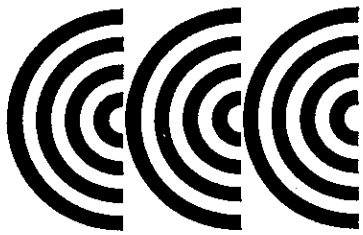

Acoustics Bulletin

January 1982 Volume 7 Number 1

INSTITUTE OF ACOUSTICS

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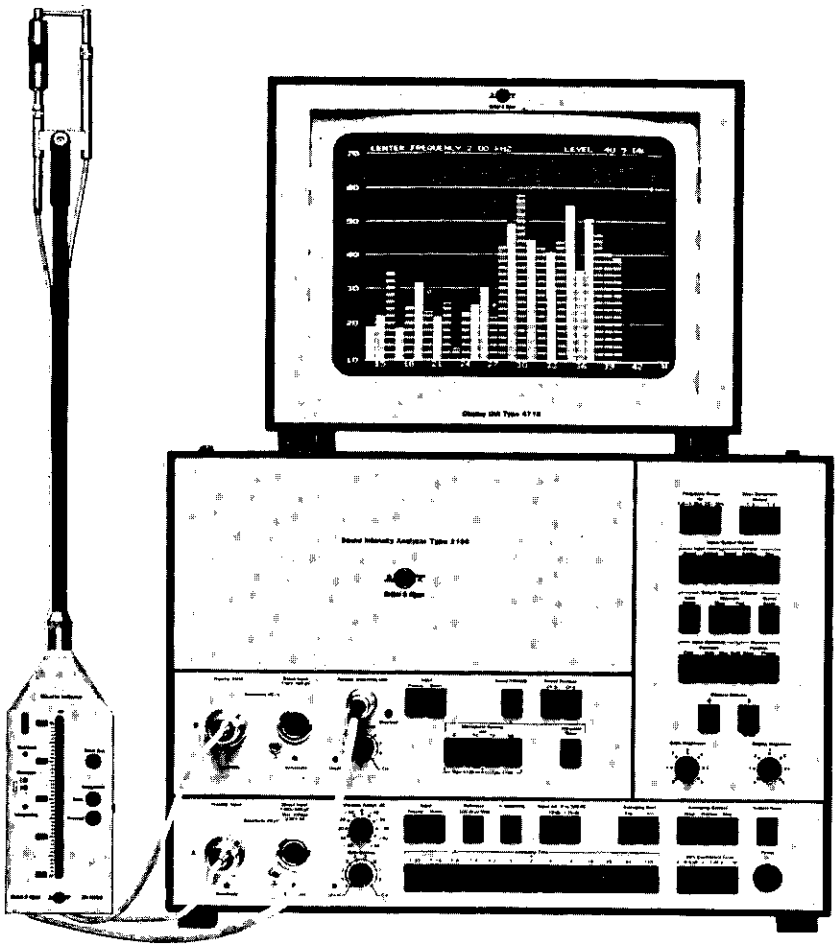

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The Institute of Acoustics was formed in 1974 by the amalgamation of the Acoustics Group of the Institute of Physics and the British Acoustical Society and is now the largest organisation in the United Kingdom concerned with acoustics. The present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

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

Membership of the Institute of Acoustics

Membership of the Institute is generally open to all individuals concerned with the study or application of acoustics. There are two main categories of membership, Corporate and Non-corporate. Corporate Membership (Honorary Fellow, Fellow, Member) confers the right to attend and vote at all Institute General Meetings and to stand for election to Council; it also confers recognition of high professional standing. A brief outline of the various membership grades is given below.

Honorary Fellow (HonFIOA)

Honorary Fellowship of the Institute is conferred by Council on distinguished persons intimately connected with acoustics whom it specially desires to honour.

Fellow (FIOA)

Candidates for election to Fellow shall normally have attained the age of 35 years, have had at least seven years of responsible work in acoustics or its application, and have made a significant contribution to the science or profession of acoustics.

Member (MIOA)

Candidates for election to Member shall normally have attained the age of 25 years, must either (a) have obtained a degree or diploma acceptable to Council and have had experience of at least three years of responsible work in acoustics, or (b) possess an equivalent knowledge of acoustics and cognate subjects, have had experience for not less than seven years of responsible work in acoustics or its application, and must have been a Non-corporate member of the Institute in the class of Associate for not less than three years.

Associate

Candidates for election to the class of Associate shall have attained the age of 18 years and (a) be a graduate in acoustics or a discipline approved by Council, or (b) be a technician in a branch of acoustics approved by Council, or (c) be engaged or interested in acoustics or a related discipline.

Student

Candidates for election to the class of Student shall have attained the age of 16 years and at the time of application be a bona-fide student in acoustics or in a related subject to which acoustics forms an integral part. Normally a student shall cease to be a Student at the end of the year in which he attains the age of 25 years or after five years in the class of Student, whichever is the earlier.

Full details and membership application form are available from: The Secretary,
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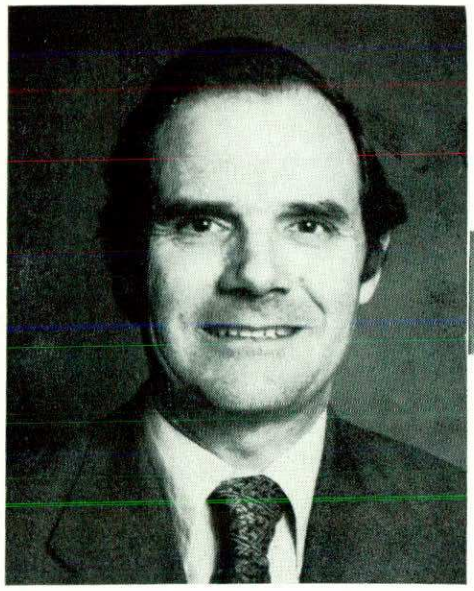

President's Letter

Dear Member,

I should like to report on several matters discussed at the recent meeting of Council. The main item of interest to the majority of members was the development of the policy on Regional Groups and Specialist Branches. Council acknowledges that the contact point with the Institute for most members will be through local groups and wishes to see the establishment of such groups in areas not currently served by such activities. This is seen as the best way of bringing the Institute to the members and encouraging additional members to join and have an effective influence on the development of acoustics in this country. I hope to meet shortly with the members of the North West Branch to hear their views and others are invited to send any ideas for new groups to Trevor Smith. Council has asked Trevor to take on the task of encouragement of groups and branches and I am sure that he will be pleased to hear from you.

Another matter discussed was the continuing success of the Diploma Scheme. Seventy-five candidates were successful in obtaining the Diploma this year and automatically join the Institute as Associates for the next year. Congratulations. Members will be pleased to hear that the Sixth Form Lectures are to be revived, and Prof Lord and Dr Wells have agreed to give three later next year.

The demise of the Noise Advisory Council has caused much concern and disappointment amongst many members. Council has agreed to take upon itself the organisation of a group similar to the NAC which could study current matters of importance, keep an eye on the developing legislation and act as a scientific body to comment on proposals, standards, etc. A Noise Advisory Group is to be set up within the Institute and all the former independent members of the old NAC will be invited to join in the work.

Members will probably have heard by now that I shall be leaving the Institute of Sound and Vibration Research in September 1982 to take up the appointment of Principal of the University College of Swansea. My wife and I will be sorry to leave Southampton which has been our home for 25 years, but we are looking forward to the new opportunities and challenges in Swansea.

I send best wishes to you all for the Christmas season and the New Year. May you all prosper!

B. L. Clarkson

Acoustics at Keele

Most of the research activity related to acoustics at the University of Keele takes place in the Department of Communication and Neuroscience. This Department was established in 1960 to undertake multidisciplinary research into communication between the brain and the outside world. Approximately half of the staff are concerned with problems of hearing and speech.

Auditory Neurophysiology

THIS RESEARCH is largely concerned with understanding the neural mechanisms underlying hearing, particularly the coding of frequency and intensity information in the auditory system. The technique employed is to insert microelectrodes into neurones in the auditory system and to study their responses when sounds are applied. A computer-controlled sound-generating and response-recording system is used, which enables the frequency and intensity characteristics of a large number of neurones in different parts of the auditory system to be measured. It has been found that various forms of physiological, chemical and mechanical insult to the cochlea modify these characteristics, and this work has led to explicit studies of animal models of deafness and more recently, of tinnitus. These studies include behavioural measurements of auditory discriminations in the same animals investigated electrophysiologically.

Other projects are concerned with the mechanisms underlying the masking of one sound by another and sound localisation.

Cochlear Mechanics

An instrument sensitive to small displacements, the capacitive probe, has been developed to measure the vibrations of the basilar membrane. This has been used to measure basilar membrane vibration at the same time as the responses of individual auditory neurones were being recorded, for comparison of the tuning characteristics.

Currently the capacitive probe is being used to study the cochleas of certain animals which have specialised hearing systems. In particular, bats have been examined because of their ability to use echolocation, and the crocodile because of its philogenically primitive hearing.

A sensitive microphone has also been developed to measure sound emitted by the cochlea either in response to sound input or spontaneously as an acoustic correlate of tinnitus, or ringing in the ears.

The relationship between cochlear echoes, audiogram fine structure and tinnitus is also being investigated.

Auditory Psychophysics

The pitch and loudness of complex sounds are being studied, with particular regard to the way in which these impinge on theories of hearing. There is much interaction with the auditory neurophysiological work as the same acoustic stimuli can be employed in both areas, and the results compared.

The physiological work has suggested that frequency resolution is impaired in hearing loss of cochlear origin. This hypothesis has been proved with human patients, and the work has led to the suggestion that frequency resolution may be dissociated from threshold elevation. It may be a sensitive early auditory pathology. (This work was undertaken in collaboration with the ENT Department of the North Staffs Hospital Centre and more recently through the joint appointment of an Audiological Scientist in the University Department of Postgraduate Medicine.)

Other work concerns an investigation into evidence for direction-specific channels in the processing of frequency modulated signals.

Speech Synthesis

A computer-controlled speech synthesiser has been in operation since the mid-sixties. It has been used mainly for experiments in speech perception, but has also been employed to investigate methods of speech output from computers. A series of programs were written which translated text in digital form into a phonemic transcript which was subsequently converted into speech using the synthesis-by-rule technique. This system is being implemented to work in real-time on a series of microcomputers in the Computer Science Department.

In the Communication and Neuroscience Department a new synthesiser has been constructed with a programmable glottal pulse. Preliminary results show that this generates sounds which have very realistic speech waveforms.

Speech Perception

Speech perception is studied by means of a computer system which generates the sounds and records the listeners' responses. The sounds may be generated from natural speech, digitised, and stored on the computer's disc, or they may be generated on-line by means of a speech synthesiser.

This system has been used to study many aspects of speech perception, such as the effects of fundamental frequency and tempo on perceptual boundaries and the relation between formant frequency and duration in the perception of vowel categories.

Speech Analysis

Two projects in speech analysis are currently under way. One is concerned with fundamental frequency estimation. Most 'pitch trackers' consist of two parts: the first estimates the fundamental frequency and the second employs logic to smooth the raw output of the first. The logic employed depends on the theory of intonation which is accepted. The present project is a computer model which generates an optimum fit given a system of intonation rules. This system is to be used to compare theories of intonation.

The second project is a computer simulation of the auditory system based upon available physiological information. The aim of this project is to study how speech is analysed by the auditory system.

Aids for the Hearing Impaired

Impairment of frequency resolution tends to destroy important speech information. This has led to the design of aids to alleviate the problem either by sharpening the formant structure of the speech sounds or by presenting different regions of the speech spectrum to opposite ears. It is hoped that the research into tinnitus may lead to improved techniques for masking it or alleviating it in other ways. Correction of other distortions inherent in certain types of hearing loss are also being investigated (especially by multichannel compression).

There is also a project to design an aid for lipreading which electronically detects certain features of the speech wave and presents these to the lipreader visually in such a way as to reduce the ambiguity in the signal. □

W A Ainsworth

ACOUSTICS '82

INSTITUTE OF ACOUSTICS SPRING MEETING

University of Surrey, 29 March – 1 April

Acoustics '82 will present technical sessions in the following areas.

A. Environmental, Transportation and Propulsion Noise

B. Physical Acoustics and Ultrasonics

C. Signal Processing in Acoustics

D. Subjective Auditory Effects

E. Poster Session (open to any paper on Acoustics)

Invited papers will include the Rayleigh Medal Lecture.

Technical visits have been arranged for the afternoon of Tuesday 30 March to:

Acoustics Section, National Physical Laboratory

The Institute of Oceanographic Studies

The National Gas Turbine Establishment

There will be a Technical Exhibition and Exhibitors' Reception.

One afternoon is to be left free for delegates, who are invited to take part in short tours of the historic town of Guildford. The Annual General Meeting of the Institute of Acoustics will be held at 17.00 pm on Wednesday 31 March.

A full programme for accompanying delegates will include, besides the Conference Banquet, a private tour of Clandon Park, one of the outstanding Palladian country houses in Britain; visits to local Wealden craft industries and to the J & M Dolmetsch workshop for ancient musical instruments, and luncheon on the River Wey.

The Conference is being organised at the University of Surrey by a Committee under the Chairmanship of Dr J M Bowsher. Further details are available from the Conference Secretary, Institute of Acoustics, 25 Chambers Street, Edinburgh EH1 1HU.

The Rolls-Royce Role in Aircraft Noise Reduction

M J T Smith
Head of Noise Technology, Rolls-Royce Limited, Derby

Aircraft noise became an international issue in the late 1950s with the entry into commercial service of the Boeing 707 and Douglas DC8 aircraft. Airport noise levels from these aircraft were significantly higher than their propeller powered contemporaries, and as they grew in number so did the noise problem.

NOISE abatement techniques using modified flight procedures were introduced, monitored and enforced at the airport. This process proved insufficient to control the problem. Lawsuits in the US totalled many millions of dollars, and European nations cooperated within the International Civil Aviation Organisation to support the US in introducing noise into the sphere of Aircraft Certification, a process that had hitherto been limited to safety. By the time Noise Certification was frozen into international law some 10 years after the first jets entered passenger carrying service, there were some 3000 in worldwide operation and the number was predicted to double before the end of the century. The emerging noise problem of the 1960s was not, therefore, predicted to go away.

Subsequent to the introduction of Noise Certification there has been a general toughening of the Standards, and wider application of the original rules. For example, whilst the original rules applied only to completely new aircraft designs, during the mid 1970s they were extended to embrace all aircraft types entering service in the USA and Europe. More recently 'fleet-wide' application has meant that all in-service aircraft that cannot comply with the original rules will now have to be phased out of operation during the mid 1980s.

It is, therefore, easy to see why noise is important to Rolls-Royce. Figure 1 shows the world fleet distribution as projected through to 1995, expressed in terms of older types and modern technology aircraft that can comply with the toughened standards of the US Certification Rule FAR Part 36 (1). Rolls-Royce have interests in modern 'widebodies' such as the Boeing 747, Lockheed L1011, and older types like the BAC 1-11 and F28. Equally, the Company has a big stake in the 'new technology' class, notably the B757, and intend to compete to replace the now ageing B737 and DC9 types.

As a result every new engine design is subject to noise control action. Moreover, since heavy emphasis is now being placed on fuel efficiency, and because noise control action is not always compatible with improving efficiency, the process is painstaking and requires a considerable knowledge of the generation and control of all sources within a gas turbine engine. For this reason the work at Rolls-Royce ranges from fundamental research through development work to new project activity and day-to-day development issues.

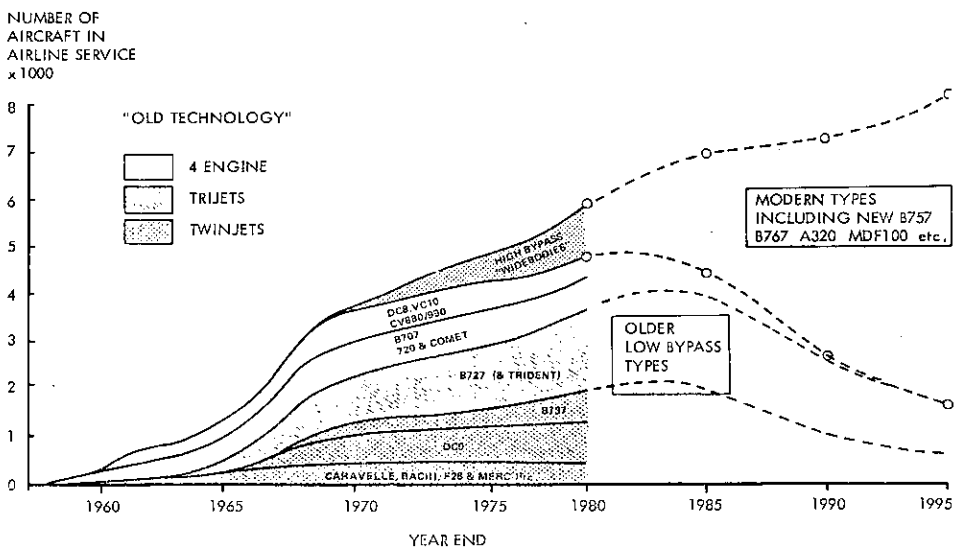

Figure 1 Jet aircraft in airline service worldwide

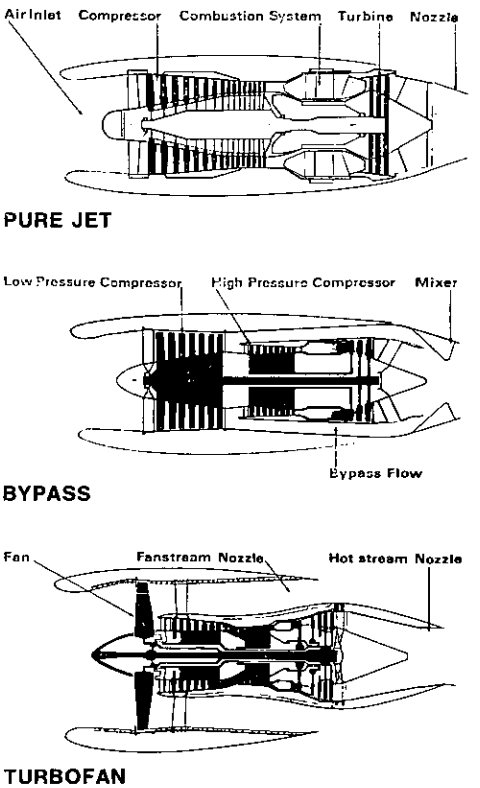

Figure 2 Typical Engine Layouts

Sources

Every major engine component produces noise, as does the jet mixing process behind the engine. It is the jet noise sources that originally did, and still often can, dominate the aircraft noise problem at airports, and as long as the aero-propulsion engine relies upon exhausting a jet into the atmosphere these sources will be with us. Jet noise is a function of jet velocity, and as velocities have been reduced with the advent of the high bypass turbofan engine internal sources have emerged of equal importance, due to the higher airflows handled by the turbomachinery. The three basic engine types in service today are illustrated in Figure 2, and their noise characteristics in Figure 3. The early turbojets relied upon moving comparatively small quantities of air at high velocity, whereas the modern

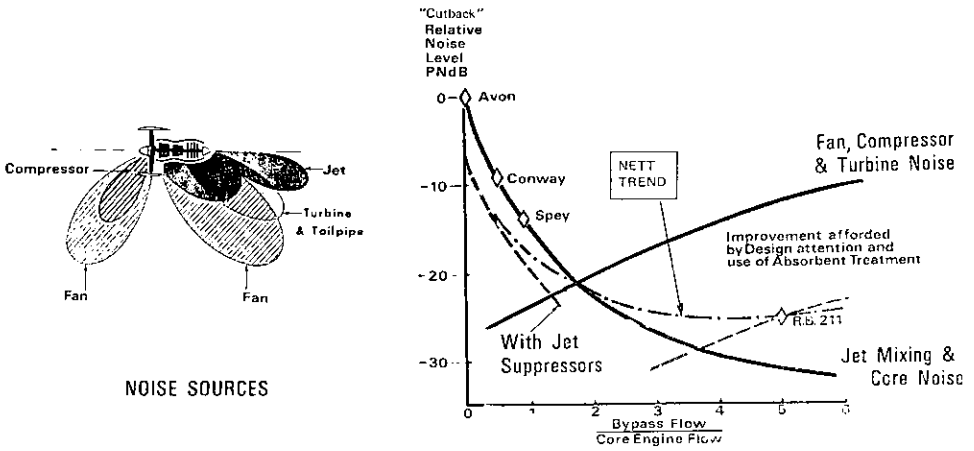

Figure 3 Noise source variation with bypass ratio

turbofan moves five times as much air at reduced velocity for the same propulsive thrust. Hence, increasing bypass ratio, or reducing specific thrust, produces a downward trend in jet noise but an increasing trend in turbomachinery noise, the main sources being the fan and the later stages of the turbine. Were it not for noise control action modern turbofans would be as noisy as the original pure jet engines. The total process requires consideration of each significant source.

Jet Noise

Lighthill (2) showed jet noise power to be a function of around the 8th power of velocity. With the early pure jet engines the obvious noise control technique, that of reducing velocity, was not appropriate without considerable loss of thrust or increase in engine size and weight. Therefore, efforts were made to reduce the two important elements, the turbulent mixing noise and the more discrete shock element, by modifications to the exhaust nozzle geometry. Simple changes to geometry can virtually destroy the feedback mechanism of a stabilised shock structure, but more extreme modifications are necessary to reduce the jet mixing process.

Figure 4 illustrates the typical 'suppressor'. The technique relies upon subdividing the jet into smaller discrete elements, and thus increasing the characteristic Strouhal frequency. Whilst velocities close to the nozzle are not reduced, the mean velocity downstream of the nozzle where the low frequencies are produced is lowered. Moreover, since low frequencies are not naturally attenuated by the atmosphere, increasing frequency to take advantage of the absorptive qualities of the atmosphere at high frequencies tends to enhance overall noise reductions at large distances from the engine. The problem with modern engines is that the exhaust jet dimensions are large, and subdivision into sufficiently small elements to reduce low frequencies and take advantage of atmospheric absorption produces very lossy configurations. For this reason control of jet noise on high bypass turbofan engines is more a matter of selecting the right engine cycle and optimising the velocities and areas of the primary and secondary streams, such that the high velocity centre stream takes advantage of the 'shielding' effect of the secondary flow, and resultant reduced shear.

Addition of a conventional jet suppressor to the core stream alone would produce totally unacceptable scrubbing drag losses in the bypass flow, but internal mixing ahead of a single propulsive nozzle offers some potential for noise reduction.

Today's research problem is, therefore, one of understanding the jet structure and noise producing mechanisms so as to produce novel ideas allowing noise reduction at very small cost in terms of propulsive efficiency.

Turbomachinery Noise

The rotating machinery of the fan and turbine systems produces noise of two entirely different characters. The passage of air over the many blades of a turbomachine produces a broadly distributed noise of a random nature, resulting from turbulence induced in the flow. Its spectrum is very similar to jet noise, although it is normally generated several octaves higher in frequency due to the small blade dimensions. Its level is very much a function of the amount of work done by the fan or turbine system.

The second, and audibly more obvious source of noise, is discrete in nature. It can result either from shock waves propagating from the supersonic tip of the fan at high engine power condition, or from the pressure field and trailing edge wake interactions between rotating and stationary stages. Research into this, and the broadband component, has been intense over the past 10 years or so. The design criteria for minimising tones are well established, but tend to run counter to the powerplant efficiency objectives. Increasing the separation between rotating and stationary blade rows results in increased engine length, weight and

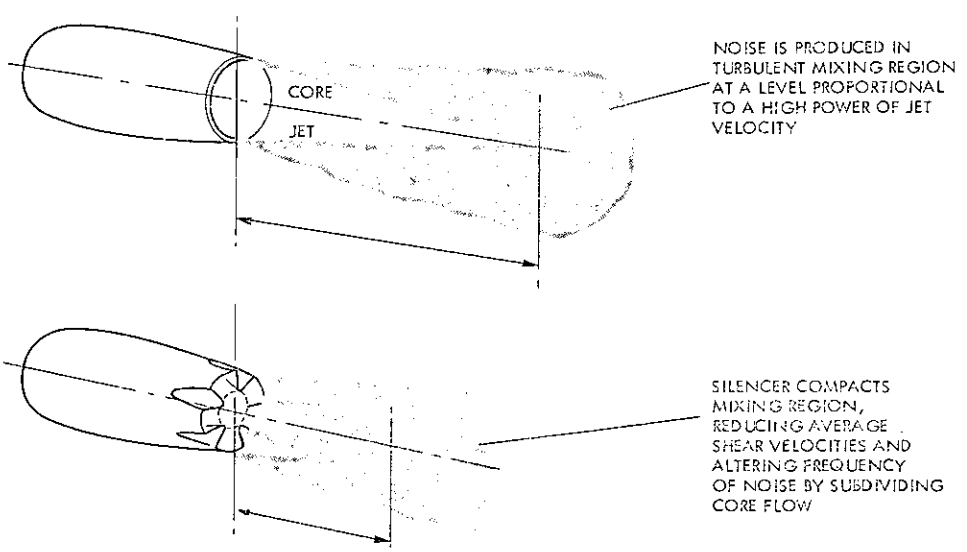

Figure 4 Jet silencer operation

cost. Choice of blade and vane numbers such that the rotating pressure patterns are acoustically 'cut-off' before they can radiate from either the inlet or exhaust ducting can conflict with aerodynamic and structural requirements. Consequently, the modern turbofan engine relies heavily on incorporating acoustically absorbent duct wall linings for suppression of the turbomachinery noise sources.

These linings, high technology ceiling tiles, serve to reduce the energy in the acoustic wave incident on the flow duct wall before it can emerge from either the intake or the exhaust system of the engine. They work in two modes; the reactive (cancellation by the reflected wave) and resistive (absorption by friction losses in the liner) and are designed to suit the particular characteristics of the source in question. An extremely discrete and sensibly constant frequency will be suited to a reactive type of liner, whereas the broadband or multi-discrete tone source requires a resistive liner which is effective over a wide frequency range.

Figure 5 illustrates the many different types of liner that are used or being considered for use in the modern turbofan engine. The bulk, usually fibrous type of liner, often produces the ideal absorptive characteristics, although it presents great problems in fluid absorption. In the intake the absorption of water, which can turn to ice and crack structures, and in the exhaust where retention of unburned fuel is a clear hazard, are two issues which have so far prevented their use.

Consequently current research emphasis is on constructing liners of the multi-layer type and which approximate to the absorption characteristics of the bulk material without presenting the same hazards. They are by necessity heavier than simple bulk material, difficult to manufacture and not reliably predictable in performance.

Other Sources

Various other sources contribute to the overall noise of an engine, including the combustion process. Here, the turbulent nature of the mixing process prior to fuel burn, and the burning process itself both introduce broadband noise sources.

Additional sources result from airflow over all surfaces in the engine ducting, including the acoustic liners.

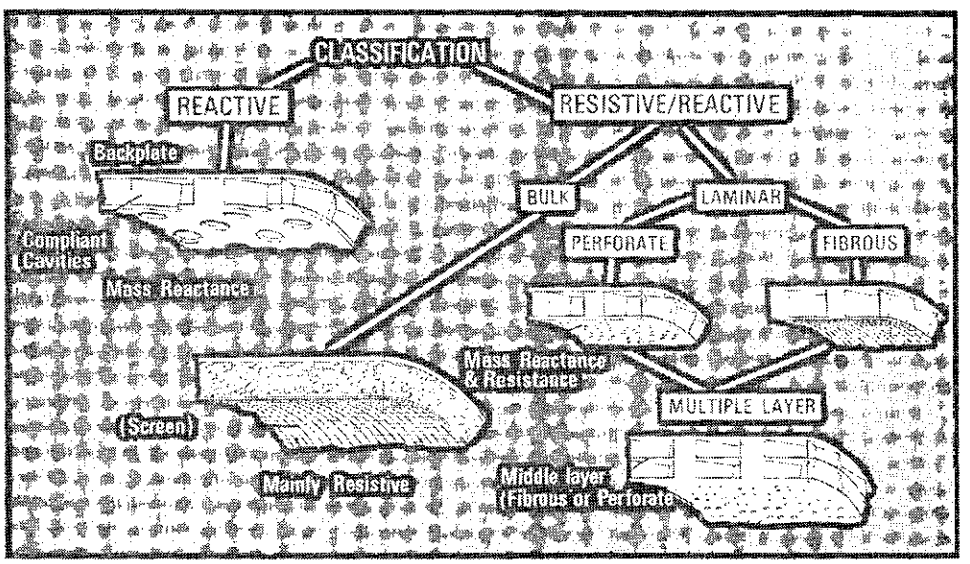

Figure 5 Duct lining

Control of combustion noise is a subject in its infancy, and the relevance of noise sources generated by flow over the engine structures has yet to be quantified. However, increases in noise have been observed where the aerodynamic performance of a particular engine duct feature is away from optimum. 'Optimum' is often the engine power setting appropriate to aircraft cruise, whereas the significant conditions from the noise standpoint are the more off-design conditions of full power during take-off or very much reduced power for approach. The dilemma is, therefore, to produce an acceptable acoustic environment under conditions which are not of great relevance in the main operation of an engine at high altitude cruise. Weight, performance and fuel efficiency at cruise are of major competitive importance and noise control has to be exercised with minimum impact on these factors.

Installation Effects

Over and above the noise generated by the engine there are marked effects contingent upon the way it is installed into an aircraft, and how it is operated. Firstly, forward speed alters both fan and jet noise levels. The flow into the fan is aerodynamically 'cleaner' in flight and often reduces tone levels (3), and shear between the jet and the ambient air is lower, reducing jet noise also. Conversely if there is significant distortion of the gross flow into the engine intake because of features of the installation or if the jet flows close to the flap structure, additional sources are generated. Under normal conditions the influence of the airframe structure on the noise emitted by the engine is considerable. Installations beneath the wing, or on the rear of the fuselage beneath the tailplane, give rise to additional reflection/scattering sources. Moreover, the engine is not the only source of noise. The airframe, particularly under the landing configuration where high lift flaps and the undercarriage system produce significant turbulence, is a source of low frequency noise.

To the side of the aircraft flightpath other factors, such as shielding of the noise by the fuselage or the exhaust of another engine, can reduce the levels in the same way as the wing and tailplane structures can augment it beneath the flight track. The properties of the atmosphere, and of the ground surface, also serve to distort true source noise such that the noise heard by the observer on the ground may be different both in level and spectral character from that emitted by the engine.

All these factors have to be borne in mind and accounted for when accurate predictions of a project installation are required, or when experimental measurements are accounted for in terms of the basic engine noise sources.

Rolls-Royce Effort in Controlling Aircraft Noise

Because the design and development cycle and continuity of service operation means that a successful aircraft project will span well over a quarter of a century, it is necessary to address the noise issue in both the short and longer terms. For this reason the Company attacks the noise problem in two modes.

Firstly, there is a broad-based component programme run by qualified senior engineers, which is largely divorced from the day-to-day project problems. Fan, turbine, jet, combustor noise and acoustic liner technology are all treated as separate subjects and investigated from first principles in a co-operative programme between the Company and the National Gas Turbine Establishment at Pyestock. Because of the environmental nature of the noise problem the Government contributes significantly to the overall research programme. NGTE and Rolls-Royce agree on subject sharing, and provide leadership on their designated aspects. UK universities are also involved. Major facilities exist at Pyestock and on Company sites to allow the individual component investigations to be carried out. These include the National Anechoic Facility for turbines and jets at Pyestock, the large scale Absorber Facility, also at Pyestock, and the Compressor/Fan Noise Facility and engine test beds located on Company property (Figure 6). Work on aircraft is carried out from the Company Flight Test Establishment at Bristol or in conjunction with the main airframe customers around the world.

The short and medium term activity, which embraces the application of research findings and ensuing control technology to the product, is carried out by a separate group. It deals with day-to-day project aspects, carries out development testing and also furthers the demonstration of noise control technology on special experimental engines. A further group is responsible for turning project and general research findings into design methods and prediction techniques. The above work absorbs about 70 per cent of the Company effort on noise technology, the other 30 per cent being concentrated on the vital features of noise measurement and data processing. Advanced techniques for the detection and measurement of noise are developed by this group, who are also responsible for the data acquisition on all the Company test facilities and from flight tests together with the analysis and reduction of data into appropriate formats.

The total effort on noise in terms both of manpower and of finance is difficult to assess, but the technology group is staffed by between 50 and 60 people, and it is directly responsible for spending some two to three million pounds per annum. The considerable investment in hardware in engine development, production and product support and the manpower necessary to expedite this work, must be considerably greater than the effort on technology alone.

Current Activity

All RR engines are subject to noise control activity. From the older low bypass ratio Spey engine (still in service, and in new production line versions of the F28, BAC 1-11 and Gulfstream III executive aircraft) through to the latest RB211 variants for the B747, L1011 and the B757 aircraft, most aircraft have grown by around 25 per cent over the original launch size. The engines have to grow accordingly, although the growth is usually constrained by the diameter limitations placed upon the engine either from the aerodynamic or installation problems that larger sizes create. Consequently, the extra 25 per cent thrust has to be squeezed out of almost the same sized pot. This always creates noise problems, and many of the day-to-day issues are associated with trying to improve the performance of the many noise producing components within the engine, and counteracting there are inbuilt design features aimed at controlling source noise.

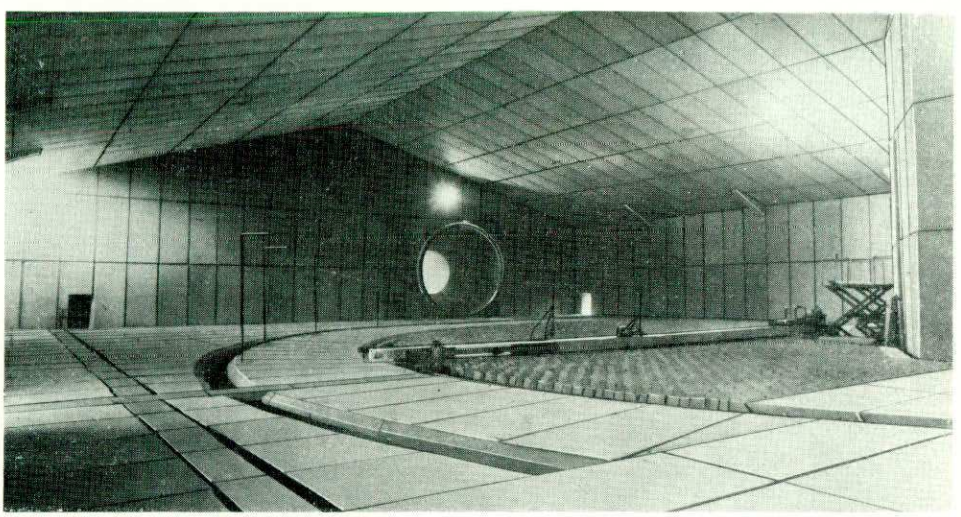

Figure 6 The anechoic chamber in the fan noise research facility

Perhaps the most important immediate projects are the higher thrust versions of the RB211-524 for B747 and L1011, and the RB211-535 for the B757 and the new joint RR/Japanese RJ500 project aimed at replacing the older low bypass engines in the 100-150 seat capacity type aircraft.

The RJ500 is unusual in that it is a completely new engine. Since the launching cost of a completely new engine and aircraft is tremendous, it is not surprising to find industry putting more and more emphasis on growth and adaptation of existing products. All the RB211 applications referred to fall into this category; even the new 2 engined B757 aircraft is, in many respects, a development of existing hardware. The fuselage is the same as the existing 3 engined B727, and the RB211-535 is a smaller version of the basic RB211 family of which the -524 is the version in the larger L1011 and B747 aircraft.

Growing an aeroplane involves increasing engine thrust. Historically the increased jet noise that higher exhaust velocities create.

Whilst these problems are all tackled on a short-term basis, they do rely on the findings of the long-term research programme and the engine based demonstrator exercises. An example of such a demonstrator exercise is the ongoing Quiet Engine Programme (4) that the Company initiated in the mid 1970s. This programme originally took an RB211 engine from the Lockheed Tristar development flight line and made a series of modifications to the non-rotating features of the installation, in order to demonstrate the value and feasibility of improved noise control features. Although many features of the programme are investigated on specialised component facilities, the integration of the individual findings into a full scale unit provides definitive project information. Unfortunately, it often produces unexpected and discouraging results. Nevertheless, the information that such a programme provides, expensive though it is, ends up far cheaper than making the wrong decision in a new engine project. Failure to comply with modern noise

requirements can prevent an aircraft from entering service. With large modern aircraft costing billions of pounds in development before they enter service, and selling for around £30 million each, the consequences of failing to meet noise standards are enormous. And even when they are in service they can be restricted in their operations by local airport noise rules, including curfews, quotas and runway limitations. Until aircraft are seen and not heard, the problem will not be solved. □

References

1 FAR Part 36 Noise Standards — Aircraft Type Certification — filed November 1969. Federal Aviation Authority, Washington DC, USA.

2 M J Lighthill, *On Sound Generated Aerodynamically*. Proc Royal Society, Vol 211, 1952 and Vol 222, 1954.

3 N A Cumpsty, and B W Lowrie, *The Cause of Tone Generation by Aero Engine Fans at High Subsonic Speed and the Effect of Forward Speed*. ASME 73-WA/GT4, December 1973.

4 M J T Smith, *Quietening a Quiet Engine — The RB211 Demonstrator Programme*. SAE 760897, November 1976.

Industrial Pollution and Control

The First International Conference on Industrial Pollution and Control is to be held on 14-17 December 1982 in the Republic of Singapore. The conference aims to bring together environmental specialists to discuss and examine environmental problems encountered due to rapid industrial development and will include papers on the following topics: Air pollution and control, Water pollution, Noise pollution, Industrial health, and Industrial waste and treatment systems.

Intending authors should submit 500-word summaries of their contributions to reach the organising committee as soon as possible. Summaries and requests for further information should be addressed to: Dr R B W Heng, MIOA, Conference Secretary, First International Conference on Industrial Pollution and Control, Department of Mechanical and Production Engineering, National University of Singapore, Singapore 0511. □

Calls for Papers

The Meetings Committee of the Institute of Acoustics is always pleased to receive offers of contributions to any of its meetings. Contributions are particularly sought for the following:

BS 4142 Reviewed and Criticised

London, 8 February 1982
Meeting Organiser: James Moir
James Moir & Associates, 16 Wayside, Chipperfield, Herts WD4 9JJ

(200 word abstracts as soon as possible)

Design and the Consultant — Everyday Acoustic Details

Portsmouth Polytechnic, 26 February 1982
Meeting Organiser: Dr J A Powell
Portsmouth Polytechnic, School of Architecture, King Henry I Street, Portsmouth PO1 2DY

(200 word abstracts as soon as possible)

Noise Control in Factory Buildings

Department of Architecture, University of Cambridge, 26 May 1982
Meeting Organiser: Dr R J Orlowski
Department of Architecture, University of Cambridge, 1 Scroope Terrace, Cambridge CB2 1PX

(200 word abstracts by 31 January)

Design and Use of Acoustic Test Rooms

London, 28 June 1982
Conference Organiser: Dr G M Jackson
Atkins Research and Development, Woodcote Grove, Ashley Road, Epsom, Surrey

(200 word abstracts by 28 February)

Auditorium Acoustics

Edinburgh, 8 - 10 September 1982
Conference Organiser: Dr R K Mackenzie
Heriot-Watt University, 25 Chambers Street, Edinburgh EH1 1HU

(200 word abstracts by 31 March)

ACOUSTICS '82

University of Surrey, Guildford, 29 March to 1 April 1982

Full details of all the papers to be presented at Acoustics '82 are, unfortunately, not yet to hand. The session on **Subjective Auditory Effects** contains a very wide variety of papers ranging from a discussion of Studio design and another on spatial impression in concert halls through some work on very low frequency hearing to the perception of speech with hearing impairment present. The **Physical Acoustics** session includes a sub-session on intensity measurement both at audible and at ultrasonic frequencies; a sub-session on calibration of ultrasonic transducers, a sub-session on measurements in non-homogeneous media as well as other papers on work at ultrasonic frequencies. The **Poster Session** is proceeding slowly at present, but an interesting mixture of papers has already been received. The range of papers for the **Environmental, Transportation & Propulsion Noise** session is deliberately very wide and this session should contain something of interest to almost anyone concerned with noise measurement, generation, propagation and assessment.

Pioneers of British Acoustics

Acoustics and Ornithology: Professor William H Thorpe

The advent of tape-recording and sound spectrographic analysis has led to considerable activity in the study of animal communication systems and, in particular, bird-song has been a productive area for investigation. For a number of decades Prof William H Thorpe, MA, ScD (Cantab), has been the leading British researcher in this field.

This work has received recognition by election as a Fellow of the Royal Society (1951), the award of the Godman-Salvin Gold Medal of the British Ornithologists Union (1968) and more recently (1981) 'The Frink Medal' of the Zoological Society of London. Although in his eightieth year Prof Thorpe is still quite active and his latest book entitled *The Origins and Rise of Ethology* appeared as recently as 1979.

Amongst his other publications are *Learning and Instinct in Animals* 1956, *Current Problems in Animal Behaviour* (ed with O L Zangwill) 1961, *Bird Song: The Biology of Vocal Communication and Expression in Birds* 1961 and *Duetting and Antiphonal Song in Birds* 1972. He was Director of the Madingley Sub-Department of Animal Behaviour, University of Cambridge (1966 - 69), where he is now Professor Emeritus of Animal Ethology. He has held the Presidency of Section D (Zoology) British Association (1956) and that of the British Ornithologists Union (1955 - 60).

By the use of vocal signals birds have developed a sophisticated system of communication which has a close similarity to that of man. The acoustic signals provide a wide spectrum of frequency and intensity and simple signals can be transmitted by simple sounds which may be shared by several species, eg the 'mobbing' calls given by small bird families, such as those of the blackbird, robin, wren, chaffinch, etc, in the presence of a predator owl.

Modern research into bird-song is mostly restricted to the full or primary song which Thorpe showed for example can be extremely complicated as in the case of the Gouldian finch.

This full bird-song acts as a specific recognition mark and it also conveys environmental information regarding the territory controlled by the male bird. The need for the female to distinguish her male sexual partner means that the song of the latter must contain individual variants.

The chaffinch is still perhaps the most satisfactory bird species for experimental investigations on song-learning ability and Thorpe initiated such work at the end of the 1950s using sonographic analysis. The general procedure has been to isolate acoustically the baby bird so that if, when isolated, it develops a normal pattern of songs and calls, then it is considered to have an inherited vocal behaviour. This isolation does not seem to affect the call tones but the full song is influenced, suggesting that some type of learning process takes place if normal development is to occur. Lack of space prevents a fuller account of this interesting work and maybe the Institute can arrange a meeting on Biological Acoustics in the near future. □

RWBS

Institute Ties

Ties will shortly be available at £4 each inclusive of VAT and post and packing, or £7.50 for two. The design is of Terylene Crimplene repp with the main blade 3½ inches wide and having the Institute's crest (see the title page of the Bulletin) just under the knot. Three colours are available: navy, maroon and brown. To order your tie please fill in the form below and return it with the due remittance to the IOA Secretariat.

..... cut here .....

Institute Ties

Name: .....

Address: .....

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Navy		
Maroon		
Brown		
	Total:	

This form should be returned with your remittance to Mrs Cathy Mackenzie, Institute of Acoustics, 25 Chambers Street, Edinburgh EH1 1HU.

Acoustic Source Location

IOA Meeting at Birkbeck College London, 2 November 1981

With an audience in excess of two dozen, Roy Lawrence chaired the morning session. Monsieur Berhault represented Metrovib and had travelled from France to present the first paper. He started by outlining the overall problem centring on machine noise identification. Members of the audience were slightly startled to see his use of a two-dimensional array containing many tens of microphones forming a surface surrounding the specimen, although he also proposed methods such as the use of six accelerometers to categorise an engine block.

Stuart Glegg of Southampton University addressed himself to the assumption made in techniques such as polar correlation and the acoustic telescope that the source region is confined to a single line such as the axis of a jet engine. When the array has a wide aperture this assumption may lead to gross errors. A by-pass duct resembles a ring of sources rather than a single point on the axis. A source twelve wavelengths off the axis will have its resolution 'blurred' by approximately five wavelengths. When the resolution is not sought to a precision better than one nozzle diameter, the assumption is relatively safe; however, an array wide enough to produce good low frequency resolution is likely to encounter trouble at higher frequencies. He went on to pre-empt some of Mike Fisher's revelations on the 'source breakdown technique'.

Svend Gade represented Brüel and Kjær, travelling from Denmark to make a spirited presentation based on a new instrument launched by B & K. He introduced the intensity vector for which a pressure gradient must be derived from two microphone signals. He considered the deployment of these microphones at some length, arguing the case for an axial arrangement in which the microphones faced each other with a separation which might be varied from 6 mm to 50 mm according to the frequency range of interest. He stressed the need to match the phase response of the microphones to 0·3° over the required range. The resulting system had a cosine law directionality and the broad maximum was argued as a virtue. For pinpointing a single source the 90° null of the system would be used.

After a break for an excellent buffet lunch Professor Shon Ffowcs Williams chaired the afternoon session with great verve and with meticulous timekeeping. Roger Kinns of Y-ARD in Glasgow dealt with gear tooth noise. To seek greater perfection in the gear tooth profile is an expensive business requiring precision machinery. It may be cheaper to reduce the vibration by structural modification. The typical marine gearbox which he considered weighed 100 tons, was 5 metres in diameter and at 200 rpm might produce a tooth contact frequency of 500 Hz. With overlapping modes and variations of vibration from build to build the analysis task was complex. He described the method of 'shaker' trials using reciprocity to derive a Green's function for the forces at the bearings and showed a graphical representation of the statistics of the 'transfer inertencies' from shaker to bearing. The eventual result is a mathematical model from which to decide whether extra damping is worthwhile.

Tat Jin Teo of Portsmouth Polytechnic presented a number of results showing the use of the coarse fine array in the acoustic telescope. In particular he was concerned with the loss of resolution when the microphones were deliberately misplaced and with the development of self-calibration techniques to correct for such errors. In practice, equivalent errors will be encountered in tape recording techniques. From a single deployment of microphones two different sub-sets were chosen to provide a comparison of performance of a 14 microphone equispaced array and a 10 microphone coarse fine array showing that despite the reduction in the number of microphones the coarse fine resolution was much sharper, being only one quarter of the width of that of the equispaced array. Calibration made a dramatic improvement to the coarse fine performance but a sample interpolation technique gave little further improvement.

John Billingsley of Portsmouth Polytechnic was concerned with the use of the coarse fine array for the analysis of moving sources. The acoustic telescope method is based on the summation of series of microphone samples held within a computer, where for each focus position various time shifts are applied to the microphone signals to compensate for the difference in acoustic transit between the source and that microphone. When the source is moving these time shifts become themselves functions of time. However, it is relatively simple to use a table of shift values to obtain the effect of 'panning the camera with the source'. He pointed out that by replaying the data of a flyover test a focal length and tracking velocity could be adapted to give the sharpest possible image, assuming, of course, that the sharpest image was the 'correct' one.

Mike Fisher of Southampton University presented the jet engine noise source breakdown method with a forthright reply to Shon's earlier jibe that, 'You can find the source if you know where it is'. By assuming that the source locations are known, in the form of discrete regions at the inlet and other well defined orifices of the jet engine, with a reasonably well known shape for the distribution in the mixing region, a least squares fit can be applied to attribute well defined quantities to these contributions. Moreover the location of the sources may be allowed to vary slightly, perhaps in response to refraction effects. The method's main benefit was that it allowed the automation of the analysis of data giving results in the form of comparative power spectra for the various regions.

J D Antippa of the Central Electricity Generating Board described the development of a steam leak detector. He outlined the choice of transducers with a number of experimental reflectors leading up to a final production device with parabolic horn and with a second wide angle transducer for automatic gain control. The final read-out is in the form of a bar of light emitting diodes to eliminate the need to read a meter in low light conditions.

By dint of ruthless timekeeping and a cavalier treatment of the tea break, Shon gained a full half hour for discussions despite the addition of an extra paper to the original programme. The discourse was a lively one and ranged over all eight papers, continuing long after the formal close of the meeting. □

John Billingsley

NEW ELECTIONS

The following elections have been approved by Council.

Fellow

M E Bryan
B E Miles
T G Muir
P M Nelson
J A Powell
W Sachse

Member

R Bainbridge
N J Boulter
A Champion
S K Chan
K M Collins
P Cox
G M Coward
S P Davison
D S Gaunt
S Y M Hui
C J Jenkins
K C Lam
D R Landeg
E A Lindquist
F P McCorry
W McTaggart
J Mozina
J F Priest
K Rabouhi
M D Randall
P C Reeve
B C Ross
P J Smith
P B Spence
J M Stewart
J W Storer
D T Sugden
G Townsend
A E Watson
M G Williams
J P C Wong

Associate

A Calvo
T M Cheung
T L Chung
A J Colthurst
R M Crossland
N A Edwards
J Fleming
C J Franchetti
N D Fraser
C L Ho
D J Hughes
P Kingston
H K Kong
S K Kwok
M J Ledger
P Love
A R Mackenzie
R K McLaughlin
P H Oxburgh
W R Purves
L Sehter
J R Stirling
T G Talbot
F G Thompson
R F Towers
C Wallace
M S Williams

Student

R Borkum
G M Naylor
J R Nedwell

IOA Annual Subscription

As detailed in a circular sent to all Members of the IOA, the following subscription rates will apply for 1982.

Fellow: £38

Member: £27

Associate (over 30): £24

Associate (under 30): £20

Student: £10

Institute of Acoustics Diploma Examination 1981

A total of 134 candidates were registered for the General Module Paper from 9 different centres, which included for the first time Colchester Institute and Heriot-Watt University. This total is about 17 per cent in excess of the 1980 registrations. The percentage of passes was slightly lower at 80 per cent compared with 93, 85 and 84 for the years 1978, 1979 and 1980 respectively. It is interesting to note however that the average of the more recently joined centres reached the 1978 percentage level.

The IOA Award for the best overall performance for the Diploma 1981 examination was divided between R A Sargent of Derby Lonsdale College of Higher Education and J M Southwell of Newcastle upon Tyne Polytechnic. The following candidates are specially commended for their meritorious performance in the 1981 examination: Candidates Nos A0105; A0120; B0059 and J0008.

The number of Diploma awards was 77 (5 being from a previous year registration) which compares unfavourably with 101 in 1980. This disparity arises from the disturbing fact that 30 candidates failed to present their project in the allotted time, and of these over 50 per cent came from one centre. The specialist paper of Transportation Noise was particularly well-answered this year but that of Law and Administration, although still the most popular, did not reach the high standard of the entries of previous years.

Sixteen candidates qualified in extra

Congratulations to the following candidates who qualified for the IOA Diploma

N E Surrey College of Technology

G Buck
Miss L A Carrodus
K-S Chan
K M Collins
D R Cooke
G M Coward
D Denton
M J Green
Y K Kam
P R Morgan
B Newington
W L Parkinson
D R Poole
R E Richards

Liverpool Polytechnic

M H Dawson
L A Ditchfield
Miss E M Dunne
J Fleming
A J Gilbert
S Jones
J N Kirkham
F P McCorry
V L McGrath
A Marshall
R T Peters
P Robinson
N C Rotheroe
P J Turner

Newcastle upon Tyne Polytechnic

B Caygill
G Craigs
J L Craigs
R Crosby
M J French
C H Simpson
J M Southwell
M Sullivan

Cornwall Technical College

R Coates
A R Jones
A P Mayne
I D Travers
Mrs M S Williams

Leeds Polytechnic

J P Blackburn
R M Crossland

Bristol Polytechnic

D J Baillie
D J Hughes

specialist modules and our congratulations are conveyed to I McG Fraser (Diploma 1979) on being the first to qualify in all five specialist modules.

A notable feature of the successful Diploma candidates in this year's examination was the decrease of about 20 per cent in the number of Health Officers who qualified, although in two of the newer instruction centres the old level of approximately 75 - 80 per cent was maintained. Since the overall number of entrants remains approximately the same as last year it suggests that the Diploma is having an increasing appeal to industrial workers concerned with acoustics. This interest could be stimulated by the new module of Vibration Control although the initial response was numerically small. Its mathematical content is probably a difficulty for many health officer candidates, as was evident in the almost complete avoidance of Questions 2 and 3 in the examination paper.

Again the general standard of the project reports submitted was excellent and made judgement of the winner of the ANC prize a difficult one. Finally it was decided to share the prize between J P Blackburn of Leeds Polytechnic and J M Southwell of Newcastle upon Tyne Polytechnic. The titles of their projects were respectively: *A Comparative Study of the Determination of L_{eq} for Railway Noise by Prediction and Direct Measurement* and *Selby Coalfield — A Study of Noise in the Vicinity of Level Crossings*. The following candidates receive special commendation for the merit of their presentations: A0106, B0059, D0016, G0022, H0011, H0018, J0007, K0004. □

RWBS

Diploma Exam 1982

The IOA Diploma examinations will be held on Monday and Tuesday the 7th and 8th of June this year. Project reports should be submitted not later than 25 June. □

Tottenham College of Technology

F A Benn	J M McGillivray	D W Turner
D F Edge	W D Page	P C Ward
J Lingford	M Roberts	

Derby Lonsdale College of Higher Education

S A Beard	C J Faulkner	R Payton
P S Court	R A Fisk	R P Perry
H G Cox	J R Fraser	R A Sargent
G E Crossley	P G Marshall	

Colchester Institute

R R Barrett	J E Gibbs	T G Talbot
L Bojko	T S Huggins	J R Tanswell
B G R Coley	J Reeve	

Heriot-Watt University

D J Connolly	W McTaggart	A E Watson

The following holders of the Diploma have passed additional specialist modules

N E Surrey College of Technology

D R Bayliss (1)	R J Hossack (1)	P J Smith (1)

Liverpool Polytechnic

W A Baines (2)	I McG Fraser (1)	W T Milburn (2)
K Bentley (1)	T J Gould (2)	P N Wright (2)
D H Collins (1)	D A Logan (2)	
P Cox (2)	J D Lyon (1)	

Tottenham College of Technology

R C Dorney (2)	R N Lovett (1)	P R Russell (2)

Personalia

Professor Gordon Tucker

Scientists and engineers in many fields are facing the decision of early retirement and they may find encouragement from the example of a leading founder member of the Institute of Acoustics, Professor Gordon Tucker.

Some six or seven years ago he took early retirement from the post of Head of the Department of Electronics and Electrical Engineering at the University of Birmingham, where he had been responsible for the setting up of the first underwater acoustics facility at a UK university. On retiring he obtained a non-paid post in another department to engage in his growing interest in industrial archaeology. I had the opportunity recently to sense what an authoritative position he has attained in his new field of investigation on the occasion of the AGM of the Windmill and Watermill Group of SPAB when he gave a most interesting and informative talk on *Millstone Making*.

It is often forgotten by the acoustician that he has a distinct advantage, arising from the multi-disciplinary nature of his subject, in moving more easily than most workers in other fields to new spheres of interest.

Dr Martin Grützmacher

Acoustical workers in the UK would wish to send their congratulations and best wishes to Dr Martin Grützmacher on reaching his eightieth birthday. The occasion was marked in November by a lecture at the Physikalisch Technische Bundesanstalt, Braunschweig, West Germany, from Professor Dr L Cramer with the title *Physik des Geigenkörpers*. Dr Grützmacher has been closely concerned with acoustical standardising committees for many years and from 1966 to 1980 was chief editor of Acustica. □

RWBS

Material for the April issue of Acoustics Bulletin should reach Mrs F A Hill at 25 Elm Drive, St Albans, Herts AL4 0EJ, no later than 19 February.

Letter to the Editor

Dear Madam,

Frequency Doubling of a Medical Tuning Fork

With respect to the problem posed by P M Haughton in the October edition of Acoustics Bulletin, may I suggest that the explanation may be found in a consideration of 'centrifugal force'.

The fundamental mode of vibration of the fork consists of lateral or x direction movements as shown in Figure 1. The natural overtones are formed by more complex bending waves of the fork's twin cantilevers as shown in Figure 2, and these generate the anharmonic frequencies $6.27f_1$, $17.55f_1$, etc, as mentioned by Haughton.

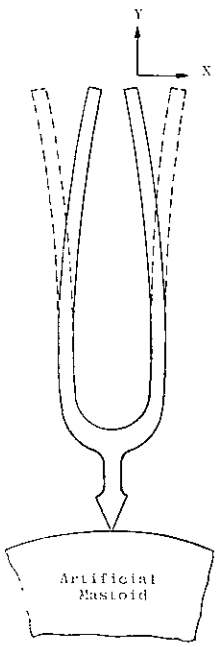

Figure 1 The fundamental vibration

However if we return our attention to the fundamental mode depicted in Figure 1, and consider the motion of a segment near the tip of one of the prongs of the fork, it can be seen that this segment describes a path that approximates to a circular arc with its centre somewhere near (actually a little above) the root of the prong. Elementary mechanics tells us that associated with a tangential velocity:

$$v = \frac{dx}{dt} = 2\pi f_1 a \cos(2\pi f_1 t)$$

there is a centrifugal force equal to:

$$F = \frac{mv^2}{r} = \frac{4\pi^2 f_1^2 a^2 m}{r} \cos^2(2\pi f_1 t)$$

where m and r are the mass and 'radius of gyration' of the segment respectively.

Hence we see that there is a centrifugal force in the y direction proportional to $\cos^2(2\pi f_1 t)$. This force is always positive and can be analysed as a static component plus an oscillation of twice the fundamental frequency f_1

$$\cos^2(2\pi f_1 t) = \tfrac{1}{2}(1 + \cos 4\pi f_1 t)$$

Alternatively, avoiding mathematics, centrifugal forces acting on the tip of a prong exert a tug at its root when the tip moves from left to right, and a second tug when the tip moves from right to left, hence providing two tugs for every cycle of the fundamental vibration.

As these centrifugal forces are in the y direction their effects are transmitted very readily through the stem to the artificial mastoid whereas the fundamental x direction movements of the two prongs are almost self-cancelling in the stem. Any residual x movement due to imbalance is tangential to the mastoid surface and would therefore have to be transmitted through shear forces, which explains why the double frequency of 256 Hz is stronger than the fundamental of 128 Hz.

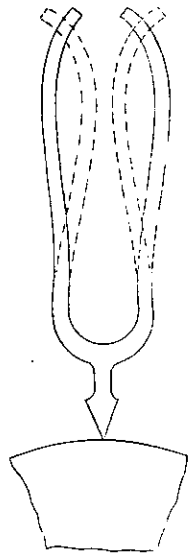

Figure 2 The first anharmonic overtone

Yours faithfully,
R R Hudson,
Vice-Principal,
Gateshead Technical College.

The Darlington Quiet Town Experiment

The report of the former Noise Advisory Council on the Darlington 'Quiet Town' Experiment was published in November. This two-year project, the first of its kind in the world, set out to show how noise might be reduced at home, at work and out of doors. It involved an expert team of staff from Darlington's Department of Environmental Health, with the active support and co-operation of Durham County Council, the local police, schools and many other organisations. Educational aspects were particularly strongly emphasised, the view being taken that the education of the next generation of potential noise-makers is likely to prove the most effective way of reducing noise nuisance in the long term. (See January 1979 issue of Acoustics Bulletin.)

The 37-page report outlines the origins and objectives of the experiment and explains why Darlington was selected as the study town. The social surveys and experiment activities are described and the encouraging interest in the project both in the UK and abroad is discussed. The 33 pages of Appendices include a framework for anti-noise campaigns and examples of the publicity material used.

It is perhaps unfortunate that the results of the social surveys, carried out to assess people's subjective responses to noise levels before and after the Experiment, were not more conclusively favourable. Nevertheless the Experiment was clearly very successful in 'conveying the message that noise is a problem worth tackling . . .' Other schemes are already under way in the UK and in France and the USA, and for anyone contemplating setting up their own 'Say No to Noise' project the information contained in the Appendices alone is enough to make this a valuable document.

The Darlington Quiet Town Experiment is available from HMSO, price £8.50. □

ISVR Courses 1982

16 – 18 February	Vibration testing and signal analysis
16 – 18 March	Shock and vibration control
22 – 26 March	Instrumentation and measurement techniques for vibration control
29 March – 2 April	Clinical audiology
29 March – 2 April	Noise and vibration control for environmental health officers
14 – 18 June	Instrumentation and measurement techniques for noise control
6 – 10 September	Industrial audiology and hearing conservation
13 – 17 September	Technical Audiology 'A'
13 – 17 September	Advanced Noise and Vibration

Further information may be obtained from:

Mrs G Hyde
ISVR Conference Secretary
The University
Southampton SO9 5NH

Telephone: 0703 559122
Ext 2310 (Mrs Hyde)
Ext 752 (Dr J G Walker, Short Course Organiser)
Ext 2294 (Enquiries)

Speech Aids for the Handicapped

Speech Group Meeting at Bedford College, London, on 23 September 1981

An exciting variety of papers was presented at this one day meeting which was rounded off by a stimulating discussion session.

The morning session began with two papers on delayed auditory feedback devices, by D D Lindsay (Aberdeen) and G Manson & J Kirkowski (Cork). The audience was treated to an excellent review of the field, its history and potential, followed by a more detailed and technical presentation relating to a particular device. With technology becoming cheaper, lighter and less power hungry the future for wearable devices looks promising, although trials suggest that several speech production deficiencies cannot be helped through delayed feedback.

The morning session continued with two papers on speech displays for the deaf. R Wright *et al* (RNID) gave a brief survey of such devices and showed how some engineering problems could be overcome through the use of microcomputers. These provide simplicity of construction, flexibility of function, ease of use, and as a bonus, other valuable effects such as educational computing experience. Not least, the deaf children exposed to such technology can view the equipment as less 'speech biased' or authoritarian than conventional apparatus. F Fallside (Cambridge) concluded the morning session with a presentation of the computer based system currently being explored in his laboratory. This does not attempt speech spectrographic display, as does the equipment described by Wright, but instead focuses on feature identification and display. The features are presented along with information from 'correct' performances for the student to assess his progress. The power of these computer based systems for speech processing aids of one sort or another is clearly only limited by the inventiveness of the teams working with them. The future for these aids looks promising.

After lunch, in a session on tactile displays, I Summers (Exeter) reported on work using a single vibrator (piezoelectric crystal), as the transducer of an acoustic environment monitor. He followed this up with some provocative suggestions concerning the suitability of such a simple device for speech reception. G Dodgson & B Brown (Sheffield) reported work on electrotactile stimulation of the wrist (or rather, the nerves running up the arm from the hand, stimulated electrically through the wrist). They also found that subjects could make good use of the information for monitoring the acoustic environment. Once again the potential for assistance with speech reception and production seems clear. W Edmondson (Bedford College) talked about the philosophy behind the various tactile devices which have been tried over the last half-century or more, and offered the conclusions that improved tactile stimulation is possible (although most engineers go for very simple and physiologically inappropriate stimulation), that speech processing is necessary for effective use of the

London Evening Meetings

On 24 September a larger than average band of stalwarts gathered in a strange space under the eaves of County Hall to hear Joy Goodman, Health and Safety Adviser at St Thomas's Hospital, talk about Noise in relation to Health and Safety at Work. Although she described herself as knowing nothing about the technicalities of acoustics it became clear that noise was a very significant aspect of her work and that her grasp of the principles involved was admirable. A good deal of stress is caused by noise at work and her concern was not so much with the major problems covered by the Code of Practice, where the available solutions are well established, but rather with the levels below 90 dB(A) that make the working environment thoroughly unpleasant. In Joy's words, the noise irritants rather than the noise aggressors.

To illustrate her points she led us on an imaginary tour of the Hospital. The sheer size of the operation of a major teaching hospital was a revelation to most of us: 29 acres of hospital employing 5000 people, most of whom have no direct contact with patients. Rather than the calm and restful wards of our imaginations, most of the hospital is a bustling industrial complex with all the associated noise problems; metal working machinery, fork lift trucks, bottle crushers and mechanical services on a vast scale to cite just a few. Many of the problems clearly stemmed from poor design in the layout of the hospital which placed noise producing and noise sensitive areas in conflict with each other. The discussion was as wide ranging and interesting as the talk and Joy even received some free consultancy advice on one topic! What was distressing was that it was clear that even in a hospital almost all the affected staff are prepared to risk hearing damage rather than wear the protection provided.

R C Hill

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tactile—or visual—channel (but should not be too complex because the human being has a better pattern processor than anything yet in hardware), and that the purpose behind the instrumentation should not be naïvely optimistic (we should not try to substitute for hearing in its entirety).

The generally forward looking, conjectural and adventurous tone of the day was well reflected in the final session, a discussion session following tea, on the topic of speech synthesis devices. Those taking part were W Edmondson, F Fallside, D L Gibson (Telecom), J Holmes (JSRU), and R King (Southampton). The interests in the field proved to be wide-ranging and the session was very informative. The applications for these devices seem to be for those with speech production difficulties and blind people who need text to speech converters. Systems developed so far depend entirely on text for input. J Holmes provided several taped examples of the output from various devices. The fact that these were fun, although an effort to listen to in one or two cases, shows how far we still have to go before they produce output confusable with the real thing. □

W Edmondson

On 29 October Dr Mike Langley of Wimpey Laboratories gave a talk on his experience in monitoring and assessing vibrations from piling operations. Matters discussed included measurement parameters, cautionary levels appropriate to both human comfort and building damage, monitoring equipment and measurement techniques. Particular reference was made to the importance of selecting transducer mounting devices which gave vibration levels representative of the motion of the surface being monitored. Dr Langley went on to discuss several case studies and the following conclusions were drawn.

a In general ground vibrations from piling operations are attenuated when transmitted into buildings. Typical peak velocity vector sums are generally half to three quarters of that in the adjacent ground.

b Of the options open for reducing ground vibration from piling operations, trenches between the rig and sensitive area are not thought to be very effective while for drop hammer piling useful attenuations can be achieved by reducing the drop height.

c Vibrations from piling operation rarely cause damage to buildings, structures or services mains. However, people often express concern over damage to their property at velocity levels well below the cautionary standards normally adopted. Such concern can often be alleviated by good public relations coupled with measurement programmes.

Communication in a High Noise Environment

UT SECURE VOLENT—so the 26th November audience were informed—means 'to make flight safe', this being the motto and objective of the Royal Air Force Institute of Aviation Medicine whence came the evening's speakers Dr Brian Lisher and Dr Richard Pratt. Brian first took the floor and in briefly introducing the work of the Institute described some of the means at his disposal whereby extreme flying conditions can be simulated in the laboratory—including a 3 metre stroke vibrator, a 30g centrifuge and a high altitude chamber—all of which seemed to be dedicated to the process of ensuring that the aircrew should find the real thing a doddle by comparison.

Brian described how the Institute's interest in the internal noise environment in military aircraft was heightened in 1960 by the introduction of Phantom and Buccaneer aircraft and since then by the growing need to employ high speed low altitude flight as the only practicable means of escaping enemy detection. With modern jets flying at speeds of the order of 600 knots at little more than tree height, the resulting turbulence surrounding the cockpit canopy gives rise to very high internal noise levels, in some cases up to 120 dB in level flight rising another 10 dB during manoeuvres. Other factors contributing to the cockpit noise environment include noise from the cabin conditioning system and discrete tones from the main engine fans. All in all Brian painted a picture of the modern jet pilot immersed in a high level noise climate, broad band up to about 8 kHz generously laced with tonal components around 2 to 2½ kHz.

Having established the extent of the problem, Brian outlined the steps taken to protect the pilot and his communications system. Because of the priority to conserve overall weight in the interests of military efficiency, all the protection is based on the aircrew's oxygen mask and helmet. Unfortunately noise measures seem to rate rather low on the priority list for these items which are responsible for many aspects of the pilot's well-being. Specially designed ear protectors

whilst providing good attenuation are unfortunately just too large to be of practical use, although Brian noted that these may be of some benefit in due course for helicopter based sonar operators seeking enemy submarines.

At this point Richard took over the presentation and played tapes of aircrew commentary from different aircraft types. Despite an apparent near miss with some hang gliders the Hunter pilots certainly seemed more relaxed in their relatively quiet (105 dB) environment by comparison with the Sea Harrier pilot (120 dB) who clearly had to use much increased vocal effort to effect a signal to noise improvement and whose transmission clearly showed the 2 kHz engine tone every time the respiratory valve in his oxygen mask opened. The Wessex helicopter pilot showed that throat microphones gave a reasonable signal to noise ratio but provided poor syllable articulation, whilst the enhanced all round performance characteristics of a mask mounted microphone as against a boom microphone were demonstrated by the dialogue between instructor and student in a Chipmunk.

Richard explained something of the Institute's work on transducer development, including a new noise cancelling boom microphone, and in particular described the procedures he uses for identifying the best microphones for the job in hand. He favours intelligibility testing using a multiple choice rhyme test. The observer has to identify a spoken word from a choice of six whilst being subjected to a controlled environment closely simulating actual conditions. Whilst this procedure has proved very useful in identifying good microphones, Richard told us how he has introduced the additional factor of reaction time to the basic concept of accuracy, finding this a more sensitive discriminator of system performance. Examples of test results were presented from which the relationships of word identification accuracy and reaction time could be seen as a function of signal to noise ratio in the system.

As regards the measurement of attenuation afforded by helmets, Richard has adopted the principle of simultaneous recordings of external and internal noise levels, largely because of the ease with which such measurements can be undertaken in real flight by using miniature microphones and tape recorders. Measured values of helmet attenuation were presented which indicated that in $\frac{1}{3}$ octave bands the insulation ranged from some 5 to 10 dB at around 100 Hz rising to about 45 dB at 8 kHz.

An interesting discussion period elicited some of the techniques now under consideration, including the possible use of 'antinoise' to provide an improvement in the apparent sound insulation of the helmets to about 20 dB at low frequencies. Also in hand is an investigation of the use of the newly derived Speech Transmission Index from Holland as a means of improving still further the discrimination of communication system components. As an indication of the interest developed by the speakers, the discussion could only be concluded by the expiration of the GLC's time limit and all left the meeting well satisfied with the insight into Brian's and Richard's work for the RAF Institute of Aviation Medicine. □

A J Jones

Membership of Standards Organisations

Many IOA Members have been asked, or may at some future time be asked, to sit on committees involved in the preparation of standards or similar documents. Other members may wish to make direct contact with members of such committees. It has therefore been suggested that a list be kept of members sitting on standards committees and your co-operation in preparing this list would be appreciated. Please therefore send the information requested below to: The Editor, Acoustics Bulletin, 25 Elm Drive, St Albans, Herts AL4 0EJ, or to the Secretariat at Edinburgh.

Name: .....

Place of Work: .....

Organisation:	Committee	Whom do you represent? (IOA, employer, other)
BSI	.....	.....
IEC	.....	.....
ISO	.....	.....
ESDU	.....	.....
BCR (EEC)	.....	.....
Other (please specify)	.....	.....

Please tick here if you do *not* wish this information to be published in Acoustics Bulletin. □

Appreciation

A prominent Dutch acoustician, Professor Dirk Willem van Wulfften Palthe, passed away in August of 1981 in his sixty-third year. He started his career as an assistant lecturer under the distinguished Professor Kasten in 1955 and subsequently he became Professor of the Acoustics Group at the University of Technology at Delft. He had been a member of the Advisory Board for the Organisation of Applied Scientific Research, TNO in Delft, since 1965. He was also president of the Dutch delegation in international normalisation conventions. Members of the old Acoustics Group of the Institute of Physics who attended the Anglo-Dutch-Spanish Acoustics meeting at Rotterdam will remember his enthusiasm for the occasion and only recently he expressed a desire for further meetings of this type. □

RWBS

High Intensity Sound

IOA Meeting at Birmingham University, 22 September 1981

Eight papers were presented at this Institute meeting, discussing various aspects of the generation, measurement and effects of high intensity sound. The duties of Chairman for the day were ably carried out by M W Owen of National Nuclear Corporation who kindly stepped into the breach at very short notice.

The meeting commenced with a general description by L Yeh of GEC of the Whetstone test facility and its origins. He traced briefly the development of the various types of noise generators now employed in test work in the GEC reverberation chamber and progressive wave tube. The facility was originally concerned with the investigation of noise induced structural damage in nuclear reactor gas circuits, but has since embraced similar problems in the fields of satellites, aircraft and rockets.

B H Bickers of NNC gave further valuable insight into the problems associated with the effects on components of the very high levels of circulator induced noise in the gas circuit of a nuclear reactor. The problems were approached initially using $\frac{1}{3}$ scale model techniques, but since testing was not practical for large items the use of the Statistical Energy Method for response prediction was developed. This has proved to be a powerful method for large multi-modal platework structures, particularly in predicting the effects of gas damping at high pressures, when finely tuned resonances can virtually disappear.

In rounding off the morning session, A Failey of British Aerospace described the test facility built at Weybridge in 1966 to combat aerospace associated noise problems. He also showed some very interesting examples of structural failures of both test specimens and noise generators.

The afternoon session commenced with a description by A C Rapier of UKAEA of the development at Windscale of a high intensity noise test chamber to operate at high gas pressures. This involved considerable study of the operation in high density gas of a commercially available electropneumatic transducer, which was originally designed for use in atmospheric air. During the course of the work, it was found that the flow resistance of the transducer increased with gas flow because pressure differences within the unit caused the modulating valve slots to adopt a more closed mean position.

R G White covered some aspects of his work at ISVR on carbon fibre reinforced panels having strength/weight ratios greater than aluminium. Analytical behaviour predictions are in good agreement with test results for thicker panels, but not for thin structures, which exhibit gross non-linear behaviour. D Sims of British Aerospace presented an account of an adaptation of the progressive wave tube test technique which more closely simulates the flight conditions of a guided missile. The method also reduces the acoustic power requirements, and involves a working section, termed an acoustic shroud, shaped to suit the streamlining of the specimen or to vary the acoustic pressure distribution. E J Smeaton described the test facility which had been installed by the CEGB in the old power station at Gravesend, and included an interesting survey of operational problems and experience. I H G Hopkins of NNC discussed aspects of his work on sound absorption measurements on nuclear reactor thermal insulation in high pressure gas using standing wave and reverberation techniques. The work has shown several sources of damping in the insulation and has demonstrated the importance of making absorption measurements in representative gas conditions.

The meeting was attended by some 20 delegates and was successful in presenting a review of current work in the somewhat specialised field of high intensity sound. □

H Slinn

Scheduled Helicopter Operations outside London

Although social surveys around major airports in the UK have established relationships between levels of fixed-wing aircraft noise exposure and the magnitude of the resultant community response there is a complete absence of social survey data indicating community reaction to regular helicopter overflights outside the GLC area. On seeing the result of the public inquiry conducted in May 1981 into the proposals of the Milton Keynes Development Corporation to develop land at Pineham for heliport operations, I thought it worthwhile bringing to the attention of the membership several conclusions arrived at by the Inspector (Air Vice-Marshal B P Young) covering the noise implications of the proposals.

a The application of BS 4142 (by the consultant to the local residents) to the helicopter noise events generated by regular take-off and approach overflights was considered inappropriate.

b The reasoning which led the consultant to the MKDC to recommend that a level of 80 dB(A) peak should be considered as a criterion of acceptability for individual helicopter movements for properties affected by the heliport was generally accepted. In fact the Section 52 agreement drafted by the Development Corporation subsequently suggested the imposition of a 78 dB(A) peak limit at any dwelling for an average of 55 movements per 15-hour weekday and 25 movements on Saturday.

c Possibly the most interesting statement was that where overflights are to occur across designated areas of outdoor recreational activity, the Inspector was of the opinion that 'the regular intrusion of noise levels of the order of 75 dB(A) or more would be wholly out of place and at variance with the purpose of that designated public open space'. In this particular situation helicopters were to overfly—chiefly on full-circuit approaches under visual flight rules — a lake which was considered an important feature of an associated linear park; altitudes were expected to be less than 500 feet.

I suspect it will be 1984 at the earliest before any results of the long hoped for social survey into helicopter noise exposure reaction will be available for general application by planners and noise control engineers in the UK, and I think it valuable to have available informed opinion such as is contained in this Inspector's report. □

Chris Hill

BRANCH AND GROUP NEWS

North West Branch

A promising attendance of twenty-one members were present at the first meeting of the Branch held on 17 September at the University of Salford to listen to Dr Gareth Millward of Rank Hi-Fi Ltd talk on *Loudspeaker Measurements*. Dr Millward illustrated his talk with slides and discussed the various methods used to test loudspeakers. The discussion that ensued touched on other aspects of 'hi-fi'.

Twenty-four members attended the second meeting of the Branch, held at the University of Salford on 19 November, when Ken Irish of Vibronoise Ltd spoke on *The transmission of groundborne vibration from impact and vibratory piling*. Ken gave a brief outline of the vibration problems associated with various types of piling. With impact piling, vibration usually has little effect on buildings further than 10 metres away from the piling although noise would have a very great impact! The worst problems of possible damage were associated with vibratory piling particularly where the natural ground frequency, the building frequency and the piling (input) frequency were all similar. It is a paradox though that, although vibration from vibratory piling is worse than that from impact, complaints are much less because there is less noise.

Ken suggested that before vibratory piling was carried out the natural ground frequency should be measured and compared with the input frequency of the pile driver and natural frequencies of nearby buildings. If vibration was likely to be a problem then at least monitoring of buildings could take place. Environmental Health Officers who specify vibratory piling in preference to impact piling for noise reasons please note!

Another result of vibratory piling which could be an 'indirect' cause of building settlement is the settlement of the sub-strata by compaction. Ken went on to demonstrate the equipment used to measure vibration, as well as that used to measure vertical and horizontal ground movement. Altogether a most informative meeting and presentation, recommended to other branches.

The first three meetings of the 1982 Programme have now been arranged. The meetings are open to members and non-members. The first two are to be held in the Bridge Room in the Maxwell Building of the University of Salford commencing at 6.30 pm and the meetings will conclude with a social discussion in the nearby 'Flemish Weaver'.

In his talk on 21 January, *Case Studies —Occupational/Industrial Noise Control*, Alan Bednall of the Health and Safety Executive will look at the work of the HSE on the control of noise in industry. At the AGM on 18 February, members will have the opportunity to express their opinions on the activities of the Branch and elect a new Committee and Chairman for 1982. After the business meeting it is intended to hold a 'potted problems' session where members are invited to present a five-minute case study of a problem they have been involved with.

The third meeting will take the form of a visit to Pilkington Flat Glass Ltd, St Helens. The visit will commence at 2.00 pm with a tour around the plant looking at the manufacture of glass and will be followed by a series of presentations on the properties, acoustic or otherwise, of glass. Members will be entertained to a buffet tea and afterwards will be able to browse around the famous Glass Museum. The party size is limited to 30 persons and intending visitors should notify the Secretary of their wish to attend. Should the visit be over-subscribed preference will be given to regular attenders of the previous Branch meetings, so in order to be sure of a place let us see you at earlier meetings!

Further details of the North West Branch and its activities are available from the Secretary, R P Atherton, telephone: 061 678 4472.

North Eastern Branch

The full programme for the first half of 1982 is now available. The AGM and Bar Sports evening will be held at Newcastle Polytechnic on 24 February and subsequent meetings will cover the topics of *Flow induced noise and vibration* (24 March), *Noise and the Environmental Health Officer* (28 April), *Code of practice on discotheque noise* (6 May) and *The new bells at Durham Cathedral.*

Further details are available from the Secretary, Mr C Norris, 32 Shap Close, Biddick, Washington 7, Tyne and Wear. □

Musical Acoustics Group Visit to Loughborough

About a dozen members met at the Bell Foundry of John Taylor & Co on the morning of 4 November. We were welcomed by Mr Michael Milsom who gave a brief history of the firm. He pointed out that, before the development of convenient country-wide transport, bell-founding had been an itinerant craft (the finished products were too heavy to carry very far!) John Taylor had come to Loughborough in the early nineteenth century to cast the bells for the Parish Church and had subsequently found the town a suitable centre for his activities. It was very sad that Mr Paul Taylor (the last of the Taylor family) had died a few weeks previously.

We then went to the foundry itself. The moulds were made by rotating a carefully contrived profile about the mould axis. This gave the correct shape to the surface of a clay mixture built up on a core of bricks for the inner mould and inside a sheet steel casing for the outer. It was interesting to note that the best binder for the moulding material is—horse manure! (For good bells, the answer lies in the soil!) The moulds were then buried in sand on the foundry floor and filled with the molten Bell Metal (80 per cent copper, 20 per cent tin) from one or more furnaces along the wall. There were no bells being cast on the day of our visit but we were told that the actual pouring of the metal had to be completed in some four minutes — a dramatic operation often witnessed by the 'customers' (perhaps Church or Civic representatives).

Across the road were the fitting shop and the tuning room. Bells of all sizes were seen being fitted to their headstocks (axles) and bearings for ringing. Here was machinery of a scale appropriate to a railway workshop or a shipyard. In the tuning room Mr Milsom showed us the giant vertical borer used for tuning the bells. In a process first developed in this workshop, metal was removed from selected regions of the inner profile of the bell to tune each of several partials of the note to give the desired sound. The frequency standards for the tuning were provided by

tuning forks. In an inner sanctum we were privileged to see an enormous array of forks (every 4 Hz from about 100 Hz to 3000 Hz) as well as — a homely touch to some of us — some items of Brüel & Kjær equipment.

After lunch we were welcomed to the Loughborough Carillon by Peter Stratford, the assistant Carillonneur and a member of the staff of Loughborough University Physics Department. He described and demonstrated his art on the 47-bell 'instrument' in the town's war memorial tower. The keys and pedals of his console resembled those of a medieval organ and required for their operation a considerable degree of athleticism as well as musical skill. While he continued to play, we were allowed to climb to the top of the tower among the bells (the largest some 4 ft high and weighing 4 tons) and afterwards listen to the bell music from ground level across the adjacent park (a sound reminiscent of the Netherlands rather than Leicestershire).

We then went to the University to see the bell work of Dr Tom Charnley and Dr Bob Perrin and—as an added technical delight—the Display Holography work being done in the Physics Department. The holographers were able to conjure up three-dimensional images from apparently featureless glass plates; one of an attractive young lady prompted the irreverent thought that, in these days of public spending cuts, certain Very Senior Academics could be replaced by admittedly less attractive but still cost-effective holograms!

Drs Charnley and Perrin welcomed us into their laboratory and showed us their work on the modes of vibration of bells, the experimental specimen being, of course, one of Taylor's and signalling a fruitful collaboration between the Bell Foundry and the University. Identification of the modes of a bell is an important part of the work, practical tests being supplemented by finite element calculations. Mode degeneracy has received much attention as has the associated problem of 'bell warble' a matter of great importance to the bell founder.

A very successful and interesting day was spent at Loughborough. We thank Mr Alan Berry, General Manager of John Taylor & Co, for allowing us to visit the Bell Foundry and Dr Perrin for making the detailed local arrangements. □

Edgar Brown

New Products

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

Sound Intensity Analysing System — B & K Type 3360

Brüel & Kjær have produced a sound intensity analysis system which measures over the frequency range 3.2 Hz to 10000 Hz in octave and third octave bands and displays the results in real time on the screen with indication of the direction of incident sound.

The system is based on a two microphone technique and uses a finite difference approximation for calculating the particle velocity from the measured pressure gradient and hence the sound intensity.

The 3360 can be used to measure the sound power of a source even in the presence of high background levels.

Other uses include the location and identification of sources, mode studies, noise control, tracing of energy flow lines and investigation of absorption as a function of the angle of incidence.

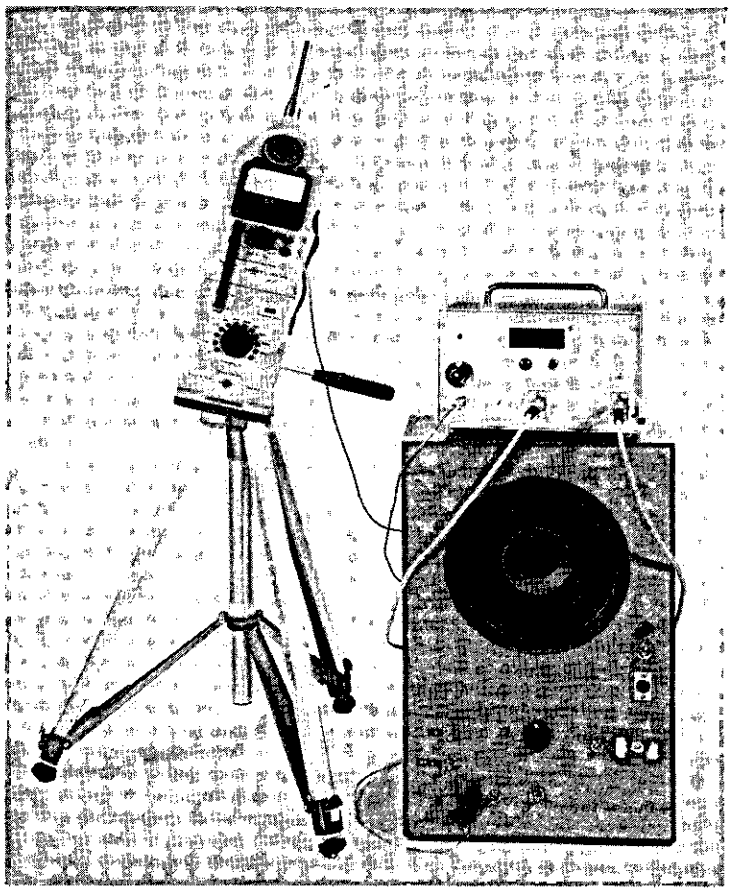
Further details from Brüel & Kjær (UK) Ltd, Cross Lances Road, Hounslow TW3 2AE. Tel: 01-570 7774.

New Reverberation Time Meter Developed by BRE

BRE has developed a simple meter which measures reverberation time when used in conjunction with a sound level meter, filter set, noise generator and loudspeaker. The meter, which gives a direct reading of reverberation time measured by the decay method, has been tested in 19 rooms at the Building Research Station. It has applications in sound insulation measurements, auditoria acoustics and noise control. The meter is to be manufactured by Gracey and Associates, 10 Barley Mow Passage, Chiswick, London W4 4PH, from whom further details can be obtained.

Industrial Sound Level Meter Model 83PE

Pulsar Instruments announce their first totally British instrument. The Model 83PE has been designed to meet BS 3489 and IEC 651. It has a range



Prototype of the BRE Reverberation Meter with ancillary equipment

from 40 to 135 dB(A) and employs a half-inch electret microphone on a telescopic boom. Price £120.

Tachometer Pulsar T48

The Pulsar T48 triggering tachometer is designed as a dual purpose unit.

Originally intended to work with its companion sound level meter the Model 44 for automatic vehicle noise measurement it is also a versatile stand-alone unit. Having available input transducers including optical, magnetic, electrostatic and voltage direct systems; the T48 will interface to most rotating devices.

Application notes are available explaining the use of the T48 for ISO vehicle noise measurement and machinery diagnostic applications.

Further details from Pulsar Instruments, 40 - 42 Westborough, Scarborough, North Yorks YO11 1UN. Tel: 0723 71351.

Piezo-ceramic Accelerometer Type A/23/S/I

D J Birchall Ltd announce the introduction of the A/23/S/I accelerometer which is a case isolated version of the A/23. The main features of the A/23/S/I are: charge sensitivity 7 pC/g, weight 4.5 g, resonant frequency 50 kHz, temperature range −55 to 300 C and price £190.

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

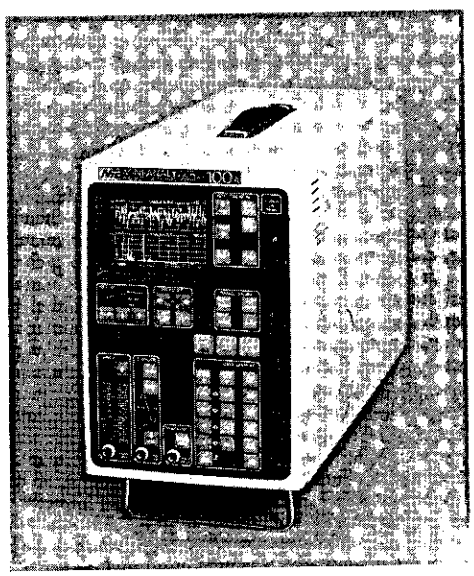
Metrologger dB306A

The dB306A Metrologger is a microprocessor-controlled integrating sound level meter which combines the functions of sound level meter, an L_{eq} meter, a noise dose meter, and a stopclock. This instrument has a four digit liquid crystal display which may be switched to any of the four functions.

Further details from General Acoustics Ltd, PO Box 20, Scarborough, North Yorkshire YO11 1DE. Tel: 0723 66347.

Mini Spectrum Analyser

Spectrum Analyser, the 100A mini Nicolet have announced an inexpensive, easy to use yet flexible FFT analyser. This new unit is small (8 inches wide × 12 inches high) and lightweight (30 lbs) and is suited for machinery diagnosis, general noise and vibration applications and production testing. It covers a frequency range of 0 - 20 kHz and offers 4000-line FFT analysis with non-destructive range expansion (zoom) and zoom scan.



The Nicolet 100A Mini Spectrum Analyser

The 100A mini analyser has a number of unique characteristics that are proving to be of considerable value to those involved in sonar and underwater acoustic studies. With 4 zoom bands of 400 lines each averaged simultaneously, a 1600-line analysis is achieved, but the zoom bands need not be set adjacent to each other. A lot of underwater work deals with transients, single and multiple, and requires detailed analysis; with the capability of 'time scan' of the data held in the 10K-sample memory of the 100A, a 'long' transient can be held and any selected 1024-sample time block selected for spectrum analysis. Conversely, any selected 400-line spectrum region can be selected with 'zoom-scan'. With regard to transducer testing, impulsing hydrophones and measuring their transient response is a way of evaluating and calibrating them. Averaging the impulses in time prior to spectrum analysis reduces noise and provides a 'clean' waveform from which to obtain the frequency characteristics.

Further information from: Nicolet Instruments Ltd, Budbrooke Road, Warwick CV34 5XH. Tel: 0926 494111. □

Noise and Safety at Work

Courses to be held in the early part of 1982 at Loughborough University Centre for Extension Studies include a three-day course on Noise and Safety at Work. This will take place on 15-18 March and will show how noise levels and noise exposure are calculated, what steps can be taken to reduce noise and vibration from machinery and from heating and ventilating equipment, and what protective devices for personal use are available.

Further details of this and other courses in Loughborough's extensive programme may be obtained from:

Mrs S M Withers, Course Tutor, Centre for Extension Studies, University of Technology, Loughborough, Leics LE11 3TU. □

Non-Institute Meetings

2 - 5 March	71st Audio Engineering Convention	Montreux, Switzerland
3 - 5 May	IEEE International Conference on Acoustics, Speech and Signal Processing	Paris, France
16 - 19 May	Inter-Noise '82	San Francisco, USA
21 - 24 June	Symposium on Fisheries Acoustics	Bergen, Norway
6 - 8 July	Fourth British Conference on the Teaching of Vibration and Noise	Sheffield
13 - 15 July	SEECO 82 — Environmental Engineering Today	Wembley, London
September	Noise Control Conference	Warsaw, Poland
13 - 17 September	3rd FASE Conference, jointly with DAGA '82	Gottingen, Federal Republic of Germany
October	21st Acoustical Conference on Noise and Environment	High Tatra, Czechoslovakia

Institute of Acoustics Meetings

1982

28 January	LEM	Instrumentation for Environmental Noise Problems	County Hall, London
8 February	M(P)	BS 4142 Reviewed and Criticised	Birkbeck College, London
25 February	LEM	Attenuating High Velocity Systems	County Hall, London
26 February	SB	Design and the Consultant	Portsmouth Polytechnic
25 March	LEM		County Hall, London
29 March - 1 April	M	**Spring Conference — Acoustics '82** Sessions on: Environmental, Transportation and Propulsion Noise; Physical Acoustics and Ultrasonics; Signal Processing in Acoustics; Subjective Auditory Effects; Poster Session	University of Surrey
29 April	LEM	Review of Acoustical Standards	
29 - 30 April	UW	Spectral Analysis and its use in Underwater Acoustics	Imperial College, London
26 May	M(P)	Noise Control in Factory Buildings	Cambridge
28 June	M	Design and Use of Acoustic Test Rooms	Birkbeck College, London
9 - 10 September	M	Auditorium Acoustics	Edinburgh
November	M(P)	Autumn Meeting	

1983

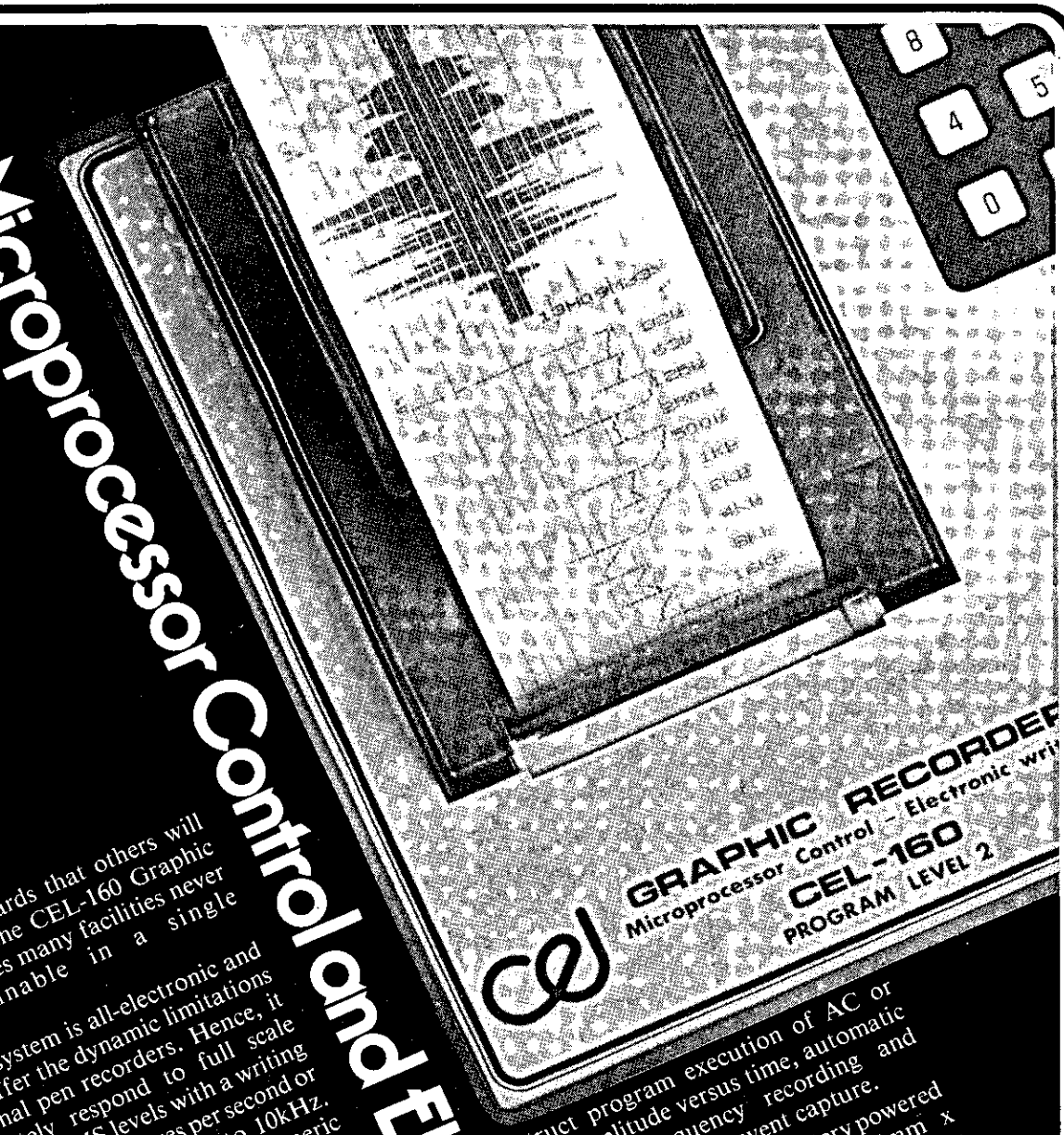
13 - 15 July	M	**Inter-Noise 83**	Edinburgh

The Institute believes that one of the most important services offered to Members is the provision of a wide range of conferences. The Meetings Committee will be pleased to receive suggestions for conference topics as well as to have comments on the present Meetings Programme. Please send your views via the Secretariat in Edinburgh.

Key
M = Meetings Committee Programme
LEM = London Evening Meeting
(P) = Provisional
SB = Southern Branch
UW = Underwater Acoustics Group

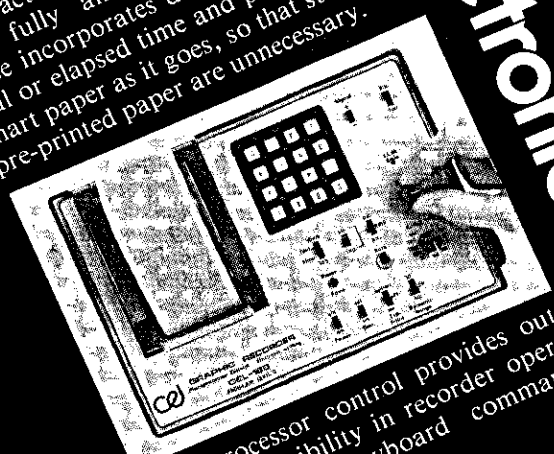
Further details from:
Institute of Acoustics
25 Chambers Street
Edinburgh EH1 1HU

Microprocessor Control and Electronic Writing



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

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



Microprocessor control provides outstanding flexibility in recorder operations. Simple keyboard commands instruct program execution of AC or RMS amplitude versus time, automatic hard-copy frequency recording and automatic transient event capture. This revolutionary new battery powered instrument measures only 275mm x 195mm x 130mm and weighs just 3 kg making it ideal for on-site or laboratory applications. Full details of this exciting new development are available from:

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

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