

Acoustics Bulletin

July 1981 Volume 6 Number 3

INSTITUTE OF ACOUSTICS

Noise Control in Perspective

A one-day seminar on Noise Control in Perspective is to be held at King Alfred's College, Winchester, on 15 September. Organised by The Institution of Environmental Health Officers, the seminar aims to give an appraisal of current workplace and neighbourhood noise legislation, its application and implications in practice; to advise on hearing conservation and noise control policy; and to give an insight into the current control technology available. The emphasis throughout will be on practicalities rather than theory and the organisers hope to provide an interface for better understanding between those holding the purse strings and those seeking an improved acoustic environment.

The seminar will be chaired by Rupert Taylor. For further details and application forms contact Bob Tennuci, 23 Chesilton Crescent, Church Crookham, Aldershot, Hants GU13 0PA. Tel: Fleet (02514) 22122 Ext 269. ☐

Non-Institute Meetings

1981

17-22 August	Ultrasound in Medicine	San Diego, USA
August	First International Conference on Human Comfort	Portugal
10-11 September	BSA Short Papers Meeting on Experimental Studies of Hearing and Deafness including Demonstrations and Poster Session	London
20-23 September	8th Vibration Conference (American Society of Mechanical Engineers)	Hartford, Connecticut, USA
30 September-2 October	International Congress on Recent Developments in Acoustic Intensity Measurement	Senlis, France
6-8 October	Inter-Noise 81	Amsterdam, The Netherlands
14-16 October	IEEE Ultrasonics Symposium	Chicago, USA
30 October-2 November	70th Audio Engineering Society Convention	New York, USA
13 November	BSA Meeting on Ototoxicity	London
30 November-4 December	Acoustical Society of America	Miami Beach, USA

IUTAM Symposia

The following Symposia have been notified by the International Union of Theoretical and Applied Mechanics. Since these Symposia are reserved for invited participants, anyone wishing to attend should make enquiries well in advance of the meeting. Further details of the Symposia are available from Professor D J Johns at Loughborough University of Technology, Loughborough, Leics LE11 3TU, or from the Editor.

1981

Stability in the Mechanics of Continua. Numbrecht, Federal Republic of Germany, 31 August — 4 September.

High Temperature Gas Dynamics. Prague, Czechoslovakia, 14 - 18 September.

1982

Three-dimensional Turbulent Boundary Layers. West Berlin, 29 March—1 April.

Fundamental Aspects of Material Sciences in Space. Ottawa, Canada, May.

Mechanics of Composite Materials. Blacksburg, Virginia, USA. 16 - 19 August.

Non-Linear Deformation Waves. Tallinn, USSR, August.

Collapse — the Buckling of Structures in Theory and Practice. London, 31 August — 3 September.

Metallurgical Applications of Magnetohydrodynamics. Cambridge, 6 - 10 September.

Intense Atmospheric Vortices. Reading.

Structure of Complex Turbulent Shear Flow. Marseille, France.

Third Congress of FASE

The 3rd Congress of the Federation of Acoustical Societies of Europe and the 9th Meeting of the Deutsche Arbeitsgemeinschaft für Akustik (DAGA) will be held jointly at the University of Göttingen, Federal Republic of Germany, from Monday 13 - 17 September 1982. The themes of the Congress will include Speech research; Room and building acoustics; Flow acoustics; Non-linear acoustics and Physical acoustics. The conference languages will be German, English and French.

The scientific programme will be organised by Prof M R Schroeder and Prof E-A Müller, Göttingen. Offers of contributed papers from all areas of acoustics (duration: 15 minutes) and requests for further information may be addressed to: Prof M R Schroeder, FASE/DAGA '82, Drittes Physikalisches Institut, Buergerstrasse 42-44, D-3400 Göttingen.

The Congress will be preceded on 13 September by a colloquium on a speech research topic. ☐



Editor:
F A Hill

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

Advertising enquiries to:
H A Collins Ltd
37 Ruskin Road
Carshalton
Surrey SM5 3BQ
Telephone: 01-647 1393

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

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

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

Sponsor Members

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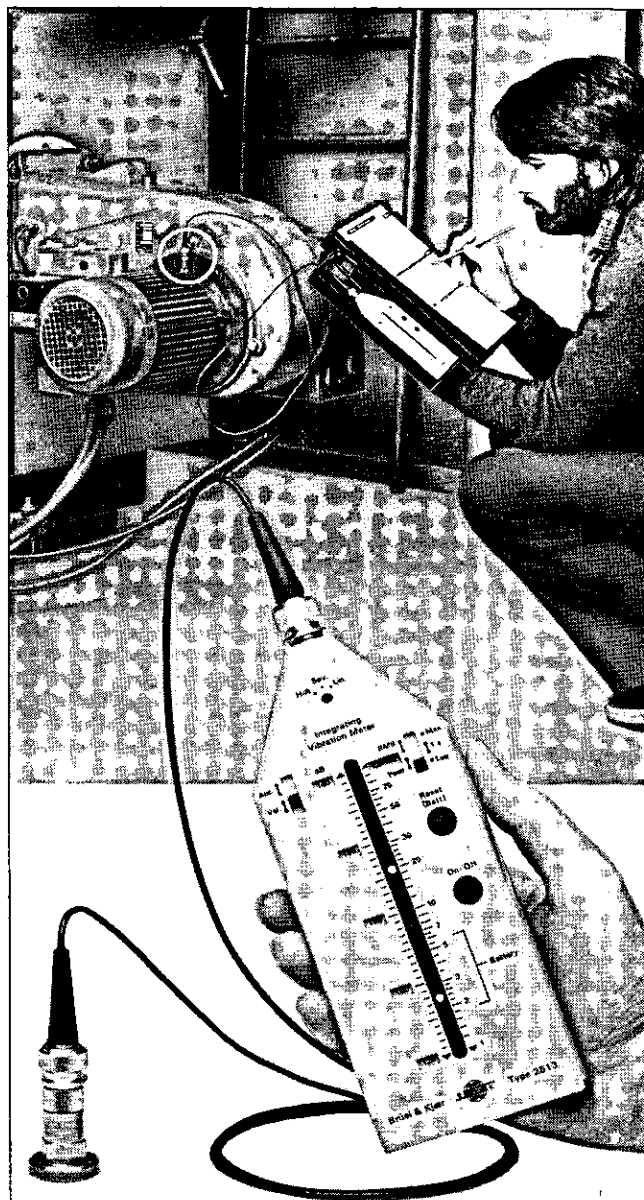
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Whittingham Acoustics Ltd
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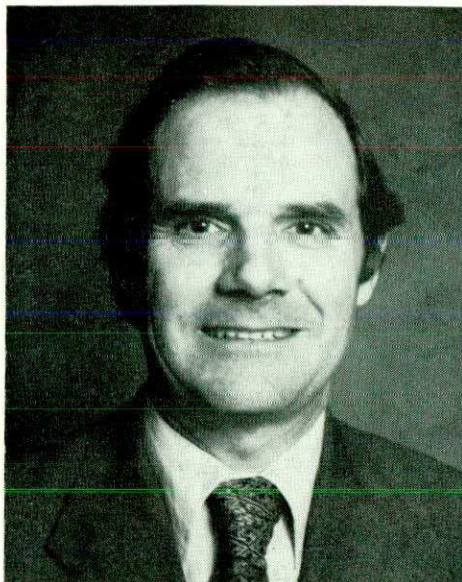
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President's Letter

Institute of Acoustics

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ISVR, Southampton University

Dear Member,

The Spring Conference in Newcastle was a great success; many thanks to Trevor Smith and all who helped to make it go so well. We were honoured to hear an excellent Rayleigh Medal Lecture given by Uno Ingard. The way that modern developments linked up with some of Rayleigh's ideas as revealed in his scribbles on the back of Agenda papers was a great tribute to his pioneering work and made a most enjoyable lecture. It was also a great pleasure to present an Honorary Fellowship to Fritz Ingerslev, who has done more than anyone else to encourage the development of acoustics in Europe and is a good friend of the Institute. We were also privileged to hear invited lectures from Jürgen Meyer and Elfyn Richards.

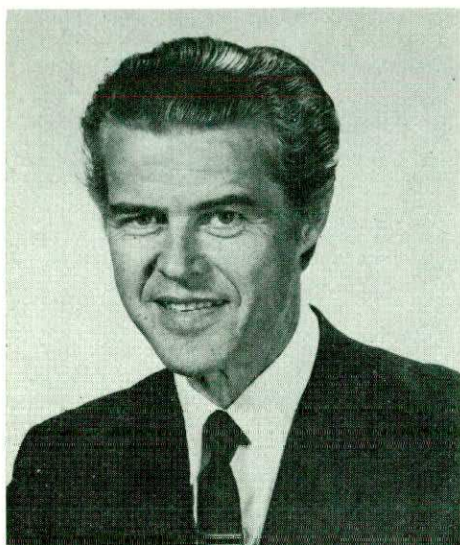
It was very unfortunate that the Institute meeting on Noise Source Location had to be cancelled because of lack of support. As Meetings represent the major activity of the Institute it is vital that we do our utmost to make them attractive even in the current financial climate. If you have any suggestions for 'winners' please pass them on to Geoff Leventhall, our new Meetings Secretary.

B. L. Clarkson

CITATIONS

RAYLEIGH MEDAL 1981

Professor K Uno Ingard



In 1948, having just completed his doctoral studies at Chalmers Institute of Technology in his native Sweden, Uno Ingard came to the Acoustics Laboratory of the Massachusetts Institute of Technology as a Visiting Research Fellow. In his doctoral work, he had already made an outstanding contribution to knowledge of the acoustic impedance of an orifice—the celebrated ‘iris in a waveguide’ problem—and in his early days at MIT he expanded these studies, developing improved methods of calculating sound absorption characteristics of materials with perforate facings and, with S Labate, carrying out the first of his pioneering investigations of the non-linear impedance of orifices, the second being some years later with H Ising. The land and weather conditions in New England apparently suited this particular transplanted Swede, because, after his Visiting Fellowship finished, he returned to MIT as quickly as possible, was appointed to the permanent academic staff, being promptly promoted to Professor of Physics, and has remained there ever since.

In keeping with his considerable youthful expertise on the athletics field as a high-jumper, he soon leapt to fame as an acoustician, becoming in fact an all-round virtuoso—something of an ‘acoustic decathlete’. His studies on resonators and associated topics were followed by important research contributions on reflection of sound from the ground, including effects of atmospheric turbulence, on duct

acoustics, with flow as well as without, on physical acoustics problems such as plasma acoustics, and on many other topics.

In mid-career, as it were, he desisted a bit from his acoustics research to contribute to a programme for developing improved introductory physics textbooks. This phase was followed by his collaboration with P M Morse to convert Morse’s *Vibration and Sound* (second edition) into that great modern classic *Theoretical Acoustics* by P M Morse and K Uno Ingard, which appeared in 1968. The range of this book reflects Professor Ingard’s wide interests and expertise, and his innate insistence on keeping the physics foremost even in the midst of the inevitable acreage of mathematical analysis required in theoretical acoustics. The book is an outstanding achievement, a great monograph of lasting value, which will long be appreciated by generations of students of acoustics. For this contribution alone, he is deserving of the Rayleigh Medal for 1981, and his wide and continued contributions to acoustics research and education make him doubly deserving.

Professor Ingard’s contributions in research and pedagogy, being of an intrinsically public nature, may perhaps tend to obscure the fact that his approach to acoustics has always been intensely practical. For example, in his student days at Chalmers he made an essential contribution to the electro-mechanical design of the first Brüel and Kjær graphic level recorder. He has engaged widely in practical consultancy on engineering acoustics problems. Perhaps under some persuasion from his brother-in-law (W W Lang, Jr) he provided considerable help in the early days of formation of the Institute of Noise Control Engineers. He has also, of course, rendered much service in the Acoustical Society of America.

Perhaps his outstanding characteristic is his predilection for simple answers to complicated problems. As a physicist-cum-engineer he realises that real problems are usually complicated and that theory is often a necessity in their solution, but he is never guilty of indulging in theory for its own sake. It is as an illuminating, and somewhat indiscreet, postscript to the generous acknowledgement to Professor Herman Feshbach in the Preface to *Theoretical Acoustics*, to record the fact that in his Visiting Fellow days at MIT, Uno dropped out of Herman Feshbach’s

two-semester course on *Methods of Mathematical Physics* after only a few weeks, muttering that Herman’s approach was ‘far too mathematical’!

This characteristic, too, shows in his talent for formulating research problems that are well-defined and fundamental physically, but nonetheless have many direct practical applications. Happily this is a characteristic that is naturally transferred, as intrinsic to his philosophy, to both his students at MIT and to the readers of his published work.

Thus it is wholly appropriate to honour Professor K Uno Ingard by the award of the 1981 Rayleigh Medal, for his outstanding all-round research contributions, for his outstanding all-round services to the subject and profession of acoustics, and especially for his co-authorship of a classic textbook and monograph which will continue to serve generations of students of acoustics.

AB WOOD MEDAL AND PRIZE FOR 1981

R C Spindel



Robert Spindel studied electrical engineering at The Cooper Union, receiving his BE in 1965. He took further degrees at Yale University, culminating in a PhD in 1971 for work on acoustic scattering. Then he moved to Woods Hole Oceanographic Institution, where he is now an Associate Scientist with Tenure.

The main drive of his work at WHOI still involves acoustic scattering, and in particular the transmission and fluctuation of low-frequency sound as measured at long ranges in the sea. These studies help in our ability to

Inter-Noise 82 - Call for Papers

Dr Sam Haddad FIOA has been invited by the Secretariat of Internoise 82 to organise a special session on Engine Noise Control. Internoise 82 is to be held at the Jack Tar Hotel, San Francisco, USA, on 17-19 May 1982, and contributed papers for the Engine Noise Control session are welcome. Abstracts should be approximately 400 words in length. Three copies of each abstract should be submitted as soon as possible to: Dr S D Haddad, Department of Transport Technology, Loughborough University of Technology, Loughborough, Leics LE11 3TU. Tel: 0509 63171 Ext 648.

The deadline for receipt of abstracts is 20 August 1981. ☐

Calls for Papers

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

Industrial Applications of Ultrasound

Birkbeck College, London, November 1981
Meeting Organiser: Mr A W Crawford FIOA
DDS Engineering Co Ltd, West Ham Lane East, West Ham,
Basingstoke, Hants RG22 6PP
(200 word abstracts as soon as possible)

Sound Propagation Outdoors

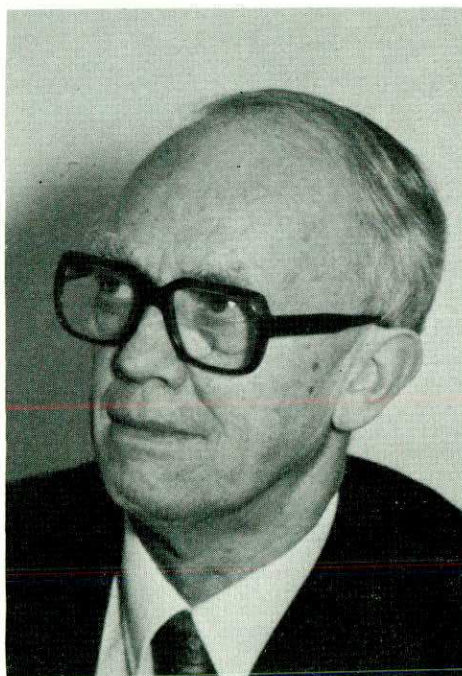
Open University, Milton Keynes, December 1981
Meeting Organiser: Dr K Attenborough FIOA, Faculty of
Technology, Open University, Milton Keynes MK7 6AA
(200 word abstracts by 31 July)

predict the vagaries of acoustic propagation. But the focus of the research has been the relationship to the ocean environment, and hence the use of acoustic remote-sensing techniques to look at the variations in that environment. This opens up the practical possibility of monitoring the behaviour of very large portions of the ocean, an idea of great current interest. A major result of the work has been a quantification of the role of internal waves in producing fluctuations with periods between the inertial and buoyancy periods.

Spindel has been concerned not only with major experiments and their interpretation, but also with the necessary engineering developments. These include a suite of instruments for measuring the fluctuations, moored acoustic sources, and an acoustic Doppler navigation system. Other research interests have been in volume reverberation, micro-earthquakes and long-range echo-ranging.

Spindel has taken an active part in the general functioning of WHOI, and in the affairs of the Acoustical Society of America and the IEEE. But primarily we note his extensive and distinguished research work, as expounded in many presentations and numerous papers. For these studies, centred around ocean sound propagation, the Institute of Acoustics is presenting Robert Spindel with its A B Wood Medal and Prize.

HONORARY FELLOWSHIP Fritz Ingerslev



Fritz Ingerslev has played a prominent role in the field of acoustics, not only in his native Denmark but also internationally. Appointed head of the Acoustical Laboratory under the Danish Academy of Technical Sciences in 1945, he became widely known following the publication in English of his book *Acoustics in Modern Building Practice* in 1952. The following year he received his Dr tech for a

thesis on distortion in electrodynamic loudspeakers, and in 1954 was appointed Professor and Head of the Laboratory of Telephony and Telegraphy at the Technical University of Denmark, serving as Dean of the Electrotechnical Faculty from 1960-63; he became Head of the Acoustics Laboratory in 1963. Prof Ingerslev served as President of the Scandinavian Acoustical Society for seven years and his outstanding contribution within his own country was recognised by the award of the Cross of the Order of Dannebrog, 1st Degree.

Internationally he is well known for his unstinting assistance to Acustica (since 1955), as a Member of the Acoustics Commission of IUPAP (on which he served as Secretary for nine years), and as Chairman since 1968 of ISO TC43 'Acoustics' and ISO TC43/SC1 'Noise'. He was President of the most successful 4th ICA held in Copenhagen in 1962, and of INTER-NOISE held in 1973, and since 1974 has been President of International INCE. He is a Fellow of the Acoustical Society of America and of the IEEE, and is a longstanding Member of the Physical Society (now amalgamated with the Institute of Physics).

Prof Ingerslev's contribution to the science and practice of many aspects of acoustics has been truly outstanding, and the Institute of Acoustics is honoured by his acceptance of Honorary Fellowship. ☐

SPRING CONFERENCE & EXHIBITION ACOUSTICS '81

From 21 to 24 April the Spring Meeting of the Institute, ACOUSTICS '81, was held in Newcastle-upon-Tyne at the Castle Leazes Halls of the University. The conference attracted an international gathering of speakers and delegates and in addition to the technical sessions featured a Trade Exhibition and Technical Visits.

The wide spread of interests within the acoustics profession was represented in five parallel technical sessions; subjects covered ranged from the structural dynamics of oil rigs to the vibration of

Dynamics. There were forty individual papers plus the Presidential Address and the Invited Lecture by Prof Richards which fell into this general subject category. The major problem was that we had to present these contributed papers in two parallel sessions. Although it was possible to arrange the papers in such a way that major clashes of interest were avoided it was impossible to eliminate all conflicts. It was not felt appropriate to encourage large-scale involvement of the finite element workers and flutter was not included. With these exceptions a

drilling equipment. Brian Erskine, a member of the North Eastern Branch of the Institute who is shortly to retire from ICI, presented a comprehensive paper on the acoustic design of large process plant, which reflected his wealth of experience gained over many years in the chemical industry.

We were particularly pleased to welcome speakers from Europe and the USA who provided useful contributions on various instrument developments with applications to quality control, community noise analysis and hearing damage. Robin Howie (Institute of Occupational Medicine) raised many important questions in an interesting and entertaining paper concerning the current position of hearing loss hazard assessment. This paper provoked much discussion and it was with reluctance and some difficulty that the Chairman kept to the pre-arranged time schedule.

Owing to the unfortunate late withdrawal of three papers from the session on Prediction Methods, contributions from researchers at Cambridge University dealing with the propagation and absorption of sound in factories were supplemented by a paper from Sweden on the use of viscoelastic materials for increasing the sound insulation of timber structures.

A lively final session on Noise Control, chaired by Derek Percy (IAC Ltd), brought the proceedings to a very satisfactory conclusion. The final contributions included recent practical advances in the use of pipework lagging, acoustic enclosures and the suppression of high pressure vents, together with an interesting presentation by Alan Cummings (Missouri University) on the attenuation of high amplitude acoustic waves in perforated structures. It was fitting, however, that the final paper should be presented in his own inimitable fashion by Trevor Smith (British Gas), Chairman of the North Eastern Branch of the Institute, who did so much work behind the scenes to ensure the success of Acoustics 81 at Newcastle.

Overall, the technical papers were well supported by valuable contributions and comments by delegates from the floor; in particular, I am sure that the presence of and contributions from



Invited Speakers and Medallists (left to right): Professor Elfyn Richards, Professor Jurgen Meyer, Professor Fritz Ingerslev and Dr Robin Mackenzie

trombones and from noise control at chemical plants to the analysis of speech sounds.

ACOUSTICS '81 served to highlight that the strong scientific and technological traditions of the North East are still very much alive. Indeed, it was these strengths that the North East Branch of the Institute displayed in providing the main organisation for ACOUSTICS '81.

TECHNICAL SESSIONS

In all, five parallel sessions ran each day of the conference: two on Structural Dynamics and one each on Industrial Noise, Speech and Hearing and Musical Acoustics.

Structural Dynamics

There was an excellent response to the request for contributions on Structural

very broad coverage of the fields of structural dynamics was achieved. The papers relating to ship hydrodynamics were complemented by the visit to the British Shipbuilding Research Association centre at Wallsend.

B L Clarkson

Industrial Noise

Approximately twenty technical papers were presented during the three days of the conference and the widely ranging subject matter was considered in four sessions: Plant Noise, Instrumentation and Hearing Damage, Prediction Methods and Noise Control.

Consideration of Plant Noise ranged from practical suggestions for improving the quality of acoustical data provided by plant manufacturers to the most recent results of research into noise from drop hammers and mining

Professor Richards (ISVR) were greatly appreciated by everyone. In addition, thanks are due to John Brant and the management of Burgess Industrial Silencing Ltd for allowing us to visit their premises.

B Oakes

Ron Beresford, from the Newcastle University School of Education, master-minded the session on **Speech and Hearing**. This area of acoustics is in the process of combining traditional phonetics with modern electronic analysis — an exciting development which will gain in importance as computers begin to use verbal communication methods. In addition to the varied selection of papers in the main session, delegates were able to enjoy two contributions to the Poster Session and a visit to the Audiological Unit in the ENT Department of the Royal Victoria Infirmary, hosted by the Senior Physicist there, Mr Clive Elliott.

Musical Acoustics

The Musical Acoustics Sessions were marked by the presence of two speakers invited from overseas: Dr J Meyer of the Physikalisch-Technische Bundesanstalt in Braunschweig had been invited to give a Plenary lecture on *Acoustics and the Performance of Music* and Mrs Judit Angster of the Acoustic Research Laboratory of the Hungarian Academy of Sciences, who is perhaps the only person working on measuring the absolute power output of musical instruments, had come from Budapest to talk on that subject.

There were plenty of papers from the UK to support these and they reflected the wide range of subjects covered by the term 'musical acoustics'. Full details are given in the complete list of papers elsewhere, but it should be noted that papers were presented ranging from the use of Finite Element techniques to study the vibrations of musical instruments and acoustic resonance spectroscopy to the problems of making subjects discriminate musical instruments reliably and exploring the ways melodies are perceived.

One of the special features of the sessions was that from the very first paper, discussion was lively and protracted. As organiser of the sessions I would like to acknowledge the very special contributions made to the discussions by Michael McIntyre. It was largely due to his activity that we all enjoyed so many revealing asides from

the formal papers. All the speakers entered into the spirit of the occasion with enthusiasm and the three days were most stimulating and useful. We all felt that our break with the conventional atmosphere of a meeting was beneficial even though the almost constant interchange between audience and speaker must have appeared disconcerting to a casual onlooker. Attendance at special meetings on musical acoustics is never likely to be very high, and the running average of around 25 we managed to maintain must be considered very satisfactory.

Dr Meyer's plenary paper was most enthusiastically delivered and revealed exemplary preparation of a complex subject. Those in the audience who were new to the ideas presented seemed to find them fascinating and stimulating and I feel sure that there will be renewed interest in these general aspects of musical acoustics.

On the last morning, the musical acoustics sessions turned to problems relating to buildings and music and, after Dr Fleming's paper, we all enjoyed a real *tour de force* from Dr Meyer who spoke (in English) 'off the cuff' about how he has been able to calculate the probable acoustical conditions prevailing in the concert halls used by Haydn. Since two of these halls no longer exist, we were treated to a musico-acoustic detective story which vividly brought to life the concepts relating to sound power of instruments, to energy densities in reverberant fields, to directivity patterns and to musical taste which had been touched upon in his plenary paper the day before.

To sum up, we had a most useful and stimulating three days and our visit to Harrison & Harrison, where we learnt much 'folk-acoustics', was the final gilding.

J M Bowsher

Abstracts of papers presented in the Technical Sessions appeared in the April Acoustics Bulletin.

Poster Session

An alternative way of presenting information was provided by the Poster Session organised by Ian Diggory, British Gas Engineering Research Station. This is the first time a poster session has been included in a Spring Conference and was, therefore, something of an experiment.

This type of session gives authors a chance to present visually material which does not lend itself to a more

formal presentation; contributors are able to discuss their work with interested colleagues in greater depth than is possible in a normal technical session.

Of the twelve posters presented, eight were concerned with environmental noise problems emphasising the need for further work in this area; two posters dealt with speech research, one with vibration measurement instrumentation and one with a portable graphic level recorder.

Attendance at the Poster Session was less than anticipated due to the popularity of the Technical Visits which coincided with the session. Despite this all concerned thought the session was of great value and should be retained at future Spring meetings. However the format should be somewhat different, with the poster material on display prior to the actual session to attract interest; authors would then be available at a specific time (or times) to discuss their material.



Professor Ingard receives the Rayleigh Medal from the President

EXHIBITION

A Trade Exhibition was held in conjunction with ACOUSTICS '81 which attracted fourteen companies who exhibited their products; these ranged from materials for controlling noise and vibration to sophisticated electronic measuring equipment. The exhibition was very well attended, particularly during the Exhibitors' Reception on the opening night.

TECHNICAL VISITS

On the afternoon of 23 April, technical visits were made to: British Ship Research Association, Wallsend; Burgess Industrial Silencing, South Shields; Harrison & Harrison (Organ

Builders) Ltd, Durham; and the Audiological Unit in the ENT Department, Royal Victoria Infirmary, Newcastle-upon-Tyne.

The visits were well supported with more than 100 delegates from the Conference taking part.

INTERNATIONAL FLAVOUR

ACOUSTICS '81 attracted many overseas visitors, reflecting the international character of acoustics.

Two of the four plenary lectures were given by internationally acknowledged figures in acoustics from abroad: Professor Uno Ingard, Massachusetts Institute of Technology, gave an excellent review paper on acoustical physics and its application to noise control, whilst Professor Jürgen Meyer, Braunschweig, West Germany, presented his paper dealing with acoustics and the performance of music. Other speakers and delegates came from East and West Europe, the United States and the Far East, giving the conference a truly international flavour.

MEDALS AND AWARDS

During the conference the 1981 Rayleigh Gold Medal, the highest award of the Institute, was presented to Professor Uno Ingard, in recognition of his contributions to acoustics. Another eminent acoustician to be honoured at the conference was Professor Fritz Ingerslev, Technical University of Denmark; he was made an Honorary Fellow of the Institute.

SOCIAL EVENTS

The social activities associated with the Conference were designed to allow delegates and guests to relax after the intensive programme each day.

The Exhibitors' Reception, held on the evening of 21 April in the Exhibition Area, provided a congenial atmosphere for delegates to renew old and make new acquaintances; the added attractions of a Real Ale Bar and live music ensured a very pleasant start to the Conference Social Programme.

The next evening the Lord Mayor and Lady Mayoress of Newcastle-upon-Tyne, Councillor and Mrs J Kerrigan, entertained delegates at a Civic Reception amid the refined elegance of the Mansion House, Jesmond. The Institute was able to respond to this hospitality the following evening when the Lord Mayor and Lady Mayoress were guests-of-honour at the Conference Dinner.



Professor Fritz Ingerslev with the Lord Mayor and Lady Mayoress of Newcastle-upon-Tyne, Councillor and Mrs J Kerrigan

During and after dinner, the delegates and guests were treated to a taste of traditional North East Folk Music; the Northumbrian small pipes were ably played by Richard Butler during dinner and later the Sandgate Morris Dancers provided an entertaining display of traditional dancing, with some of the more energetic delegates taking part before the night was over.

A programme of visits each day took the dozen or so guests who accompanied delegates, to Durham, Washington Wildfowl Trust, the Roman Wall and Wallington Hall; brief but very enjoyable visits which gave our guests a glimpse of the many attractive and interesting places in the area around Newcastle.

WEATHER

No report of ACOUSTICS '81 would be complete without a mention of the weather. From the very start of the Conference, it was determined to show visitors that Newcastle was indeed in it had succeeded only too well. Be the 'frozen North'; by noon on Friday, between 10.00 and 12.00 on Friday morning about six inches of snow fell causing chaos to air, rail and road traffic in the region.

Unfortunately, for those travelling southwards that was the way the snow went; tales filtering back since tell us of car journeys of seven hours to

Manchester (150 miles) and 11 hours to Southampton (300 miles); cancelled trains and planes and many uncomfortable and extended journeys were the general order of that day. It should be added that the Conference was held as late as possible in the Easter vacation to avoid bad weather; so much for planning!

POSTSCRIPT

ACOUSTICS '81 has been over now for a month and we've had time to sit down and reflect on that Conference. In summary, the 1981 Spring Conference was the largest meeting held by the Institute to date, with over 200 delegates registering; more than 75 papers were presented in the five parallel sessions and four plenary sessions.

ACOUSTICS '81 would not have been possible without the help of many named and unnamed helpers; our special thanks go to all of the team for their unstinting efforts.

Last of all, our thanks go to all who took part, especially the delegates, without whom ACOUSTICS '81 would not have been the great success it was; thank you for coming and participating; thank you for being tolerant when things went wrong; please do come again, we'd love to see you. □

T Smith

Appreciations

Retirement —

Professor T H Tarnozzy

Members of the Institute of Acoustics will wish to convey to Prof T H Tarnozzy their best wishes for a happy and healthy retirement upon his relinquishment of the Scientific Directorship of the Acoustical Research Laboratory at Budapest. Experimental Acoustics has prospered greatly under his leadership and it is pleasing to learn that his active services will not be completely lost for he retains the Presidency of the Acoustical Commission of the Hungarian Academy of Sciences.

Professor Ping-chuan Feng

It is unfortunate that the resurgence of Chinese acoustics has experienced a sad loss in the death in March of last year of one of its best known teachers and research workers, Professor Ping-chuan Feng, at the age of 70. After graduating at Zinghua University, he spent a period in the USA where he obtained a PhD degree. His acoustical interests ranged from theoretical to applied aspects and included electro-acoustics and underwater sound. He was a vice-president of the Chinese Acoustical Society and of the Chinese Electronics Society, and also editor of the journal *Acta Acustica*. Prof Feng was also editor of two books respectively on Fundamental Acoustics and on Fundamental Electroacoustics.

Professor N S N Nath

Having in mind the intense activity today in acousto-optic interaction investigations, the significance of the passing at the age of 67 in September 1979 of Professor N S N Nath did not receive at the time the world recognition that it deserved. Nath, a mathematics graduate, was the first research fellow of the famed Indian research worker, Professor C V Raman, and under him in his first year of study Nath developed a theoretical explanation of the Raman line in diamond. This work earned for him, at the early age of 23, the Fellowship of the Indian Academy of Science. It was in the following year, with Raman as his co-author, that Nath developed the well-known Raman-Nath theory of the diffraction of light by ultrasonic waves. He was later the recipient of an 1851 Exhibition Scholarship which he held at Cambridge University. On returning

Diploma in Acoustics and Noise Control

The Diploma was sat at nine Colleges throughout Britain this year by a total of 158 students. That the numbers have remained so high despite the difficult economic climate is encouraging. It is particularly pleasing to hear many students say that they really enjoyed the course despite the hard work. Dr Stephens, the Chief Examiner, presented the Diplomas to successful students of 1980 from North East Surrey College of Technology and was able to see for himself the enthusiasm of students for the course.

The change of date for the General Module to March requested by some Colleges has met with a few difficulties and it has therefore been decided to revert to June from 1982. Thus the relevant dates for 1982 will be Thursday 3 June for the General Module and Friday 4 June for the Specialist Modules. Projects should be completed by 25 June 1982.

In order that the opportunities in acoustics can be appreciated by those studying advanced level physics at school the Institute is intending to organise some lectures on acoustics at several Polytechnics. It is expected that three of these will take place just before Christmas at Leeds, Portsmouth and Ulster Polytechnic. It is a few years since the Institute organised something similar when they were highly successful with some 200 to 900 sixth formers attending excellent lecture demonstrations. □

B J Smith

to India he joined Andhra University and later Patna University where he continued to work on his theory of lattice vibrations.

Jan Frederik Schouten

The death has occurred at the age of 70 of a leading worker in the field of psycho-acoustics, Jan Frederik Schouten, who founded the Institute for Perception Research in Eindhoven, Netherlands, in 1957 and was its Director until his retirement in 1972. This Institute combined Schouten's dual interests, for his doctorate thesis had been concerned with the psychophysics of adaption of the human eye. This background was evident in his sound synthesiser in which he used a rotating slit to scan the mask of a time function, the modulated light flux being converted to an electric current which in turn excited a loudspeaker. In this way the time function was converted into a periodic sound and the system was applied by Schouten to investigate the 'case of the missing fundamental'. It was his work on pitch perception that stimulated a worldwide interest in the subject. Before founding the Institute of Perception Research, Schouten had held since 1950 the assistant directorship of Philip's Telecommunication Industry and in this field he was active in pioneering work in digital signal transmission. □

RWBS

NEW ELECTIONS

At its meeting on 30 April 1981, Council approved the following elections.

Fellow

N A Grundy	I Roebuck
D C Hothersall	S J Young
J C Jaffe	

Member

H Au	Y H Kim
P J Butcher	S-F P Lo
R M Chapman	C D Lyle
D F Corfield	R P Robinson
M R Denney	R N Vasudevan
J P Emerson	M L Vuillermoz
R J Green	

Associate

T M Black	P B S Livett
R R Barratt	F P McCorry
D A Butterfield	P G Marshall
B G R Coley	R Payton
R K Collyer	A J Quinn
D P J Coughtrie	M Roberts
M J French	D E Sherwin
A J Gilbert	C H Simpson
J E Gingell	M Sullivan
P Hepworth	C J Tubby
J R Lambert	

Student

S J Jardine

Pioneers of British Acoustics

Robert Hooke

Robert Hooke (1635 - 1703) was born in the Isle of Wight, the son of a clergyman, and received his early education at Westminster. On entering Oxford he supported himself by waiting at table, which he regarded as humiliating. His anti-social and quarrelsome personality may be attributed to the ill-health he experienced in his youth. At Oxford he was fortunate in attracting the interest of the British physicist, Robert Boyle, and it was largely the remarkable mechanical skill of Hooke that made a practical success of the air-pump which Boyle had devised.

Robert Hooke was elected a member of the Royal Society, recently formed in 1633 and in the previous year he had been appointed to the only salaried post in the Society, that of 'curator of experiments', and this post he held for the rest of his life. He was also the secretary from 1677 to 1683. He is best known for the law which bears his name and which was based

on experiments in which he showed that in an elastic medium the stress was proportional to the strain for small displacements, a fundamental assumption in the oscillatory motion of sound. His more direct contacts with sound are described in his *Posthumous Works* where he 'showed a way of making musical and other sounds by the striking of teeth of several brass wheels, proportionally cut as to their number, etc'. About 150 years elapsed before this device was used for scientific measurements, by Savart (1830) for the determination of pitch. The other acoustical device he proposed, or rather anticipated, was the stethoscope, also in the *Posthumous Works* and described as follows 'There may also be the possibility of discovering the internal motions and actions of bodies . . . whether animal, vegetable, or mineral, by the sound they make; that one may discover the works performed in the several offices and shops of a man's body, and thereby discover what instrument or engine is out of

order . . . in plants one might discover by the noise of the pumps for raising the juice, the valves for stopping it . . . methinks I can hardly forbear to blush when I consider how the most part of men will look upon this . . . I have been able to hear very plainly the beating of a man's heart . . .' It was again about 150 years before the stethoscope became a reality and was applied to pathological diagnosis by the French physician Laennec in 1819. It is also of further interest to note that some 300 years later we have begun to apply the sounds in bodies under stress, now called acoustic emission, as a diagnostic tool in industry.

Robert Hooke has been described as a philosopher, physicist, chemist and inventor but he was also an eminent microscopist and he coined the word cell to describe the cavities seen in thin slices of cork, and this term has now become intimately associated with biology. Hooke's scientific achievements would probably have received greater recognition if they had been less varied, for he was a great originator but did not prosecute his ideas in depth. □

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ACOUSTICS LETTERS

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THE INSTITUTE OF ACOUSTICS

SEVENTH ANNUAL REPORT

OF THE COUNCIL 1980

DURING the past year the improvements in administration and management arising from the relocation of the headquarters office in Edinburgh and from the appointment of Mrs C M Mackenzie as Secretary to the Institute, have become clearly evident. The efforts of the Honorary Treasurer, Dr H G Leventhall, to stabilise the financial situation of the Institute have met with considerable success.

The mantle of Presidency has passed from Professor P Lord to Professor B L Clarkson. Council wishes to place on record its grateful appreciation of the initiative and guidance exercised by the Immediate Past President in the difficult process of the re-organisation of the administrative services of the Institute. Dr D E Weston has taken on the office of President Elect.

Owing to the enthusiastic efforts of group, branch and individual organisers, under the energetic direction of the Chairman of the Meetings Committee, Dr R Lawrence, the number and variety of meetings continues to increase. This may be considered to be a sure sign of the vitality and worth of the Institute. The Institute of Acoustics has been invited to host the 1983 meeting of the International Institute of Noise Control Engineering.

The policy of publishing abstracts of papers presented at meetings in the Acoustics Bulletin has been implemented. The pre-prints produced for members attending the meetings are available for purchase. Professor B L Clarkson retired from the office of Chairman of the Publications Committee, to be succeeded by Dr D E Weston. Council wishes gratefully to acknowledge the very substantial contribution to the development of the Institute made by the current President over the past five years in this capacity.

The number of registrants for the Examination for the Diploma in Acoustics and Noise Control rose to 163 in 1980, of whom 102 completed the Diploma. Additional colleges were approved during the year bringing the total to 12. A new module in Vibration Control has been introduced. Council wishes to acknowledge the contribution of representatives of other organisations to the development of the Diploma course, and also to pay tribute to the Chief Examiner, Dr R W B Stephens for his tireless work on behalf of the Institute.

As a result of the reception by the secretariat of numerous requests for information and guidance, a Professional Register of consultants, manufacturers and agents in the field of acoustics has been produced and is available on request.

Mr R M Taylor, who had previously served as Honorary Treasurer since the inception of the Institute, retired during 1980; his services to the Institute, and to the British Acoustical Society, are acknowledged with gratitude.

At the close of the year the total number of corporate and non-corporate members stood at 709 and 284 respectively.

STANDING COMMITTEES

The operation of the Institute is carried out by Council through the following standing committees: Meetings, Membership, Publications, Diploma Advisory and Examination Boards, and Medals and Awards.

Meetings

In spite of the present national financial difficulties the Meetings Committee is pleased to report that an encouragingly high level of support has been maintained for meetings arranged during the past year.

Acoustics '80, the Institute's 1980 Spring Conference, was held at Bedford College, London, with Dr H G Leventhall as the organiser. Easter-time in Regents Park added particular pleasure to the value of an intensive meeting and approximately 150 delegates attended although exchange rate considerations are thought to have discouraged some would-be European delegates.

The 1980 Autumn Conference attracted 85 delegates to the Hydro Hotel in Windermere, a reduction of some forty per cent on the number that attended the previous year's event at the same venue, reflecting perhaps the relative popularity of the subjects being treated. In this case also, the backcloth of the Lake District in November provided a delightful setting for a busy technical programme.

A number of very successful one- and two-day meetings were held throughout the year and it is difficult to select any for special mention. However, one that merits particular comment is the two-day conference on Diesel Engine Noise Research organ-

ised by Dr S Haddad at Loughborough University. Many noted overseas workers in the field contributed to an excellent programme that attracted over seventy delegates, more than one-third of whom came from abroad. This experience underlines further the general value of meetings arranged around a tightly focussed theme.

The Committee has been strengthened during the year by the addition of Mr B C Grover who will continue the valuable links that already exist with the British Society of Audiology.

Of particular concern to the Meetings Committee during the later stages of the past year has been the question of advising Council on the most suitable dates and venue for Internoise '83 which the Institute has been invited to host by International INCE. The claims of various competing venues for this important international event have proved difficult to evaluate.

The Meetings Committee is as eager as ever to receive suggestions from the membership regarding subject areas that might form the basis of a successful meeting or conference, including where appropriate offers to organise such an event. In this context the Committee is pleased to record its gratitude to the large number of members who came forward in this way during the past year.

Membership

The Membership Committee met five times in 1980 and considered 199 applications for membership, of which 154 were successful. Three more sponsor members were enrolled to bring the total to 13.

Since last year a decision has been taken to offer reduced subscription rates to retired members under certain conditions. An effort has been made to popularise the category of sponsor membership and it is hoped that there will be a significant increase in this category. Firms whose products and markets depend upon the expertise and practice of acoustics can, by supporting the Institute, assist in its attempts to improve the professional status of its members and to organise meetings and courses which increase professional capability. The firms' employees thereby benefit directly and as general membership increases and public awareness increases, the firms' products should find a larger market.

Publications

Mrs Alison Hill has completed a very successful first year as Editor of Acoustics Bulletin, and has been confirmed in office. The policy of publishing abstracts of Meetings Papers in the Bulletin, in lieu of distributing Proceedings to the whole membership, has now been implemented. Comments and new ideas on the Bulletin contents are always welcome. A new advertising agent for the Acoustics Bulletin has been appointed.

Consideration is being given to the possibility of publishing a quarterly Journal of Acoustics, largely to provide a high quality medium for Medals lectures and versions of suitable Meetings papers. Contact has been made with several publishing houses with whom the Institute might collaborate on this project. There are many problem areas: the editorship, the organisation for ensuring and for refereeing a sufficiency of good papers, and the decision on reduced rate or free issue of the Journal to the IOA membership.

Diploma Advisory Board

There have been no changes in the membership of the Advisory Board during 1980. It is of great encouragement to the Institute that the representatives of other organisations are prepared to give of their time for the development of the Diploma. Additional colleges have been approved during the year, bringing the number to 12:

Bristol Polytechnic
Colchester College of Higher Education
Cornwall College of Technology
Derby Lonsdale College of Higher Education
Heriot-Watt University
Leeds Polytechnic
Liverpool Polytechnic
Newcastle Polytechnic
North East Surrey College of Technology
Robert Gordon College Aberdeen
Slough College of Higher Education
Tottenham College of Technology

The number of registrants for the Diploma Examination in June 1980 increased to 163, of whom 102 completed the Diploma. The pass rate in the General Module was 84 per cent, which is comparable with 93 per cent and 85 per cent for the years 1978 and 1979 respectively. Eight colleges participated, including for the first time Bristol Polytechnic, Derby Lonsdale College of Higher Education and Tottenham College of Technology. The newcomers are to be congratulated on the excellence of their examination record; only three candidates failed to pass the General Module examination in an aggregate entry of 39. It is pleasing to report an increasing number of candidates taking the opportunity to add to their experience by taking extra specialist modules. The examination still has a strong appeal to Environmental Health Officers, who formed over 80 per cent of the total registration. The standard of projects has been outstandingly high. The Institute's prize for the best student was awarded to Mr S F Lo, who studied for the Diploma at North East Surrey College of Technology. The Association of Noise Consultants awarded a prize for the best project to Mr R Bainbridge, who studied at Newcastle Polytechnic. The 1981 General Module examination will be taken at the end of March, which should assist students and also avoid the delay in processing final results. An additional module in Vibration Control will be taken for the first time in June 1981.

Continued on page 17

Proceedings of The Institute of Acoustics - Abstracts

Acoustic Emission and Photo-Acoustic Spectroscopy

21-23 July 1981 at Chelsea College, London

Photo-Acoustic Spectroscopy of Immobilised Thylakoids by Glutaraldehyde Action

B Thomasset, T Thomasset, D Guillochon, J N Barbotin and A M Vejux
University of Compiègne, France

The important problem of biological energy conversion has emphasised the use of immobilised photosynthetic systems such as chloroplast membranes (thylakoids). In these immobilising processes the key point is the functional stability of the thylakoids under continuous work.

In the present paper thylakoids are immobilised within serum albumin polymers by glutaraldehyde action at subzero temperature. Glutaraldehyde is widely used as a cross-linking agent but it is also well known that the activity of both PSI and PSII photosystems is inhibited by such a reagent. However it has been shown previously that PSII is still active and stable after immobilisation. The glutaraldehyde effect on oxygen production and photo-acoustic (PA) signals of thylakoids in suspension is presented. As a function of the incubation time, an increase of the PA signal at 680 nm and a corresponding decrease of the oxygen production appear. The protective effect played by serum albumin is also discussed.

Similar experiments with immobilised thylakoids by glutaraldehyde are also reported. By using 0.32 per cent of glutaraldehyde the PA spectrum of the immobilised thylakoids exhibits no significant difference compared to that of native material. The activity results indicate a deleterious effect; however the increase of the PA signal at 680 nm is quite limited.

These results suggest that the mode of action of glutaraldehyde is different in the immobilisation process. The use of PAS in the study of immobilised photosynthetic systems has proved valuable.

Quantitative Spectroscopy of Weakly Absorbing Condensed Media

C K N Patel
Bell Laboratories, New Jersey

Weakly absorbing features of condensed media often contain significant information important in the structure of materials as well as in the application of the materials to technology. In the last ten years revival of an old technique has led to major advances in the ability to measure quantitatively spectroscopic features of weakly absorbing gases, liquids and solids. This technique, called opto-acoustic spectroscopy by the scientists responsible for its early development and demonstration of its

capabilities, relies upon non-radiative decay of the absorbed energy to heat the illuminated volume and the subsequent detection of heat as an acoustic signal. The opto-acoustic technique when applied to gaseous media was shown to be capable of measuring absorption coefficients as small as 10^{-10} cm^{-1} as early as 1973. But similar ability to measure small absorptions in condensed media was not shown until 1978 in spite of a straightforward extension of the early gas phase studies to liquids and solids in 1973. Recently, a consideration of acoustic impedance mismatch between the medium in which the acoustic signal is generated and the transducer that detects the pressure signal, has led to the development of a pulsed laser immersed (for liquids) or attached (for solids, powders and thin films) piezoelectric transducer opto-acoustic scheme which has been shown to be capable of measuring absorption coefficients as small as 10^{-7} cm^{-1} in condensed media. In this paper I will review the technique and describe its application to measurement of weak absorption spectra in the visible and infrared region arising from linear as well as nonlinear interaction of radiation with materials. The linear studies include spectroscopic studies of organic and inorganic liquids, thin films, powders and solids. The nonlinear processes so far studied include two photon absorption and stimulated Raman scattering. Further, I will describe the opto-acoustic spectroscopy of solids and cryogenic liquids at temperatures as low as 20K. Finally, I will detail the extensions of these opto-acoustic studies where the initial excitation is provided by sources other than optical ones, eg X-ray and electron beams.

Opto-Acoustic and Photothermal Material Inspection

G Busse
Hochschule der Bundeswehr, Munich,
Federal Republic of Germany

Thermal waves can be locally generated by absorption of modulated light in a solid. Their propagation depends on thermal properties. When the light spot is scanned across the sample, one obtains a local response which is a temperature modulation characterised by magnitude and phase. Both can be used for mapping of thermal structures, however, phase angle imaging is advantageous because the influence of optical structures can be eliminated.

Opto-acoustic and photothermal imaging differ in the way the temperature modulation is detected. With opto-acoustic methods one observes either gas pressure oscillations when the sample is kept in an enclosure, or modulated thermal expansion

of the sample itself. This removes the need for an opto-acoustic cell, but both methods require some physical contact with the sample. Photothermal detection is based on modulated thermal emission correlated with temperature modulation. Therefore it has the advantage of remote detection.

As the thermal wavelength (which determines depth range in these applications) can be varied via modulation frequency, the methods can also be used for depth profiling which is important for subsurface inspection of opaque materials like metals and semiconductors.

Photo-Acoustic Measurement of Optical and Thermal Properties

P Poulet and J Chambron
Faculty of Medicine, Strasbourg, France

R Unterreiner
Institut National des Sciences Appliquées,
Villeurbanne, France

Photo-acoustic spectroscopy allows the measurement of two thermal properties: diffusivity and effusivity—and of the optical absorption coefficient of condensed media. A theoretical model of the photo-acoustic effect demonstrates that the study of the amplitude of the photo-acoustic signal as a function of the modulation frequency or simultaneous measurement of phase and amplitude at a given frequency is sufficient to obtain these properties.

Experimental results illustrate the use of photo-acoustic spectroscopy in the measuring of optical absorption spectra and of thermal properties of liquids and biological samples using either conventional or open-ended cells.

Photo-Acoustic Microscopy for NDE of Metals and Ceramics

R L Thomas, L J Inglehart, L D Facro and P K Kuo
Wayne State University, Detroit, USA

The technique of scanning laser acoustic microscopy (SPAM) is shown to be a useful tool for nondestructive evaluation (NDE) of surface and near-subsurface flaws in opaque solids. In the case of surface flaws, detection is primarily the result of spatial variations in optical reflectivity and resolutions of better than $6 \mu\text{m}$ will be demonstrated. For subsurface flaws, detection is by means of thermal wave imaging, with probe depth and lateral resolution governed by the thermal diffusion length in the solid. Since the thermal diffusion length scales inversely with the square root of the chopping frequency of the laser irradiation, systematic searches for defects as a function of depth are possible. The phase of the photo-acoustic signal is also quite use-

Acoustic Emission and Photo-Acoustic Spectroscopy

ful in discriminating between surface and subsurface effects. Quantitative comparisons between theory and experiment will be presented for a plane, backsurface defect in an aluminium slab, and examples will be given of SPAM micrographs for natural and fabricated defects in metal alloys as well as SiC and Si₃N₄ ceramic test bars and complex shaped turbine engine components.

Fourier Transform Infra-red Photo-Acoustic Spectroscopy of Condensed Phases

B S H Royce
Princeton University, New Jersey, USA

The application of Fourier transform techniques to photo-acoustic spectroscopy has enabled this method to be extended into the important infra-red spectral region between 4000 and 400 cm⁻¹. This paper will discuss the technique of FTIR-PAS as applied to the study of a wide range of solids and indicate some of the advantages and problems associated with the method. Particular attention will be paid to the procedures required to make the method quantitative. Experimental data will be presented which will demonstrate the advantages of FTIR-PAS in the study of two phase systems, samples which are strongly light scattering or opaque and systems undergoing a chemical reaction.

Photo-Acoustic Spectroscopy of Synthetic Polymers

J Chalmers and H A Willis
ICI Ltd, Plastics Division,
Welwyn Garden City, Herts

The high sensitivity which can be achieved with the Fourier Transform infra-red spectrometer (FTIR) permits the photo-acoustic technique to be applied for measuring spectra in the IR 'fingerprint' region. The spectra obtained are superficially similar to conventional absorption spectra, hence it is now possible to use the photo-acoustic technique for the qualitative identification of polymers, following the usual 'characteristic band' approach to the analysis of the spectrum.

A major advantage of PAFTIR in polymer studies is that materials may be examined in many different forms, eg fine powders, granules, mouldings, thin films or coatings. Thus it is much more versatile than conventional transmission spectroscopy which can be performed only on solutions or thin films.

Examples are given of spectra recorded on samples in different physical forms and some observations are offered on the practical effects of changing particle size and film thickness, and the choice of experimental conditions to obtain good quality spectra in reasonable recording times.

Investigation of Ultraviolet Light-induced Ageing of ZnS Phosphor Using 2-Beam Photo-Acoustic Spectroscopy

L Eaves and P E Simmonds
University of Nottingham and University of Wollongong, New South Wales, Australia

A two-beam photo-acoustic technique is

employed to monitor ultraviolet light-induced darkening of ZnS (Mn, Cu) powder used for large area electroluminescent panels. The darkening process is a possible ageing mechanism in these devices and occurs for above band gap ultraviolet irradiation at wavelengths less than 345 nm. Photo-acoustic measurements are made of the light-induced change in the absorption spectrum and the influence of doping and contamination by atmospheric water on darkening rates.

Recent Trends in Gas-Phase Spectrophone Measurements

T Hunter
University of East Anglia, Norwich

A brief historical summary (up to c 1970) will show the early experimental limitations and, more importantly, the lack of suitable opto-acoustic models for dealing with multi-state relaxation phenomena. The recording of gas-phase spectra will be discussed with particular emphasis on the examination of very weak transitions; in this section various extra- and intracavity laser configurations will be examined with analysis of some of the difficulties encountered in using acoustic resonances as amplifiers.

The areas of energy transfer and gas kinetics, in general, offer scope for extensive growth in time-dependent (frequency domain) spectrophone studies. Some examples in these areas will be examined: (a) developing from vibrational-translational energy transfer measurements, vibrational-vibrational processes in multi-state systems, (b) relaxation of excited state atoms and the concomitant yields of such atoms from molecular states, (c) intersystem crossing in systems, (d) atom and radical reactions, and (e) intramolecular vibrational relaxation.

Optical Probing of Thermal Waves — Application to Spectroscopy and Imaging

J Badoz, D Fournier and A C Boccara
Ecole Supérieure de Physique et de Chimie, Paris

It is well known that, following a periodical irradiation of a solid sample, thermal waves are propagating within the sample and in the surrounding fluid (gas, normal or superfluid liquids). The magnitude and the phase of these waves either exhibit a dependence with the wavelength of the irradiation and give information on the spectral properties of the sample or show a geometrical dependence closely related to the shape and/or to the spatial distribution of the thermal properties of the sample.

These thermal waves can be easily probed by using the photo-thermally induced deflexion of an He-Ne laser beam ('mirage effect'). The sensitivities are rather good, indeed amplitude of periodical temperature fluctuations of about 10⁻⁷ degrees has already been detected.

In the field of spectroscopy, examples will be given concerning the spectra of either opaque or weakly absorbing materials (powders, thin films and bulk materials). Recently the coupling of a Fourier Transform interferometer and the photothermal deflexion has led to a noticeable improve-

ment of the sensitivity (2 to 3 orders of magnitude over photo-acoustic detection).

Finally, for imaging applications, hidden structures can be observed and surface profiling in the 0.1 range can be achieved.

Some Aspects of the Practical Application of Photo-Acoustic Spectroscopy

D H McQueen
Chalmers University of Technology,
Göteborg, Sweden

P Helander and I Lundström
Linköping University of Technology,
Linköping, Sweden

Initial work on photo-acoustic spectroscopy has concerned the measurement technique itself. The transition to the practical application of photo-acoustic spectroscopy in solving real problems has been slow. This development is illustrated using an analysis of the published literature from 1973 up to and including 1979.

We have applied photo-acoustic spectroscopy to several industrial problems. One project was to measure the binder content of mineral wool for thermal insulation. The measurement results are shown for two mineral wool types. Although our experiments were successful technically, their practical usefulness was limited by the sample size. It proved difficult to illuminate large enough sample volumes to compensate for variations in the binder content in the sample cross sections, for instance.

In another application we measured the protein content of flours. These experiments were also successful, but the applicability of photo-acoustic spectroscopy here is limited by the finite thermal diffusion length in the sample. Unless the flour grains are small compared to the thermal diffusion length, only the surfaces of the grains are investigated, and this can give results which are not entirely appropriate. Further, we found that it was important to keep the water content of the flour constant. Also, the problem of illuminating large enough samples is difficult to overcome using conventional photo-acoustic cells.

The limitations imposed by the finite thermal diffusion length are transformed to advantages when studying thin or layered samples. There are obvious applications of photo-acoustic spectroscopy in such areas as optics (coatings for optical components, etc) and the semiconductor industry.

Measurements on opaque or light scattering liquids are difficult with conventional spectroscopic instruments. Photo-acoustic spectroscopy is well suited to such measurements, especially since the role of light scattering has now been clarified (P Helander, I Lundström and D McQueen, *J Appl Phys* 51, 3841 (1980)). However, continuous on-line or flow-through measurements have not been possible until recently, because of the requirement of a closed sample volume in conventional photo-acoustic sample cells (for an exception see for instance C K N Patel *et al*, *Optics Letters* 5, 27 (1980)).

We discuss the design and application of a photo-acoustic sample cell for flow-through measurements briefly. The flow-through cell should be of interest in medical and pro-

cess applications because of its simple and robust design. Further, since it is a flow-through cell, larger volumes of sample liquids can be interrogated spectroscopically than is the case with conventional sample cells. This may open up new applications for photo-acoustic spectroscopy to practical use as a process control method.

Some Observations Regarding Quantitative Analysis Utilising Photo-Acoustic Spectroscopy

G F Kirkbright and D E M Spillane
UMIST, Manchester

This paper presents some practical results concerning quantitation in photo-acoustic Spectroscopy. Examples are given of analysis in the UV/Visible and Infra-red regions of the spectrum and the effect of sample composition on the calibration curve is discussed.

Photo-Acoustic Observation of Heterogeneous Photo-Catalytic Reactions

Tsuguo Sawada, Tamotsu Iwasaki, Shohei Oda and Kenichi Honda
Faculty of Engineering, University of Tokyo

This paper discusses new applications of photo-acoustic spectroscopy to investigations of the photo-chemical reaction of sensitising dyes absorbed on semiconductor powder.

Application of PAS to Turbid Media

Tsuguo Sawada, Shohei Oda and Yoichi Gohshi
Faculty of Engineering, University of Tokyo

Quantitative measurements of turbid particles in a liquid have been carried out. In contrast to the usual turbidimetric measurement the photo-acoustic signal intensity in PAS was not affected by differences of size distribution.

The Design of a Photo-Acoustic Cell and its Practical Performance

M Ahmed, W G B Britton, R W B Stephens
Chelsea College, London

An acoustic impedance analysis of a resonant photo-acoustic cell is presented. Such a cell has been designed to study the dependence of PA signal amplitude on the modulation frequency (20 Hz — 1 kHz) for various geometries. It is concluded that the study of the acoustic impedance as a function of frequency for various geometrical parameters can lead to the improved design of such systems.

The Analysis of Acoustic Emission from Refractive Materials

D Bell
The British Ceramic Research Association, Penkhull, Stoke-on-Trent

Bulk production refractory materials are impure ceramics containing a high proportion of pores and discontinuities which can give rise to very high acoustic emission rates under stress. Source location is very difficult with these materials.

Current work involves the mechanisms of deformation and failure at high temperatures where visco-elastic effects begin to take over. The high temperatures cause problems in the use of waveguides and in signal interpretation.

Examples concerning refractory failure under thermal and mechanical stress will be discussed.

Acoustic Emission in Concrete

M C Reymond
Département des bétons et des métaux du LCPC, Paris

The formation and propagation of micro-cracks and their influence upon the properties of concrete have been studied in a sample with a notch under tensile stress. A new cracking test consists in maintaining a prismatic concrete sample at constant length as soon as it has been fabricated. In effect if the sample shrinks then it is extended or on the other hand if it swells then it is compressed. This phenomenon is studied by acoustic emission.

Acoustic Emission Standardisation — A Comparison Method for Calibrating Acoustic Emission Transducers

R Geng, W G B Britton and R W B Stephens
Chelsea College, London

In order to meet the increasing need for the standardising of AE measuring systems a new method has been developed for the calibration of transducers on a laboratory scale. In this procedure the signal obtained from a transducer under calibration is compared with the reference signal derived from a wideband transducer of the same type. Both signals are processed on the Harris 125 computer at Chelsea College to give the required frequency spectrum of the transducer under test.

Simulated acoustic emission sources were provided by (i) pencil-lead breaking and (ii) impinging spheres, of different sizes and materials, on a plane solid surface. A good agreement was obtained in the experimental results and with the predicted values, thus implying the basis of a source independent calibration method.

Investigation of Damage on CFRP under Mechanical Loading by AE

D Valentin and A R Bunsell
Ecole Nationale Supérieure des Mines de Paris, Evry Cedex, France

Although unidirectional carbon fibre reinforced plastics (CFRP) exhibit totally elastic behaviour, it is generally acknowledged that when a specimen is under a constant load above some critical level the fibres will break continuously and long-term failure will ensue.

Recent studies by Laroche and Bunsell have highlighted the advantage of AE as a means of quantitatively investigating the damage of unidirectional CFRP under constant load. This work has produced a model of kinetic damage and hence a possible definition of a minimum life time for this

type of material as a function of load conditions. In particular, this study has shown that the type of damage produced is independent of the details of the previous loading history, so that the accumulated damage can be represented by the total number of emissions recorded.

The present work shows how this model can be extended to cross-ply composites in creep and also to other types of mechanical loading, eg fatigue.

Both flat samples cross-ply at $\pm 45^\circ$, $\pm 15^\circ$ and (0.90)_u and filament wound tubes in the same structures have been tested in creep and fatigue. Large diameter tube specimens (90 mm) were chosen to compare AE data with those of flat specimens since they can be considered, to a first approximation, as very wide, infinitely long, flat specimens. In this way, edge effects such as delamination or shear deformation are eliminated, thus avoiding spurious AE data. It was found for both types of material that when those specimens failed by the breaking of fibres rather than by delamination or matrix shear, then AE results are similar to those obtained with unidirectional materials, ie the acoustic event number versus time plot follows a characteristic logarithmic curve.

Studies with Simulated AE Signals

W Sachse
Cornell University, Ithaca, New York

We describe measurements on various structures with several simulated AE sources. We show how the signals in the near-field of the source can be deconvolved to find the emission source function, the transient structure function and the response of the detection transducer.

General Purpose Classifier for Acoustic Emission Signals

R W Y Chan, D R Hay and C Y Suen
Failure Control International,
Tektrend International Inc,
Lachute, Quebec, Canada

Pattern recognition techniques comprise one of the most promising and flexible solutions in sorting and correlating acoustic emission (AE) signals to their emission source and to the severity of their effect on structural integrity. A general purpose classifier has been designed and implemented for identifying different types of AE signals using computer-based pattern recognition techniques. An outline of the system organisation and an application of such a system to classify different types of AE signals are given. Satisfactory results were observed and some potential applications of such a general purpose classifier are discussed.

Acoustic Emission Amplitude Distribution Analysis applied to Glass Reinforced Plastics

M G Phillips, F J Guild, F J Ackerman and B Harris
University of Bath

The experimental technique of 'amplitude

Acoustic Emission and Photo-Acoustic Spectroscopy

sorting' is commonly applied to the amplified acoustic emission (AE) signals originating from microstructural damage events in stressed materials. As each burst of emission is received, its maximum amplitude is determined and the appropriate counter of a multichannel analyser is incremented. The resulting record may be displayed as a histogram: number of events versus amplitude.

The authors have previously reported the use of this technique to reveal comparatively coarse differences in quality between samples of glass-reinforced plastics (grp). The work relied upon photographic records of the amplitude distribution taken at intervals in the course of a tensile test.

In the present paper, the authors describe the interfacing of a proprietary amplitude sorting unit with a mini computer, such that continuous records of AE amplitudes as a function of load and time may be generated. The stored data is analysed in a variety of ways, in particular by following the development of AE activity with time in chosen amplitude ranges — a technique advocated by D W Stone (private communication).

Recent results indicate that with this refinement AE is able to detect much more subtle differences in grp quality, such as the effects of resin type and cure condition.

Identifying Fatigue Crack Growth by AE Analysis

T J Holroyd
Rolls Royce Ltd, Derby

On-line signal processing is a necessary part of all AE systems and its effects upon a known signal can be readily determined. Only if the signal can be reduced to an unambiguous form does the possibility arise for the elimination of skilled operator involvement. In this respect conventional

methods of processing AE signals during fatigue tests have been found to be less than satisfactory. In this paper the merits of an alternative method of analysing the AE signal are discussed and examples of its application in laboratory and rig shop environments are presented.

The Analysis of Acoustic Emissions from Polymer Systems under Load and from Chemical Reactions

D Betteridge
University College of Swansea
M E A Cudby
ICI Ltd, Plastics Division,
Welwyn Garden City, Herts

A variety of mathematical methods have been applied to the analysis of acoustic emissions from commercially significant polymers, composites and chemical reactions.

1 *Frequency analysis* from which it is concluded that the median frequency is a useful defining parameter for an individual acoustic signal.

2 *Auto correlation analysis* which demonstrates that there are periodic variations in acoustic time series.

3 *Cepstrum analysis* which is used to detect echoes within an individual signal.

4 *Cluster analysis* which may be used to classify a sequence of signals into groups defined by some suitable parameters, eg amplitude, load and energy.

The objects of these methods are to simplify the complex data obtained from acoustic emission experiments and to seek correlations between acoustic signals and mechanical behaviour. The method of cluster analysis looks most promising and will be described by reference to the analysis of data from closely related polymers and their glass-filled counterparts.

Diagnosis of Engine Faults by Noise Emission Analysis

E Roeder
KLETEK Control Systems Ltd,
Bremen, Germany

Every engine, every motor, turbine, gearbox compressor, etc, changes its noise and vibration characteristics with faults or defects caused by wrong adjustment, production or fitting. Some of these defects can be heard by experienced operators during the final operation test of the engine or the motor. But in high quality and quantity production such subjective tests are not tolerable any more.

Special noise analysis techniques and the correlation of noise with other machine data make automatic detection of defects and diagnosis of faults possible. The technique and operation of the KLETEK control systems for automatic diagnosis are described by examples of engine fault diagnosis, diagnosis of wind-screen wiper motors and diagnosis of electric ventilators. Using noise analysis controlled by the operation or running of different systems together with computer diagnosis, it is possible to describe every defect in a system and to give defined information for rectification of the systems.

Non-Invasive and Non-Traumatic Diagnosis of Bone Abnormalities by Acoustic Emission Techniques

H S Yoon
Rensselaer Polytechnic Institute,
Troy, New York, USA

Abstract not available.

The Application of AE Evaluation to Machine Health and Process Monitoring

M Arrington
Acoustic Emission Consultants Ltd,
St Ives, Huntingdon, Cambridgeshire

Abstract not available.

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Medals and Awards

The 1979 Rayleigh Medal was presented at the Spring Conference to Professor P E Doak of the Institute of Sound and Vibration Research, Southampton University. On this occasion Honorary Fellowships were conferred upon Professor John Lamb of Glasgow University and Professor William Taylor of Caithness. The A B Wood Medal was awarded at the Autumn Conference to Dr I Roebuck of the Admiralty Underwater Weapons Establishment, Portland.

BRANCHES

North Eastern Branch

The 1980/81 session commenced in September with a new form of meeting. A few students from the Polytechnic were invited to give short talks on their projects. The meeting was well attended and generally successful. The Committee are considering making this type of meeting a permanent feature of the programme. The November meeting on Work Place Noise was well attended (49 persons) but only a handful were IOA members. The December meeting was held jointly with the IOP. The subject, Musical Acoustics, was very interesting. The attendance of only 21 people was disappointing. The January meeting on Microcomputers in Acoustics was held at ERS and was well attended, some of the audience having travelled from London especially for the meeting.

Throughout the year the Branch Committee has been very busy making arrangements for the forthcoming Spring Conference to be held in Newcastle in April. This opportunity to host the Spring Conference has enabled the Branch to demonstrate to Council one of the uses of Branches and Groups and it is hoped this will encourage the Council to create more Branches.

Southern Branch

During 1980 there was a programme of six lectures to meet the demands of its potential audience. Considerable support was derived from non-IOA visitors to meetings and especially from Environmental Health Officers. At the Annual General Meeting, Dr James Powell and the Committee were re-elected with Dr Ray Shack and Mr G Charnley remaining as Honorary Secretary and Honorary Treasurer respectively. Dr Powell will continue to represent the Branch's views to Council, especially in this time when so much attention is being given to group matters. The programme for 1981 was finalised in September 1980 and the membership of the area has been informed.

South Western Branch

A committee has been formed as the basis of a new branch centred on Exeter. It is hoped to complete the formal establishment of the branch early in 1981.

GROUPS

Building Acoustics Group

The major activity in 1980 was the contribution of sessions at the Institute's Spring Meeting held at Bedford College, London. Sixteen papers were presented and attracted substantial numbers of delegates. Included in the programme was a technical visit to the Hexagon multi-purpose hall at Reading. Although the visit was undersubscribed, it was highly informative and terminated with a practical demonstration of the hall's acoustic qualities. There were several other meetings during the year that were of interest to Building Acoustics Group members. Of particular note were the sessions on Impulse Response Techniques in Room Acoustics, organised by Dr Peter Lewis at the Autumn Conference in Windermere, and the Loughborough meeting, organised by Mr Chris Walker, on Sound Insulation.

1980 saw the introduction of a Building Acoustics Group newsletter aimed at keeping the members informed and generating ideas for future events. Discussion of the newsletter during the Group's open meeting at the Spring Conference generated several ideas, some of which should form the basis of meetings during 1981. It is intended to update and continue the newsletter in future years.

Committee membership underwent several changes during the year, with the resignation of the founder Chairman, Dr Chris Gilford, and of Mr Hugh Creighton and Mr Paul Newman. Dr Geoff Jackson became Chairman and Mr Peter Allaway joined the committee. Mr Howard Latham became a co-opted member.

Speech Group

During 1980 the Group held a total of four technical meetings. The first of these, held at University College, London, was on Speech Production and Perception in the Disabled. About 40 people attended, and six papers were presented on various speech and hearing pathologies and related subjects. In June the Post Office Research Centre, near Ipswich, hosted a meeting on Speech Processing for Digital Telecommunications. After a review on speech coding methods from the Joint Speech Research Unit and some comments from the Post Office on speech detection in digital speech interpolation systems, the remaining three papers were from the telecommunications industry on various specific digital processing methods. This meeting was extremely well attended, with an audience of about 80.

In September the Group experimented with its first whole-day meeting, on Speech Intelligibility, at the University of Aston. An audience of 50 heard a well balanced programme of seven papers that covered all aspects of intelligibility, ranging from problems of speech pathology, through commercial telephony, to speech communication problems in deep sea diving. The last meeting in the Group's programme

was at York University in December when we had an audience of 30 for seven interesting papers on various aspects of speech perception.

The group has also been associated with a joint meeting between the Institute of Acoustics and the British Pattern Recognition Association. The subject was Pattern Recognition in Acoustic Signals, and the meeting was held at the University of Surrey. Three of the papers at that meeting dealt with the subject of automatic speech recognition.

A significant number of the non-members who attended our meetings this year have since applied for membership, and the total size of the Group is now nearly 50.

Musical Acoustics Group

The Group has maintained its policy of visits and occasional technical meetings. The latter have deliberately been curtailed in the current year because the Group is responsible for a major contribution to the Spring 1981 Meeting in Newcastle and has been asking members to contribute to that meeting rather than a small group gathering.

Visits have been paid to the musical acoustics work of Professor Taylor in the Physics Department of University College, Cardiff, and to the Boosey & Hawkes factory in Edgware. At Cardiff a programme of work covering both physical and psychological problems was described, and a new laser holographic system for the study of guitar vibrations was demonstrated. At Edgware, visitors were taken on a specially arranged tour and thus were able to go deeply into many of the aspects of brass or woodwind musical instrument production with expert guides.

Those members near to Birmingham, Cambridge, Guildford or Southampton were able to attend a very stimulating lecture by Professor G Weinreich from the University of Michigan and the Institut de Recherche/Coordination Acoustique Musique in Paris, entitled *Recent Developments in the Acoustic Spectroscopy of Violins*, giving an account of some new work on the processing of radiating sound fields as well as on the physics of the coupling between bridge and belly.

Industrial Noise Group

The first meeting of 1980 was arranged to be the Annual Spring Conference, which allows members to meet informally. In July a visit to the Building Research Station proved extremely popular, with 27 participants enjoying the lectures on past and current activities in the field of sound insulation and noise research, including participation in the acoustic activities associated with the EEC. The third meeting of the year, at Coventry Climax Limited, Coventry, was attended by 15 members who heard a lecture on the various problems of actually measuring the noise of their fork-lift trucks and the difficulties in determining standard tests under load conditions.

The Group remained a very popular section of the Institute during 1980, with well in excess of 200 members, about 10 per cent of whom were distributed throughout the world outside the UK, thus indicating the importance of industrial noise. An analysis of Group membership on a geographical basis and of members' interests was carried out via a questionnaire circulated to members and an interesting programme for 1981 has now been tentatively formulated.

Underwater Acoustics Group

Three meetings were arranged for 1980, namely: Signal Processing in Underwater Acoustics, University of Loughborough, 21-22 May 1980; Underwater Communication and Navigation, University of Surrey, 9-10 September 1980 and Transducers for Sonar Applications, University of Birmingham, 16-17 December 1980.

Mr B Woodward acted as local organiser for the Loughborough meeting which attracted thirteen contributions two of which were from overseas. The number of registrations was however, at thirty, somewhat less than expected.

The call for papers for the Underwater Communication and Navigation meeting produced no response. In view of this, together with the fact that a similar meeting had only recently been held by the Hydrographic Society, the committee was forced to cancel it. This was a most regrettable step to take. In order to provide greater protection in the future over such clashes, the office of Programme Secretary was revived and Mr B Robinson was elected to this office.

The Transducer meeting at Birmingham University was locally organised by Dr B V Smith and was a great success. There were seventeen contributions, five of which were from abroad. In parallel with the conference, a manufacturers' exhibition was held.

The number of members of the UAG of the IOA now stands at seventy-four.

Aerodynamics Group

This group has not been active of late, but it is hoped to reactivate it in 1981.

ADMINISTRATION

Council wishes to acknowledge the efficient and courteous service provided by the Secretary, Mrs Cathy Mackenzie, and her assistants during the first full year of operation at the Edinburgh office.

THE YEAR AHEAD

It is expected that improvements in the infrastructure of the Institute will derive from the deliberations of the Working Party on Group and Branch Policy. An individual member of Council will take special responsibility for encouraging and aiding Group and Branch development. It is to be hoped that one result of this innovation will be the attraction of a substantial number of new members. □

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FASE Symposium on Acoustics and Speech

The Federation of Acoustical Societies of Europe (FASE) holds one technical meeting in most years. In odd-dated years these meetings are called Symposia and each one covers a single acoustic theme. In even-dated years the meetings are called Congresses, and have a small number of different themes running in parallel. This year's Symposium covered the subject of Acoustics and Speech, and was held in Venice from 21 - 24 April. It was organised locally by the Italian Acoustical Association in co-operation with other Italian institutes.

VENICE in late April sounds a delightful prospect, with warm days, a fascinating city, and people travelling around by gondola. This year, however, the weather somewhat spoilt the realisation of these hopes. The temperatures were roughly comparable with those in London in the same week (around 10 deg C), and there was drizzle for most of the time; on the Friday it rained heavily. Venice has buildings mostly in the range 100 to 800 years old, so there is no opportunity for a 'Conference Centre' with modern lecture rooms such as one might expect to find in many cities of similar size. The meeting was held at the Fondazione Giorgio Cini, which is on the island of S Georgio Maggiore. The island is about three minutes by boat across the lagoon from St Mark's Square. The only significant buildings on this small island are a church and the Fondazione Cini, which obviously was also originally built for religious purposes. Now its rooms are hired out to various organisations for conferences, committee meetings, etc. The island is visited by the city's water-bus service every few minutes, and the conference organisers also provided a special boat every morning and evening.

Because of the weather it was cold inside the buildings, and the only place to sit outside the lecture rooms was in the gardens — not a good idea because of the rain. There were reasonable cold snack and hot drink catering facilities for lunch and for the morning and afternoon breaks, but nowhere to sit while consuming the refreshments. All these features meant that the Fondazione Cini was not a very friendly environment for a scientific meeting, but undoubtedly its most serious disadvantage, particularly for an acoustics meeting, was the fact that the lecture rooms have a reverberation time of about two seconds! Even with

a fairly good distributed loudspeaker system it was often not easy to understand words spoken by the lecturers, and for many participants it must have been particularly difficult when the lectures were in the native language of neither speaker nor listener.

There were a total of eight invited lecturers, including many whose work is renowned throughout the world. Professor Hiroya Fujisaki from the University of Tokyo described some fascinating work he had done on modelling the fundamental frequency variations of speech and a wide variety of singing styles in terms of a second order linear system, involving the mass and stiffness of parts of the larynx structure. The input to this model was assumed to be simple on-off neural commands. He presented very convincing evidence that his data fitted this parameterisation extremely well, and developments based on this model might appreciably simplify pitch control in speech synthesis systems. Professor Gunnar Fant from the Royal Institute of Technology in Stockholm reported his recent studies on the details of vocal tract excitation during voiced speech, and its relationship to the acoustic structures above and below the larynx. Using the technique of 'inverse filtering' he had accumulated a large amount of data about the air flow between the vocal folds, and about how vocal fold action interacts with the acoustic system.

Professor Manfred Schroeder, from the University of Göttingen and Bell Laboratories in USA, explained the recent work he and his colleagues at Bell had done on medium-bit-rate coding of telephone bandwidth speech signals. The method is a variant of adaptive predictive coding, where analysis of the speech is used to find the parameters of a time-varying recursive filter that can best predict

speech waveform samples from knowledge of previous samples. The prediction error signal is also coded for transmission, and in general requires fewer bits per waveform sample than the original speech signal. Schroeder's latest work uses a sophisticated tree-search coding algorithm for the error signal, and he had succeeded in making the reconstructed speech waveform subjectively indistinguishable from the high-quality input, with an effective data rate of less than one bit per sample of the residual signal. Even allowing for the recursive filter parameters, the total data rate would have been only about 12 kbit/s. This work was presented as a research study exploring the limits of what is achievable. The system performance is far in excess of what is necessary for telephone transmission, and its implementation at Bell Laboratories was about 100 times slower than real time using a Cray processor.

The contributed papers had not been refereed, and were of a very mixed standard. They came from a wide variety of countries from both eastern and western Europe but there were none from the Soviet Union, which is not at present a member of FASE. Although English, French and German are all official FASE languages, almost all papers were presented in English, the only exceptions being a small number in French. The subjects included speech synthesis, automatic speech recognition, digital coding, assessment of transmission performance, various aspects of speech signal processing and several other topics. A few presentations were in poster format in a separate room, which also housed a small equipment exhibition. Some of the papers put forward useful new ideas, although the poor acoustic environment tended to inhibit discussion.

The whole meeting served as an excellent opportunity for personal contact between people who do not often see each other's work. This was particularly valuable to participants from the UK, who because of language problems are in general more aware of research activity in North America than elsewhere in Europe. There is thus a strong reason to encourage British participation in future FASE meetings. The next will be a FASE Congress from 13 to 17 September 1982 in Göttingen, combined with a main meeting of DAGA, the German Acoustical society. □

J N Holmes

Noise at County Hall, London

Many people express surprise when they first hear of the existence of extensive laboratories at London's County Hall, and yet a scientific advisory service predates not only the present Greater London Council, but also its predecessor, the London County Council. The first full-time scientist to advise the Metropolitan Board of Works was appointed well over 100 years ago, but it seems unlikely that his remit at that time included acoustics although noise was even then a problem in London, and school halls probably had acoustics problems still familiar today.

The present Scientific Branch is part of the Director-General's Department and has a staff of about 130. It is divided into six main Divisions: Materials Sciences, Technology, Analytical Services, Health and Safety Sciences, Central Support and Environmental Sciences, and it is the last of these which concerns us here. The Environmental Sciences Division, with about 25 staff, is divided in two Groups, Air Pollution and Noise, but other environmental topics, such as for example wind turbulence, are also tackled as and when the occasion arises.

In the Scientific Branch work on noise first started in about 1960, when the question arose of selecting a suitable site for a heliport in London. It was realised that little or no information existed about background noise levels, let alone the anticipated noise of helicopters. To remedy this, a physicist recently taken on to do work on atmospheric radioactivity was handed a Dawe Sound Level Indicator, with an instruction booklet, and asked to find out all about background noise levels in the vicinity of possible heliport sites. Not surprisingly, this was found to be not quite as straightforward as it appeared, but it did serve as a useful basis for learning about noise, and stimulating interest in it. Now, over 20 years later, this particular job, although perhaps in a different form, has re-surfaced yet again!

The early work on noise had its greatest value in showing up how little was in fact known about urban noise in general and about London's problem in particular. Very little had been written anywhere about noise measurements, surveys or planning, and literature searches on noise were as difficult as nowadays, but for the opposite reason! At the same time as the LCC's Scientific Branch decided to start serious work on noise, the Building Research Station also became concerned about extending its own work on sound insulation to cover environmental noise. The result was a very

successful co-operative project, the 1961 London Noise Survey. This involved 24-hour automatic noise measurements at 540 sites on a grid spread over a 36 sq mile area of Central London, and as well as being the first major urban noise survey it is probably still the largest to be carried out anywhere. The cost was shared between the Building Research Station and the London County Council and, while LCC staff selected sites, positioned the mobile laboratories and carried out the measurements, the tapes were analysed at BRS and both organisations published reports on the results. These also provided the basic data for the 1963 Wilson Report on Noise and introduced the concept of L_{10} .

In the 1960s, the LCC/GLC work on noise expanded rapidly, mainly in connection with the problem of traffic noise. A considerable number of investigational projects were carried out relating to topics such as 'before and after' measurements near urban motorways, the effect of composition on levels of noise from urban traffic, the determination of average noise levels for different types of vehicle, as based on 1100 measurements, and the variation of noise levels with height in tall buildings. Surveys and predictions were also made to advise architects regarding the siting and insulation requirements of new schools and housing, and on acoustics of halls in colleges and schools. In 1973 the passing of the Land Compensation Act and the associated Noise Insulation Regulations caused a sudden upsurge of work which had to be completed within legally defined deadlines. Staff numbers increased in an effort to meet this demand, as well as that due to the ever-growing problem of aircraft and helicopter noise. Other important events of that period were the formulation of GLC guidelines on noise in 1975, and the publication subsequently of Codes of Practice for Pop Concerts and for Discotheques.

At the present time, there is a staff of

fourteen in what has now become the Noise Group, and the range of equipment available for measurement and analysis has come a long way from the days of the single sound level indicator. Although most noise measurements are made using data loggers, with subsequent computer analysis, a comprehensive range of equipment is now available, enabling a wide variety of acoustics projects to be carried out at the request of Council departments and certain public bodies outside the Council. Because of the shortage of staff, the emphasis is on capital rather than labour intensive methods and measurements are made automatically



Fixing a BLEEP to a flag-pole — now usually done by means of a 'Skyraker' platform

wherever possible. One useful development by the Branch has been the use of BLEEPS — boxes for long-term evaluation of environmental pollution — which can be fitted to lamp-posts and are, nominally at least, vandal-proof. Staff time is also being saved by the use of a new computer program related to the implementation of the Noise Insulation Regulations. This includes digitisation of the base maps, an evaluation of noise levels, and determination of eligibility.

It may be of interest to describe briefly some of the work presently in progress.

The work of the Noise Group is at present divided among three sections:

Highways and Inter-Disciplinary, Strategy and Consultancy. The first of these is responsible for work related to the implementation of the Noise Insulation Regulations arising from new and improved roads. It also covers, as the name implies, both noise and air pollution assessment for new and proposed traffic management schemes and for new road construction. These include environmental comparisons to establish how many people would be affected by alternative scheme proposals, and to what extent. Studies on cost effective methods of reducing noise, including the evaluation of barriers, are also made. A large proportion of the work is carried out at County Hall, using maps, plans and traffic statistics supplied by the Council's Department of Transportation and Development, but frequent and extended field measurements are also required, particularly for traffic management schemes. The expertise and instrumentation of the Air Pollution Group is of course always available to support the Highways and Interdisciplinary Section, as required.

As the strategic authority for Greater London, the Council is concerned with London's existing and future environment, and one of the main tasks of the Noise Strategy Section is to provide advice in this field. To be effective this requires the identification of existing and potential noise sources, and the formulation of practical policies to control these. This includes the setting of guidelines which take into account not only the need to protect the environment, but also the economic, transportation and entertainment requirements of life in the capital. For example, one of the major and continuing tasks of the Strategy Section relates to the Council's desire to protect London's environment against aircraft noise, while maintaining the premier position of London's airports in Europe. The work on this includes the preparation of reports to Council Committees, often in response to Government consultation documents, relating to topics such as night restrictions, landing procedures, noise monitoring, minimum noise routes and insulation grant schemes. In order to

provide objective information on aircraft noise, the GLC, in co-operation with the eight London Boroughs most affected, operates an independent Local Authorities Airport Noise Monitoring System. Unlike the British Airports Authority system, which is designed to check on noise infringements, the LAANMS is concerned with both landing and departing aircraft (over 70 per cent of London's overflights are by landing aircraft) and at various distances from the airport. The Strategy Section is responsible for the operation of the system, and the analysis and evaluation of the data. Another important current project, partly funded by the EEC, is concerned with evaluating the benefits of providing insulation against traffic noise for dwellings. This involves internal and external noise measurements, as well as a social survey. It is hoped that the results of this project will be available late in 1981. History appears to repeat itself and helicopter noise is again very topical, with a new temporary heliport about to start operations from a platform on the River Thames, and the noise from this will also be monitored. Consideration is also being given to a larger heliport in London's Dockland. On traffic noise, the Branch was recently asked to report on the environmental implications of the Armitage Report on Heavy Lorries, and the problem of lorry routes and restrictions in general is still a very active topic, and will undoubtedly remain so.

Last, but certainly not least, the Consultancy Section provides advice to other departments of the Council on a very wide range of topics. These include the evaluation of sites both for new noise-sensitive as well as for noise-producing developments, the investigation of noise complaints in Council-owned or Council-affected premises, the measurement of sound insulation between dwellings, improving the acoustics of small auditoria, advising on the acoustics of new court-houses, monitoring noise at pop festivals, and checking on hearing risk situations for Council employees. The Noise Group does not, however, deal with noise complaints in general, unless the Council is itself affected, as these are the responsibility of the individual London Boroughs.

A topic of particular concern at present is that of construction noise and consideration is being given to methods of predicting and evaluating this. Although a great deal of work has



Early type mobile laboratory, with pneumatic mast

already been done on this problem by other bodies, it is still the one which appears to be the most intractable, partly because there are so many inherent variables.

Much of the work referred to has been published in over 40 papers and articles prepared by officers of the Division, and this short summary of the work of the Noise Group at County Hall cannot pretend to be exhaustive, or to cover any of the topics in depth. It will however be sufficient, it is hoped, to give some idea of the variety of the work, and may help to further dispel any remaining ideas that local government officers are merely pen-pushers sending memos to each other! □

George Vulkan

This article is published with the approval of the Scientific Adviser to the Council, but the views expressed are those of the author and not necessarily those of the Council.

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Phase change for the EPA?

In a recent issue of Noise News, the Journal of INCE/USA, the following letter was published. It was received by the Editor in response to a letter from the Editor to the Environmental Protection Agency requesting clarification of rumours circulating since earlier in the year about the future of the federal noise programme.

Dear George:

You asked me to clear up some of the rumours that you have been hearing:

President Reagan has decided that the EPA noise control programme should be phased out by the end of fiscal year 1982 (September 30, 1982). The Administration believes that the benefits of noise control are highly localised, and that noise can be adequately controlled at the State and local level without the presence of a Federal programme. This recommendation was presented to Congress on March 10, 1981, in the President's budget proposal.

The major components of EPA's existing noise control efforts are promulgation and enforcement of Federal noise regulations, the provision of financial and technical assistance to State and local noise control agencies, the conduct of noise health effects research, the demonstration of noise control technology, and assistance to the FAA and States and localities in the area of aviation noise.

During the next 18 months, activities will be phased out in an orderly manner. Much of the phase out will take place by October 1, 1981, with both the Regional offices and the Noise Enforcement Division out of business by that time. A primary goal of the phase out will be an effective transfer of existing Federal noise control responsibilities and of the knowledge EPA has gained on noise control, to State and local governments and other interested parties.

Sincerely

Charles L Elkins

Deputy Assistant Administrator for Noise Control Programmes.

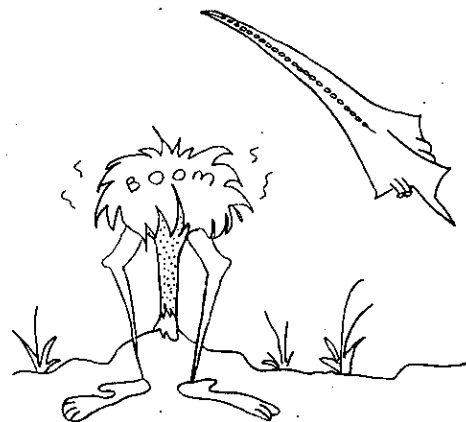
In the same issue the 1981 INCE President, Malcolm J Crocker, reports that a letter has been sent to President Reagan by INCE and he urges all the INCE/USA membership to write to

their congressmen and senators. He goes on:

'Unfortunately states and cities usually do not have the resources or technical expertise to write noise standards and regulations. I do not think leaving all noise problems for states and cities to solve will work at all well. Of course states and cities should write community noise regulations for use of vehicles and other mechanical equipment which are peculiarly suited to their needs. But how can they write noise *emission* standards for vehicles, etc? Would manufacturers want to go back to the chaotic situation of ten years ago when each state and major city set different vehicle noise standards with different levels and different effective timetables? If they consider carefully, I think manufacturers should prefer uniform federal noise standards.

'What I think is needed is some general national noise plan which is coordinated and harmonised with those of the other OECD nations. With the beginning of a new administration in the USA we have the chance to consider and formulate such a plan. Or else we have the chance to bury our heads in the sand.'

Only months previously—and reported in the same issue of Noise News—INCE/USA had celebrated the 10th Anniversary of the INCE Conference and the 10th Anniversary of the creation of the US EPA, recalling the part played by INCE in the passage of the US Noise Control Act of 1972 (giving, incidentally, control over civilian aircraft noise and sonic boom to EPA). Yet now the signs are that those concerned about noise will indeed have to resort to that primitive form of hearing protection, and bury their heads in the sand. □



1980 IEEE Ultrasonics Symposium

This annual meeting was held in November 1980 at Boston, Massachusetts, and attracted a record attendance of 550, about 252 being foreign visitors. More than two hundred invited and contributed papers were given, in three to four parallel sessions, over the three days and there were poster sessions in addition. These were held in a room used for coffee breaks and the posters were thus given the benefit of a wider audience than for the normal lectures.

The meeting was sectionalised under seventeen different headings, including for the first time a full-day section on photoacoustic spectroscopy, which was opened by four successive invited papers, the initial one being given by Dr Alan Rosenzweig of Lawrence Livermore Laboratory. The lecturer dealt with the specific topic of Thermal Wave Imaging and Microscopy in which intensity modulating optical or electron beams, by scattering or reflection from an object, can reveal its thermal inhomogeneities. Resolution of sub-surface features can be as good as one micron and the lecturer illustrated the technique by its use in examining solid-state electronic devices. E K Brandis gave a further interesting application involving intensity modulation of the electron beam of a scanning electron microscope. The energy levels excited by the electron beam de-excite mainly by electron emission, X-rays and heat generation, the presence of the latter being detected by the production of thermal wave images. J F McClelland (Iowa State University) spoke of the use of PAS for opaque materials and in particular for investigating ion implantation and recrystallisation processes. The next contribution by C K N Patel (Bell Labs) was concerned with liquids and solids and by using a tunable dye laser of 0.1 mJ he showed that spectra could be obtained for materials with absorption coefficients as low as 10^{-6} cm^{-1} . The latest development in the PAS technique is the Fourier Transform Infra-red PAS and it formed the basis of two papers by K G Hockley *et al* (Oklahoma State University) and B S H Royce *et al* (Princeton University). The former used the technique for characterising freshly cleaved coal while the latter illustrated the Christiansen effect.

Amongst the other sections, that of imaging and acoustic microscopy attracted a great deal of attention, while specialist areas like magneto-static waves and sputtered ZnO films contained most useful information. The latter topic was introduced in the invited lecture of F S Hickernell (Motorola Inc, Government Electronics Division, Scottsdale, Arizona) who described how it was possible to sputter a film whose acoustic and piezoelectric properties approached closely to those

of a single crystal of ZnO.

As might have been anticipated the largest contribution of about 40 per cent came from areas associated with surface waves while at the other end of the scale only between two and three per cent of the papers were on biophysics. Limitation of space prevents individual mention of the many significant contributions to this excellent meeting but those unable to attend can peruse the material at leisure by purchasing the two volumes containing the conference papers from the IEEE Service Centre, 445 Hoes Lane, Piscataway, NJ 08854, USA. The 1981 meeting will be held in Chicago on 14 - 16 October. □

RWBS

The Institution of Environmental Health Officers

On 1 May 1981 the Environmental Health Association received the new title of The Institution of Environmental Health Officers. Founded in 1883, the Institution now has approximately 6500 members—Environmental Health Officers (EHOs)—most of whom work for local authorities in England, Wales and Northern Ireland. Their responsibilities include housing, health and safety in places of work, food hygiene and safety and environmental pollution (both air pollution and noise). The Institution is regularly consulted by government departments on proposals relating to environmental health. It provides representatives to serve on various other professional organisations and has formed liaison groups with a number of other professions so as to co-ordinate environmental policies.

A high academic level is required for membership of The Institution of Environmental Health Officers which administers the Environmental Health Officers Education Board—the body responsible for education, training and qualification of EHOs. The change of name reflects the high professional standing of the organisation, the only one concerned with 'environmental health' as a total concept. The new name is also a step towards becoming a Chartered Institute.

The new designatory letters for Fellows of the Institution are FIEH and for Members MIEH.

IEH
19 Grosvenor Place
London SW1X 7HU
Tel: 01-235 5158/5159.

ISVR Short Courses

In addition to the 10th Advanced Noise and Vibration Course, to be held on 14 - 18 September 1981, the Institute is presenting a new series of advanced courses on Vibration Theory and Practice, as follows:

October 1981: Vibration theory and applications to design (3 days)

November/December 1981: Computational techniques for dynamic structural design (3 days)

February 1982: Vibration testing and signal analysis (3 days)

March 1982: Shock and Vibration Control (3 days)

Further information on ISVR courses and conferences may be obtained from:

Mrs O G Hyde or Dr J G Walker

ISVR

The University

Southampton

Telephone 0703 559122, Ext 2310 or 752.

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New Products

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

CEL 160 Graphic Recorder

The latest developments in semiconductor technology and electronic design have been applied to produce an all-electronic microprocessor controlled Y-t recorder with specialised application to acoustic and vibration measurements.

The CEL 160 Graphic Recorder is capable of:

- Real-time waveform recording up to 10 kHz.

- Transient waveform recording using built-in 1800 word memory, with automatic data transfer to hard copy.

- Built-in sound level meter to IEC 651 Type 1 permits direct connection via CEL 2980 microphone preamplifier of suitable microphone and accelerometer inputs for recording of sound and vibration level.

- True RMS detector with a crest factor of 5.

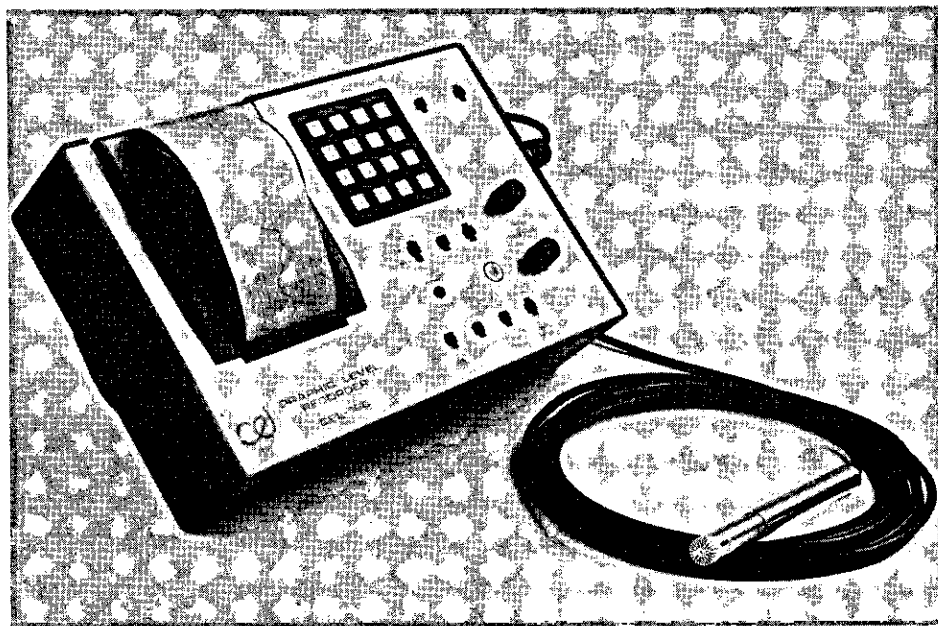
- Four averaging times from 10 msec to 10 sec.

- 'A' scale frequency weighting and external filter option.

- Programmable automatic frequency plots with a wide variety of frequency analysers.

- Variable filter-dwell-time which is long at low frequency for optimum averaging and short at high frequency for optimum scan time.

- Further user specifiable programming options.



CEL Graphic Recorder

- Time axis annotation by 24 hour real-time clock and additional time grid.

- Amplitude axis annotation in either dB for logarithmic recording or per cent for linear recording.

- Gain adjustment to normalise input level in volts/per cent or volts/dB.

Its specialist application in the field of acoustic and vibration measurement is enhanced by the following advanced design features:

The operating principle on which the recorder is based is the electrical discharge writing method. A rechargeable battery pack can be recharged without removal from the instrument and will power the recorder in the expanded trace recording mode for up to 50 hours.

New CEL Sound Level Meters and Analysers

Recent additions to the range of meters from CEL include the CEL 314

Type 1 Precision Impulse Sound Level Meter, the CEL 228 Type 2 Impulse Sound Level Meter and Analyser, and the Rion SA59A Third Octave Spectrometer.

For further information contact: Tony Myles, Sales Manager, Computer Engineering Limited, 14 Wallace Way, Hitchin, Herts SG4 0SE. Tel: 0462 52731.

Integrating Vibration Meter B & K type 2513

The Integrating Vibration Meter, Type 2513, brings a new concept in simplicity to precision vibration measurement by calculating a true mean-square average of the vibration over a period of 1 minute. It displays the squared result on a thermometer-type LED display with a constant 6 per cent resolution over its 100 to 1 range. The display adjusts its brightness automatically to compensate for ambient light conditions and it can also be set to read current or maximum values of true-RMS or true-peak levels.

The 2513 can be set to measure either acceleration or velocity in the range 1 to 1000 m/s² or 0.1 to 100 mm/s respectively. Its frequency response is 10 Hz to 10 kHz, and it includes weighting filters for measuring Vibration Severity and Hand/Arm Vibration to ISO recommendations.

Ear Simulator B & K Type 4157

This new ear simulator closely reproduces the physical and acoustical parameters of the human ear by having similar dimensions and volume and providing the earphone under test with a similar acoustic impedance. Reliable and reproducible measurements to proposed IEC and ANSI standards are thus ensured. It connects directly to the various B & K instruments for hearing aid testing.

Wide Range Measuring Amplifier Type 2636

B & K have produced a wide range measuring amplifier, the 2636, which when used with their microphones and preamplifiers complies with Type 0 Impulse requirements of IEC 651 for precision sound level meters.

Further details are available from Brüel & Kjær (UK) Ltd, Cross Lances Road, Hounslow TW3 2AE.

GenRad 1988 New Sound Level Meter with Leq and Octave Bands

The 1988 is a precision integrating (L_{eq} and L_{ox}) sound level meter with

both analogue and digital display with fast, slow, impulse and absolute peak response characteristics. The meter may be preset to measure between 1 second and 24 hours unattended, but at any time during a sequence the meter may be interrogated to give the instantaneous value, the L_{eq} , L_{ax} , maximum and time elapsed.

Measurements may be taken using A, B, C or linear weighting or ten built-in octave frequency bands.

Outputs include AC, DC over 70 dB dynamic range and RS 232 interfacing to printer.

GenRad Spectrum Analysers

The second generation of GenRad 2512A portable 100 kHz Real Time Analyser is now available. It has additional standard features including overlap processing, arithmetic operations, integration/differentiation, log display, supply for transducer pre-amplifiers and a wider range of engineering units.

The 1995 portable $\frac{1}{3}$ -octave integrating real time analyser has been expanded to cover frequencies up to 80 kHz.

GenRad also introduce a new multi-channel A/D input module for their

2500 systems which will expand the number of input channels from two to sixteen.

Further details from GenRad Ltd, Norreys Drive, Maidenhead, Berks SL6 4BP. Tel: 0628 39181.

Acoustic Enclosure Panels

General Acoustics Ltd are marketing in the UK a range of standardised enclosure panels for noise control purposes manufactured by IAMA in Sweden. Three variants are available: P80H for noise refuge purposes, P80D with double sided absorption for use in work bay separator panels, and P80E with single side absorption for use in machine enclosures.

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

Communication Systems for use in Noisy Environments

Reliance Safety Products are introducing the complete range of intercommunication systems for noisy environments. The range caters for all requirements running from simple systems with cable communication, to larger factory wide systems for 'receive only'

or complete two-way transmission without cables.

Further information from Reliance Safety Products Ltd, Ryburne Mill, Hanson Lane, Halifax. Tel: 0422 62171.

M8 Audio Dosemeter

The M8 Audio Dosemeter is a self-contained pocket-sized instrument with a small, lightweight microphone which is clipped on to the shirt collar near the ear where it receives and accumulates approximately the same noise dosage as the ear. It measures in accordance with ISO R 1999.

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

Fourier Transform Program

Previously requiring a minicomputer or special hardware, digital frequency analysis is now a practical possibility on the popular CBM (PET) and Apple desktop microcomputers, using a Fourier Transform routine developed by Structured Software.

Further details from: Structured Software, 25 Handley Court, Riversdale Road, Liverpool L19 3QS. □

Letter to the Editor

Dear Madam,

Despite its official demise, brought about by the Quango-devouring Michael Heseltine, it is rumoured that the Noise Advisory Council may well reconstitute itself, devoid of Central Government help, if sufficient support can be found.

How appropriate it would be if the IOA were to provide a home for the re-born NAC, perhaps with the assistance of the Institution of Environmental Health Officers, if necessary.

Yours faithfully,

Malcolm Scobie (MIOA).

At a recent meeting of Council a small committee was constituted to consider the part which the Institute could play in a re-formed NAC. Any ideas on this subject to Geoff Leventhall, please.
— Ed. □

New EPA Standards limit Motorcycle Noise

The US Environmental Protection Agency has issued standards limiting the noise from newly manufactured motorcycles and replacement motorcycle exhaust systems. The standards are to be phased-in over a two- to five-year period beginning in 1983. No existing motorcycles, or any built before 1983, will be affected. Mopeds are also covered by the standards.

The new standards require that by 1 January 1983 the A-weighted noise level shall not exceed 70 dB (mopeds) or 83/86 dB (motorcycles, according to type) and that by 1 January 1986 these limits shall be further reduced to 80/82 dB for motorcycles, according to type.

The EPA anticipates that these standards will, on average, reduce the noise from new street motorcycles by 5 dB. The overall reduction in noise expected to result from the introduction of the standards should provide a decrease of 55 to 75 per cent in interference with human activities (such as sleeping and conversation) and a decrease of 7 to 11 per cent in the severity and extent of overall traffic noise impact.

EPA expects that the costs of compliance with these standards will be reflected in increased purchase prices—around 2 per cent for motorcycles and 25 per cent for replacement exhaust systems; no impact on increase in moped prices is anticipated since most of those sold in the USA already comply with the 70 dB limit.

The new standards will pre-empt state and local noise standards, thereby providing national uniformity of treatment.

The EPA has also proposed to amend the testing requirements of the final motorcycle, and motorcycle exhaust systems noise regulations, thereby increasing the effectiveness of the new standards. □

London Evening Meetings

It was a great pleasure to welcome Roy Lawrence, at the time Chairman of the IOA Meetings Committee, to the LEM on 26 February, particularly as he is based in Liverpool. Despite the distance he had travelled, he was not allowed to relax quietly at the back but was given the task of introducing the speaker for the evening — Tony Jones of AIRO.

Using the title *Measuring Sound Insulation*, Tony described and illustrated the techniques and procedures required by the new BS 2750:1980 for field and laboratory measurements, highlighting the differences from the earlier Standard and referring to the historical development. The new Standard has not exactly been universally acclaimed although the consensus of opinion seemed to be that it was a step in the right direction. The biggest problems seemed to lie in Part 2, concerning precision of various sorts. It was noted that this part was already being considered for revision, possibly more along the lines of the method proposed by the BRE Working Party which specifies positions for the microphones, speaker and tapping machine and deals with such practical problems as how to cope with awkward shaped rooms and still get repeatable/reproducible results.

The various ways of expressing the results of the measurements were also described, including the new rating method in BS 5821:1980, but despite all the improvements there was survey evidence that sound insulation was not as good now as it was 20 years ago. This point featured strongly in the discussion that followed the talk, with a good deal of concern being expressed about the conflict between poor insulation at low frequencies and the improved low frequency response of modern Hi-Fi equipment. One questioner wondered whether the tapping machine could ever be expected to give a sensible measure of the annoyance caused by children roller skating on a pedestrian walkway running over bedrooms!

On 26 March Richard Clough of Wimpey Laboratories Ltd stepped in at the very last moment to deputise for the advertised speaker in a talk entitled

Improved Assessment of Construction Site Noise. This public spirited action gave him the doubtful privilege of being the first speaker to give a second full-length talk in the LEM series.

Since the inception of the British Standard on construction site noise BS 5228, which incidentally is being revised, a lot of new information has become available from various organisations such as BRE, TRRL, CIRIA and Wimpeys themselves. Richard attempted to bring all this information together and to present a unified picture under the headings: Prediction, Monitoring and Methods of Control.

Much of the prediction information is empirical and the reasons for its divergence from theoretical relationships were not easy to explain but were the subject of quite a lot of speculation. Measurement accuracy in determining 12-hour L_{eq} values by sampling has bothered people for a long time and in this case it was nice to see statistics presented which showed how the errors increased as the sampling period was reduced. Most of the construction processes generate a good deal of noise but it was interesting to note that the list of alternative 'quiet' machinery is steadily increasing even if the rate of progress is slower than we would all like it to be. This must indicate that some people are prepared to spend money on controlling noise.

One of the advantages of an informal meeting such as this is that it is possible to get answers to questions that would not even be asked in other circumstances. It was generally agreed by both the EHOs and contractors' representatives that site boundary L_{eq} levels of about 70-75 dB(A) are acceptable but that above these levels there are problems.

What a shame it was that so few people came to County Hall on 21 May to help Les Moore celebrate 25 years of involvement with vibration problems. All who were there learned a lot, not least the importance of keeping detailed records, including photographs, so that our own experiences can be passed on to others perhaps less expert than ourselves at some time in

the future. Les certainly showed how such meticulous records should be kept and how they can form the basis of a good talk.

His presentation was based on the theme *25 Years in a Shaky Business* and illustrated some of the highlights from a varied career. Many of the case histories that he showed were related to his considerable experience with marine engineering where high levels of vibration appear to be an unwanted fact of life. He showed examples of various manifestations of vibration in ships ranging from rather disreputable coasters to RMS Queen Elizabeth and even a luxury ocean racer. Some of the solutions were extremely imaginative and were as varied as the problems — it wasn't just a case of putting the odd isolator here or there!

Breweries also seem to have featured large in Les's professional career and one such establishment provided a case where lack of thought when designing a cooling plant had exposed the adjoining buildings to 69 dB(A), a problem that could have been predicted from the fan data if only someone had bothered. The distinctions between noise and vibration blurr a bit when dealing with low frequencies and Les described a case where the exhaust emissions of 14 Hz were causing a major problem all over a ship. A very effective silencer was designed based on the principle of noise cancellation, a principle that some people would have us believe has only just been discovered.

One point that was emphasised was the importance of getting the 'feel' of the problem and then taking measurements to substantiate the impression formed. The use of simple equipment in the right place gives good answers and does not confuse the situation with too much data. Professor Grootenhuys came along to hear how one of his old students had got on and heard Les admit that he never could follow his lectures. Maybe there is hope yet for the rest of us! □

R C Hill

Material for the October issue of Acoustics Bulletin should reach Mrs F A Hill at 25 Elm Drive, St Albans, Herts AL4 0EJ no later than 21 August.



Institute of Acoustics Meetings

1981

21 - 22 July	M	Photo-Acoustic Spectroscopy	Chelsea College, London
July	M	Non-Verbal Auditory Communication	ISVR, Southampton
22 September	M	Generation, Measurement and Effects of High Intensity Sound (Joint with the Society of Environmental Engineers)	University of Birmingham
23 September	SG	Speech Aids for the Handicapped	Bedford College, London
24 September	LEM	Noise and Health and Safety at Work	County Hall, London
29 October	LEM(P)	A talk about railway noise	County Hall, London
16 November	M	Industrial Applications of Ultrasound	Birkbeck College, London
26 November	LEM	Communication in a High Noise Environment (relating to Aircraft)	County Hall, London
14 December	M	Outdoor Sound Propagation	Open University, Milton Keynes

1982

29 March- 1 April	M	SPRING CONFERENCE — ACOUSTICS '82	University of Surrey
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1983

13 - 15 July	M	INTER-NOISE '83	Edinburgh
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Key

M=Meetings Committee Programme
LEM=London Evening Meeting
SG=Speech Group
(P)=Provisional

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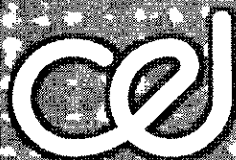
1 **CEL-175.** Three-function instrument providing all the features of a precision sound level meter with the addition of an L_{eq} calculation and peak hold facility. Outputs are provided to allow the instrument to be used with a wide range of analysis and recording equipment.

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3 **LR-04.** A High Speed Level Recorder with an exponential writing characteristic that ensures the recorded trace can be interpreted directly against Standards calling for measurements to be made with conventional sound level meters. A unique accessory, the Significant Event Expander, provides a times ten expansion of the trace whenever a preset threshold is exceeded.

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