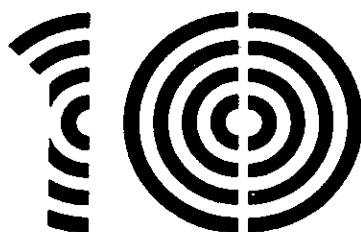




Acoustics Bulletin

October 1984 Volume 9 Number 4



INSTITUTE OF ACOUSTICS

Low Noise Microphone System

... for very-low-level sound measurements



NEW

**Microphone
Type 4179**



**Preamplifier
Type 2660**

84-072

FEATURES:

- Overall A-weighted noise floor of -2,5dB(A)
- Sensitivity nominally 1V/Pa
- System frequency response in accordance with IEC 651, Type 1
- Individually calibrated microphone, including frequency response curves, sensitivity, inherent noise

For sound pressure and sound power measurements of very-low-level sources, for laboratory hearing research, and for measurements which were, until now, limited by the inherent noise of the microphone and preamplifier assembly, Brüel & Kjær Condenser Microphone Type 4179 and Microphone Preamplifier Type 2660 constitute a uniquely designed microphone system.

The inherent noise level of conventional one-inch condenser microphone assemblies is typically +5 to -5dB in the 1/3-octave bands from 20Hz to 20kHz. With specially designed Type 4179, the combined assembly noise floor is some 12dB lower in each 1/3-octave band. The system sensitivity is high and the frequency response is in accordance with IEC 651, Type 1. Like other B & K Condenser Microphones, the 4179 is individually calibrated and supplied with a calibration chart which includes all important data for the microphone.

... now you can almost hear the grass grow !

BRUEL & KJAER (UK) LTD

Cross Lances Road, Hounslow, TW3 2AE Middlesex. Telephone 01-570 7774, Telex 934150 bk labs g
Globe House, Gordon Street, Chadderton, Oldham, Lancs. OL9 9QW. Telephone 061-678 0229

Acoustics Bulletin



Editor:
F A Hill

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

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

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

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

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

The views expressed in Acoustics Bulletin are not necessarily the official view of the Institute, nor do individual contributions reflect the opinions of the Editor.

Single copy £4.50

Annual subscription (4 issues) £14.00

ISSN: 0308-437X

Multiple copying of the contents or parts thereof without permission is in breach of copyright. Permission is usually given upon written application to the Institute to copy illustrations or short extracts from the text or individual contributions, provided that the source (and where appropriate the copyright) are acknowledged.

© 1984 The Institute of Acoustics

All rights reserved

October 1984

Volume 9

Number 4

Contents

	Page
President's Letter	3
Acoustics at the Home Office	4
Appreciations	10
Editorial?	12
Statistics of Institute Membership	13
Noise in the next Ten Years — Ten Years On!	14
American Award	14
Proceedings of The Institute of Acoustics: Autumn Conference 1984	15
Courses	22
Birthday Honours	22
Underwater Navigation	23
Titles of Diploma Project Reports	24
In case you didn't hear...	24
Speech Technology Assessment Group	25
IOA Honours and Awards	26
National Sound Archive	26
Branch and Group News	27
First BCS-approved Laboratory for Acoustical Calibrations	27
Speech Technology Assessment	28
London Evening Meetings	28
10th International Symposium on Nonlinear Acoustics	29
New Products	30
IOA Meetings	inside back cover



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.



Architects

ARCHITECTURAL AND CIVIL ENGINEERING DEPARTMENT

The BBC wishes to appoint two senior architects to join groups based in Central or West London, engaged on a varied programme of capital projects at centres throughout the United Kingdom.

Applicants must be Registered Architects and should have around ten years experience within the profession since qualifying.

Preference will be given to those candidates with additional qualifications in the field of acoustics, equivalent to membership of the Institute of Acoustics.

Salary is in the range of £11,907 to £14,542 depending on qualification and experience. Relocation expenses will be considered.

If you require further information, please telephone Mr. R. J. Fowler on 01-576 1268.

For an application form write to Engineering Recruitment Officer, BBC, P.O. Box 2BL, London W1A 2BL, quoting reference 84.E.4109/ARB.

We are an equal opportunities employer.

CENTRAL OR WEST LONDON

Acoustics Bulletin

One of the leading publications in its field, Acoustics Bulletin provides an important key readership representing the major interests in the rapidly growing acoustics market.

ADVERTISEMENT RATES (from 1 January 1985)

Full page	£180
Half page	£120
Quarter page	£80

Rates for special positions, colour, series etc on request.

Litho.

Publication dates: January, April, July, October.

Copy deadline: 1st of preceding month.

Enquiries to:

Sydney Jary Limited
28 Southway
Carshalton Beeches
Surrey
SM5 4HW
Tel: 01-642 5775



Presidents Letter

Institute of Acoustics

President

Dr H G Leventhall
Atkins R & D

Immediate Past President

Dr D E Weston
Admiralty Underwater
Weapons Establishment

President-Elect

Prof H O Berkday
University of Bath

Vice-Presidents

Mr M S Ankers
Environmental Health Dept,
City of Manchester

Dr J M Bowsher
University of Surrey

Mr T Smith
British Gas R & D, Killingworth

Honorary Treasurer

Dr R Lawrence
Liverpool Polytechnic

Honorary Secretary

Mr R C Hill
AIRO, Hemel Hempstead

Dear Member,

One thing the President sees, which most others do not, is the Institute's full Membership List. This includes occupational group and date of birth (and when the last subscription was paid). In glancing through the list, a few patterns could be discerned, leading to the more detailed appraisal which is given later in the Bulletin. The table on page 13 shows membership distribution amongst the six occupational groups used in the Membership List. The largest group is in Public Authority work, which reflects the foresight of Council in establishing the Institute's Diploma in the late 1970s.

The age pattern of Institute members is given in Figure 1 on page 13, showing date of birth in five-year intervals. The mode of the distribution is for members who are presently about 35-40 years old with a rapid fall to the 20-25 year olds. At ages greater than the mode the fall is more gradual, with a sharp drop after retirement (ie born before 1920). The distributions for Associates, Members and Fellows separately are given in Figure 2, where the mid-points are displayed for clearness. The modes are 25-30 years old for Associates, 35-40 years old for Members and 45-50 years old for Fellows.

Despite the well known difficulties of long range forecasting one can attempt to assess the state of our Institute in 15 years time, at the turn of the century. There will have been transfers from Associate to Member and Member to Fellow. Those born before 1940 will be retired or close to retirement, which may be at age 60, if present trends continue. This means that 75% of our present Fellows will be retired. We lose members through both retirement and resignation, but over the past few years there has been a steady rise in membership numbers, much of it from Local Authorities. If we retain our present members and continue to attract new members, the peak in Figure 1 will broaden to the left, so that in 15 years time it may span four of the year groups. The age distribution will have a broad centre and, allowing for loss of half the retired members, leads to a total membership of nearly 2000. Perhaps 2000 members should be our target for the year 2000, or maybe 1999, which will be our 25th anniversary year.

If we are to achieve this membership we must have the continued and active support of present members in encouraging their colleagues, particularly their younger colleagues, to join the Institute. Do you know any likely members? We must also recognise developing needs well in advance and move to fill them, as we did with the Diploma. Can anybody suggest where we should be looking next? I will be pleased to hear your ideas.

Yours sincerely,

Geoff Leventhall

Acoustics in the Home Office

The Scientific Research and Development Branch

B J Blain

The aim of the Scientific Research and Development Branch of the Home Office (SRDB) is to develop new methods and equipment for assisting 'clients' to make better use of their resources, or to enable them to do things they could not do before. The chief clients are the Police, Fire, Prison and Civil Defence services. Being quite a small unit, with a low profile in news media terms, the work is not widely known by the general public, and the Branch is often confused with other technical organisations within the Home Office, such as the Directorate of Telecommunications, the Police National Computer Unit, the Research and Planning Unit, and the Forensic Science Service. The objectives of the Branch are, however, different from those of the other organisations.

THE BRANCH employs approximately 130 scientific and technical staff plus administrative and craftsman support. On the Police side, the Branch benefits from the presence of some fifteen senior police officers, who are seconded for two or three years at a time and who work closely with the scientists, acting as experienced and down-to-earth advisers on the operational value of the projects. These officers make up the Police Research Services Unit, which is headed by an officer of the rank of Assistant Chief Constable. Geographically the Branch is a bit scattered, with an office block in Central London housing the largest number of individuals, and outstations at locations around southern England providing the rest of the accommodation.

As would be expected in an organisation dealing with a very wide range of operational requirements in a number of services, the SRDB research programme is extremely varied and flexible. Some projects deal with the use of large computers for data storage of various kinds, some with microprocessors for local or distributed processing, or office automation. Research is carried out on recognising faces, detecting and retrieving fingerprints, and protecting officers from bodily injury. Other projects are concerned with the integrity of premises, either to detect intruders or to discourage potential escapers. The Branch must be able to make use of a wide range of disciplines, including mathematics, computer science, optics, electronics, mechanics and acoustics. The Acoustics Group is based at the SRDB laboratory a few miles from St Albans in Hertfordshire. Its work covers a number of aspects of acoustics, and to convey an impression of the range of interests four individual projects will be described.

Audible Warnings

The initial concern about audible warnings was voiced by traffic police officers. They complained that when they were trying to make good progress along a trunk road, perhaps responding to a 999 message or attending the scene of an accident, they were continually baulked by middle-of-the-road drivers. These were motorists who hogged the outside lane of a dual carriageway or motorway, maintained a steady 55-60 mph, never looked in their mirrors, and paid no attention to the two-tone horn sounding in the police car. The two-tone air horn is the device which produces the familiar 'hee-haw' sound, and which replaced the rather ineffective, if gentlemanly, gong some years ago. It consists of two resonators of slightly different lengths operated alternately by an air pump.

A preliminary investigation demonstrated quite conclusively that the problem was not caused solely by the inattention of the target driver. A number of different audible warning units were collected, including compressed air, electromechanical and electric equipment, and were mounted on a pursuit vehicle. This vehicle was driven up and down the runway of a disused airfield, following a target car at a variety of speeds and separation distances. It was found that at 60 mph an observer in the target car could not hear any of the test devices until the vehicle separation was unacceptably small, i.e. a few yards.

The next step was to examine all parts of the acoustic path, from generator to ear, to see if any improvement could be made, see Figure 1. As the acoustic signal travels from the source it initially meets a stream of high velocity turbulent air. It spreads out and reduces in intensity according to the inverse square law and because of effects such as atmospheric absorption and ground plane reflection. On reaching the target vehicle the signal meets more turbulent air, before it is transmitted through the windows and body panels to the interior. At this point the sound pressure must be high enough compared with the ambient noise to be detected. This ambient noise is due to the engine, transmission, tyres on the road, external air turbulence, and what is euphemistically termed 'in-car entertainment'.

The Wolfson Unit for Noise and Vibration Control at Southampton University

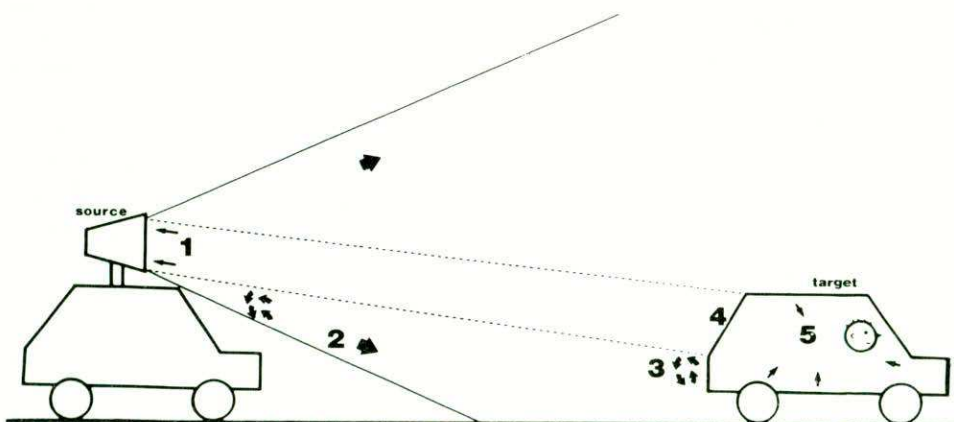


Figure 1 Acoustic path from audible warning device

- 1 : turbulence at source
- 2 : inverse square law spreading
- 3 : turbulence at target
- 4 : insertion loss
- 5 : in-car noise

carried out much of this examination. To measure the effect of turbulence near the sound source a loudspeaker was mounted on the roof of a vehicle and the output was monitored using microphones on swinging booms as the vehicle drove at speeds up to 80 mph, see Figure 2. It turned out that turbulence had little effect on loudspeaker directivity or efficiency below 4 kHz, and could be disregarded.

Attenuation through the air was quite insignificant, although reflections from the road could produce gross interference effects at certain distances. The latter effect could result in an increase or decrease in level, but there seemed to be no way to optimise the situation. The effect of turbulence at the rear of the target car was estimated by towing a large loudspeaker mounted on a trailer at dangerously high speeds around a disused airfield and measuring its output, see Figure 3. Once again vehicle speed seemed to have very little effect on the signal level.

The insertion loss of vehicle, i.e. the attenuation suffered by the signal as it penetrates to the interior, was found to be quite significant, ranging from 10 to 30 dB. This loss varied very widely and rapidly with frequency, all vehicles exhibiting a number of low-attenuation frequency 'windows'. Thus one way to be reasonably sure of penetrating to the inside of any car was to use a sweeping tone signal, so that at least some frequencies would suffer only minimum attenuation.

Noise was measured inside a small number of vehicles and the literature was searched to obtain figures for a wide and representative range. Typical values of sound pressure levels for vehicles travelling at 70 mph were 80-90 dB at 200 Hz, dropping to 60-70 dB and lower at frequencies above 2000 Hz. Air horns, which produce their maximum energy at frequencies around the peak of the internal noise, obviously start off at a considerable disadvantage. An optimum unit should produce a significant output at frequencies above 1 kHz.

The final piece of research was done for the Branch by the Institute for Consumer Ergonomics at Loughborough. Ten signals were prepared consisting of square waves varying in frequency between 1.5 kHz and 2.5 kHz. The frequency modulation over this range was at various rates and with different characteristics (triangle, sawtooth, square). The aim was to see whether, for a given frequency range and output level, the choice of a particular modulation influenced the detectability of a



Figure 2 Measuring effect of turbulence on sound source

signal or its 'attention-attracting' ability. In the experiment subjects sat at a visual terminal and carried out a demanding pursuit task, simulating a driving situation, while typical in-car noise mixed with the test signals was presented to them over headphones. The level of the signal was increased until the subject responded.

The responses showed a definite consistency. The slower modulations, 1 and 1.3 Hz, were detected at lower output levels, and the downward going sawtooth was seen to be best. About 3 dB separated the best from the worst,

which, although not an enormous difference, was thought worthy of consideration.

As a result of the investigation, two prototype audible warning units were built which incorporated all the potential improvements which had been identified. In addition three loudspeaker units were driven in parallel, which produced a more directional beam than a single unit, thus providing more efficient signal production and possibly less annoyance to non-target road users and the police vehicle crew. It is seen in Figure 4. Although the prototype



Figure 3 Measuring effect of turbulence at target vehicle



Figure 4 Prototype loudspeaker array in cowling

proved to be too cumbersome and expensive for general use, a number of commercial manufacturers have produced units which have most of the desired characteristics. A large number of police forces now use improved audible warning devices, which seem to be an advantage when operating on the open road. An unfortunate consequence is that there has been an increase in the number of complaints from members of the public about noise pollution in built-up areas. Clearly it is not possible to satisfy everyone's requirements.

Interview Recording

One of the recommendations of the Royal Commission on Criminal Procedure was that police interviews with suspects should be tape recorded. It was hoped that a recording would materially assist in resolving disputes about what was actually said. The three main benefits were seen to be safeguarding the suspect, protecting the police from false allegations, and saving court time by minimising the number of so-called 'trials within trials'.

There was, however, little evidence of the extent of costs and savings which would arise from tape recording, nor had the inevitable practical snags been investigated. A two-year field trial was therefore put in hand, in which six police divisions would set up recording facilities in their interview rooms. The Home Office Research and Planning Unit would closely monitor all cases, and determine the effects of the record-

ing on the criminal justice process. A typical interview set-up is illustrated in Figure 5.

Clearly, it is not possible to buy a £20 recorder with a built-in microphone, place it on a table in any room which happens to be available, and thus reliably obtain first-class audio recordings. Moreover the need for tapes to be used in evidence, and thus for the recording process to ensure as far as possible the integrity of the tapes, created special requirements. Unless care was taken confusion would be

added rather than removed, and the Branch was asked to contribute to a technical working party which would take care of the acoustic and electronic aspects of the trial.

An early interest concerned the acoustic upgrading of the interview rooms. It seemed undesirable to spend a great deal of money on purpose-built studios, particularly as the quest was for an economic system for more widespread use. What therefore was the minimum treatment which would still guarantee a good recording under most conditions? Two aspects had to be considered: the transmission of unwanted sound into the room from outside, and resonances and echoes within the room. Sound transmission is minimised by massive room boundaries, and internal resonances are reduced by having non-reflecting walls and ceilings and by avoiding major room dimensions with simple integral ratios. Remembering the motto about silk purses and sow's ears, the participating forces were therefore asked to forget, where possible, cube-shaped ground-floor rooms overlooking the High Street, built with plaster-board or glass walls.

As many as possible of the following features were recommended: non-cubic dimensions, single or double brick walls, good quality double glazing, thick curtains, well-fitting heavy doors with sound-excluding strips where necessary, sound absorbing ventilation ducts, carpet on the floor, acoustic tiles on the ceiling and walls, and carpet on



Figure 5 Typical interview room lay-out. Note position of microphone on wall

the outside corridor floor if this was a busy thoroughfare. The minimum requirements will only be firmly identified after the results of some of the Field Trial recordings have been examined.

As special rooms were being dedicated to the trial, it was possible to mount microphones in permanent positions. It seemed that the best type to use was the 'pressure zone' or 'boundary layer' variety, consisting of an electret transducer mounted facing and in close proximity to a reflecting boundary plate. All sound energy reaching the transducer arrives via this plate so that there can be no interference effects between direct and indirect soundwaves. At the position of the transducer, very close to the reflecting plate, direct and reflected waves are in phase. This type of microphone has a uniform hemispherical response, and no distortion is introduced by the wall surface on which it is placed. Thus if the interviewee decides to walk around the room during interrogation the microphone should be able to cope adequately. A useful extra benefit is the microphone's neat and unobtrusive appearance. While there is no intention of making any covert recordings, some people may well be intimidated by the sight of a large studio microphone sitting a few inches from their faces.

The major topic of concern was the design of the actual recorder. After considerable discussion at all levels, a number of operational requirements were identified. First, it was essential to make two simultaneous recordings during the interview, one to be immediately sealed and treated as an exhibit, and not touched without directions from the Court. The other would be a working copy for use by the prosecution and for making further copies as required, eg for defence lawyers. The practicalities of the trial dictated that the recordings should be made on cassettes rather than open reel tape, each interview being associated with one or more dedicated cassettes. For reasons of recording quality, ready availability of tape and widespread compatibility with existing machines, Philips-type compact cassettes were chosen.

The second requirement was for a timing track. This would assist listeners and transcribers to locate particular passages of interest, and also serve as a check on unauthorised editing or other tampering with the material. It seemed sensible to have a stereo recording head, using one channel for the speech and the other for the time. A 'speaking clock' based on a speech synthesis chip was favoured over a coded system, so that

using a standard stereo playback machine the listener could hear the time track directly. By designing the time channel level to be some 20 dB below the mean speech level, a mono playback machine could be used in emergencies without the timing being too intrusive.

The third requirement was for reliability and simplicity in use. Thus a number of fail safe mechanisms have been incorporated, including a warning system which is activated by cassette jamming, tape breakage, loss of signal in either channel, the cassette nearing its end, and mains failure. The only controls are two touch switches for 'start' and 'stop', there being no level adjustments, forward or re-wind facilities, erase head or playback mechanism. The units have been built by DMW Associates of Daventry, and it will be very interesting to see how they stand up to hard use by non-technical operators over a period of two years.

Tape Enhancement

In recent years the police service has had to deal with increasing numbers of audio tape recordings. Tapes may originate from the police, the legal profession, persons involved in police investigations, defendants, members of the public and so on. Typical examples are recordings on logging machines in Information Rooms, dictating machines, and now of course interview rooms.

The quality of recordings can vary enormously. Intelligibility will depend principally on the characteristic of the recording system, the communication channel and the acoustic environment of the talker. For example, a recording made in a quiet acoustically-treated room, in which the participants speak slowly and distinctly and directly towards a nearby high quality microphone connected to a professional quality open reel recorder, is likely to produce a clear, intelligible result. Conversely, a cheap micro cassette recorder running at slow speed, with automatic gain control, utilising a built-in microphone, and operated in a noisy environment, is likely to result in a less satisfactory recording. Most recordings of interest to the police fall somewhere between these extremes.

If the police have to deal with a degraded recording an important requirement is to have the material processed so as to enhance its intelligibility. The Branch has developed and implemented a wide range of techniques to improve the speech quality of recordings. A limited operational service is offered to the police and others through the Tape Laboratory at the Branch.

The degradations which substantially affect speech intelligibility may be categorised into two types: additive and convolutional. Additive noise is the recording of extra, unwanted signals as well as the (speech) signal of interest. It can be thought of as degradation by masking. The noise might be added to the signal before it reaches the microphone, within the communications channel, or within the recording system. Examples of additive noise are background music detected by the microphone, mains hum electrically induced into the connecting cable and tape hiss due to the characteristics of the recording medium.

Convolutional degradation results from the signal passing through a section or sections of the acoustic, transmission and recording paths which have a non-flat audio frequency response. This type of degradation, which affects both the wanted signal and the additive noise, may be thought of as distortion. Examples are reverberation within a hard walled room, the effect of limited band-width telephone lines, and poorly equalised recording circuitry.

Audio tapes may suffer from other types of degradations but usually these do not materially impair the intelligibility of the speech. Examples are excessive amplitude variation, and speed instability caused perhaps by an exhausted battery power supply.

Another important feature of a degradation, whether additive or convolutional, is how rapidly it takes place. If the characteristics of a degradation remain constant for long periods, then the process is described as stationary. If they vary over periods of the order of seconds then they may be described as pseudo-stationary. If they change more rapidly than this, then they are known as non-stationary.

To recover an original signal from a degraded recording it must first be decided how to differentiate between the wanted and unwanted parts. Probably the simplest example is a recording of two pure tones of widely different frequencies (representing stationary additive degradation). A conventional analogue high pass or low pass filter will attenuate one of the tones, leaving the other unaffected. When the desired signal is speech such a solution is rarely suitable, because the frequency bandwidth of the speech may extend from 300 to 3000 Hz, and is often even wider. Unless the frequency of the interfering degradation falls outside this range it cannot be simply attenuated without affecting the speech.

Speech itself is a very complex signal, which can exhibit a number of characteristics. Vowels, for instance can be strongly harmonic and remain approximately constant for a considerable time, up to 0.5 second. Nasals are rather more amorphous, while fricatives consist largely of broad-band noise. Thus there is no simple way to distinguish between speech and the common types of degradation. In general, the greater the difference between the speech and degradation in terms of spectral band-width and stationarity, the greater the potential for enhancing the recording.

Conventional analogue studio equipment can be successfully used to reduce some stationary degradations. Because such equipment is usually in the form of a bank of filters whose gain is controlled by hand, there is no possibility of coping with rapidly changing interference.

For example if there is a high pitched whistle masking a conversation, a low pass filter may successfully attenuate the noise while only slightly affecting the higher speech frequencies. Unfortunately, mains hum, for example, one of the commonest additive stationary degradations, is not susceptible to such an approach. This is because the hum consists of a very narrow fundamental frequency band at 50 Hz (in the UK) plus high amplitude harmonics at 50 Hz spacing throughout a significant portion of the speech band. No analogue filter bank is able to provide a number of high-attenuation notches whose bandwidth is so narrow that the speech itself remains unaffected.

An operational case of stationary convolutional degradation which was presented for enhancement involved the recording of a public speaker using a megaphone, which introduced a number of stationary resonances into the recording of the voice. These were identified using a spectrum analyser, and a filter bank was set up to provide an approximately inverse characteristic. When the recording was played through this filter bank high quality speech was recovered.

Another analogue device is the compressor-limiter, which reduces excessive amplitude variations by attenuating loud passages and amplifying quiet ones. While such a process does not increase the intelligibility, it can make a tape less tiring to the listener. In fact it is generally true that in the majority of cases analogue treatment cannot resurrect a badly degraded recording unless an enormous amount of painstaking

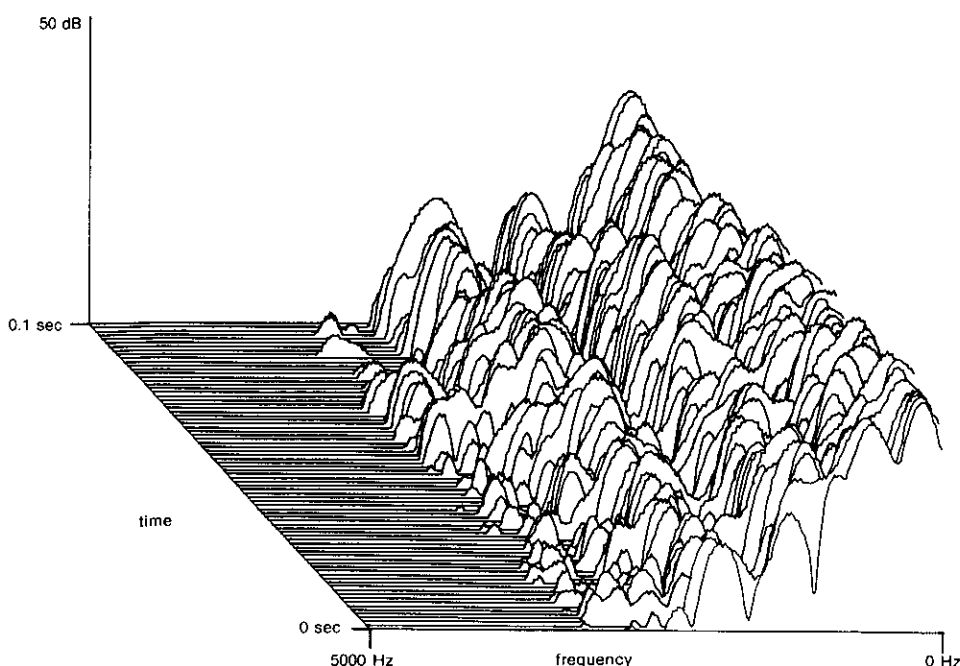


Figure 6 Isometric spectrogram of speech with masking music

effort is applied, processing the tape second by second. What these techniques can produce, however, is a recording which is easier to listen to, thus enabling a transcriber to work for longer continuous periods between rests.

Digital methods offer a far more extensive and flexible approach to the enhancement of a recording. Using a

DEC PDP 11/60 computer new processes have been developed and techniques from other sources have been optimised, thus building up a suite of tape processing algorithms.

A normal audio recording, of course, consists of a continuously varying magnetic field on the tape, which is in analogue format. Before the signal can

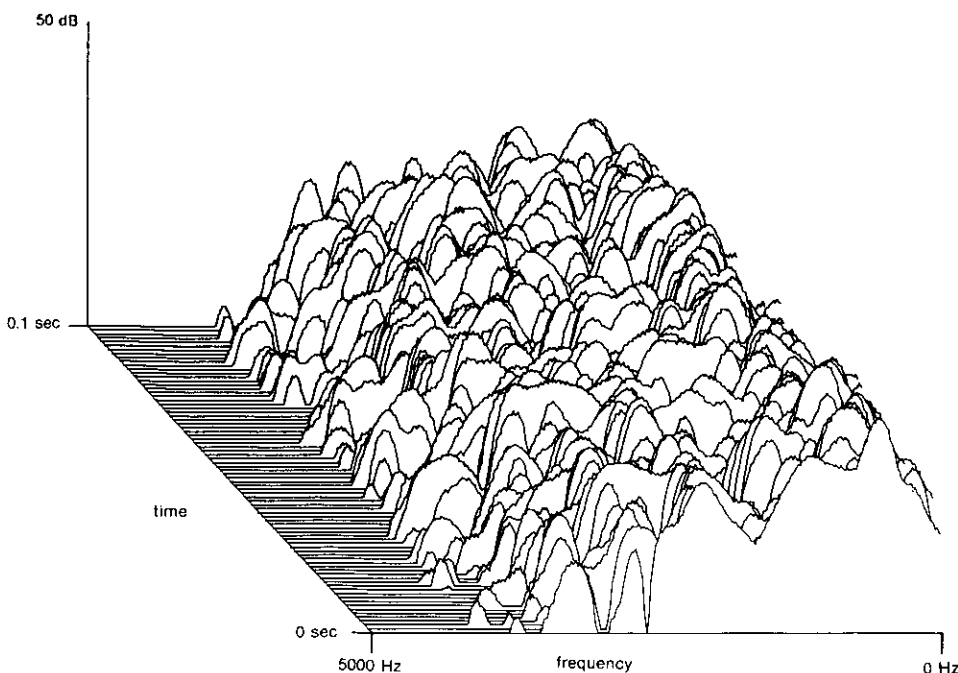


Figure 7 Spectrogram of speech processed using the music removal algorithm

be processed by the computer it has to be converted to digital format, in which it is represented by a series of separate numbers. To do this the output from the recording is played through an amplifier and filter to an analogue-to-digital converter on the computer, which samples the waveform at a specified rate (usually 10 kHz) and stores the equivalent digital values on disc. As each digital sample is stored as a 12 bit number it can be seen that a one minute recording requires the storage of more than 7 million bits of data.

The most general approach to enhancement is to use an adaptive digital filter. This is a process which continuously changes its characteristics in response to changes in the signal. Such an adaptive filter can be used in principle to reduce all types of stationary or non-stationary degradation, additive or convolutional. The separation is achieved by methods which rely on the difference in stationarity between the desired speech signal and the noise. Provided the adaptation rate of the filter is sufficiently slow for it to be unable to follow speech but sufficiently fast to follow the degradation, then the functions can be separated.

Although the adaptive filter is an extremely powerful technique, and now exists in hardware implementations running in real time, it has been found in practice that better results can often be achieved by using special purpose processes for particular types of degradation. As an example, to reduce a steady masking tone the following process has been developed. The Fourier transform of each segment (a few tens of milliseconds) of the noisy signal is calculated which in effect produces the frequency spectrum of the recording, segment by segment. The frequency components in each segment which are above a selected amplitude threshold for a chosen proportion of the time are then identified and set to zero. The inverse Fourier transform of each segment is then calculated to produce the output sequence. The process has been extended to cope with slowly varying tones, such as noise from a variable speed motor.

A process has been developed for removing background music, on a stereo recording where one channel contains mostly the music or on a mono recording when access to an independent version of it has been available. Again a frequency spectrum is calculated of each segment of each channel. From the spectrum of the 'music' channel a filter is then constructed which is multiplied by the signal



Figure 8 Part of the Audio Tape Laboratory

in the 'music plus speech' channel, resulting in a cleaned up speech-only signal. An isometric spectrogram of speech with additive music is shown in figure 6, which is a two dimensional representation of the three dimensions of time (the x-axis), frequency (the y-axis) and intensity (the 'height' of the curves). The main music frequencies can be seen looking like mountain ranges running across the figure. Figure 7 shows an isometric spectrogram of the same passage, after processing. The harmonic structure of the music is no longer visible, the remaining curves representing the speech which has been left.

Probably the most commonly encountered stationary additive degradation is that due to mains hum. To eliminate this type of noise a simple digital comb filter program has been written which removes the fundamental frequency plus all the harmonics, at the expense of introducing a faint echo. The computer implementation was so successful that a hardware version was built which has been used operationally with considerable effect.

Audio Tape Laboratory

With the increasing use of tape recording mentioned earlier, it became apparent a few years ago that a national service was needed, to supplement that provided by the Metropolitan Police, to assist in handling and processing of audio tapes. An operational Tape Laboratory was therefore set up, in accommodation right next to the acoustics research laboratory so that substantial

and rapid technical liaison could be maintained. A part of the Laboratory is shown in Figure 8.

At present the main functions of the Laboratory are to produce enhanced copies of recordings, to examine tapes for authenticity and in support of police investigations, to offer various copying, replay and transcription facilities, and to provide expert witness evidence.

The enhancement processes are largely based on the work described in the previous section. Many tapes can be improved to a noticeable extent by using the simpler analogue techniques. Where a recording is of marginal intelligibility even a modest improvement can be of great value, and police officers have occasionally expressed surprise at the improvement obtained by just playing their tapes on superior equipment.

The implementation of computer techniques has increased the range of recordings which can be usefully enhanced. The Laboratory makes use of the processes such as adaptive filtering, comb filtering, and music removal, as well as techniques for minimising broad band noise, amplitude compression, and speed modification. The work is considerably aided by the display and output facilities of the computer, such as rapid and repeated access to a particular passage, and the immediate display or print out of waveforms, spectra, and spectrograms.

Tape authentication involves an exhaustive examination with a view to corroborating statements about the manner

in which a recording was made. Thus a tape which has been edited, twisted, dropped in water, partially erased and otherwise damaged, can be as authentic as any other tape provided that such abuse is declared as being part of the history of the recording. Occasionally, however, there are gaps in this history, particularly where the recording originates from a non-police source. The usual approach in such cases is to find explanations for anything which might have similar attributes.

The characteristics of the recording must be examined and related to the recorder which made it. Each noise and period of silence, each click and bang should be accounted for. The tape is subjected to close visual examination using a microscope. The magnetic variations of the recording can be rendered visible by dropping a liquid containing a

magnetic sediment on the tape, rather like sprinkling iron filings around a magnet. This enables the alignment, azimuth and wear characteristics of the recording head to be noted. The waveform of recorded dialogue can be plotted on paper for closer examination by using a UV chart recorder or the computer printer-plotter.

The switching transients, or on/off clicks, for the recorder and recordings are compared. The effects of battery exhaustion, use of an external microphone and of pause control may be examined. The use of automatic record level, the rapid movement of the recorder and the ease of switching on and off may all be relevant to the investigation.

Because of the close liaison between operational and research staff the work of both sections has prospered. The

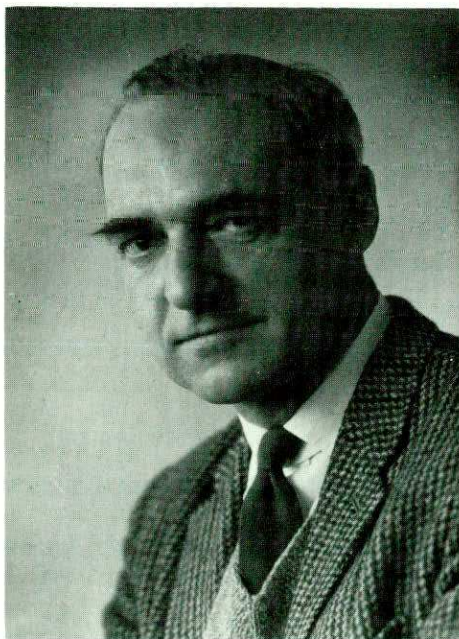
Tape Laboratory can make use of the latest algorithms, perhaps techniques specially written for a particular job, even if the program is not yet fully debugged. The research team gains by having access to a continuous stream of operational material, and by the unique motivation provided by urgent operational requirements and, with luck, the appreciation of satisfied customers.

The Acoustics Group, and indeed the SRDB as a whole, are fortunate that this attitude permeates the whole of their work. A constant interchange of ideas between the customer and the scientist is the major incentive to run the high quality and relevant research and development projects, of which the Branch is so proud. □

CROWN COPYRIGHT

Appreciations

Professor Peter H Parkin
August 1917 - June 1984



The Institute of Acoustics has lost one of its most renowned members, for Peter Parkin had achieved world fame and recognition for his qualities as an engineer, scientist and acoustic consultant. Peter graduated from Queen Mary College, London, in Electrical Engineering (with honours) and in 1938 started work for his doctorate on the dielectric strength of air at high frequencies, a work which was interrupted

by the First World War and was never completed. In 1940 he joined the Admiralty team on mine-sweeping research under E C Bollard and so became involved with acoustics for the first time during the development of the acoustic mine. After the war Peter joined the Building Research Station as a Senior Scientific Officer and on his retirement had become Head of the Acoustics Section. In 1967 he received a Special Merit Award which had been preceded in 1964 by the Wolfe Award (£500) 'for the most outstanding research item in the [then] Department of Scientific and Industrial Research', which referred to his work on 'assisted resonance' in the Royal Festival Hall. This work was started in 1963 and led to many research contracts being placed to support post-graduate work at the Universities of Salford, Southampton and London (Queen Mary College and Imperial College). Peter Parkin's auditoria activities were considerable including the development of loudspeaker columns in reverberant buildings (Westminster Abbey and St Paul's Cathedral) and some of this research was carried out in conjunction with Professors Cremer and Meyer of Göttingen University. A current interest had been in model studies (starting with the National Theatre and the new concert hall in the Barbican) and recently he supervised work in progress on this topic at Cambridge University.

The Institute of Acoustics was proud to honour Peter Parkin with the award of the Rayleigh Gold Medal in 1976 and in the same year he gave the distinguished Fairey Lecture at the Institute of Sound and Vibration, Southampton, where he

was also appointed Research Professor on his retirement from the BRS.

This illustrious record would be incomplete without reference to his valued publications, of which his textbook with colleague H R Humphreys entitled *Acoustics, Noise and Buildings* was a notable contribution to acoustics literature. He was a contributor also in the prestigious report issued by the Wilson Committee (1963) entitled *Committee on the Problem of Noise*. Peter Parkin was certainly a leading Pioneer in British Acoustics of today and he leaves behind an inspiration to us all.

RWBS

R B Newman (1917 - 1983)

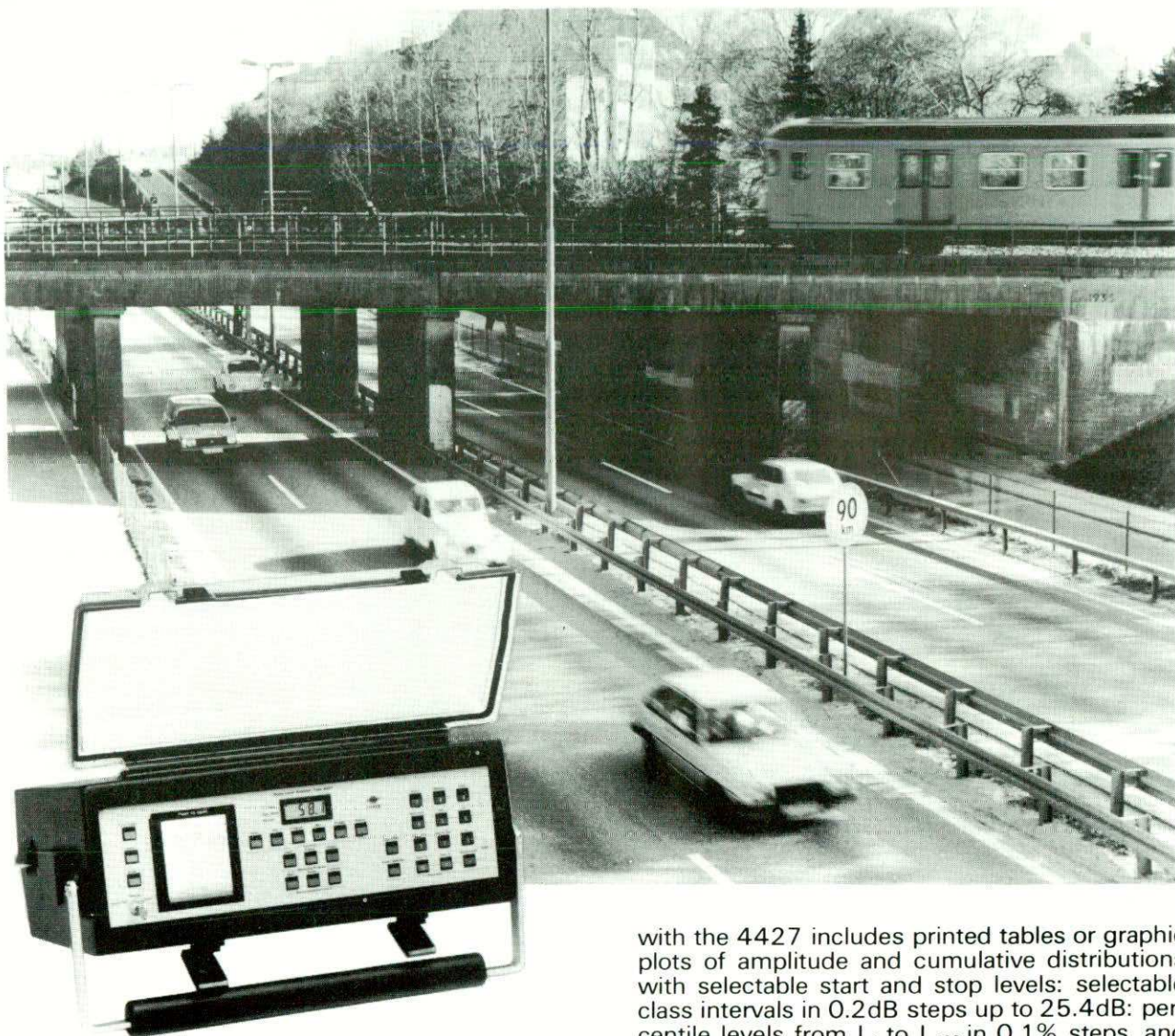
The initials BBN are a combination well-known to the world of architectural acoustics as denoting the consulting firm of Bolt, Beranek and Newman. Bob Newman passed away on 2 October of last year and the Institute of Acoustics records this somewhat belated recognition of its appreciation of his outstanding contributions to acoustical designing in architecture. Bob Newman was originally trained as a physicist but later turned his whole attention to architecture. He was a person of great charm and wit and his lucid style made him a first class lecturer.

An excellent memoir written by R H Bolt and L L Beranek is to be found in the June 1984 issue of JASA. □

RWBS

HEARING'S DECEIVING - SEEING'S BELIEVING!

Register your complaints about noise in writing on this new Noise Level Analyser



Noise Level Analyser Type 4427

The B & K 4427 recording analyser is a highly sophisticated but portable instrument capable of handling the analysis and recording of traffic, aircraft, industrial, occupational or any other kind of noise likely to be encountered within human environments. It has a 110dB dynamic range with choice of A-weighted or linear frequency response. When connected to a B & K microphone it can act as a precision sound level meter and not only provides a digital display updated once per second with 0.1 dB resolution, but also provides a continuous sound level plot on its built-in printer. It can also act as a precision integrating sound level meter, displaying and continuously plotting one second Leq plus either Leq or SEL over other selected measuring periods. Statistical processing

with the 4427 includes printed tables or graphic plots of amplitude and cumulative distributions with selectable start and stop levels: selectable class intervals in 0.2dB steps up to 25.4dB; percentile levels from L_0 to L_{100} in 0.1% steps, and many other calculations including standard deviations. Provision is made for the selection of threshold level and minimum duration for the recording of intrusive noise events. Print-outs of maximum levels, SEL, Leq and times for each event are obtainable. Automatic operation of the 4427 can be fully controlled by a set of measuring routines controlling input, timing and output. Such routines can be either pre-set or user defined as required and there is an automatic print-out at the end of each period. The 4427 has IEC interface with optional modem interface and fulfils all relevant parts of BS 5969 (IEC 651) Type 0 and the proposed standard for Integrating Sound Level Meters Type 0. When used with B & K's Low Noise Microphone System, the resultant combination of wide dynamic range and low level recording is without equal anywhere.

BRUEL & KJAER (UK) LTD

Cross Lances Road, Hounslow, TW3 2AE Middlesex. Telephone 01-570 7774, Telex 934150 bk labs g
Globe House, Gordon Street, Chadderton, Oldham, Lancs. OL9 9QW. Telephone 061-678 0229

Editorial?

Since I have now been editing *Acoustics Bulletin* for five years, I have concluded that it is time I came out of hiding and produced an Editorial. No - not a real editorial made up of controversial comment on acoustics or pungent criticism of the Institute; I leave that for page three. I should like to say a little about my job as Bulletin Editor and about yours as Bulletin readers and contributors.

First, a confession: as you may have noticed, I am not an acoustician. Like many editors of semi-technical and even technical journals, I am a linguist (which is one reason why I have a soft spot for Speech Group). I am an editor because editing involves, among other things, using and presenting language as comprehensibly as possible, and I am Editor of the Bulletin because I find acoustics interesting - and also because I happened to be in the right place at the right time.

In many respects my lack of acoustical expertise doesn't matter: even the hottest acoustician might quail when faced with a discussion of ultrasonic attenuation in doped bismuth germanium oxide, or energy distribution in cylindrical elastic shells, or even synchronous adaptive noise cancellation, unless this happened to be his or her specialist area. In one respect however it does cause problems: I don't peruse the science pages of the dailies at breakfast, or keep the *New Scientist* on my bedside table; so I am not in the constant touch with developments in the acoustics world which I should like to be. This means that I am more dependent than an acoustician might be on you, the other acousticians to give me the news I should be passing on. That's right: there's a pep talk coming.

The quality of a journal depends partly on the editor and printer and others involved in its administration and physical production, but more on the authors who contribute. As Editor I am aware of at least two inadequacies in the Bulletin: too many events of acoustical significance pass unremarked by the *Institute of Acoustics' journal* and a good balance between items relating to the different disciplines has rarely existed, at least during my editorship. My personal contacts are mainly concerned with environmental and building acoustics; I have little direct contact with physical acoustics, speech, ultrasound, underwater acoustics So here comes the pep talk. If you feel that

your discipline is inadequately covered (and a large proportion of you should) please let me know. Tell me the subject I should be covering; suggest whom I should contact for further information, or even put pen to paper yourself. That is the only way you will achieve equal rights for your subject with noise in the Bulletin.

There are of course plenty of excuses for not writing for the Bulletin - there must be, for I have yet to hear from 97% of you. Let me dispose of a few of these excuses!

It may be that you are too busy producing long technical papers for more erudite acoustic journals. This is fine; but if what you are saying is worth saying in detail to your fellow specialists, might it not also be worth communicating in brief to your fellow acousticians who specialise in other fields? If we are to remain under the one umbrella of acoustics we need to communicate between disciplines - which I see as one of the more important services of the Bulletin. I should like to see some of you sending me 500 words outlining recent developments and research in your field.

It may be that, at the other end of the scale, you have never been in print before and feel you have not got anything to say. I bet you have! For you too I could find half a page in which to publish your interrogations, observations or ruminations.

It may be that you aren't quite sure what 'we' (the editorial 'we', basically Publications Committee) want for the Bulletin, or how to go about writing. Well, what 'we' want is an interdisciplinary exchange of information about acoustics and about the Institute of Acoustics, and a phone number where 'we' can reach you if your information arrives in the wrong form. I have a number of dictionaries and several red pens, with which to deal with any other problems with which you may present me.

My address is in at least two places in every Bulletin and a date by which contributions should be received appears in bold type somewhere in each issue.

So that only leaves one excuse: you simply can't find the time. Thank goodness the other 3% did! Otherwise I'd be out of a job....

Now that you have decided to write something for 'us' after all, perhaps you would like to know what to do with it, and what I will do with it.

If I know you are considering sending something for a forthcoming issue, you will receive a reminder from me a fort-

night before the copy date. My reminder notes come in signed limited editions and should therefore not be tossed into the wastepaper basket or used as a mat for your coffee cup. By the time those who genuinely *are* lecturing in Japan/having a baby/on holiday/examining/ being examined/sick have failed to send their items on time, yours will probably be the only thing to arrive on the day. Please get it typed if you possibly can; quite apart from the fact that my typing is slow, your secretary (wife/husband?!) is more likely to understand your writing - and you can check it. Leave a margin of 250 mm and at least 350 mm at the top for corrections, and for instructions and clarifications (eg for Greek symbols) for the Printer.

Once it has arrived your article becomes known as copy and is at the mercy of The Editor. Editors are notorious for being compulsive fiddlers - making alterations just to stamp their own mark of ownership on an author's output. I try to avoid this (I've no doubt though that there are some who would claim I don't) and to allow the author's own style to prevail; there are however one or two practices which always make me reach for the red pen, such as excessive and often incorrect use of 'hence' and 'different to/than' instead of 'different from'. More important is the detection of areas of ambiguity or incomprehensibility, and I have been known to notice actual errors such as k slipping in incorrectly before Hz. Once the copy has been checked and marked up for the Printer it is sent off to him and I heave a sigh of relief.

Some time later I receive galley proofs. I do not send these to correspondents unless particularly requested to do so, since this would increase the length of time the whole production process involves (nor, I'm afraid, can I normally manage to acknowledge receiving copy). One set of proofs I check for printing errors, sometimes a rather boring job as I've already read the Bulletin right through at least once, but sometimes lifted by the errors themselves. Like the set of proofs which as well as accusing two members of 'casual analysis' announced that 'for many years the BBC has used criteria for background noise and sound insulation which were derived in the late 1690s'. Or the time when a picture of a polystyrene model with earphones found its way among the portraits of the Council Officers. Or.... In fact our printers are rather good, and I sometimes think that they introduce

howlers just to keep us editors on our toes. After proof-reading I have a game of jigsaws: I spread the bits of Bulletin on the dining-room table and shuffle them around to produce a layout or make-up. This part is great fun except when the cat jumps up on the table or someone opens the French windows by mistake and introduces a draught.... It is actually a far from random process and ideally requires a more logical mind than I have. This is also the point at which the adverts which Sydney Jary

has been acquiring for us are included in appropriate positions.

The make-up and corrected proofs are sent off to the Printer who then provides me with page proofs to check; the Bulletin is then printed and sent up to HQ in Edinburgh for despatch to you. I tidy up my dining-room cum study and start thinking about the subjects to be covered in the next few issues.

Which brings me back to you. As you will have gathered quite a lot of work goes into the preparation of your

Bulletin, which is then produced to a rather higher standard than most house journals. From all reports, it gets read, too, and the more interesting it is to readers, the more interesting it is to potential advertisers, which is an important consideration. So next time you have something to say, please think about saying it through the Bulletin to rather a lot of other acoustics workers -not just to the chap who shares your office. Thank you. □

Alison Hill

STATISTICS OF INSTITUTE MEMBERSHIP

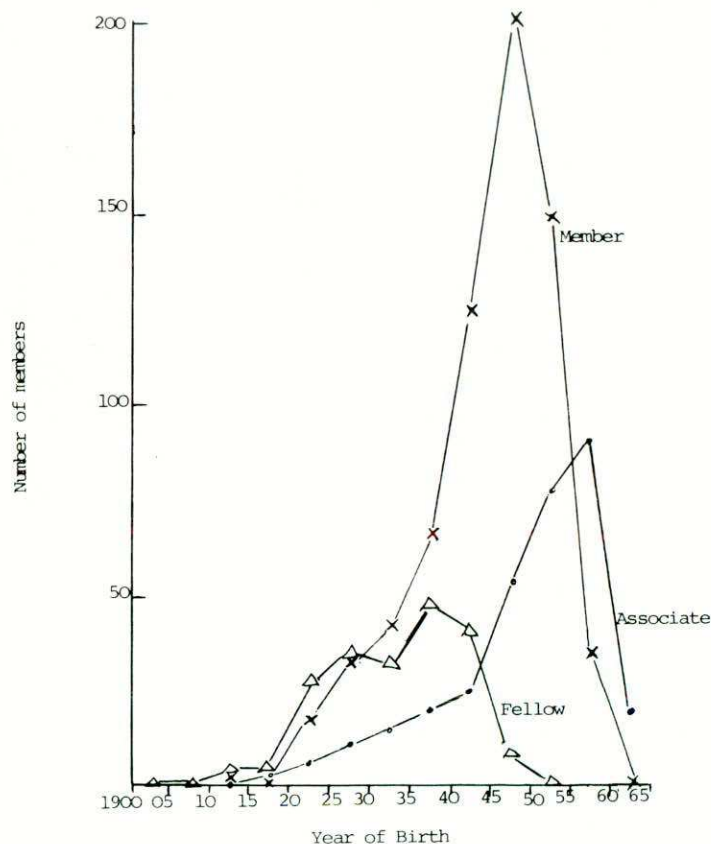


Figure 2 Age distribution of Institute grades of membership

Comments on the statistics illustrated in the Table and Figures, and on their significance for the future of the Institute, may be found in the President's Letter on page 3.

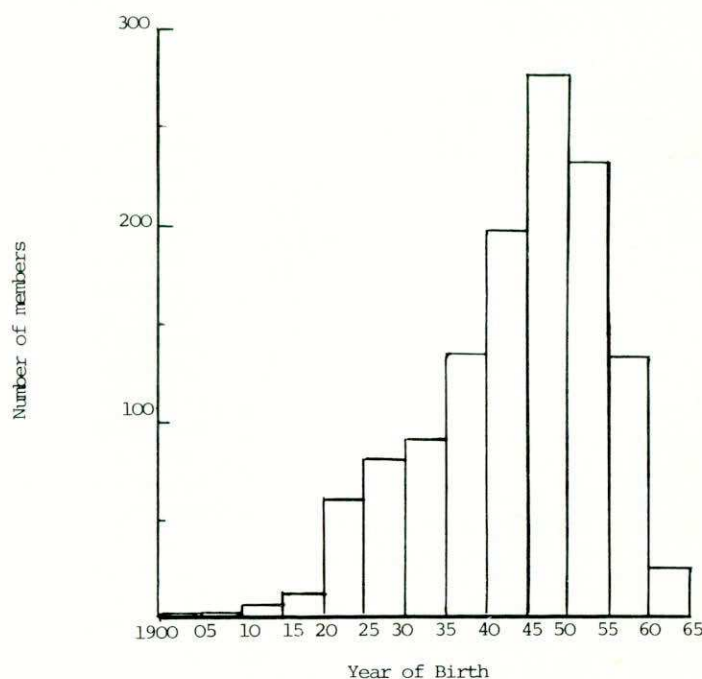


Figure 1 Age distribution of Institute Members

	Associates	Members	Fellows	Total
Research and Development	38	110	35	183
Consultancy and architecture	38	114	49	201
Polytechnic teaching	8	52	13	73
University teaching	20	59	74	153
Industry/Commerce	65	162	23	250
Public Authority	149	170	10	329
Total	318	667	204	1189

Plus 17 students and 40 "other occupations" giving a total of 1246.

Table 1 Occupations of Institute Members

Noise in the next Ten Years – Ten Years On!

In the IOA's Newsletter No 1 dated Summer 1974 - the antecedent of Acoustics Bulletin - there appears a note about three new reports from the Noise Advisory Council. One of these reports, entitled *Noise in the Next Ten Years*, gives '.... a broad view of noise problems as they seemed likely to develop over the next ten years'. Such attempts at clairvoyance on the part of any Government agency positively invite a critical review of their predictive abilities.

In fairness to the members of the Panel it should be stated at the outset that theirs was a very reasonable prediction. Many of the pointers to the future that they gave have indeed come about. It is largely in matters of emphasis and time scale that they have been shown to have erred but the effects of the recession and the change in the political party in power half-way through the period which resulted in radical changes in the allocation of responsibilities and resources are perhaps factors that the Panel were not equipped to take into account. Nor could the Panel have foreseen that the NAC itself would not survive to review its own performance.

Not surprisingly, in view of the close relationship between the Noise Advisory Council and the Noise Policy Division of the Department of the Environment, the short-term predictions were fairly accurate. At that time Whitehall was actively engaged on the passage through Parliament of two major items of legislation with noise abatement implications, the Control of Pollution Act and the Health and Safety at Work etc Act, both enacted in 1974. In the second part of the ten-year period, problems such as acid rain and the disposal of waste nuclear material have tended to relegate noise matters in the hierarchy of environmental protection and have absorbed a significant proportion of the limited funds available.

The report identified four principal categories of noise nuisance, namely road traffic, aircraft, neighbourhood and occupational noise. In the road traffic noise section the increasing population likely to be exposed to this form of pollution is set out together with the measures that could be taken to reverse the trend. However, on re-

reading the section there appears to have been an underlying pessimism about this particular topic, which has since proved justified. Certainly a 'Quiet Heavy Vehicle' has been developed but it will be many more years before this technology has any impact on the noise exposure levels and the EEC directives and our own Regulations have done little to push down the noise emission levels of vehicles.

Much more optimism was evident in the aircraft noise section and indeed this has proved to be probably one of the most successful areas of noise reduction during this period. The replacement of noisy aircraft by quieter types has proceeded, although the recession has perhaps kept the noisy types in service for longer than was anticipated. The effect of this noise reduction has benefited substantial numbers of people who live in the vicinity of major airports. When the report was written much hope was pinned on hush-kits as a short-term measure but as no international regulations were made to force airlines, already hard hit by world recession, to spend money on such devices they were never widely fitted.

Neighbourhood noise was a topic that had already been given detailed consideration by NAC and being less clearly definable than other topics the space devoted to it is rather scant. Certainly Noise Abatement Zones have been created and a Quiet Town Experiment held but it is clear that the impact they have had is less than was envisaged when it was written that '.... the Panel is convinced that the measures proposed in the Report would contribute significantly to the reduction of neighbourhood noise during the next ten years.'

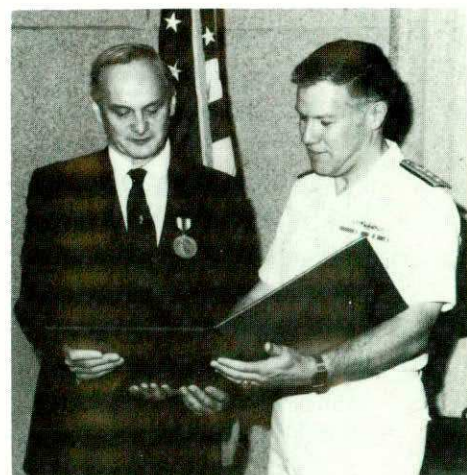
In the area of occupational noise the panel appear to have underestimated the impact that hearing damage risk would have on industry in this period. The Health and Safety Legislation has done much to galvanise Industry into action and to awaken an indifferent workforce to the health hazards involved. There is still much that needs doing and there is no room for complacency at this stage but the progress that has been made goes well beyond the additional publications envisaged by the Panel.

With the benefit of hindsight it does seem strange that the Panel did not predict that the biggest advances in the battle against noise would be made in the areas where there was a risk to health, where the absolute noise levels were highest and where the exposure of the public to the nuisance was most concentrated. However, accepting that the world economy has restricted the progress that we should like to have made, it is gratifying that the limited resources seem to have been applied to those situations where the need was greatest. Such achievements must bode well for the profession in the next ten years. □

R C Hill

American Award

Dr Alan Powell MIOA has been awarded the Captain Robert Dexter Conrad Award, the US Navy's highest honour for scientific achievement.



Rear Admiral John B Mooney, Jr, US Navy, reads the citation for the Conrad Award to Dr Alan Powell

Dr Powell, born in Buxton and a graduate in aeronautical and mechanical engineering from both Loughborough and London, bears the distinction of having been the first research student of Professor Elfyn Richards at Southampton. He has been the recipient of many awards both British and American and the Honorary Degree of D Tech was conferred on him at Loughborough University of Technology in December 1980. His work has spanned both aeroacoustics and naval acoustics and he is at present Technical Director of the David Taylor Naval Ship Research and Development Center. From the Institute of Acoustics we send congratulations across the waves. □

Proceedings of The Institute of Acoustics — Abstracts

Autumn Conference 1984

2 - 4 November 1984, Windermere

Speech Analysis

SAY — A Speech Analysis system based on an IBM Personal Computer

P R Alderson, G Kaye, S G C Lawrence, D A Sinclair, B J Williams and G Wolff
IBM UK Science Centre, Winchester

SAY is a speech analysis tool intended for a diverse set of users engaged in the evaluation of natural and synthetic speech.

The system consists of an IBM PC-XT Personal Computer with 640K RAM and 20 Mbyte hard disk, IBM 370 host connection together with special purpose digitisation and display hardware. Speech may be recorded and replayed from the hard disk at sampling rates up to 40 kHz. A vector display capable of showing two waveforms of up to 1024 points is provided together with waveform scrolling and editing facilities. The user may edit the waveform either by selecting, copying, deleting or modifying portions of the speech waveform — viewing the results of his efforts on the display and also listening to the results as required, or system macros may be invoked to perform more complex operations on the selected portions of the waveform (eg Fourier, LPC and cepstral analysis).

Particular care has been taken to provide a flexible, easily understood interface accessible to a diverse set of users (eg linguists, phoneticians, speech therapists, engineers). In the editing mode the user is provided with a special purpose control panel containing keys allocated to the most common editing functions — these permit him to display easily or replay portions of the edited or unedited wave and to scroll these waves across the display, selecting and manipulating portions by the use of a joystick and on screen cursors. A wide range of sophisticated signal processing facilities are provided via a host link to the IBM UKSC IAX signal processing package. These facilities include spectral and cepstral analysis, grey scale and colour spectrogram display, LPC analysis and pitch contour extraction. As the system is developed some of the signal processing facilities will move from the host into the PC. This will be achieved by the use of a PC-XT/370, Discrete Fourier Transform (DFT) hardware based on a prime radix transform and the attachment of a raster colour display. This will provide real-time speech spectrograms, displayed in time synchronisation with the speech waveform.

The Acoustic Flow of Speech

R K Moore, M J Tomlinson and S W Beet
Royal Signals and Radar Establishment, Malvern

In many speech processing tasks it is necessary to have access to transitional information. Currently, techniques for deriving such information tend to be

heuristic in nature, primarily due to the 'timeframe' nature of most speech analysis techniques and to the lack of suitable continuity measures. What is needed is a better quantitative description of transitional information in speech data. To mitigate these problems this paper presents the concept of 'acoustic flow': an optimising technique which is guaranteed to derive the best explicit representation of the transitional information in a speech pattern which is changing over time. The technique is shown to be completely analogous to the concept of 'optic flow' in image analysis. Examples will be given of the acoustic flow of a range of speech signals, and the implications of the technique for various areas of speech research will be discussed.

The Automated Phonetic Transcription of English Text

S G C Lawrence, B J Williams and G Kaye
IBM UK Science Centre, Winchester

There have been many reports of rule systems for automated text-to-speech transcriptions. These have to varying degrees produced as an intermediate stage a phonemic transcription of the input. This paper describes a rule system that takes an input text stream in conventional orthography and produces

- 1) A broad phonemic transcription with some vowel reduction.
- 2) A detailed allophonic transcription.
- 3) A narrow phonetic transcription with varying degrees of assimilation depending upon the type of speech to be simulated.

At present the speaker model is RP, but other accents are equally possible within the general system design. Use is made of the automated lexical stress assignment techniques described elsewhere at this conference.

The system has been implemented on an IBM Personal Computer. It runs faster than real time and displays the results in conventional IPA with diacritics, thus giving the user immediate feedback. Examples illustrating the quality of transcription will be given, together with statistics on the accuracy based upon a phonemically tagged version of the LOB corpus. Besides being of value as part of a speech synthesiser, the system is also seen to have uses in the teaching of phonetics.

Aligning Speech with Text

D R Miller and S D Isard
Laboratory of Experimental Psychology, University of Sussex

The system described in this paper aligns the speech wave of an utterance with a phonetic transcription of it. The input to the system is a sampled waveform of an utterance together with a transcription, and the output is a set of pointers into the

waveform giving the locations of the phones mentioned in the transcription.

The system proceeds through stages of:

- (1) *Segmentation*: The speech wave is segmented, using rates of change of various parameters to find 'acoustic edges'.
- (2) *Labelling*: The assignment of phone class labels to the segments using a two-level rule based system.
- (3) *Grouping*: The grouping of the phone class labels into possible syllables.
- (4) *Matching*: The matching of the transcription and possible syllables.

We have in mind three applications for such a system:

- a) The construction of diphone dictionaries for synthesis of speech on a variety of voices and dialects.
- b) As a verification module in a speech recognition system.
- c) As an aid in manipulating utterances to construct stimuli for laboratory experiments.

Lexical Stress Assignment in English: A Metrical Approach

B J Williams
IBM UK Science Centre, Winchester

Stress placement in English words has often been seen as at least partially unpredictable. If true, this would make it impossible to synthesise English by rule from completely unrestricted text. However, given the correct information, it seems likely that lexical stress can in fact be predicted for English with acceptable accuracy.

The work to be reported makes use of information on word class membership, morphological structure, syllable structure and phonemic category, to divide the word into 'stress foot' structures according to the principles of metrical phonology. These structures are then bracketed in a binary-branching tree within morphological domains. From this tree, it is possible to ascertain the syllable which receives lexical stress, and the vowels which suffer reduction.

A computer program has been written to implement this theory for a subset of English. The structure and performance of this technique will be presented and discussed in the context of a text-to-speech synthesis system for English.

Grammatical analysis in the synthesis of speech from text

J G Wolff and G Kaye
IBM UK Science Centre, Winchester

To convert text into speech and achieve accurate phonetic transcription, natural intonation patterns, rhythm and stress assignment apparently requires some analysis of the syntactic structure of the text and, ideally, some semantic analysis too. This paper describes a syntactic parsing system and a computational grammar which

Autumn Conference 84

has been developed to form part of an experimental system for synthesising speech from text.

The parser uses a top-down, best-first search strategy combined with chart parsing techniques to minimise unnecessary processing when back-tracking occurs. Alternatives to this strategy will be briefly considered. The parser is designed to fail 'gracefully': if a full parsing of a piece of text cannot be achieved then the best partial parsing is given.

The computational grammar developed for use with this parser is designed to achieve a favourable balance between the range of structures which can be recognised by the parser and the storage cost of the grammar itself. To this end, as much reliance as possible is placed on cues to syntactic structure like function words and affixes. The size of the dictionary to be used with the grammar has been minimised, consistent with accurate parsing.

The grammar has also been designed to dovetail with the parsing strategy employed to minimise the amount of pattern matching and backtracking during the parsing process.

Normalisation: Fundamental Questions

C G Henton

Phonetics Laboratory, University of Oxford

Much work on the problems of speaker normalisation has focused on, and considered central, the problem of voice pitch. Pitch, it has been assumed, is the basic separator of female and male voice qualities. Schwartz claims that the FO value can be used as the basis for cross-speaker normalisation.

Using a large database of closely-controlled speakers of Received Pronunciation, an auditory theory of normalisation reveals that an average male-female shift of 1.1 Bark is appropriate for vowel spectra. Assuming that the voice fundamental is represented auditorily as part of the spectral shape, it would be expected that the 1.1 Bark difference would apply also to the fundamental. However, measurements of average male and female FO values now show that the difference is only 0.85 Bark. Either RP males are speaking too 'high' or RP females are speaking 'lower' than the theory predicts. Thus some support is given to the notion of 'perceived androgyny' of RP speakers (Elyan *et al.*). The influence of socio-phonetic expectations on pitch control is also examined, including suggestions that females use a greater pitch range.

Diphthongs: Implications for Dynamic Auditory Processing

A Bladon

Phonetics Laboratory, University of Oxford

New evidence is presented that diphthongs are indetified not, as Gay has suggested, from their formant frequency rate-of-change, but primarily in terms of the quasi-stationary spectra at their endpoints (onset and offset). The auditory space available to a diphthong endpoint can be quite large, thus permitting the familiar 'undershoot' (to a language-specific extent).

If this is so, then the dynamic metric for auditory distance which is proposed by Bladon (in the still awaited *Fallside and Woods, Computer Speech Processing*), and which also appears to be implicit in the concept of data-adaptive frame rate (eg Bridle and Brown, *Proc Inst Ac*, 1982), is an

inappropriate model for diphthongs. One thing the ear is not doing, during the transitional part of a diphthong, is — as that metric assumed — estimating the spectral shape change over time. Instead, I argue that the auditory role of the spectral change partway through a diphthongal stimulus is twofold: as a weighting flag, and as a spectral pointer (cf the physiological data of Delgutte and Kiang, *JASA*, 1984).

Building Insulation and Privacy

The Sound Insulation of Access Floors

R N Galbraith and R Bussell

Sandy Brown Associates, London

Access floors (computer type) are now commonly used in offices, as an alternative to suspended ceilings, for providing services distribution space. Sound transmission via the access floor and floor void affects the sound insulation between offices when an open office space is partitioned.

Laboratory measurements of the sound insulation of ten different access floors have been carried out using the 'room to room' method. The performance of access floors is discussed in the light of the results of these tests. The effect of penetrations through the floor for air grilles has also been measured.

Insulation of Flats formed by Conversion

A J Gibbon

High Peak Borough Council

Manchester Area Council for Clean Air & Noise Control comprises sixteen constituent local authorities. The Council recently adopted a procedure for applying practical sound insulation into flats created by converting existing premises.

Large older dwellings are frequently converted to form a number of self-contained flats and the trend to an increased provision of small units of accommodation is expected to continue.

Although the Building Regulations require new dwellings to meet requirements for adequate sound insulation against airborne and impact noise, there are no such requirements for conversions. However, local authorities have an opportunity to take preventive action in respect of noise annoyance through the granting or refusal of planning permissions. By this means the sound insulation needs of new dwellings formed by conversions can be incorporated.

This report identifies matters to be taken into account where flats are produced and outlines the way in which potential noise problems might be avoided. Early consideration is essential if the new dwelling unit is to have any chance of attaining the standards normally applicable to new build situations.

The technical details incorporated in the adopted procedures are taken from well established criteria and are no doubt used by other Authorities in the UK. However, it is hoped that the bringing together of published data together with reasoned argument may in some way produce a step in the right direction to enable control through planning legislation to become an accepted practice at all Government levels.

The Replacement of Masonry by Timber in Traditional House Separating Walls

C Walker

British Gypsum R & D, East Leake

This paper will outline the work carried out by the Acoustics Department of British Gypsum Limited in co-operation with Bryant Homes Limited of Solihull, in constructing two pairs of new traditional houses where for the first time ever, the separating walls were loadbearing timber studding, whilst the rest of the structure was brick and block.

The paper will be illustrated by colour slides which show the detailed techniques used. At the end of the construction period the houses were tested according to BS 2750 Pt 4. Flanking transmission via the adjacent bay windows in the living rooms proved to be a problem at low frequency, nevertheless, mean normalised level differences in excess of 55 dB were achieved.

Improving the Sound Insulation of Glazed Partitions

C Inman

Pilkington Glass Ltd

G Kerry

University of Salford

There may be occasions when the total office landscape is visually desirable and yet for some occupants acoustical privacy remains essential. Glazed office partitions, thoughtfully designed and engineered, can satisfy both the criteria but all too frequently these partitions fail to meet the acoustic requirements. Offered as an option in a standard partitioning package the more common arrangement utilises a simple timber, metal or plastic frame in which is held, usually by neoprene gaskets, single or double glazed panels of monolithic glass.

As part of an ongoing development programme the performances of a variety of glazing systems including monolithic, laminated and sealed units have been established and these include a number of systems which can give optimum performance in internal partitions. Additional tests carried out under controlled conditions with similar frames constructed from a range of materials have shown that the choice of frame material is of little consequence in determining the system sound reduction index. However the tests have also shown that optimum performance is not always achieved if gaskets are used instead of mastic putty.

The object of the paper is to present and discuss some of the results of the development programme relevant to internal partition design.

The Effects of lower Reverberation Time in British Living Rooms

Marion Burgess

School of Architecture,

University of New South Wales, Australia

An average reverberation time in British living rooms has been considered to be 0.5 sec and this value forms the basis for the normalisation of field measurements of sound insulation. Over the last three decades the Building Research Establishment has made many measurements of reverberation time in connection with other investigations. This data has been examined to show the change that has occurred in reverberation time, to compare it with other published data and to obtain an estimate of the current average reverberation time. The current

lower value of reverberation time increases the normalising constant so that the actual noise reduction between rooms is up to 3 dB better than estimated from the normalised level difference. The shorter reverberation time also has an effect on room constant so that the direct field dominates over a distance 40% greater than when the reverberation time was 1.5 sec.

Evaluation of the Sound Insulation Properties of 40 Types of Timber Frame Walls under Laboratory Conditions

X Bohineust
ITBTP, Paris

A test programme was recently instituted by the Ministry of Research and Industry Ministry to improve the understanding of acoustic characteristics of timber frame walls in France. This study was concerned first with an experimental and theoretical characterisation of timber framed party walls, dividing walls and facades.

The effects on acoustical performance of the type of stud, the installation of fibrous absorption material, the number of screws, the presence of resilient channels and finishing were studied.

Sound transmission loss tests were conducted on forty types of walls and then compared with computed results. The transmission loss of single leaf partitions was calculated using Sewell's method for isotropic boards, and Orbudabi's method for orthotropic boards (plywood). The transmission loss of single or double studing was calculated using Sharp's and Angel's methods.

The analysis of the mechanisms of sound transmission and the experimental laboratory data permitted general rules to be defined to improve the sound insulation performance of wood stud partitions.

Examination of the Validity of a Single Figure Measure of Privacy and Intelligibility

R J Bowdler
Sandy Brown Associates, London

In a wide range of acoustic and noise consultancy — from industrial noise through office design to the design of auditoria — there is a need to provide a quick, though approximate, assessment of whether voices will be intelligible, unintelligible or not heard at all. The various measures developed to date rely on an analysis, often detailed, of the background noise level spectrum.

Over 100 different spectra have been taken and the values of Articulation Index, Speech Privacy Potential, Preferred Speech Interference Level, NR level and dB(A) have been compared. The results of the measures of intelligibility and speech interference by these accepted methods have been compared with a single figure index, based on the background noise level in dB(A). This shows that good correlation is obtained for a wide range of spectrum shapes.

Rapid Sound Insulation Calculations

P H Allaway
Grootenhuis Allaway Associates, Royston

The calculation of Composite Sound Insulation Indices, and sound pressure level spectra due to transmission through walls and other barriers, is boring and time consuming. For an Acoustic Consultant, whose cost to his client is based on the time expended on the client's project, time must not be wasted

on trivial calculations even though the answers may be critical to his advice and recommendations.

Using a microcomputer can save time and tedium.

For acoustic privacy work, the Room-to-Room calculation is most often needed but much the same kit-of-parts is needed for the calculation of noise ingress to a building from outside and, conversely, noise egress to outside from an internal source. These calculations can therefore be grouped rather conveniently into a small suite of programs for a microcomputer.

This paper describes the logic and use of such a suite of programs. No listings will be given but applications will be discussed with particular reference to acoustic privacy. Simplification of the standard calculation procedures to suit the inevitable vagaries of site tolerances, flanking transmissions, etc will be discussed.

Automatic Speech Recognition

Whole Word Templates and Stochastic Models: some Important Relationships between Apparently Different Techniques for Automatic Speech Recognition

J S Bridle
Joint Speech Research Unit, Cheltenham

Whole word template matching is a well established technique for automatic speech recognition. The most successful systems use dynamic programming for coping with unknown non-linear timescale relationships, and there are successful extensions to deal with connected words and to model timescale variability more faithfully. Recently a 'new' technique has come into vogue, seeming to offer some advantages in modelling power and computational efficiency.

We explain the main principles of this stochastic modelling (also known as hidden Markov modelling, or HMM), with reference to publications in this area which are more than a decade old, and show how template matching methods may usefully be re-interpreted as special cases of stochastic modelling.

Some Implications of the Effect of Template Choice on the Performance of an Automatic Speech Recogniser

M J Russell, J C A Deacon and R K Moore
Royal Signals and Radar Establishment, Malvern

Researches in the field of Automatic Speech Recognition (ASR) frequently quote 'recognition rate' as a measure of the capabilities of new ASR algorithms. The inadequacy of this method of assessment is well documented: it has been shown that differences in recognition rate tend to reflect differences in test conditions, such as speaker, vocabulary or environment, rather than the relative capabilities of alternative algorithms. However, even if these variables are controlled, for example by the use of standard databases, there are other factors, more closely linked to the algorithms themselves, which can critically influence performance. This paper addresses one such factor: the choice of reference words, or 'templates'.

Experimental results will be presented for both commercial and laboratory speech

recognition systems which show that recognition accuracy is crucially dependent on the choice of reference words. It will be shown that the extent of this dependency varies significantly between speakers. Comparisons will be made between observed and predicted distributions of error rates for different speakers and possible implications for a quantitative measure of 'speaker consistency' will be discussed.

Template Adaptation in Speech Recognition

R I Damper and S L MacDonald
Department of Electronics, University of Southampton

Abstract not available

Problems with Dynamic Frequency Warping as a Technique for Speaker-independent Vowel Classification

W A Ainsworth, K K Paliwal and H M Foster
Department of Communication & Neuroscience, University of Keele

A dynamic frequency warping algorithm has been used to match the spectra of vowels of one speaker against the vowels of different speakers. Although the technique resulted in a transformation which produced a good match, it was not accurate as a speaker-independent vowel classifier. With reference spectra from the vowels of male speakers and test spectra from the vowels of female speakers, and *vice versa*, the recognition scores were only 33%, whilst with reference and test spectra from different utterances of the vowels of the same speaker the scores were 96%.

The problem is that the dynamic frequency warping algorithm is too general. It needs to be made more specific by applying appropriate constraints. The development of constraints which considerably improve the speaker-independent scores will be described.

A Noise Compensating Spectrum Comparison Measure applied to Automatic Speech Recognition

J S Bridle, K M Ponting, M D Brown, and A W Borrett
Joint Speech Research Unit, Cheltenham

Many potential applications of automatic speech recognition are made difficult by background noise. A crucial part of many speech recognition systems is a method for comparing two spectrum cross-sections, one from the input and one from a template, to produce a 'distance'.

We describe a method for comparing two noisy spectrum estimates so that differences due to the noise have little effect. We first compute a weighting function to go with each speech spectrum, based only on that spectrum and its corresponding noise spectrum estimate. The spectrum distance calculation combines two speech spectra and their weighting functions in a way that makes full use of the original information, and provides a measure of the differences between the speech spectra that are not due to the presence of noise. The new method leads to a particularly efficient implementation in hardware, as the weighting function can be represented by very few bits (we use just one) and the distance calculation can be pipelined.

The effect of the method is illustrated on synthetic spectrum shapes and results are presented of its use in a connected word recogniser using speech with added noise.

Autumn Conference 84

Boltzmann Machines for Speech Pattern Processing

J S Bridle
JSRU Cheltenham
R K Moore
RSRE, Malvern

All modern speech recognition machines are based on variations of the same methods for representing speech knowledge and searching for interpretations that are consistent with the data and the knowledge. These markov models and dynamic programming put very severe constraints on the structure of the speech model, and thus the type of speech knowledge that can be represented. These limitations have caused some speech scientists to turn to 'artificial intelligence' symbolic reasoning methods for representation and search.

Recent developments in cognitive modelling are providing an intriguing alternative method of building, tuning and using knowledge representations in a style we could call 'artificial perception'.

We present an introduction, for the speech technology research community, to 'optimisation by simulated annealing' and adaptive stochastic constraint satisfaction networks ('Boltzmann machines'). We indicate how the latter might be applied at various levels of speech pattern processing, and illustrate with a very simple network that learns to 'recognise' peaks in a one-dimensional function.

Self Organising Neural Arrays for Speech Recognition

G Tattersall
British Telecom, Martlesham Heath, Ipswich

Over the last twenty-five years many attempts have been made to simulate electronically the action of neurons in the brain with the aim of producing a pattern recognising machine with some of the characteristics of a human. However, until recently it has not been appreciated that neural models incorporating lateral excitation and inhibition exhibit self organising properties which can result in the unsupervised extraction of features from the patterns applied to the system, eg Kohonen (1) and Hirai (2).

Recently it has been demonstrated that this type of self organising neural system can be used effectively for the recognition of the phonemes of one speaker who has trained the system. However, these experiments have been limited by computational speed to small neural arrays containing about 400 neurons and input patterns of up to twenty dimensions.

At British Telecom Research Laboratories a high speed hardware self organising neural array is being built which will contain up to 65000 neurons and will deal with input patterns of up to 256 dimensions. The system will work in real time and will be used initially for the recognition of isolated words. A description of the principles and performance of the system will be presented in the paper.

Acoustic-Phonetic Networks — Applying Phonology in ASR

M Huckvale
Department of Phonetics and Linguistics,
University College London

The influence of the phonetic context on the realisation of a word in some continuously

spoken phrase may be described by phonological rules. Knowledge of such systematic variation is of potential use in speech recognition systems. However such phonological knowledge is usually expressed as operations on phonetic symbol sequences — whereas speech recognisers operate on continuous acoustic signals. To utilise phonological knowledge previous systems have either used acoustic-phonetic recognisers as front ends or made gross assumptions about the acoustic realisation of phonetic segments.

In this paper a procedure is proposed which allows phonological rules to operate on acoustically-derived speech segments. Acoustic segmentation is performed using pair-comparison of test words, and the phonetic labelling of these segments allows construction rules to be written that are similar in form to phonological rules. A combined system of rules may then operate on a phrase grammar to generate a network describing many possible realisations of every phrase but in which the nodes carry acoustic segments instead of phonetic symbols. This network may then be used for recognition with an efficient graph searching strategy such as dynamic programming.

The Analysis and Classification of FO Contours

D Lindsay
Department of Communication & Neuroscience, University of Keele

Much of the recent interest in FO contours has been in determining whether there is a phonology of intonation. The existence of basic categories of FO contours would have implications for the analysis of continuous speech as well as for the study of speech perception. Recent work on the perception of the pitch movement associated with the intonation nucleus suggests that there is a fixed number of 'tones of English' that are required for a complete description of British English.

That work is developed further here by using a prosodics-only recogniser to analyse these nuclear tones. The recogniser operates on a database of monosyllabic words spoken in a variety of ways using the prompts of semantic cues. The recogniser was trained on a subset of the utterances and classified the remainder. Linear dilation and dynamic time warping (over a range of adjustment windows) was used to derive the reference-test distance, for both speaker dependent and independent operation. Although the overall performance does not compare with that achieved by recognisers operating at the segmental phoneme level, the results suggest that a limited classification of tones is possible. A possible application for this independent prosodic analysis would be as a separate knowledge source within a continuous speech recognition system.

Reasoning about the Acoustic Realisation of Semivowels using an 'Intermediate Representation' - the 'Speech Sketch'

P D Green and A R Wood
Department of Computing, North Staffs Polytechnic

We argue for an approach to acoustic-phonetic reasoning in speech recognition based on the 'Speech Sketch' - a data structure in which the behaviour of spectral parameters is explicitly described. We represent acoustic-phonetic knowledge in

frame-like structures whose terminals map onto the descriptors of the speech sketch. Part of a frame expresses how the manifestation, in the speech sketch, of the event it describes is expected to change with context. The speech sketch describes what has happened and the frames describe (in an equivalent way) what is expected to happen in particular speech events. 'Recognition', within this paradigm, is achieved by a recursive matching function which resembles the 'inference engine' of an expert system.

We hope to present results, at this conference, from a testbed implementation of the above ideas, in which a speech sketch for formant frequency parameters is used to distinguish between /l/, /rl/, /wl/ and /lj/ in various environments.

Generating Multiple Solutions from Connected Word DP Recognition Algorithms

S J Young
Department of Computation, UMIST

Current DP-based connected speech recognition algorithms operate by matching concatenated strings of whole word templates against the unknown speech and dynamic programming is used to compute efficiently the string whose total distance from the unknown is a minimum. This 'best' string is then output as the recognition result.

Although this technique can give reasonable performance when applied to real systems, practice shows that substitution, insertion and deletion errors are relatively common making the actual string spoken, not the 'best' string, but the 'nth-best' string. Thus, conventional DP algorithms which are designed to give the best, and only the best, string will fail in these circumstances.

In many application areas, however, there is often sufficient high level knowledge (syntax, semantics, etc) to enable the correct 'nth-best' string to be selected in preference to the n-1 better scoring strings. Hence, such failures could be significantly reduced if only the pattern matching algorithm could generate multiple candidate solutions.

This paper describes an algorithm for generating multiple solutions from a DP pattern matcher. The algorithm is a generalisation of Sakoe's Phrase Level Matcher which generates candidate solutions in rank order. It has been applied to a variant of the one-pass DP algorithm developed by Bridle and others and results will be presented which illustrate its performance.

The conclusion of the paper is that for limited task domain conversational systems at least, the algorithm presented offers considerable potential for improving overall recognition performance.

The Classification of Phonemes by a Self-ordering Network

M J Carey
MITEL Telecom Ltd, Newport

Self-ordering arrays are capable of displaying the underlying relations between data in a set. The principles of self-ordering have been applied to the phonemes of English speech.

The phonemes are hand-edited from continuous speech, and analysed using the mel frequency cepstrum coefficients (mfcc's). They are then applied to a self-ordering array which positions the different

phonemes so that the overall inter-element distances within the array are minimised. Under these conditions each phoneme forms a cluster, and the array maps the distribution of the phonetic data from the tenth order mfcc space onto two dimensions.

An important conclusion which can be inferred from this result is that the phonemes are intrinsically two-dimensional since each phoneme only forms one cluster in the array. The arrays formed by this technique can be used to cluster data for such purposes as vector quantisation and a phoneme based speech recogniser.

Ship and Diesel Engine Noise

Measuring Power Flow of Noise in Fluid-Filled Pipes

P W Keyte

Plessey Electronics Systems, Templecombe

Techniques were developed for the measurement of the distribution of power flow in pipe networks found in some shipboard hydraulic systems. The techniques involved cross-spectra and wave-number spectra of the normal accelerations of the tube wall to measure power flow in the acoustic and flexural waves. The measurements of power flow were checked experimentally on an hydraulic test rig.

Multiple and Single Input Techniques applied to the Noise and Vibration of a Medium Power Diesel Engine (1200 kW)

P R Wagstaff and M Taghavi Nejad

Université de Technologie de Compiègne, France

Because of the periodicity of the combustion pressure signals, standard signal analysis techniques to measure the relationship between diesel engine noise and the pressure of individual cylinders give false results for a multi-cylinder engine. The high coherence between the pressure signals has led to the use of multiple input techniques to resolve this problem. This paper applies both techniques in a slightly different way to overcome some of the objections to earlier applications. It is shown that the results using these two methods are comparable for the high frequency range (2 kHz - 10 kHz) and that the results for individual cylinders may be related to abnormalities in their combustion pressure characteristics. Multiple input methods are shown to have a limited application in the frequency ranges below 2 kHz for relatively simple simulated systems. In the real case this advantage is affected by statistical errors.

A Noise Reduction System for Permanent Outdoor Enclosures of Standby Generating Equipment

D M Allen-Booth and B Quartermain

Department of Physics, Sheffield City Polytechnic

The effectiveness of various strategies adopted to control the noise emitted by a standby diesel generator sited in a suburban location will be discussed. Expanded cross-section silencers in the air flow system were tuned to give maximum attenuations at 250, 750, 1250 Hz etc corresponding to the known engine harmonic frequencies. Details of the construction of these silencers from high-density chipboard will be given.

The effect of diesel engine acceleration rates on noise levels

M Croker

Ricardo Consulting Engineers, Shoreham-by-Sea

During legislative exterior testing of diesel powered vehicles the engine is usually the dominant source. Most legislation is based on a drive-by test where the vehicle is accelerated at its maximum rate for the gear ratio selected past a stationary microphone.

Engine noise at any given speed under transient conditions will usually be greater than that measured at a stabilised full load state. This paper describes a series of transient tests carried out on a naturally aspirated diesel engine installed in an anechoic cell. Engine acceleration rate (at maximum speed demand) was determined by a micro-processor controlled dynamometer.

It is concluded that for the purposes of assessing engine noise under transient conditions a 'free' acceleration test (engine accelerating itself and the dynamometer) at maximum speed demand is directly comparable with a test at typical in-vehicle engine acceleration rates.

The Mobility of T-Intersections of Plates

Björn Petersson

Technical University of Denmark

A most essential part of the structure-borne sound and vibration process is the transmission from a source structure to a receiving structure.

Recently, a large research project on ship acoustics, carried out within the Nordic countries, has been finished. Among the results gained from this project are procedures for the prediction of the mobilities of the source and receiver structures. In these procedures, however, points at or very close to stiffeners or stiffening plates were excluded.

In a continuation of the above mentioned project the structural configurations of T-intersections have been studied and a model for the dynamic characteristics of points at the intersection have been developed.

In this paper the theoretical model is briefly outlined and the experimental results are presented. In addition, prediction procedures for the estimation of the point mobility for the translatory force component are described.

Some Methods and Procedures for evaluating and attenuating Sound and Vibration Transmission paths in large industrial and Marine Engineering Environments

M A Swinbank

MAS Research Limited

Abstract not available.

The Active Mount

G B B Chaplin and M C J Trinder

Wolfson Centre, University of Essex

A comparison is made between the vibration isolation properties of the conventional elastomeric mount and those of a selective active mount. Attention is focused on the inherent qualities of the selective active mount, in particular, that the mount provides excellent isolation at the harmonic frequencies related to the engine rotation rate,

but at other frequencies the mount is totally rigid.

The principle of operation of the selective system is outlined, together with a discussion of an installation of an active system.

The Reduction of Noise from Heavy Diesel Engine Goods Vehicles (QHV90 Project)

J W Tyler, Independent Consultant

Co-operative programmes of research and development between government and industry since 1971 (TRRL Quite Heavy Vehicle Project) have shown that it is possible to reduce the noise emitted by a maximum weight goods vehicle to about half the level obtaining at the start of the work, ie to around 80-82 dB(A), and without large economic penalties.

Following this work the Armitage report to government in 1980 called for regulations on noise to reduce the permitted levels to 80 dB(A) by 1990 and in 1983 the European Community proposed a draft directive to reduce the allowable noise from goods vehicles to levels varying from 78 to 84 dB(A). The Government has launched a joint project with industry, 'QHV90', to conduct further research and to support industry in the design, development, construction and testing of a range of prototype heavy goods vehicles, engines and system components to meet the more rigorous noise limits that are likely to be in force by 1990.

This paper describes the background leading to the QHV90 Project and outlines the technical content with special reference to the acoustic problems involved in quietening this class of vehicle.

Design of Quiet Diesel Power Stations

H Kenyon

Martec Environmental Engineering, Skelmersdale

Design criteria, both operational and environmental, which determine available strategies for the control of noise from diesel power stations will be discussed.

The Design and Manufacture of Vessels in Singapore for North Sea Oil Exploration

R W Heng

Department of Mechanical and Production Engineering, National University of Singapore

Abstract not available.

Speech Perception

The Influence of Response Categories on the Identification of Vowels Excerpted from Conversational Speech

J Koopmans-van Beinum, H A L Wouters,

H J A G Buiting and L C W Pols

Institute of Phonetic Sciences, University of Amsterdam, The Netherlands

In this paper we will report on an experiment that is part of a detailed study which aims to find out to what extent Dutch vowels can be identified on the basis of short excised segments of free conversational speech.

An earlier study (Koopmans-van Beinum, 1980) revealed that the percentage of correct identifications of unstressed Dutch vowels from free conversation of two male and two female speakers is some 33%, averaged over all vowels. On the basis of calculated values for the Acoustic System Contrast ASC (being the total dispersion of the vowel system per

Autumn Conference 84

speaker) it was predicted that the percentage of correct identifications of stressed vowels would be some 50%. A second experiment (Buiting, 1982/83; Buiting, Pols, and Koopmans-van Beinum, 1983) focused on the question whether or not, and if so to what extent, additional information is comprised in the transitions from or to the surrounding consonants. In the first part of that study, concerning vowels of only one of the male speakers, the percentages of correct identifications varied from 46% for V to 58% for CiVtC stimuli (V=vowel, t=transition, and C=consonant). A repetition of this identification experiment with carefully chosen stressed vowels from free conversation of all 4 speakers presented to trained listeners revealed a score varying from 50% to 89% correct.

In the present study we concentrated on the question whether, and to what extent, the response categories that were presented to the listeners on the score-sheets, were of influence on the percentages of correct identifications, if more and more of the transitions were added. In order to answer this question we repeated the last study with exactly the same speech material of one male speaker, and presented the same stimuli two times to the same listeners with an interval of one week. Once they had to reply on score-sheets with only the possible vowels as the response category, and once on score-sheets with the possible vowels presented in their original consonant surroundings. The results of these identification tests will be discussed in more detail at the conference.

Study of the Role of Formant Transitions in Vowel Recognition by using the Matching Paradigm

L C W Pols, G W Boxelaar, and F J Koopmans-van Beinum
Institute of Phonetic Sciences, University of Amsterdam, The Netherlands

In a well-known paper by Lindblom and Studdert-Kennedy (1967) the role of formant transitions in vowel recognition was studied by using continua of synthetic [wVw], [jVj] and [V] stimuli which had to be identified as either [j] or [v]. They concluded that in the recognition of monosyllabic nonsense speech the identity of a vowel is determined not solely by the formant-frequency pattern at the point of closest approach to target, but also by the direction and rate of adjacent formant transitions.

As an extension of earlier identification experiments (Koopmans-van Beinum, 1980; Buiting *et al.*, 1983) with vowel segments isolated from natural speech with or without the transitions to neighbouring consonants included, we intended to study the role of formant transitions in more detail. This was done by asking subjects to match dynamic synthetic stimuli, consisting of various formant transitions, with stationary vowel sounds. Of these stationary sounds one formant frequency could be controlled by the subject. The dynamic stimuli were of the type [V₁V₂] or [V₁V₂V₁] without [V₁] necessarily being a representative Dutch vowel, and the subjects were asked to match [V₂]. A great many possible transitions in [V₁V₂V₁] stimuli had to be excluded because they caused a consonantlike sensation of [w] or [j], which could not be matched with a stationary vowel sound. So far there is no indication of strong overshoot effects, nor of great differences between four-formant and one-formant stimuli. Also the one-formant

stimuli still sounded rather speech-like. Perceptual extrapolation of truncated formant transitions, as described by Fujisaki and Sekimoto (1975), could not be found. Preliminary data suggest that the matching results could be influenced by the presence or absence of a vowel boundary near the target value.

Identification and Discrimination of Halliday's Primary Tones

W A Ainsworth and D Lindsay
Department of Communication & Neuroscience, University of Keele

A set of intonation contours have been synthesised which include the five primary tones of British English proposed by Halliday. Discrimination and identification functions have been measured for these intonation contours. It was found that the average values obtained from identification functions produced intonation contours which corresponded well with the pitch movements on tonic syllables suggested by Halliday. Discrimination functions were predicted from the identification functions, and these were found to be positively correlated with the measured discrimination functions. It is suggested that this provides strong evidence for the categorical perception of the tones.

The Perceived Rhythm of English and French as assessed by the Tapping Task

D R Scott and S D Isard
University of Sussex
B de Boysson-Bardies, CNRS, Paris

Pike (Intonation of American English, UMP, Ann Arbor, 1945) and many others have claimed that English is a stress-timed language, having equally spaced inter-stress intervals (ISIs) as opposed to French which is said to be syllable-timed. Although measurements of ISIs in English show equally spaced ISIs to be the exception rather than the rule, it is the generally accepted view that there is a tendency for more-or-less equally spaced ISIs. Darwin and Donovan (Proc Nato ASI, Ed J C Simon, Reidel, Dordrecht, 1980) found that when English listeners were asked to tap out the rhythm of stressed syllable onsets of English utterances, the rhythm of their taps was more isochronous than that of the stress beats of the target utterances, and conclude from this that English is *perceptually* isochronous. Using the same task, we have replicated their results, but have found that English listeners also tap more isochronously to French targets. Moreover, so do French listeners. We conclude that the results of the tapping task cannot be used to support the distinction between stress-timed and syllable-timed languages.

Where do Features Interact?

Geraldine A Foster
Laboratory of Experimental Psychology, University of Sussex

Theories of phoneme recognition generally assume that two stages of processing are involved: auditory feature evaluation and phonetic feature integration. The plausibility of this type of model depends critically on the independence of features at the auditory evaluation stage. However there is evidence from studies on synthetic speech that features do interact. What is not clear is whether these interactions arise at the auditory or the phonetic level of processing. It has recently become possible to separate these two levels using an illusion in which

the perceived place of articulation of auditory stop consonants is altered by dubbing them over inappropriate lip-movements (McGurk and MacDonald, 1975). For example, a bilabial stop dubbed over nonlabial lip-movements will generally be perceived as an alveolar having the same voicing as the auditory stimulus. Here stimuli which are bilabial at the auditory level become alveolar at the phonetic level.

I will report a perceptual experiment which exploits this phenomenon in order to test whether feature interactions between place and voicing occur at the auditory or the phonetic level of processing. The results suggest that these interactions are attributable to the phonetic stage, and therefore that features may well be evaluated independently at the auditory level.

Roles of Lips and Teeth in Lipreading Vowels

M McGrath and Q Summerfield
MRC Institute of Hearing Research, University of Nottingham

M Brooke
Department of Computer Studies, University of Lancaster

Lipreaders identify vowels more accurately than analyses of the differences in steady-state lip-shapes suggest (eg Montgomery and Jackson, 1983, JASA 73, 2134-2144). As a first step in assessing the importance of duration and of the movements of articulators in addition to the lips, we measured the ability of normally-hearing observers to lipread 11 monophthongal vowels in both natural and synthetic /bVb/ syllables, both with and without training. Natural exemplars were recorded on videotape in three conditions: (i) full-face and using ultraviolet light and luminous makeup, (ii) lips and teeth and (iii) lips alone. Synthetic exemplars were created by measuring points specifying the shape and movements of the lips, teeth, and jaw, in natural utterances, to control a vector-graphics display of a talking face. Following training, the accuracy of vowel identification was 70% (full-face), 56% (lips and teeth), and 50% (lips alone) where identification of close front vowels was particularly impaired (eg /i/ was confused with /3/). Without training, performance was poorer; 55% with the full-face and 37% with the synthetic syllables. The pattern of confusions among the synthetic vowels was similar to that in the natural condition with lips and teeth — the primary articulators whose movements distinguished the synthetic syllables. Multidimensional scaling showed that the principal perceptual dimensions on which the vowels were distinguished were rounding-spreading, close-open, and duration. These initial results suggest (a) that a vector-graphics display can convey important temporal and spatial cues to the identity of vowels; (b) that syllable duration and the separation of the teeth help distinguish vowels with similar lip shapes; but (c) that additional cues are required for a full specification of visible vowels.

Open Session

Sound Propagation Above an Inhomogeneous Plane

S N Chandler-Wilde and D C Hothersall
School of Civil and Structural Engineering, University of Bradford

Evaluation of the effect of terrain type on the propagation of environmental noise over flat

ground has long been of academic and practical interest. Recently approximations have been proposed for the prediction of sound propagation above a two-impedance plane. In this paper boundary integral equations are presented, the solutions to which exactly solve the problem, in neutral atmospheric conditions, of propagation from a point or line source above an inhomogeneous impedance plane. The exact and approximate solution of these equations in an efficient manner is discussed, with particular reference to the calculation of propagation above a finite impedance plane in which a strip of another impedance is embedded. Calculations are made illustrating the effect of varying the location, between source and receiver, of a strip of finite impedance ground embedded in rigid ground.

The Effects of Intermicrophone Interference in Acoustic Intensity Measurements

F R Wagstaff and J C Henrio
Universite de Technologie de Compiègne, France

The use of two microphones in close proximity to measure acoustic intensity has resulted in a number of investigations of the effects of acoustic interference between the microphones. The face-to-face arrangement of the microphones has generally been preferred to the side-by-side arrangement because of the superior performance measured in such investigations. The results of such measurements are often affected by the kind of fixation used to support the microphones, which is generally different for each case, and by the fact that they are made in an anechoic room, which does not correspond to the normal industrial environment. A new method of measuring these effects is presented which enables the effects of the microphones to be separated from those of the support. Results are presented for the side-by-side and face-to-face configurations in more realistic measurement conditions.

Processing and Analysis Techniques for Sound Intensity Measurements as applied to 3-Dimensional Acoustic Studies

K Jones
GenRad Ltd, Maidenhead

New applications and processing techniques have been developed for the acoustic intensity analysis field within recent years. Both measurement devices and data analysis techniques have been enhanced to increase the user capability and flexibility for dealing with the noise analysis problems of identification, quantification, correlation and correction.

This method provides the user with total access to a three-dimensional acoustic data base for analysis of complex sound problems. Special analysis techniques are available for both on or off line processing of sound intensity data from 1, 2 or 3 dimensional acoustic acquisition, as well as from velocity or extended frequency bandwidth measuring probes.

By utilising a 3-dimensional representation of the acoustic field the true Intensity Vector may be observed, simplifying the measurement process and greatly enhancing the user's understanding of the field under study.

Hearing Damage and Annoyance from Clay Pigeon Shooting

J C Goodchild
Department of Physics, Liverpool Polytechnic

The results of an audiological survey of competitors and spectators at shooting competitions at agricultural shows show considerable evidence of hearing damage even amongst subjects under 25 years of age.

Differential damage between right and left ears is clearly evident and correlates well with right or left handedness of the shooters.

Experimental measurements of the attenuation of shotgun noise with distance over grassland under upwind and downwind conditions are presented and the results of altering the direction of shooting have also been measured. The potential to cause annoyance amongst residents living at different distances from clay pigeon shooting grounds is then assessed using Smoorenburg's procedures.

The effect of wind turbulence on outdoor sound propagation

G W Burrows and R Lawrence
Department of Physics, Liverpool Polytechnic

Instantaneous measurements of wind turbulence and acoustic attenuation over open grassland have been made using 28 ms bursts of octave band noise and pure tones over a frequency range of 250 Hz to 4 kHz. Results of measurements made over a range of 4 metres to 24 metres will be presented and discussed.

Speech Production, Voice Quality and Interpretation

Aerodynamic Aspects of Voice Production

B Cranen and L Boves
Institute of Phonetics, Nijmegen University

A number of adult male subjects have performed in an experiment in which simultaneous recordings were made of the pressure at two points in the trachea and at two points in the pharynx, of the electroglottogram, the photoglottogram and the acoustic speech signal during the production of VCV and CVCV nonsense utterances. The set of vowels comprised /a, e, i, o, u, y, ʌ/; the consonants were /p, b, t, d, k, g, s, z, f, v, h/. The pressure recordings are made with ultra-miniature transducers mounted equidistantly in a thin plastic catheter which is inserted into the trachea via the posterior commissure of the glottis. Thanks to an elaborate *in vivo* calibration procedure absolute pressure measurements can be obtained in the frequency band from DC to 5 kHz. Using the electroglottogram and the photoglottogram to describe glottal area time functions we can study the pressure-flow relations around the glottis. Our analysis has concentrated on vowel dependent source-tract interactions and on the flow phenomena related to the voiced/unvoiced distinction.

Speaker-specific Patterns for Articulatory Synthesis

C Scully
Department of Linguistics and Phonetics, University of Leeds

Where different speakers show small differences of acoustic structure for the same broadly defined auditory goals, it may be supposed that these arise, in part, from their different individual patterns of articulator kinematics. Aerodynamic data from real speech and inferred patterns of movement and co-ordination for a vocal tract articulator, the velum and the vocal folds will be presented. The aim is to characterise an individual speaker in terms of the parameter values needed for the control of an articulatory synthesiser and to consider how these are organised across natural phonetic classes. The level of complexity likely to be required for timing organisation in /VCV/ productions will be discussed.

Acoustic Analysis of Vocal Fold Pathology

J Laver, S Hiller and J Mackenzie
Department of Linguistics, University of Edinburgh

Abstract not available.

Relations between Perceptual Ratings of Voice Quality and Acoustic Measures

R van Bezooijen and L Boves
Institute of Phonetics, Nijmegen University

Auditory voice quality descriptions have been made of the spontaneous speech of 32 male speakers, 16 youngsters and 16 elderly persons, varying in socio-economic status. The descriptions were made by three trained subjects, who rated the speakers on 27 scales, 19 of which were taken from the vocal profile analysis protocol designed by Laver and his co-workers. The reliability of the scores on 24 scales proved to be satisfactory. The unreliable scales have been discarded. The acoustic analysis of the speech samples, each of which had a duration of at least 60 s, consisted of the computation of the long-term average spectrum, the (averaged) formant frequencies and a number of Fo statistics, including Fo mean, Fo range and pitch perturbation. Univariate and multivariate data processing techniques are being employed in order to establish the relations between the acoustic measures and the perceptual ratings.

The Assessment of Speech Intelligibility at the Royal Signals and Radar Establishment

R L Pratt
RSRE, Malvern

The Royal Signals and Radar Establishment has a particular interest in quantifying the performance of voice communications systems. This paper describes the special purpose acoustics facilities available at the RSRE, and reviews the assessment techniques employed.

The facilities comprise an anechoic chamber and a pair of High Noise rooms. Using the latter the acoustic environment of a variety of military platforms may be reproduced, with sound levels in excess of 120 dB attainable. This makes it possible to create speech material for use in our intelligibility tests under realistic conditions.

An automated system for the administration of the Diagnostic Rhyme Test has recently been completed, in which subjects listen to

isolated words recorded using a given communications channel, and then select the word they thought they heard from a pair of rhyming alternatives presented visually. A typical set of results will be presented, together with a discussion on their interpretation.

FO Perturbations as a Function of Voicing of Prevocalic and Postvocalic Stops and Fricatives, and of Syllable Stress

K Silverman

MRC Applied Psychology Unit, Cambridge

It is known that prevocalic stops perturb FO contours, but there are disagreements in the literature about the direction of the perturbations and whether they also occur before postvocalic stops. Furthermore, consonants other than stops have been largely ignored, as have possible interactions with rhythm and stress. Many studies do not adequately control or describe the intonation used by the speakers. In order to both clarify the areas of disagreement and address the gaps in the literature, a set of test words of the form *aCVCVC* were embedded in prenuclear position in carrier sentences. In each word, C was one of the 15 English stops and fricatives, and V was either /i:/ or /a:/. 3 speakers recorded 5 repetitions of each sentence, all with the same intonation. By measuring FO at 15 positions throughout each test word, it was shown that perturbations (i) occur before as well as after obstruents, and (ii) vary also with syllable stress and obstruent type (stops versus fricatives). Inferences will be drawn from the data about the role of FO in cueing consonant position, consonant voicing, and the degree of syllable stress. The results have implications for speech synthesis rules.

COURSES

Cranfield Institute of Technology are holding their three-day short course on *Basic Practical Signal Processing* from 7 to 9 November 1984. The aim of the course is to give a basic understanding of the techniques of signal processing, with practical experience in workshop sessions. Details from: Andy Tomlinson or Bob Wallace, Signal Processing and Applications Group, Cranfield Institute of Technology, Cranfield, Bedford MK43 0AL; Tel: 0234 752769.

Noise Measurement and Control is the theme of two linked one-day technical seminars to be held in Huddersfield on 7-8 November and in London on 14-15 November, 1984. The first day looks at problems and regulations in connection with Noise at Work, and on the following day the topic is How to reduce risk of hearing impairment. Details from: CEL Instruments Ltd, 35 Bury Mead Road, Hitchin, Herts SG5 1RT. □

Birthday Honours

Dr J J Knight

The Council and members of the Institute convey their warmest congratulations to Dr J J Knight on the award in the Queen's Birthday Honours List of the OBE for his contribution to medicine. His most notable work has been on hearing aids and for the National Health Service. After post-graduate acoustics research at Imperial College London, John joined the MRC unit under the late Dr Littler and afterwards was appointed physicist at the Royal National Throat, Nose and Ear Hospital, London. He has served in various capacities, including that of President, on the Council of the British Society of Audiology and has actively participated in the affairs of the old Acoustics Group of the Institute of Physics and in the Institute of Acoustics since its formation. He is a member of the Institute's Education Committee and one of the chief examiners for the Diploma Examination. □

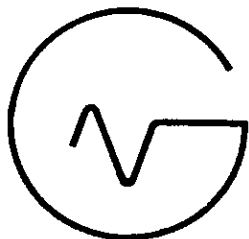
RWBS

Sound and Vibration Instrumentation for

HIRE*

Including

Bruel & Kjaer
CEL
GenRad
NEAS
RACAL
Uher ... etc



**GRACEY &
ASSOCIATES**

High Street
Chelveston
Northants
0933 624212

*Next Day Deliveries

ACOUSTIC CONSULTANTS

Due to continued expansion, vacancies exist for enthusiastic engineers or acousticians with a major independent acoustic consultancy Practice.

Applicants for the post of Assistant Consultant should have a good command of the basics of noise and vibration control techniques, and be willing to adapt quickly to a demanding and rewarding career with excellent promotion prospects.

Applicants for the post of Consultant should be experienced in building and building services acoustics and be capable of running a variety of projects with minimum supervision.

Salaries are negotiable and company cars will normally be made available for Consultants.

Application Forms may be obtained from:

**Hann Tucker Associates,
18, The Broadway,
Woking,
Surrey GU21 5AP.
Tel: Woking 70595**



Community Noise

Many national and international standards have now been enacted to limit community noise levels generated by factories, construction sites and transportation systems. Such standards although differing in detail have a common objective in requiring the derivation of a single number rating value for each location from the time varying noise pattern.

Establishment of such levels and investigation of possible infringements requires long term noise monitoring using portable versatile measurement equipment. It is for this type of measurement that the CEL-262 Environmental Noise Analyser is intended and it will find use with those organisations with responsibility for establishment and enforcement of these levels.

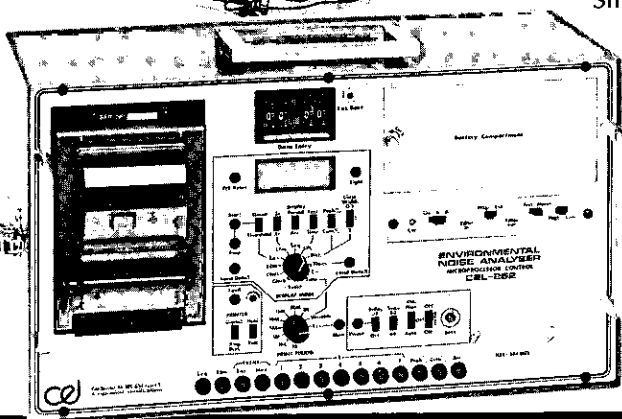
Since there are many different standards the CEL-262 has been developed to be extremely versatile and capable of meeting UK, European and American measurement requirements.

Battery powered and easily portable, the CEL-262 will operate for up to 7 days on internal batteries.

CEL-262 Environmental Noise Analyser

For comprehensive information
or free demonstration contact:

CEL Instruments Limited
35 Bury Mead Road, Hitchin, Herts. SG5 1RT
Tel: Hitchin (0462) 52731 Telex: 826615 CEL G



Underwater Navigation

This meeting was held at the Institution of Electrical Engineers, Savoy Place, London, on 24 May 1984; it was organised by the IEE and co-sponsored by the Institute of Acoustics Underwater Acoustics Group, the Hydrographic Society and the Society for Underwater Technology. Seven papers were presented on a wide range of applications of acoustics to underwater navigation and observation. The number attending was about 40, which was perhaps disappointingly small, but there were some lively discussions.

The first paper, by I C Teunon of Racal Positioning Systems Ltd on *Diver guidance using area navigation techniques*, was concerned with the directing of divers around structures such as oil rigs, using a fixed array of acoustic sources pulsed synchronously, each having a different carrier frequency. The position of the diver is found by measuring the relative times of arrival at him of the signals from several sources, the calculations being done at the operator's post on the surface. Unambiguous detection of the signals proved to be more difficult than expected, necessitating greater care in the design of the electronic circuits. Another problem was directing the diver to go in the required direction, and this was solved by providing the diver with a miniature rate-of-turn gyro.

The second paper was by J Lowe of UDI Group Ltd and described the use of mechanically scanned, short range sonars in civil engineering applications particularly for the offshore oil industry. The transducer head can be made small enough to be dropped down a borehole, and the sonar has been used in this way for mapping flooded sandstone mine workings. The slow repetition rate of the display of a conventional mechanically scanned sonar has been overcome by a scan conversion to TV standards combined with a digital frame store. A short video sequence demonstrated some of the results.

The next paper was by G M Duck (Loughborough Sound Images Ltd), and A D Goodson and J W R Griffiths (Loughborough University), entitled

Seavision - a new sector scanning sonar.

This paper described the updating of a modulation scanning sonar by improvements in the method of generating the carrier frequencies (by digital techniques), to the display (by using scan conversion techniques to produce a TV-compatible picture and with synthetic colour to indicate amplitude differences) and by the overlaying of alphanumeric data and graphics onto the display. This equipment is more portable than previous versions and can be more readily interfaced to different transducer arrays. Some video sequences were shown of the system in operation.

There was a complete change of subject for the next paper, *Acoustic tracking methods to study the offshore movements of Atlantic salmon*, by G G Urquhart of the Marine Laboratory, Aberdeen. A matter of considerable biological and economic interest is how migrating salmon find their way back to the river in which they were hatched, and relatively simple sonars have been used to track fish which have been fitted with transponding tags. The sonar is used to measure the range and bearing from a boat, the position of which is fixed geographically by radar and a microwave position-fixing system

(Trisponder). Some interesting observations have been made of the behaviour of the salmon in coastal waters, but it remains a mystery how they find their way from the distant feeding grounds (off Greenland for example) to the in-shore waters where they were caught to be fitted with the tags.

The next paper was by G R J Phillips of the Institute of Oceanographic Sciences on *Problems in deep-sea navigation and practical experience gained using long baseline systems to navigate benthic samplers*. The object is to sample particular parts of the deep water seabed over varying periods of time, and the problem is in positioning the ship and the sampler sufficiently accurately. Radio aids are either not accurate enough (eg Omega) or not available (eg Decca), and Transit satnav fixes are too infrequent. The solution was the laying on the seabed of long life, long baseline, two-transponder systems, which permit accurate relative navigation; the absolute position of the systems on the earth's surface need not be known to the same accuracy. The time delays between the signals from the two transponders are measured from the facsimile recorder normally used for the precision depth sounder, and hence pulse-to-pulse correlation is easily applied visually.

The navigation of surface ships in the course of their ordinary business was the subject of the sixth paper, *Acoustic correlation logs* by P Atkins and P D McQueen of the University of Birmingham. This type of log is being actively investigated as an alternative to the Doppler log; the principle lies in the calculation of the spatial correlation along a row of receiving transducers between two signals transmitted with a short time interval between them and reflected from the seabed immediately below the ship. The position of the peak of the correlation is a measure of the distance moved in the time interval between the pulses. Thus the correlation log measures distance rather than speed, the latter being measured by the Doppler log. Some successful trials have been carried out, which were intended to demonstrate the feasibility of the technique, but there are many problems in achieving high absolute accuracy in measuring the total distance travelled over a long period of time.

The final paper was concerned with integrated navigation and sensor systems for small, remotely controlled vehicles, by L Dominy, A B Webb and T E Curtis of ARE Portland. The vehicle is free-swimming, but power and control are over an umbilical cable. The

Diploma in Acoustics and Noise Control 1984

Titles of Project Reports

Colchester Institute of Higher Education

An investigation into the possible uses of a sound intensity analysing system for the assessment of diesel engine noise
Noise in a rural environment
Motor sports and noise
Assessment of non-employment noise
The design of a special reverberant chamber for use in the determination of sound power levels
A look at low frequency hum complaints: an investigator's perspective
The application of telephony loudness rating to hawfree telephony

Cornwall Technical College

Construction site noise and neighbourhood nuisance
The prediction of effects on the acoustic environment resulting from the construction and demolition works associated with flood alleviation scheme
Quarry blasting with reference to a local monitoring exercise
Concorde - a nuisance or not
Proposed housing near Aberdeen Airport
The microcomputer as a statistical analyser
Aberdeen Airport - Dyce
A study of aircraft noise around Wellington airport

Coventry Polytechnic

A noise nuisance assessment associated with the use of vehicle washing machines
Noise from overlocking machines
Sound insulation performance of a separating wall between two semi-detached dwellings
Noise from a British Railways rail pre-fabrication depot
Evaluation of the prediction method for calculating traffic noise by comparison with actual measurements
Investigation into the exposure to noise of persons using woodworking machines intermittently

Derby Lonsdale College of Higher Education

Small bore rifle shooting - a hazard to hearing
Fan noise
Noise induced threshold shift in a recording studio and room response

Heriot-Watt University

Noise investigation and reduction of mobile earth-moving scraper unit
Investigation of the statistical characteristics of discotheque noise
Reducing the ringing characteristics in tubular steel
An investigation into the problem of speech intelligibility within St Giles Cathedral

Leeds Polytechnic

Ear protection in the glass container manufacturing industry
Sound power labelling of domestic appliances (vacuum cleaners)
Noise transmission between working men's club and dwelling
Evaluation of noise levels on board a diesel cargo ship
Investigation of noise from a dust extraction plant

Liverpool Polytechnic

The acoustic environment of swimming pools
The accuracy of a facade correction in Para 31 *Calculation of Road Traffic Noise*
Performance testing of an office machinery acoustic load
Maximum permissible background levels for acceptable speech communication
Comparison of 3 hour and 18 hour L_{10} values for road traffic noise
Ground vibration from impact pile driving
Household appliance noise

navigation system is a conventional transponder system with frequency coding, with all the calculations being done on the support vessel. Short range observations are by a low light level TV system; longer range observations are at present done by a sidescan sonar deployed from the support vessel, but a sidescan to go on the vehicle is being developed. □

J R Dunn

In case you didn't hear . . .

Roy A Waller FIOA has left W S Atkins where he set up and for eighteen years managed the environmental consultancy unit; he is now practising on his own account offering environmental consultancy services for problems including those of the built environment and noise and vibration.

Windscreening of microphones
Background sound levels
Traffic noise level predictions
Noise arising from a fairground amusement park
Impact sound insulation of party floors
A study of motorway noise
The sound insulation provided by a folding partition
Control of noise from a beef carcass splitting saw
Interpolation techniques to estimate the air gap of a closed door

North East Surrey College of Technology

An investigation into machine noise levels in a print room
A case study of a Public Inquiry which considered amongst other matters the noise implications of a proposed large freight depot development
An investigation into the problem of noise from a boiler house to a flat situated directly above
Investigation of potential noise hazards in a vehicle repair workshop
An assessment of the noise environment of a small slaughterhouse etc
An investigation and assessment of the impact of noise from Goodwood Motor Circuit on the neighbouring environment
A study of road traffic noise levels at school premises situated along the Chertsey to Clearmount section of the M25 Motorway
Recommendations to minimise sleep and relaxation disturbance within proposed housing developments situated near railways
Acoustic performance of a timber noise barrier
Investigation of an 'ultrasonic' pest control device and the use of electrically generated sound in vertebrate pest control
Free field response of the anechoic chamber at Aquila
The Great Hall, Civic Centre Bromley. An appraisal of the hall's various acoustic properties, etc
Railway noise: a comparison of methods for determining Leq for planning purposes
Acoustic measurements of speech audiometry material
Nuisance assessment of certain local authority machinery
An evaluation of the effects of a proposed increase in bus traffic in the Broadway, Crawley
Room acoustics - a case study of noise in an office
A feasibility study for siting a matrix printer in the General Office of the Directorate of Environmental Services
An investigation of railway transport noise
Investigation into the acoustical properties of the Sir Alexander Hood Theatre
Room acoustics - the role of the microcomputer

Newcastle Polytechnic

Performance of absorbent material - reverberation method
Helicopter and aircraft noise at Carlisle Airport
Acoustic performance (structure, services) of prestige office block
Sampling times and prediction for road traffic noise
Typing pool noise complaint investigation
Hearing protection or loss?
Noise nuisance from large industrial complex
Design, manufacture and testing of electro-mechanical noise source

North Staffordshire Polytechnic

Noise emission associated with the balancing of grinding wheels
Evaluation of the efficiency of grit absorption in abrasive wheels using vibration techniques
Sound reduction at a pistol club
Noise reduction in the neighbourhood of a small engineering factory
The use of earth barriers to reduce the noise from an overnight lorry park
Noise survey and sound reduction methods in a large water pumping station

Tottenham College of Technology

Noise evaluation of clay pigeon shoots
Helicopter noise in an urban area: a case study
Sound insulation of a Victorian house
The noise environment of an office
Prediction of possible noise levels in conversion of a railway to a roadway
Gateway Community Centre

Members having a personal interest in finding out more about any of these projects should initially contact the course tutor for the Diploma in the appropriate College. Further contact is at the discretion of the student concerned. □

Terry Willson FIOA has returned from Hong Kong where he was well known as the Chairman of the IOA's first overseas Branch. He is now with the London office of SRL.

Dr Howard Latham MIOA is now leading a team of specialists in acoustics, artificial intelligence, man-machine interface and software engineering at YARD in Glasgow. The team aims to provide a speech process-

ing consultancy service to industrial and governmental concerns.

BRE Digests are now available in four bound volumes. The volumes deal with (1) Building Structure and Services, (2) Building Components and Materials, (3) Building Performance (including acoustic requirements) and (4) Design and Site Procedures, Defects and Repairs. Volumes are priced at £15.00 each and are available from HMSO outlets. □

Material for the January issue of Acoustics Bulletin should reach Mrs F A Hill at 25 Elm Drive St Albans, Herts AL4 0EJ, no later than Thursday 22 November.

Speech Technology Assessment Group

Developments in methods for speech communication with computers and other equipment have led to an increasing need for widely accepted and readily available procedures for measuring their performance. In order to establish such procedures for the assessment of 'Speech Technology', a group has been formed within the Speech Group of the Institute of Acoustics. The steering committee has been drawn from industry, university and government establishments concerned with research, development and applications. Their expertise includes acoustics, phonetics, signal processing, engineering and psychology.

The work of the group includes the following topics:

- 1) Factors which influence the effectiveness of speech technology
- 2) Procedures for measuring performance
- 3) The availability of suitable test material
- 4) Standardisation of terminology, interface protocols and instrumentation

The areas of speech technology of particular concern are automatic speech recognition and speech synthesis from text. The Speech Technology Assessment Group (STAG) will encourage and organise meetings and publications concerned with speech technology assessment, and work towards British Standards where appropriate. STAG working papers will be available from the Institute of Acoustics.

For further information contact the STAG chairman:

Dr R K Moore
Signal Processing Div.
R S R E
St Andrews Rd
Great Malvern
Worcs WR14 3PS
Tel: 06845-2733 ext 2951. □

IOA Honours and Awards

The Institute of Acoustics annually honours acousticians whose contributions to the world of acoustics have been particularly noteworthy. Since its creation in 1974 the Institute has been able to award three medals and in addition it may offer Honorary Fellowship to chosen recipients. A note appears in each January issue of *Acoustics Bulletin* inviting the membership of the Institute to put forward nominations for consideration as the recipients of appropriate medals and awards.

The medals are named after three of the 'grand old men' of acoustics: Lord Rayleigh, John Tyndall and Albert B Wood. John William Strutt, Third Baron Rayleigh (1842-1919) is remembered as a most versatile physicist, both as an experimentalist and as a physician. A graduate, fellow and finally Chancellor of Cambridge University, he was early elected to Fellowship of the Royal Society of which he was President from 1905 to 1908. He received the Nobel Prize for physics in 1904.

Rayleigh's work covered practically every branch of physics and he was the co-discoverer with William Ramsay of the rare gas argon. In acoustics, he published over 100 articles and his book *The Theory of Sound* remains a landmark in the development of the subject.

The Rayleigh Medal, of gold-plated silver and bearing the portrait of Lord Rayleigh, is awarded without regard to age to persons of undoubted acoustic renown for outstanding contributions to acoustics. The Medal was instituted by the British Acoustical Society and has been awarded by the IOA since 1975.

It may surprise some readers to discover that John Tyndall (1820-1893) was active in acoustics before Rayleigh, and indeed Rayleigh actually succeeded Tyndall as professor of natural philosophy at the Royal Institute - a post Tyndall had held for most of his career. Born in Co Carlow, Ireland, he

studied chemistry, physics and maths at Marburg University (under Bunsen) and was elected a Fellow of the Royal Society in 1852. Later he took up the subject of the acoustic properties of the atmosphere and his volume of lectures *On Sound* has been reprinted many times.

Tyndall was a distinguished experimental physicist but is remembered primarily as one of the world's most brilliant scientific lecturers. The Medal named after him, a silver-gilt medal, is awarded to a citizen of the UK, preferably under the age of 40, for achievement and services in the field of acoustics. The British Acoustical Society first awarded its silver medal in 1970 and since 1975/6 the Tyndall Medal has been awarded biennially.

Albert Beaumont Wood was born in Yorkshire in 1890 and graduated from Manchester University in 1912. In 1915 he became one of the first two research scientists to work for the Admiralty on anti-submarine problems and he later designed the first directional hydrophone for use in submarine detection. He was well known both for his many contributions to the science of underwater acoustics and for the help he gave to his younger colleagues. The AB Wood Medal and Prize, instituted after his death as a result of the generosity of his friends on both sides of the Atlantic, is aimed at younger researchers whose work is associated with the sea. The silver-gilt medal, parchment scroll and cash prize were first awarded by the Institute of Physics in 1970 and are awarded alternately to a UK and to a USA acoustician, recommendations for the USA recipients being made by the Acoustical Society of America.

The first new major honour to be created since the Institute's inception in 1974 was fittingly instigated ten years later when at the Spring Conference in Swansea, and in the presence of Dr RWB Stephens himself, Dr Edgar Shaw gave the first Stephens Lecture. Dr Stephens, a graduate of Imperial College London where he subsequently created his Acoustics Research Group, is known to us not only for his own acoustics work but also through that of the many students whom he helped and guided in their careers; he was also the first President of the Institute of Acoustics, which he was instrumental in creating. The Stephens Lecture, set up in honour of his eightieth birthday, will

normally be annual, and given at the Autumn or Spring Conference, and is intended to be an important occasion at an IOA Meeting, marked by the presentation of a scroll to the Lecturer.

The acousticians honoured by the IOA and its predecessors are given below. □

HONORARY FELLOWS

1974	W P Mason	USA
1975	Hope Bagenal	UK
1975	D G Tucker	UK
1977	R W B Stephens	UK
1977	L Cremer	W Germany
1977	R B Lindsay	USA
1978	James Lighthill	UK
1978	W A Allen	UK
1978	E J Richards	UK
1980	John Lamb	UK
1980	William Taylor	UK
1981	F Ingerslev	Denmark

National Sound Archive

In spite of the advent of the video and its widespread use, sound recordings are still considered to represent a valuable and efficient medium for communication. Many public and private organisations in Britain have collections of sound recordings containing valuable material but too few people know about the existence of such material or have access to it.

The British Library National Sound Archive (formerly the British Institute of Recorded Sound) is producing a National Directory of Recorded Sound Collections and is interested to hear about the existence of holdings of all sizes and durations, whether on tape or disc, in all subjects (including for example industro-mechanical sound). Clearly original material is of greater interest than that which is available commercially.

Any member who possesses any recorded sound material or knows where such material is located - even if it does not appear to constitute a 'collection' - is asked to contact: Jeremy Silver, Research Officer, The British Library National Sound Archive, 29 Exhibition Road, London SW7 2AS, Tel: 01-589 6603. □

BSI Committees

Any IOA member who has joined or withdrawn from a BSI Committee in the past year is requested to inform the Editor no later than 22 November in order to facilitate the up-dating of the list of members participating in BSI Committees. □

RAYLEIGH MEDAL

Awarded by BAS

1969	E Meyer	W Germany
1970	RWB Stephens	UK
1971	S S Stevens	USA
1972	R E D Bishop	UK
1973	P V Brüel	Denmark

Awarded by IOA

1975	P H Parkin	UK
1977	L M Brekhovskikh	USSR
1978	E G S Paige	UK
1979	E A G Shaw	Canada
1980	P E Doak	UK
1981	K U Ingard	USA/ Sweden
1982	G B Warburton	UK
1983	E J Skudrzyk	USA/ Austria
1984	J E Ffowcs Williams	UK

TYNDALL MEDAL

BAS Silver Medal

1970	D E Weston
1971	C L Morfey
1972	M J T Smith

IOA Tyndall Medal

1975	M E Delany
1978	H G Leventhall
1980	R K Mackenzie
1982	F J Fahy
1984	R G White

STEPHENS LECTURE

1984	Dr E A G Shaw
------	---------------

A B WOOD MEDAL AND PRIZE

Awarded by IOP

1970	B S McCartney	UK
1971	R E Apfel	USA
1972	B Ray	UK
1973	M C Hendershott	USA

Awarded by IOA

1976	P A Crowther	UK
1977	P R Stepanishen	USA
1978	A D Hawkins	UK
1979	P H Rogers	USA
1980	I Roebuck	UK
1981	R C Spindel	USA
1982	M J Buckingham	UK
1983	P N Mikhalevsky	USA
1984	M J Earwicker	UK

BRANCH AND GROUP NEWS

North West Branch

A technical visit was organised to Brüel & Kjær (UK) Ltd, Globe House, Gordon Street, Chadderton, Oldham, on Thursday 21 June at 7.30 pm.

John Houldsworth, a Committee member of the North West Branch gave a presentation entitled *Something new from Brüel & Kjær* at their northern premises, where eighteen members enjoyed being shown the full range of current equipment on sale, hearing an accurate, humorous and enlightening history of the Company's development, and receiving some Danish style hospitality within the Company's northern base, which many of us knew of but perhaps had not previously visited.

Sound and vibration measuring equipment, new studio microphones, dual FFT Analysers, Thermal Comfort measuring equipment, Luminance Contrast measuring equipment and the workshop repair and calibration facilities were all on view and provided the technical interest for the evening.

John genuinely did justice to the title of his presentation on this warm summer evening, and provided much more than a sales demonstration, which has to be part of his working life as a technical representative for the Company.

Yet again valuable professional contacts were forged between the acousticians

who attended, and in addition to recognising the contribution made by John Houldsworth, the North West Branch is indebted on this occasion to the Company's receptionist at Chadderton, Barbara, for her hard work which made this meeting such a success.

The next meeting of the Branch will be a Technical Visit to UKAEA Risley on 8 November at 2.00 pm. (Members should inform John Dinsdale on 061-480 4949 of their wish to attend this meeting as security clearance is necessary.) Suggestions as to the venue and nature of the December Social Meeting are invited. □

John Dinsdale

First BCS-approved Laboratory for Acoustical Calibrations

Last year the British Calibration Service added the field of acoustics to the range of measurements for which laboratories may obtain approval. Eleven criteria documents were drawn up by a Working Party of prominent experts, against which those seeking approval will be assessed. Approved laboratories are required to maintain traceability to the national standards established by the Acoustics Branch, Division of Radiation Science and Acoustics, NPL, whose staff are also closely involved in the BCS assessment procedures. The first laboratory to receive such approval was the Services Electrical Standards Centre at EQD 'Aquila', which is now BCS approved for the calibration of sound calibrators, pistonphones and one-inch condenser microphones.

There has been a steady increase in the demand for the calibration of acoustical instruments over recent months and this

trend is expected to continue. Apart from UK noise regulations there are a number of European Community directives regulating the noise of aircraft, land transport, construction sites, etc, all of which require the use of calibrated equipment. Moreover, acoustical laboratories accredited under the NATLAS scheme require traceable calibrations for their measuring instruments. Few of these in fact require direct comparison with primary standards at NPL and most will find it convenient to make use of the newly-approved BCS calibration facilities.

A number of other laboratories have expressed interest in seeking approval for calibrations involving acoustical instruments, including one for hydrophone calibrations at frequencies up to 15 MHz. □

M E Delany

Speech Technology Assessment

Speech Group Meeting in London

A meeting of the Speech Group of the IOA was held in the Phonetics Department, University College London on Wednesday 25 July. Despite the earlier cancellation of this meeting, due to a British Rail industrial dispute, it was well attended with almost fifty participants.

The subject of the meeting - speech technology assessment - was specifically chosen in order to follow up the one-day workshop on the same topic organised by the Speech Group in December 1983. The main outcome from the workshop was the election of a steering committee whose first job was to establish a Speech Technology Assessment Group (STAG) as a specialist sub-group of the Speech Group of the IOA. The success of both meetings is a measure of the perceived importance of the need to establish meaningful and rigorous testing procedures for both speech input and speech output devices. Participants represented a wide range of interests from industry, government and academia.

The programme for the meeting consisted of five papers with an introduction given by the chairman of the Speech Group and of STAG, R K Moore (Royal Signals and Radar Establishment). Dr Moore presented the background to the proceedings, highlighting some of the issues which currently concerned STAG. In particular, the need for a national assessment centre was identified, and a selection of suitable activities for such a centre was outlined.

The rest of the morning session was then devoted to a single paper, presented by J Peckham and J Knight (Logica Ltd), which outlined in detail a generic model of the man-machine interface and some specific proposals for using the model to guide the assessment of automatic speech recognition equipment. Specifically the speakers identified 'transaction time' as the crucial measurement of the effectiveness of the man-machine interface and then illustrated how it could be used to highlight the relative importance of factors such as dialogue design, feedback, the choice of input medium and the effects of the task and the environment. They then went on to identify error-correction as one of the most time-consuming aspects of a transaction, and variability in speech as the major cause of errors in a speech recog-

nition system. A mathematical model was then presented as a method for measuring the sensitivity of a recogniser to variability, and the necessary database defined by the model was outlined.

Considerable discussion followed this presentation since it had addressed many of the most important issues in the assessment of speech input and speech output devices. Some concern was expressed over the detailed analysis of speech signals that was needed to implement the model. However, most of the participants agreed that the paper had laid the foundations for future speech technology assessment work.

The afternoon session consisted of four shorter papers which addressed more specific needs. The first, by M P Haggard and J R Foster (Institute of Hearing Research), described the FAAF test and its relevance to the assessment of speech processing systems. It was shown how such a single-word identification test could be used to separate error types caused by low, middle or high frequency degradation as well as providing relevant diagnostic information. It was pointed out that the test enables processing differences to be expressed in the universal metric signal to noise ratio.

The second paper, presented by M J Russell (Royal Signals and Radar Establishment) outlined the speech data-base recently recorded in the Automatic Speech Recognition Laboratory at RSRE. Speech data had been collected over a period of six months from fifteen speakers using a prescribed vocabulary which consisted of the anglicised Diagnostic Rhyme Test, the digits, the orthographic alphabet and the sixty most common words in telephone conversations. In addition, the recordings had been made under a number of carefully controlled conditions such as speaking quieter, louder, in a whisper, slowly and quickly, and whilst performing a simultaneous tracking task. In total the data-base consisted of over 160,000 words. It was stated that the data-base was being made available to the speech community, and that it was suitable for assessment or for research purposes.

The third paper of the afternoon was by J S Bridle and A W Borrett (Joint Speech Research Unit) and it described a semi-automatic procedure for calibrating some properties of existing

speech data-bases. In particular, they outlined a scheme for measuring the distributions of amplitudes and durations of groups of spoken digits in the NATO RSG10 multi-lingual connected digit data-base. It was then shown how such measurements might be used to analyse the errors produced by automatic speech recognition equipment.

The final paper of the day, by A Bladon and C Carlill (Oxford University) reviewed some of the inherent limitations of existing speech data-bases, concentrating in particular on the need for a more balanced range of phonetic contrasts.

The day's events underlined the importance and timeliness of interest in the assessment of speech technology equipment, an area which is vital if the UK is to achieve a significant foothold in the world market for speech technology. □

R K Moore

London Evening Meetings

A full programme of London Evening Meetings has been planned and is already under way with a talk on brass musical instruments by Richard Smith of Boosey & Hawkes on 18 October. On 15 November a GLC speaker will discuss guidelines and criteria, and the talk on 13 December by Bill Stevens of AIRO will be about the Assisted Resonance system in the Royal Festival Hall, which has now been in constant use for 20 years.

John Miller of Bickerdike Allen Partners will speak on 17 January about sound insulation in dwellings and the meeting on 14 February will be about the mental health effects of noise; Dr Stephen Stansfield from the Institute of Psychiatry will be the speaker. On 21 March Paul Lattimore (GLC) will speak on lorry bans, and the subject of the final talk on 25 April, by Ivan King of the Polytechnic of the South Bank, will be audiometry.

All meetings commence at 6.00 pm for 6.15 pm and take place at The County Hall, London. Following a period for questions after each talk the meeting normally winds up in a local hostelry. All are welcome. For any further details contact: Paul Freeborn, Scientific Services Branch, The County Hall, London SE1 7PB, Tel: 01-633 2981; or Steve Turner at the same address, Tel: 01-633 2121. □

AIRO

Acoustics Laboratory Supervisor

Acoustical Investigation & Research Organisation Ltd is an independent consultancy which has, for more than 25 years, offered a wide range of services in all aspects of acoustics. AIRO's consultancy services are supported by extensive purpose built laboratory facilities which in their own right provide for testing and certification work and research and development projects in the fields of building acoustics and electro-acoustics.

Applications are invited from persons who could make a positive contribution to the development of AIRO's laboratory services in the position of Laboratory Supervisor. Salary would be negotiable based on age and experience but it is probable that MIOA qualification would be the minimum requirement.

Please write in confidence, with curriculum vitae, to:

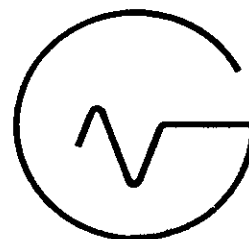
Dr A J Jones
Acoustical Investigation &
Research Organisation Ltd
Duxons Turn
Maylands Avenue
Hemel Hempstead
Herts
HP2 4SB
tel: (0442) 47146

Advanced Acoustical
Instrumentation by

NEAS*

Including

Programmable Filters
Real Time Analysers
Building Acoustics
Multiplexers
Sound Intensity
Custom Design . . . etc



GRACEY &
ASSOCIATES

High Street
Chelveston
Northants
0933 624212

*Norwegian Electronics a/s

10th International Symposium on Nonlinear Acoustics

This symposium under the chairmanship of Professor Akira Nakamura of the Institute of Scientific and Industrial Research, Osaka University, was held at the International Conference Centre at Kobe, near Osaka, Japan.

The Symposium attracted an attendance of 81 of the leading workers in the field and was representative of fifteen different countries. The technical meeting commenced on Wednesday July 28 and comprised 13 sessions in all, operating in two parallel sessions, except on the opening morning which included two invited papers on the current topic of solitons. The first, by W Lauterborn and colleagues, was entitled *Fission and fusion of solitons in inhomogeneous media* and the second, by T Tanuiti and K Nozaki, was on *Envelope solitons in nonlinear acoustics*. A contributed paper dealt with *Nonlinear and disperse distortions of the waveform and solitary*

waves, while two other contributions, all of which were of 25 minutes duration, were concerned with different aspects of the Burgers equation. The remaining sessions were divided as follows: Non-linear propagation in fluids (4) and solids (3), 2 on Parametric Arrays, 1 each on Cavitation, Noise problems and Bioacoustics, and one session on Miscellaneous topics.

The remaining invited lecture titles were *Recent development of the research for N waves* (Nakamura), *Nonlinear effects in ocean acoustics* (read by Ostrovsky), *Nonlinearity parameter B/A of biological media* (read by Floyd Dunn), *Nonlinear parameter tomography by using pumping waves* (N Ichida *et al*) while the UK representative C L Morfey (Southampton) gave as his talk *Aperiodic signal propagation at finite amplitudes, some practical applications*. Amongst the contributory papers

were two from the UK, that by David Creighton and J Nimmo (Leeds University) on *Propagation of nonlinear waves in horns* and the other entitled *Harmonic generation in aluminium and nickel single crystals* by S Siriwitayakorn *et al* (Chelsea College).

The general arrangements for the meeting were excellent and the conference centre had a pleasant situation with the various hotels situated at a convenient distance served by a fully automated light railway. This revealed a standard of cleanliness and respect of public property in contrast to the general conditions prevailing in the UK. Besides an official reception and a buffet party a ladies' programme was arranged for the period of the Symposium and some tours for the week after the meeting. The proceedings are to be published by the end of the year at a price of 8000 yen per volume, payment being by bank transfer: 10th ISNA, Akira Nakamura, Ordinary Account No 802434, Sumitomo Bank, Sannomiya Branch, Osaka, Japan. □

RWBS

New Products

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

Programmable Noise Level Analyser B & K Type 4427

The B & K Type 4427 is capable of handling the analysis and recording of traffic, aircraft, industrial, occupational or any other kind of noise likely to be encountered within human environments. It has a 110 dB dynamic range with choice of A-weighted or linear frequency response. When connected to any B & K microphone it acts

minimum durations for the recording of intrusive noise events and print-outs of maximum levels, SEL, Leq and times for each event are obtainable.

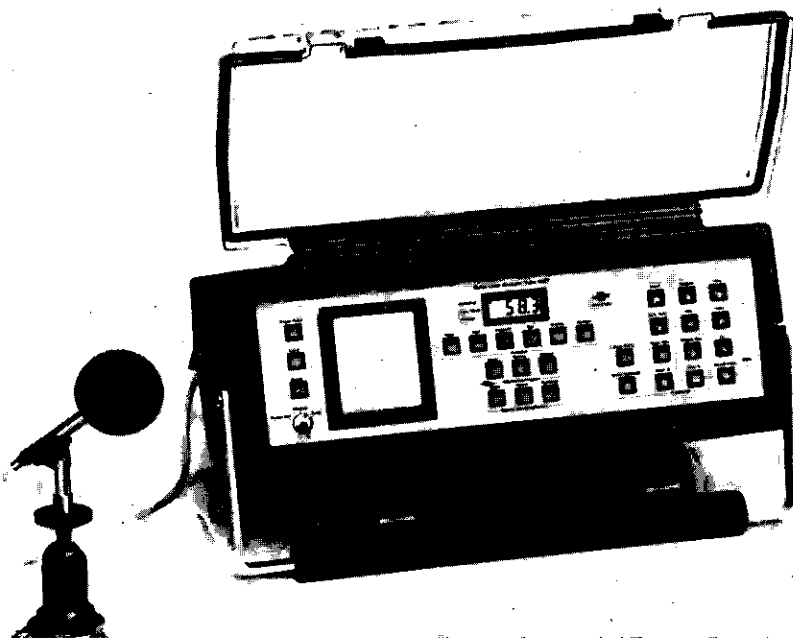
Automatic operation of the 4427 can be fully controlled by a set of measuring programs controlling input, timing and output. Such programs can be either pre-set or user defined as required, and there is an automatic print-out at the end of each period.

The 4427 has IEC interface with optional modem interface and fulfils all relevant parts of IEC 651 type 0 and the proposed standard for integrating Sound Level Meters type 0. Further

measurement range from -10 to 140 dB and to 180 dB using attenuators. Up to 1999 continuous integration time, displayed in 0.1 dB steps on an LCD. A choice of computer interface: HP-IL, RS232, or IEEE-488.

A new option, 800B-25 will provide built-in capabilities to measure: Dose, Projected Dose, RT60, Frequency, Period, Delay Time, THD, SISI, Linearity, Rise Time, Fall Time, Pulse Width, Pulse Period and Overshoot.

Further details from Industrial Monitoring Equipment Ltd, Penn House, Penn Place, Rickmansworth, Herts WD3 1SN. Tel: 0923 721155.



as a precision sound level meter and not only provides a digital display updated once per second with 0.1 dB resolution, but also provides a continuous Sound Level Plot on its built-in printer. It can also act as a precision integrating sound level meter, displaying and continuously plotting 1 second Leq plus either Leq or SEL over other selected measuring periods.

Statistical processing with the 4427 includes printed tables or graphic plots of amplitude and cumulative distributions with selectable start and stop levels; selectable class intervals in 0.2 dB steps up to 25.4 dB; percentile levels from L_0 to L_{100} in 0.1 per cent steps, plus various calculations including standard deviations. Provision is made for the selection of threshold levels and

information can be obtained from: Brüel & Kjær (UK) Ltd, Cross Lances Road, Houslow, TW3 2AE. Tel: 01-570 7774.

Acoustic Analyser model 800

The Model 800 from Larson-Davis Labs is a precision integrating sound level meter with a 60 dB display range. It can also perform octave and $\frac{1}{3}$ rd octave band spectrum analysis from 1 Hz to 20 kHz with an optional internal filter bank. With an optional computer interface card all functions can be user programmable and totally automatic using Hewlett Packard scientific calculators like the HP-85 or HP-41CV.

The recently introduced Model 800B has the additional features of: A

Real Time Analyser CRL 2.39

The CRL 2.39 Real-Time Analyser displays 10 octave bands from 31.5 Hz to 16 kHz with a 45 dB range. At the same time the 11th channel gives the A, C or Lin weighted level.

The real time display is fitted with both a 'digital hold' and 'max hold' facility plus 16 non volatile memories. Each memory stores the frequency spectra as well as the weighting, range and scale factor.

In addition to the spectrum display a liquid crystal display gives the sound level over the range 30 to 140 dB (A) to BS 5969 Class 1 accuracy. This display also incorporates a 'max hold' facility.

The CRL 2.39 accepts any of the Cirrus range of microphones plus a vibration input. Cost: £749.

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

Computerscope

The Computerscope is a digital storage oscilloscope, data acquisition and waveform analysis system. Costing from below £1000 the system upgrades a general purpose microcomputer for use in high speed data acquisition and analysis.

There are two models: the HR14, which has up to 4 channels with a maximum sampling rate of 500 kHz at 14 bit resolution, and the D2 which has 2 channels and a maximum sampling rate of 3.5 MHz at 8 bit resolution.

The Computerscope can also operate as a spectrum analyser or signal averager

and produce interval histograms and chart records. Being linked to a standard microcomputer, all information can be stored on disc or recorded as printout or graphs on inexpensive printers.

Further details from Advanced Instrumentation & Measuring Systems Ltd, Boundary House, 400 Woodstock Road, Oxford OX2 8JW. Tel: 0865 511484.

Noise Control with Fibreglass Acoustic Products

Fibreglass Ltd, which is part of the Pilkington Group, has produced a comprehensive illustrated booklet on noise control and applications for Fibreglass acoustic materials. The recommendations for applications are supported by relevant test data.

The booklet can be obtained from The Publicity Department, Fibreglass Insulation Division, St Helens, Merseyside, WA10 3TR.

Quadriseal Acoustic Door

Now available from Industrial Acoustic Company is the Quadriseal acoustic

door featuring a unique design that combines the high transmission loss of a double door system with the convenience of a single swing unit. The Quadriseal door integrates with IAC's lightweight, high performance, modular Gemini Noise-Lock double walled rooms and enclosures. Its design achieves a high transmission loss by a "piggy-back" approach that combines two doors in one - 65 mm thick leaves separated by 140 mm air space with the inner leaf mounted to the outer by means of special vibration isolator brackets. When installed the outer leaf is hung from two cam lift hinges which lower the all steel door as it closes to form a tight floor seal. Further details

from Industrial Acoustics Company, Walton House, Central Trading Estate, Staines, Middlesex. Tel: 0784 56251.

Multilevel Display GA704

The GA704 is a 10-level bright LED bar display designed for use with the GA901 'Electronic Orange'. The new display increases the range of information presented to the entertainer by successively illuminating 10 groups or

'bars' of 6 bright LEDs, as the noise level increases in 1.5 dB steps. The fifth and tenth 'bars' flash indicating respectively the warning for maximum acceptable sustained playing level and the warning that the power is about to be cut off owing to the performer ignoring earlier warnings.

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

Intrinsically Safe Noise Meter

The CEL 283/EX Integrating Sound Level Meter has received clearance for both underground and petrochemical use. The meter is a compact battery operated hand-held sound level meter to BS 5969 Type 2 and in addition is capable of simultaneous Leq measurements within its range of 30-120 dB (A), the Leq value being available from memory at the end of the survey.

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

Design Engineers

S.E. ENGLAND

Up to **£18,000**

If you are keen to gain the maximum benefit from working in an Applied Research Technology Environment, our client can offer you the finest resources coupled with the most up to date computer facilities and they will help and encourage you to develop your professional skills to their fullest.

We are confident there are few companies who can match their record of growth and innovation over the past few years. They can offer excellent opportunities for you to work in a wide range of advanced circuit/device development. Because of their expanding order book which now runs into the next century they will also give you early opportunities to use your abilities to control and manage teams and projects.

As a member of one of several small teams of professional engineers you will work in generously equipped modern laboratories devising some of the most sophisticated defence systems yet known.

We are able to offer progressive openings at all levels for ambitious engineers to establish themselves in advanced electronics design and development. Our client provides an excellent salary package, full company benefits, five weeks holiday, generous relocation expenses and they will be particularly interested if you can contribute experience to the following:

Power Engineering — development of ultra-sonic transmitters and high power switch mode supplies using the very latest FET systems and power hybrids.

VLSI Device Design — for digital signal processing applications using in-gate arrays, semi-custom and full-custom and employing some of the best CAD circuit, logic simulation and auto-placement technology available.

Analogue Circuit Development — very low noise broadband amplifier design at LF and VLF using thick film hybrids together with programmable attenuators and active filter techniques.

Digital Signal Processing — using FFT and Advanced Digital Technology in sophisticated micro processor controlled systems which also use the very latest DSP chips.

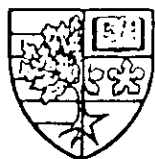
TO FIND OUT MORE and to obtain an early interview, please telephone JOHN PRODGER in complete confidence on HEMEL HEMPSTEAD (0442) 47311 during office hours or one of our duty consultants on HEMEL HEMPSTEAD (0442) 212650 evenings or weekends (not an answering machine). Alternatively write to him at the address below.



Executive Recruitment Services

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

25-33 Bridge Street, Hemel Hempstead, Herts., HP1 1EG.



Heriot-Watt University

RESEARCH ASSOCIATE DEPARTMENT OF BUILDING

Applications are invited to carry out work into sound transmission through buildings at low frequencies. Applicants should possess a good Honours B.Sc. or M.Sc. in an Engineering or Science subject.

The project extends over 18 months and the salary will be on the scale £6,310 — £7,630, (under review) depending upon age and experience.

Please apply in writing for an application form and further particulars to the Staff Officer, Heriot-Watt University, Chambers Street, Edinburgh EH1 1HX, quoting Reference No. 81/84.

BLOOMSBURY HEALTH AUTHORITY
The Royal National Throat, Nose & Ear Hospital
Gray's Inn Road, London, WC1X 8DA

SENIOR PHYSICIST/AUDIOLOGICAL SCIENTIST

Interesting post in a clinical environment for candidates with a good Honours Degree in Physics who have had several years post-graduate experience in acoustics or related subjects. It is based in the Audiological Physics Department, in which approximately 50 scientific and technical staff provide a large service commitment to audiological and ENT clinics throughout the hospital group. The main responsibility of the post is the calibration, maintenance and development of a wide range of instrumentation, and the supervision of the staff engaged on this and related work. Some teaching to professionals within the specialty of Audiology will also be required.

Salary scale: £9,010-£11,649 (Increase pending) plus £1,042 London Weighting per annum.

Job description and application form available from the Senior Administrative Assistant, (Audiology Division). Telephone 01 837 8855 Ext 4157. (Ref: AD20.)

The closing date for receipt of applications: 16th November 1984.

ANTIPHON LIMITED

Sales Engineer for Acoustic Products

Due to promotion within our organisation, we require a sales engineer to develop the sales of our high technology second generation acoustic products for the vehicle, diesel engine, industrial equipment and business machine industries. This is an interesting and demanding position for a creative and technically qualified sales engineer, with a minimum of three years' experience of working within the noise control field.

Alternatively, experienced application engineers in the noise field who have the desire and capability to develop their commercial skills could also fulfil our requirements.

The successful candidate will join a rapidly expanding international group, which provides a competitive package on salary and benefits.

Location within the Birmingham area will be an advantage, but considerable travel within the UK will be required.

Applicants should include a brief c.v. with a letter to: Sales Director, Antiphon Limited, 170 Park Road, Peterborough PE1 2UF.



Royal County of BERKSHIRE

Senior Technician

(Environmental Studies)
£5,640 - £8,712 (under review)

Qualified and experienced person to assist in the wide ranging environmental assessment of highway schemes. Practical experience in traffic noise measurement and implementation of the Noise Insulation Regulations is essential. Computing experience and knowledge of other aspects of environmental assessment an advantage. Applicants should be qualified by Degree, Higher TEC or Membership of the Institute of Acoustics.

Application forms from County Surveyor's Department, Shire Hall, Shinfield Park, Reading RG2 9XG - telephone Reading 875444 ext. 4621.

Closing date October 29th 1984.

AN EQUAL OPPORTUNITY EMPLOYER



Institute of Acoustics

Meetings

1984

November	YHB	Urban Transportation Noise	Leeds
2 — 4 November	M	Autumn Conference. Sessions on: Building Insulation and Privacy; Speech; Ship and Diesel Engine Noise	Windermere
7 November	M	Combustion Generated Noise and its Suppression	British Gas, Solihull
8 November	NWB	Technical Visit to UKAEA Risley	Risley
15 November	SB	Tour of ISVR, Pub meal, AGM and film evening	Southampton
15 November	LEM	Guidelines and Criteria	The County Hall, London
27 November	M	Microprocessors Applications in Acoustics	London
December	SB	STOL and Heliport Noise	Univ of Southampton
13 — 14 December	UAG	Underwater Acoustic Calibration and Measurements	Bracknell
13 December	LEM	Assisted Resonance in the Royal Festival Hall	The County Hall, London

1985

January	SB	Medical Ultrasonics	
17 January	LEM	Sound insulation in Dwellings	The County Hall, London
February	M	Local Government Noise Problems	Birmingham
4 February	SB	Use of Lasers in Sound and Vibration Measurement	
14 February	LEM	A talk about the mental health effects of noise	The County Hall, London
March	SB	Drilling Rig Acoustics	
25 — 29 March	M	Colour in Information Technology. Joint with the Institution of Electronic and Radio Engineers	Univ of Surrey
April	SB	Noise of Leisure Activities	
2 — 3 April	UAG	Scattering Phenomena in Underwater Acoustics	AUWE, Portland
15 — 17 April	M	Acoustics 85. Sessions on Aircraft Noise and Railway Noise; Structural Dynamics; Noise Induced Hearing Loss; Instrumentation; Open Session; Poster Session; Exhibition	Univ of York

Key:

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

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

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

A Measure of Silence?

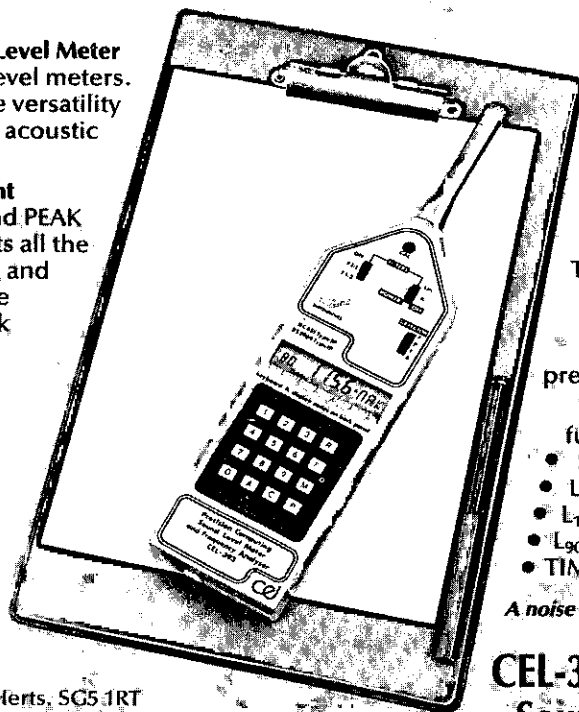
CEL-393 Computing Sound Level Meter
A NEW concept in sound level meters. This slim line meter has the versatility to deal with a vast range of acoustic problems.

Industrial noise measurement

With its TYPE 1 accuracy and PEAK response the CEL-393 meets all the relevant standards existing and proposed. Readouts for the assessment of deafness risk can be in SPL, L_{eq} or L_{max} and by using the on-board data store a profile of the days' L_{eq} exposure can be made.

Environmental noise measurement

Pocket sized and powered from a single PP3 battery the CEL-393 will allow users to carry out



surveys to assess pollution impact on FACTORIES, TRAFFIC, AIRCRAFT and RAILWAYS. The meter will provide readings of L_{eq} , L_{10} , L_{50} , L_{90} , L_{AX} and TIME and place the results in memory at user-defined intervals.

Research and development

The CEL-393 can have both OCTAVE AND THIRD OCTAVE FILTERS built inside the main unit. Engineers can take confident action to cure or prevent noise and vibration problems.

The CEL-393 provides the following functions:

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

A noise laboratory in your pocket

CEL Instruments Limited
35 Bury Mead Road, Hitchin, Herts, SG5 1RT
Tel: Hitchin (0462) 52731.
Telex: 826615 CEL G.

**CEL-393 Computing
Sound Level Meter**



ACOUSTICS 85

1985 Spring Conference at the University of York, 15-17 April 1985

The 1985 Spring Conference of The Institute of Acoustics is to be held in the city of York. The technical programme will take place on the campus of the University of York and the extensive programme of visits and events has been organised to allow delegates as well as those accompanying them to participate.

In the technical sessions particular emphasis will be placed on national and international aspects of noise legislation, hearing and noise damage to hearing; transportation noise; the acoustics of buildings and building services; the application of intensity measurements; spectral analysis and instrumentation. Offers of papers of 20 minutes duration for presentation at the Conference should be addressed initially to the Conference Secretary to whom titles and summaries of 100-200 words should be sent no later than 1 December 1984.

The Conference is being organised by the Yorks and Humberside Branch of the Institute of Acoustics under the Chairmanship of Mr John Bickerdike FIOA.

Further details may be obtained from the Conference Secretary:

Mrs C M Mackenzie
Institute of Acoustics
25 Chambers Street
Edinburgh EH1 1HU
Tel: 031 225 2143.