always agree!), unfair competition from acoustic contractors offering free advice, and the most vexing and perennial problem of whether the Association should have a different name. The name problem relates to the extensive range of services provided by ANC consultants, much of which would not be considered as noise consultancy. Suggestions included the adoption of titles such as: Noise and Vibration Consultant, Acoustician, Acoustics Engineer, Chartered Engineer (acoustical), to 'Sound Man'. To illustrate the reasons for this lack of clear identity, some examples of members' recent work are outlined below.

In the last few years noise consultants managed to assist developers to obtain planning permissions for two new major airport developments in UK despite hostile opposition both from members of the aggrieved public, other members of ANC, and what appears to be a large number of very eloquent legal gentlemen. Currently one member is trying to assist the local authority in protecting a rural village from the effect of a Jumbo Jet maintenance facility.

The extensive range of work of one consultant firm can be illustrated by two aspects of their current activity. Whilst working with the architect to achieve good acoustic conditions for passengers within an airport terminal building, they are carrying out studies on the Ariane 5 space launcher system to achieve a 24 dB improvement in airborne sound reduction compared with existing performance by design of the fairings for the payload zone. The proximity of large rocket motors to a delicate cargo in the payload is one of the many interface problems tackled.

It was alleged that a new London Night Club would create a nuisance. After work by contractors to a member's specification, the critical test was made. The owners of the club flew their PR men in from New York for the occasion, and at 2.00 am the consultant asked the neighbour where she heard the night club noise most: 'I haven't heard anything yet — I just felt sure there would be', she said.

Another interface conflict is that arising from carrying out noisy major building repairs whilst occupancy continues; recent examples include a hospital in the West country which has to be kept acceptably quiet whilst it is rebuilt and the older structure demolished to overcome 'concrete cancer'. The second case was a building with defective external facing on a concrete structure; tests were made with various drills to determine the area that could stay occupied whilst major facade repairs were made.

An unusual recent project is a study for the Department of Transport, attempting to damage a building by low frequency noise and groundborne vibration from heavy road vehicles. To simulate the two effects, firstly a large hydraulic vibration was used to produce groundborne vibrations which would occur when heavy vehicles hit a bump in the road. The low frequency noise was obtained by setting four high power 18-inch loudspeakers into the side of a refrigeration lorry, and parking this near the test house. The degradation to the test building was monitored, and the rumour is that the building came out of the attack surprisingly well.

A recent study on a residential redevelopment over the London Underground indicated excessive reradiated tube noise in the flats, due to considerable vibration which had nevertheless not damaged the flats over the last forty years.

Final acoustic commissioning tests are in progress at the Queen Elizabeth Conference Centre, near the Houses of Parliament. The tests are the culmination of a ten-year consultancy which dealt with all aspects of architectural acoustics, as well as the building services noise control for this fully air-conditioned building. Similar acoustic design work is in progress on several auditoria, including a new school of music, a small 1200 seat concert hall, and use of circular domed halls for orchestral concerts. Such work is accompanied by the continued use by UK consultants of Dr M Barron's model testing service at Cambridge.

In contrast to the requirements for unaided music or speech performance, work has been carried out on the design of better sound systems for small and large religious buildings. The specially developed Abbey Mk X loudspeakers have been included in new systems at York and Lincoln Cathedral. It is not always necessary however to install new equipment. Recently at the Derngate Theatre, a member was able to reconfigure the central cluster loudspeaker array, reset the graphic equalizer, introduce a compression limiter, and avoid the total replacement of the sound system expected by the client. The client found he had two thirds of his projected budget left to spend.

Several projects during the last year have continued the effort to establish the usefulness of Leq as a measure of noise annoyance and nuisance, if only as a reliable starting point. Manchester Airport has adopted the 24 hour Leq index as a basis for assessment of noise exposure. Attempts have been made to persuade Courts and Planning Inquiries to take some note of its value and although it has been necessary to duplicate assessments by other methods the results have generally justified the Leq approach.

The 'other' confrontation at Wapping was between ANC consultants, one of whom was working for local residents disturbed by News International plant, and one who did noise studies on that new works and those for the Daily Telegraph and Associated News Group. The work at Wapping has concentrated on noise control for the large axial fans ventilating the main print hall, and other noise sources on site; picket noise has not been solved yet!

ANC consultants have also been busy abroad with studies of helipads in Hong Kong, environmental noise regulations in the Middle East, palaces in Indonesia, equipment noise for the Singapore metro, and auditoria in Tai Wan and South Korea. They also have tried to resolve numerous neighbour noise disputes, in which sound insulation possibly has some role, although attitude effects such as 'interfering whining inconsiderate ____! ____!' are often a major component.

If our title remains Association of Noise Consultants, it appears not to do justice to such aspects of members' work as electroacoustic design, office/conference/auditoria architectural acoustics design. Also the detailed measurement, prediction and response studies on machinery and building vibration might be overlooked. The title should surely be Assocation of 'Sound' Consultants, with its double meaning; no-one could complain if his appointed consultant was, in the words of the dictionary, 'healthy, not diseased, or injured, or rotten, correct, orthodox, logical, well-founded, judicious, financially secure'!!□

**J G Charles**

# New Products

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

**Digital Signal Processor**

Loughborough Sound Images Ltd has launched a new low cost development package for the TMS 32020 Digital Signal Processor. The system is designed to run on the IBM PC and offers full support for the development of signal processing applications using the latest device in the Texas Instruments TMS 320 series of processors. Included in the package is a full size IBM PC plug-in board, a monitor program and a Macro Assembler and Linker.

The board is supplied with 32 Kbytes of RAM and accommodates up to 256 Kbytes of memory, split equally between program and data storage. 16 bit A/D and D/A converters with a sampling rate of up to 50 kHz are provided on the board. A comprehensive user manual is supplied with each package.

Further details from Loughborough Sound Images Ltd, The Technology Centre, Epinal Way, Loughborough, Leicestershire LE11 0QE. Tel: 0509 231843.

**Twin Channel FFT Analyser CF 940**

The CF 940 offers the user a 1117 line display giving an improvement in resolution of more than 250% over its predecessors. Within the CF 940 is a 768 Kbyte memory which permits a full one second time signal to be recorded digitally at 256 kHz sampling frequency and the 1 Mbyte 3.5 inch disk drive will store 300 fully annotated frames of analysed data. The complete range of CF 920 processing functions are maintained whilst in addition standard items include a four-decade frequency zoom, rpm tracking output and many structural analysis facilities.

**New sofware options for CF 900 series**

A number of software options have recently been made available by CEL Instruments for existing Ono Sokki FFT Analyzer users. These options allow the addition of extra functions to the CF 900 series Dual-channel FFT Spectrum Analyzers. There are available a number of extra outputs which permit for example hard-copy rpm tracking of chosen harmonics and also time-axis differentiation, inverse FFT and time-axis envelope software.

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

**Sub-Miniature Accelerometer A/25/E**

The A/25/E Sub-Miniature Piezo Ceramic Accelerometer manufactured by D J Birchall Limited can be used for vibration measurements on delicate structures as it introduces only 1.5 grams of extra mass. Its sensitivity is 1.5 pC/g, it has a resonant frequency of 80 kHz and a maximum continuous acceleration rating of 1500 g.

Further details from D J Birchall Ltd, 102 Bath Road, Cheltenham, Glos GL53 7JX. Tel: 0242 518588.

**B & K Graphics Plotter Type 2319**

The new Brüel and Kjær Graphics Plotter, Type 2319, will provide high quality multi-colour records of measurements made with their Dual Channel Analyser Type 2032. This 8 pen plotter will accommodate metric A4 or USA size plain paper or overhead-projection transparencies. It features IEEE 488

## *Engineering Assembly Video*

A copy of a 19-minute video prepared using TV news footage of the first Engineering Assembly is held at IOA HQ in Edinburgh. It features the messages of support put over by the Prime Minister at this meeting of the Engineering Council and gives those who did not attend the Assembly a flavour of the event. Please apply to Mrs Mackenzie if you would like to borrow the video.□

# NON-INSTITUTE MEETINGS

**1986**

24-28 August. *Thirteenth International Congress of Audiology.* Prague. Contact: XVIIIth ICA 1986, Vitezneho unora 31, 120 26 Praha 2, Czechoslovakia.

25-29 August. *Comp '86 Symposium.* Patras, Greece. Contact: Prof S A Paipetis, COMP '86 Symposium, Dept of Mechanical Engineering, University of Patras, Patras 260 01, Greece.

2-6 September. *6th FASE Symposium: Subjective Evaluation of Objective Acoustical Phenomena.* Sopron, Hungary. Contact: 6th FASE Symposium Secretariat, OPAKFI, H-1061 Budapest, Anker Koz 1, Hungary.

6 October. *Noise in Mechanical Services.* Society of Chemical Industry, Belgrave Square, London.

22 October. *SEECO 86. Environmental Stress Screening.* Coventry. Contact: SEE, Owles Hall, Buntingford, Herts SG9 9PL.

28-29 October. *Secure Communication Systems.* London. Contact: Conference Services, IEE, Savoy Place, London WC2R 0BL.

8-12 December. *1st Asian Pacific Region Conference on Deafness.* Hong Kong. Contact: Hong Kong Society of the Deaf, 901 Duke of Windsor Social Serv Bldg, 15 Hennessy Road, Hong Kong.

14-16 December. *Unhealthy Housing — a diagnosis.* Warwick. Contact: Rosemary McMahon, Health and Housing Conference Administrator, The Institution of Environmental Health Officers, Chadwick House, Rushworth Street, London SE1 0QT.

15-18 December. *Electronics for Ocean Technology.* Edinburgh. Contact: The Conference Secretariat, IERE, 99 Gower Street, London WC1 6AZ.

**1987**

24-26 March. *DAGA '87.* Aachen. Contact: Prof H Kuttruff, Institut für Technische Akustik, Templergraben 55, Aachen.

15-17 September. *INTER-NOISE 87.* Beijing, China. Contact. INTER—NOISE 87 Secretariat, 5 Zongguancun Street, PO Box 2712, Beijing, China.

*Information relating to meetings of possible interest to readers should be with the Editor at the address on page 1 no later than four months before the date of the meeting.*□

interfacing and an HP-GL compatible instruction set.

The 7 Kbyte input buffer allows fast, efficient data transfer, quickly freeing the sending device and the interface bus for other duties. Using front panel control or graphics language instructions, plots can be drawn any size and in any position within the plotting area.

The Type 2319 plots measurements as displayed on the B & K Signal Analyser Type 2032 when it is fitted with Graphics Plotter Interface Type BZ7200. A plot can be produced according to pre-set default values by pressing a single push key. Alternatively, 35 plot parameters can be defined by the user, selecting the pen colour for various areas of the plot, the plot size, page numbering, line type for the data, and other features. The plot parameters are selected by using the controls of the Type 2032.

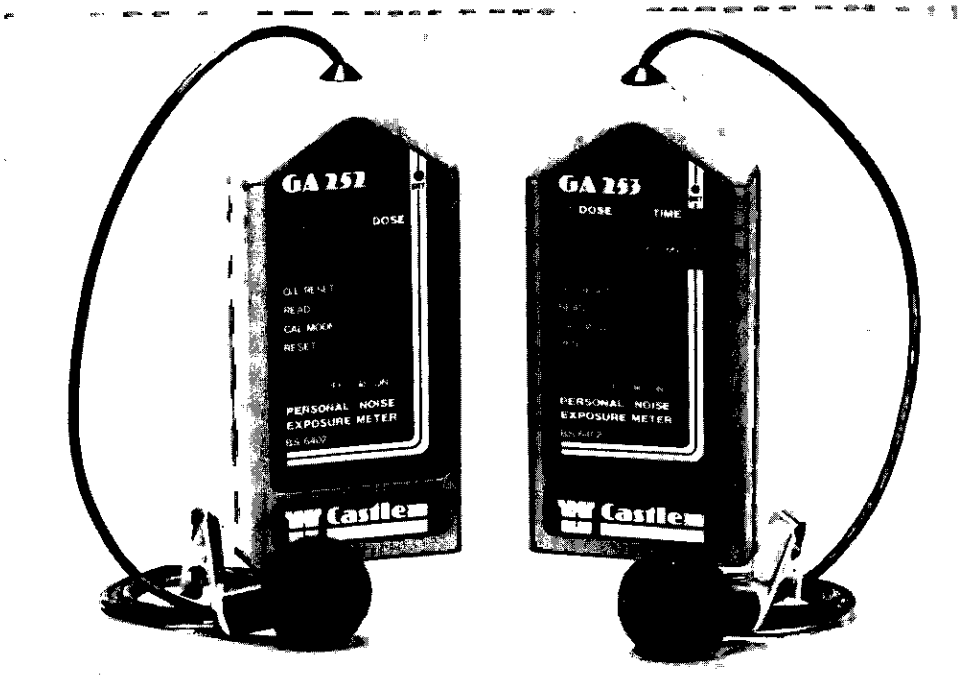
Plots generated from measurements by the Type 2032 feature fully annotated axes, user-defined text anywhere on the plot, and room for comments and notes on measurements. Using the 2032's cursors to move the pen, any point on the plot can be marked 'X' with its X-Y co-ordinates written nearby.

The graphics plotter Type 2319 can be used with any IEE — 488 interface and the capability to send HP-GL instructions. Alphanumeric characters can be selected from five sets of 96 characters each and written on to the plot in any direction and with variable aspect and slant.

**B & K Precision Sound Level Meter Type 2235**

The Type 2235 meets BS5969 and IEC 651 type 1 standards and is suitable for most general purpose sound level measurements. Front panel switches enable numerous measurement modes to be selected. These include Fast, Slow, Impulse or Peak time weighting, A, C, or Linear frequency weighting and Frontal or Random sound incidence. The display is digital with a 0.1 dB resolution and is updated every second. Provision is also made to 'hold' the display. AC and DC outputs are available for recording purposes.

Further details from Brüel & Kjær (UK) Ltd, 92 Uxbridge Road, Harrow, Middlesex HA3 6BZ. Tel: 01-954 2366.




*Castle Dosemeters GA252 and GA253*

**Dosemeter GA252/GA253**

Castle Associates have developed two entirely new personal noise exposure meters to BS6402. These new generation products are small, very lightweight, self-contained instruments with direct LED digital readout. The model GA253 features a measurement time capture circuit with its own 4 digit LED display in hours, minutes and seconds. Both models have a fast calibration mode, peak exceeded overload indication which can be reset independently of the general overall reset, and a memory to retain the last readings when the unit is switched off or even during battery changing.

Prices: GA252 is £199.00; GA253 is £260.00.

Further details from Castle Associates Limited, Salter Road, Scarborough, YO11 3UZ. Tel: 0723 584250.□

# ACOUSTIC CONSULTANT

***A KEY CONSULTANCY ROLE WITH A BLUE-CHIP CLIENT BASE***

Our client, an autonomous Business Group of Imperial Chemical Industries plc., provides an extensive range of consultancy services in the acoustics field to a large number of diverse, prestigious clients as well as to other Divisions within ICI.

With an impressive record of success to date, this high technology Company has embarked upon a planned, ambitious expansion programme, primarily in the area of acoustics, noise and vibration consultancy. As a result a challenging opportunity has been created for an Acoustic specialist to join a compact yet highly professional team at a senior level.

The post calls for a capable, innovative and imaginative problem solver aged around 28-35, who has a degree-level qualification in Acoustics allied to significant consultancy experience. The successful candidate should be able to demonstrate a commitment to future growth areas and in return will receive an unusual amount of autonomy plus the real opportunity to broaden his or her expertise. As well as considerable job satisfaction, the position commands a generous salary and remuneration package plus benefits normally associated with a major employer. Assistance with relocation expenses, to this pleasant Northern Home Counties location, will be given in appropriate cases.

If you're confident that you can handle this extremely important consultancy role, please write enclosing a full c.v. in the first instance to: Mr. B. Wood, ARA International, Recruitment Advertising Division, Edman House, 17/19 Maddox Street, London W1R 0EY.

ICI
Imperial Chemical Industries PLC

# CHIEF ELECTRO ACOUSTIC ENGINEER

**SOUTH COAST** **c £15,000**

## AN IDEAL OPPORTUNITY TO JOIN AN EXPANDING AND PROFITABLE COMPANY

Our client, a leading manufacturer of transducers for the telecommunication industry, seeks to appoint a **Chief Electro Acoustic Engineer**.

The ideal candidate, aged 25-35 and preferably qualified to graduate level in their speciality, will have 5 years post graduate experience designing and engineering electro-acoustic transducers within either the telecoms or quality hi-fi industry.

Whilst controlling a small team in a well equipped section the candidate will be expected to become involved in their own projects as well as liaising with the production and development areas.

Career progression, a company pension scheme, BUPA, 5 weeks holiday and an excellent working environment are among the benefits available. Relocation expenses will be paid where necessary.

**Please write with full C.V. quoting reference 186/C10 to Stephen Wythe, Grange Selection Limited, Jubilee Road, Chelsfield, Orpington, Kent BR6 7QZ. Tel: (0959) 34482**

GRANGE SELECTION

**EXECUTIVE SEARCH AND SELECTION**

# Institute of Acoustics Meetings

| | | | |
|---|---|---|---|
| **1986** | | | |
| 17 July | PAG | Acoustics and Ultrasonics as Probes of Emulsions and Dispersions | IoP, London |
| 25 July | SG | Perceptual and Signal-Processing Approaches to Separating Speech from Noise | Nottingham |
| August/September | NWB | Visit to British Leyland's Technical Centre | |
| 12 September | M | The Control of Entertainment and Recreation Noise. In collaboration with the Institution of Environmental Health Officers and the Royal Environmental Health Institute of Scotland | London |
| 12 September | SG | Productive Disorders | Reading |
| 25 September | PAG | Current Research in Ultrasonics and Physical Acoustics and **PAG AGM** | London |
| October | SB | Aspects of Dynamics (A Middleton) | Southampton |
| October | NWB | Meet the IOA — an open invitation to acoustic undergraduates | |
| October | ING | Finite Element & Modal Analysis | London |
| 6 October | M | Noise in Mechanical Services. In collaboration with the Chartered Institution of Building Services Engineers, the Institution of Mechanical Engineers and the Chartered Institute of Building | London |
| 23 October | NWB | Visit to Thwaites Brewery | Blackburn |
| 29 October | ING/EMB | Noise and Vibration in the Aircraft and Spacecraft Industry | Birmingham |
| November | SB | Playing Musical Instruments: Acoustics and Performance (J Bowsher) | Southampton |
| November | NWB | Evening Lecture by P D Thorne | |
| 6-9 November | M | Reproduced Sound. In collaboration with AES, ASCE, EMAS, APRS and ABTT | Windermere |
| 28-30 November | M | Autumn Conference: Speech and Hearing. In collaboration with the British Society of Audiology | Windermere |
| 4 December | M | Sound Insulation of Buildings and Building Elements | BRE, Watford |
| December | SB | Recent Developments in Loudspeaker Technology (R Small) | Southampton |
| 9-10 December | UAG | Fluctuation Phenomena in Underwater Acoustics | Weymouth |
| **1987** | | | |
| **13-16 April** | **M** | **Acoustics '87** | **Portsmouth Polytechnic** |
| **1988** | | | |
| **29 August — 1 September** | **M** | **7th FASE Symposium: Speech** | **Edinburgh** |

**Key:**

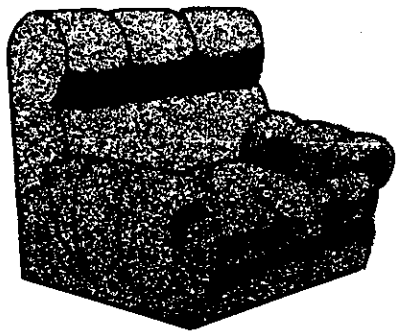
M = Meetings Committee Programme
BAG = Building Acoustics Group
ING = Industrial Noise Group
MAG = Musical Acoustics Group
PAG = Physical Acoustics Group
SG = Speech Group
UAG = Underwater Acoustics Group
LEM = London Evening Meeting

EMB = East Midlands Branch
NEB = North East Branch
NWB = North West Branch
SB = Southern Branch
ScB = Scottish Branch
SWB = South West Branch
YHB = Yorkshire and Humberside Branch

**Further details from:**

Institute of Acoustics
25 Chambers Street
Edinburgh EH1 1HU
Tel: 031-225 2143

# Professional Career Opportunities



## The Easy Way to look for your new job from the comfort of your own armchair. Our well qualified consultants will carefully match your requirements against appropriate vacancies.

We have many clients seeking Engineers and Technicians at all levels and we are particularly interested in hearing from you if you have experience in the following:-

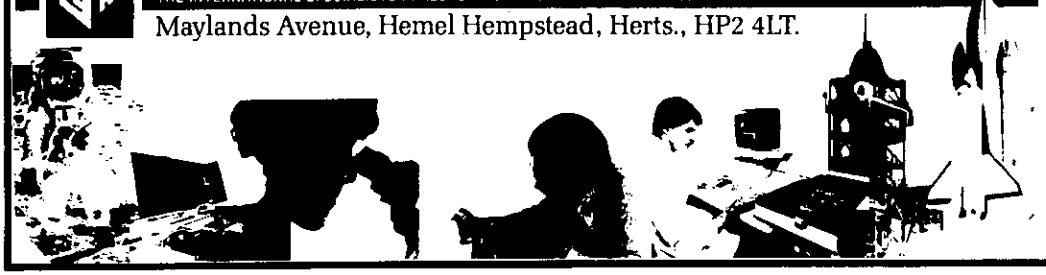
- **Signal Processing**
- **Technical Sales**
- **Project Management**
- **Acoustics**
- **Mathematics**
- **Real Time Software**

Your next step is to complete and return the attached coupon or telephone **John Prodger** on 0442 47311 or one of our duty consultants on 0442 212650 during evenings or weekends.

Executive Recruitment Services

THE INTERNATIONAL SPECIALISTS IN RECRUITMENT FOR THE ELECTRONICS, COMPUTING AND DEFENCE INDUSTRIES

Maylands Avenue, Hemel Hempstead, Herts., HP2 4LT.



NAME.....(Mr/Miss/Mrs)

ADDRESS.....

.....

POST CODE .....

TEL NO:.....

QUALIFICATIONS AGE.....

☐ NONE ☐ CG/HNC ☐ DEGREE ☐ OTHER

SALARY

☐ 0-£6000 ☐ £6-10000 ☐ £10-15000 ☐ £15000+

JOB ..... AB

Christchurch Printing Company Ltd., 6-8 Bridge Street, Christchurch, Dorset BH23 1EE