Institute of Acoustics

acoustics BULLETIN

Volume 18 No 3
May-June 1993

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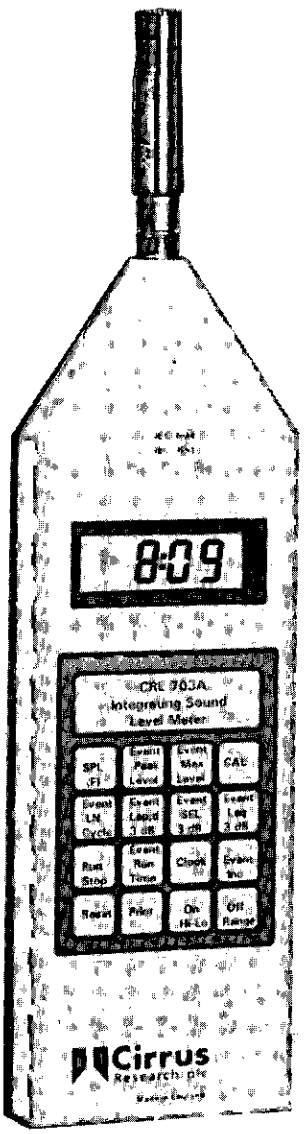

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Hunmanby, UK. Milwaukee, USA. Los Angeles, USA. Seattle, USA. Lyon, France. Dresden, Germany.

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Contributions and letters to:
The Editor
11 Colwyn Close, Yateley, Camberley
Surrey GU17 7QH
Tel: 0252 871298

Books for review to:
A J Pretlove FIOA
Engineering Department, University of Reading,Whiteknights, Reading
RG6 2AY

Information on new products to:
J W Sargent MIOA
Building Research Establishment
Garston, Watford WD2 7JR

Advertising:
Keith Rose FIOA
Brook Cottage, Royston Lane,
Comberton, Cambs. CB3 7EE
Tel: 0223 263800. Fax: 0223 264827

Published and produced by:
The Institute of Acoustics, PO Box 320,
St. Albans, Herts. AL1 1PZ
Tel: 0727 848195. Fax: 0727 850553

Production Editor:
R Lawrence FIOA
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contents

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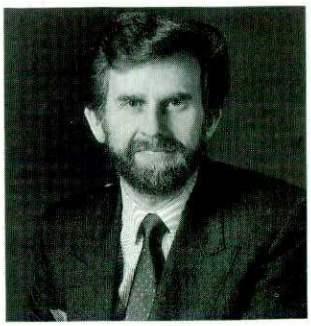

Dear Fellow Member

Thanks to all of you who returned the CEng/IEng questionnaire so promptly. So far, some 600 replies have been received, of which approximately 35% were from members who are already registered. In round terms, 50% of returns expressed interest in registering either as CEng or IEng, with a strong majority considering CEng status. Fifteen per cent of returns expressed no interest in registration for a variety of reasons. Responses were received from all sectors of the membership, from Associates to Honorary Fellows. There is still time to respond - on a major issue such as this it is important to obtain a broad view of members' interests so please find that form, fight with the grammar and send it to the Institute Office!

I referred in the last issue to the current debate in the engineering profession, and on page 5 you will find Sir John Fairclough's report on the unification study. IOA members have an open invitation to attend many of the regional meetings being organised by the institutions to debate the proposals; if you are interested please contact the Institute for details.

As regards the Institute's position as an Institution-affiliated body, in June of this year we meet the Engineering Council's Nomination Committee, against a background of strong pressure to amalgamate institutions. Our objective is to maintain our current status for registration during the period of debate in the profession, while options for future involvement by IOA are explored.

This issue also contains a valuable review article on Standardisation by John Woodgate. I am of the opinion that the IOA should play a particularly active role in national and international standards development, and in consultations on forthcoming legislation. Many members are already involved in this work at an individual level, and IOA has some representatives on BSI committees. However there is much more that we could do to ensure that the profession's views are presented through the means available to the Institute. This article is the first of a planned series, with later papers taking an in-depth look at individual standards that are relevant to our work in acoustics and vibration, such as hearing protectors, machinery noise and building acoustics, for example. If you are interested in contributing an article to the series please let the Editor know.

With best wishes

Yours sincerely

Peter Wheeler.

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ENGINEERING INTO THE MILLENIUM

An introduction by the Institute President to, and selected extracts from, an interim report on the unification of the engineering profession

The Institute of Acoustics, as an institution affiliated, nominated body of the Engineering Council is involved in the present review of the engineering profession in the UK being undertaken by a working group of the Council of Presidents (of the Engineering Institutions) chaired by Engineering Council Chairman Sir John Fairclough.

Sir John presented the findings and the proposals of the group to a meeting of Presidents of all 42 engineering institutions on 29th April 1993. His proposals for the unification of the engineering profession envisage a staged move towards a New Single Body, comprising a reformed Engineering Council merged with all the institutions. Not surprisingly, the 'big four' institutions (IEE, IMechE, ICE and IChemE) reacted with some opposition, concluding in a press release on 30 April 1993 that 'the Engineering Council has failed to give the profession the leadership it needs'. Those of you who are members of the above institutions will have seen the discussions taking place in their journals.

Of the 42 institutions, these four represent more than 60% of the total UK engineering institute members (which is approximately 500,000 including student members). Some thirty bodies, including IOA, have very small membership numbers in comparison and it is hard to escape the conclusion that the profession is unduly fragmented.

However, 'big', as the saying goes, is not always 'beautiful', and I am a firm believer that small, highly focused bodies such as IOA have a part to play nationally in the profession. Many of us would also take the view that the present structure of the engineering profession has done little to enhance the status of engineers in the UK in comparison to that awarded to our colleagues in Europe.

Sir John is pressing for an early start to the unification process, seeking Presidents' approval to set up a project team within the next month, and looking for institutional responses to his plans by October. The IOA Council is seeking the views of the membership. To assist with this, I have selected extracts from the Executive Summary of the main report for printing below as conveying, in my view, the central spirit of the report. Copies of the Executive Summary, which is twelve pages in length, are available on faxed request to the Institute office. The full report is available as a reference document at St Albans.

The four largest professional institutions are collaborating by holding regional discussion meetings and IOA members have an open invitation to participate in these events details of which may be obtained from IOA.

Members are invited to inform themselves in these ways of the issues involved and respond in writing individually to the Institute's office so that Council may make a considered response.

Introductory letter from Sir John Fairclough, Chairman of the Unification Steering Group, April 1993

'We can be justly proud of our industrial history and the contribution that engineers and their Institutions, Institutes and Societies have made towards it. But as a nation we are at an economic watershed. There is an urgent need to enhance our competitiveness if we are to maintain and develop our quality of life. There is only one source for such innovation - people. People who are able to adapt to changing circumstances and opportunities, creative in mind and spirit, and properly trained for the job. The skills we apply to the task of leading and organising people, to tap their energy and motivation, represent the main driving force to assure success. Companies who do this well prosper and gain worldwide recognition. So it is with a profession.

As a profession we share an accountability for our national economic performance. We have a responsibility to examine how best to organise our affairs and match our contribution to present and future needs. We must have the courage and commitment to learn from our history, continue with it where it is appropriate, but adopt new practices where it no longer serves our needs.

The Unification Steering Group has considered the options and we conclude, unanimously, that we must create a more effective relationship between the fragmented parts of the profession so that the whole becomes greater than the sum of the parts. We need to unify so that we can speak with a single voice on those matters that are of general concern and provide the leadership to take us into the next century with a new-found relevance and sense of importance, not for any reason of aggrandisement, but because we care about society and our role in it.

I commend this report to you and urge your support for its recommendations.'

Extracts from the Executive Summary

(The numbering of the selected paragraphs is as used in the full Executive Summary; some adjustments have been made to the layout for economy and clarity)

1. Engineers and engineering are at the heart of our national prosperity and make a major contribution to the economy. But the engineering profession lacks the powerful focus which other professions enjoy and has been less successful in influencing Government policy than the public interest requires. We need to unify the profession so that it can speak with a single voice.

2. In January 1992, the Council of Presidents of all the Institutions agreed to set up a Steering Group, which

adopted the following terms of reference: 'To consider the formation, role and organisation of a single body to act as a focal point for the engineering profession; to set professional standards of performance and conduct, to represent the profession on major issues and to provide an operating framework for engineering institutions, institutes and societies.'

3. Our study is concerned with all three grades of engineer: Chartered Engineers, Incorporated Engineers and Engineering Technicians.

Current organisation

4. At the present time, organisation and regulation of the profession are polarised between a Central Body currently The Engineering Council - and the 42 Institutions to which it has granted formal status. They have together achieved a great deal, and considerable progress has been made on such matters as common standards of competence for engineers throughout the profession, encouraging young people to consider an engineering career, and continuing professional development (CPD). The Institutions are now working more closely together.

5. We must not jeopardise these achievements - instead we must find ways of building upon them.

6. Many of the profession's problems stem from its fragmentation into over 40 Institutions and the failure of successive central bodies to speak to the outside world with a single voice. Fragmentation means there is duplication and waste and change in policy is slow. An atmosphere of mutual distrust between the Council and some Institutions has developed. Mistrust is compounded because Institutions and individual engineers play no part in the selection of Council members. Some of the medium-sized and smaller Institutions are wary of the larger Institutions.

7. Employers pay less heed to Registration and Institutional membership than we would wish. For whatever reasons, the Council has not had the desired impact in improving the influence and status of the profession or in meeting the needs of a rapidly changing world.

8. A more unified profession is not a panacea for these problems, but we are convinced that without more unity it will be impossible to solve them. We need a forum to marshall the resources of the profession more effectively.

9. Our purpose in submitting this Interim Report is to enable the profession to reach agreement on five fundamental issues, which concern mission and objectives, activities, organisation of the profession, allocation of responsibilities and the possibility of seeking legislation.

(i) Mission and objectives

10. We believe that the mission for the system of organisations which regulate and promote the profession should be: to provide leadership and vision for the profession as a whole, to speak with a powerful single voice to those outside the profession, in the UK and internationally, to provide a framework for harnessing the resources of the profession to best effect, to regulate the profession to high standards, thereby serving the public interest in wealth creation, health, safety and the environment; to meet the needs of engineers to develop their skills, knowledge and competence, to ensure a supply of engineers, which in quality and quantity meets the future needs of industry, commerce, Government and society and to ensure that the importance of engineering is understood in the community so that the profession exerts its proper influence on society.

11. From this mission statement we have developed specific objectives for the regulatory and promotional system which are set out in the Report. We believe that there is likely to be widespread support for their adoption.....

(ii) Activities to achieve the objectives

12. Existing activities of the Engineering Council and the Institutions address most of the objectives, but co-ordination is weak. Some objectives may require a major change in direction.....

(iii) Organisation of the profession

13. We do not believe that the current organisational framework can secure the real progress which is needed to fulfil the mission.

14. We describe two ways of organising the profession. We first propose a **New Relationship** between the Central Body and the separate Institutions. We then consider, as an ultimate goal, the **Central Body** and the Institutions merging into a **Single Institution**.....

16. We have sought to strike a balance between partnership and leadership, in devising our model for the New Relationship. The main elements would be:

(a) at least a clear majority of the Council members of the Central Body would be elected by individual engineers;

(b) grouping Institutions into Colleges. They would be the principal source of policy advice to the Council and would co-ordinate the activities of the Institutions;

(c) a clear and agreed statement setting out the allocation of responsibilities between the Central Body, the Colleges and the Institutions;

(d) for responsibilities covered by an agreed policy framework, suitable arrangements for the Central Body to monitor the Colleges and Institutions and ensure compliance;

(e) engendering a sense of partnership;

(f) membership of an Institution to be a standard requirement for the central Register and Institutions to move towards requiring their members to qualify for the Register, subject in both cases to defined areas of exception;

(g) measures to encourage mergers between Institutions, on a voluntary basis; and

(h) practical steps by the Institutions to accelerate collaboration between them.....

18. By a **Single Institution**, we mean one body to replace the Central Body and all the Institutions whose members wanted to participate.

19. That would involve transferring all the functions of the Central Body and the participating Institutions to a Single Institution. All the individual engineers who met the qualifying standards would join the central Register, paying a single Registration fee. Implementing this would depend upon the Central Body and the participating Institutions, after consulting their registrants and members, being satisfied that a Single Institution would bring additional advantages for the profession.

20. Once fully evolved, a Single Institution would consist of a number of specialist Divisions, perhaps half a dozen or so, covering different branches of engineering. Much

of the activity would be organised through these Divisions. They would enjoy a degree of autonomy within a Single Institution and each might be headed by its own President and Council.

21. The advantages and disadvantages would need to be explored further - when Stage II of this study begins.

22. We envisage a gradual evolutionary process which moves the profession towards a Single Institution in a series of steps. The first step would be the programme of reforms to create the New Relationship. The aim would be to implement reforms which are desirable in themselves and designed to move towards a Single Institution.

23. It is possible that all the improvements that are needed could be achieved at an interim step on the evolutionary road, stopping short of a Single Institution. In the meantime, to give direction to that evolution, the profession should set itself the long-term goal of a Single Institution.....

25. Replacing The Engineering Council with a new Central Body, which in turn was replaced by the Single Institution, would involve unnecessary upheaval.

26. It would be better to retain a reformed Engineering Council unless and until a Single Institution is established. Reform will need to include changes to the arrangements for selecting Council members and changes to adapt it to the New Relationship. The Institutions would have to make corresponding changes.

(iv) Allocation of responsibilities in the medium term.

27. If a Single Institution were established, the process would take several years. In the meantime it will be necessary to reach agreement on the allocation of responsibilities between the reformed Engineering Council, the Colleges and the Institutions under the New Relationship. We have been guided by two general principles: that the centre should do only what is best done at the centre and that the allocation should be consistent with developing real partnership and evolution towards a Single Institution.

28. We envisage a substantial degree of delegation to the Colleges and Institutions, operating within an agreed policy framework set by the Council.

(v) Is there a need for statutory powers?.....

33 Before deciding whether to seek any form of legislation, the profession will need to discuss the issues further with Government and employers.....

Stage II of the study

34. As soon as the profession has reached decisions on the five fundamental issues, Stage II of this study should begin, to: develop the New Relationship, define the Single Institution, develop the decisions taken on the other fundamental issues concerning activities and statutory powers, tackle a range of additional, second-order tasks and devise plans to implement all these changes and prepare for the possibility of a Single Institution.

We have set out in the Report tentative ideas on how these issues might be developed in Stage II, in particular on selecting Council members, on how Colleges might work and on the implementation plans.....

36. The majority of Council members should be elected through a democratic process in which all individual members of the profession take part. There should be places for Chartered Engineers, Incorporated Engineers and Engineering Technicians. There should also be some members appointed for their wider experience or as lay members, and others chosen by the Royal Academy of Engineering.....

38. Each Institution should join only one College. Opinion is divided between basing the Colleges on disciplines or on industries, and since the main purpose is to bring together Institutions which feel comfortable working with one another our suggestion is to adopt a hybrid approach involving six Colleges: Electrical, Mechanical, Civil, Extraction and Processing, Transport, Pan-disciplinary support and services (to include those Institutions whose activity is relevant to the whole of engineering).....

42. It is now up to the profession as a whole to take decisions on the five fundamental issues we have identified: the objectives, the activities, the organisation of the profession, the programme of reforms to create the New Relationship, the development of a staged plan for moving towards a Single Institution, the initial allocation of responsibilities under the New Relationship and further consideration of the statutory question.....

Recommendations

44. Our main recommendations are as follows:

Our central recommendation is that the profession should embark on a programme of reforms, drawn up by the end of 1993, to create a New Relationship between The Engineering Council and the Institutions, to achieve the agreed objectives; and should by the end of 1995 establish a proposal, on which the whole profession would then be invited to decide, to move in a series of steps from the New Relationship to a Single Institution.

We recommend that The Engineering Council should continue to act as the Central Body unless and until replaced by a Single Institution, but that the programme of reforms should include an independent review of its operation and the necessary structure and staffing to fulfil the requirements of the New Relationship, conducted by management consultants.

We recommend that all the Institutions co-operate wholeheartedly in devising and implementing the reforms we envisage, and in preparing for a decision by the end of 1995 on moving in a series of steps towards a Single Institution.

We recommend that the profession adopts the initial allocation of responsibilities between the reformed Engineering Council, the Colleges and the Institutions, set out in the Report, but keeps it under review as progress is made towards a Single Institution.

We recommend that the options on whether to seek legislation are fully explored in Stage II of this study, but that the profession should adopt the proposals in our Report without waiting for the outcome of those deliberations.

'Engineering into the Millennium', Interim Report of the Council of Presidents' Steering Group, (First published April 1993), ISBN 0 9516611 8 3. Executive Summary, ISBN 0 9516611 9 1 ❖

STANDARDS 1993 - A TUTORIAL OVERVIEW

John Woodgate

There are three sorts of people in the technological world, those who swear by standards, those who swear at standards, and those who are indifferent. The latter have traditionally been in the great majority, but this is rapidly changing. It is a forced change, brought about by a number of virtually irresistible developments which began about five years ago, and the number and influence of these developments continues to increase. The result is that many people who previously did not have to know about standards, now do need to. Furthermore, the new developments mean that much that was dogma in the past is now heresy, and this implies that many standards-conscious people need a modicum of re-enlightenment.

What are we talking about?

'Company standards demand the observance of all national and international standards, so that standards of product and service quality are maintained at the standard to which our clients have been accustomed, and sub-standard performance is eliminated.' Not great literature, admittedly, but it serves to illustrate that 'standard' has many meanings, and we had better be sure which one we are using in this article.

There is a verbose definition in ISO Guide 2 and another in BS0 Part 1. These do not provide much insight, and include explicit and implicit value judgements, such as 'approved by a recognized body', which are potentially the source of controversy ('recognised' by whom?).

A standard, in the context of this article, is 'an agreement by a group of people to adopt a defined practice'. The practice must be quite closely defined, otherwise the 'agreement' may in effect be so vague (or 'flexible') that it is ineffective. On the other hand, there may, for some, be a very positive outcome of such vagueness. Consider, for example, the well-known RS232 serial data communication standard. It is so 'flexible' that a considerable industry has grown up to provide 'sleuthware' to diagnose incompatibilities between dialects, or different implementations, of the standard, and 'fixware' to put things right.

What is in a standard?

The content of a standard may be;

- definitions, abbreviations or symbols
- methods of measurement
- performance requirements
- a code of (good) practice
- guidance

In addition, most standards-making bodies also produce publications, under various descriptive labels, which are more tentative than standards: we shall call them 'reports'.

Standards which contain methods of measurements or performance requirements form a special category, which the British Standards Institution calls 'specifications', and it would be well for other standards-makers to make this distinction as well. Furthermore, according to current thinking, that 'or' should be an 'exclusive-or', ie specifications of methods of measurement should not be in the same standard as specifications of performance requirements. This is because the same methods of measurement are usually applicable to a wide range of generally similar equipment, whereas a set of performance requirements usually applies only to a rather narrow range. It is also highly advisable not to mix code of practice material with a specification, but definitions, abbreviations, symbols and guidance may, of course, appear within any of the other types of standard. There should not be too much guidance: standards-making bodies should not write textbooks.

The threat dimension

A powerful antidote to indifference is a threat to profitability or market share caused by the introduction or enforcement of a standard. Because indifference has hitherto been the norm, protests resulting from such a threat have often been answered by 'an industry gets the standards it deserves', and that principle is still true and will remain true. Standards may be flawed in content, or ineffective, if the leading players in the field do not participate in the standards-making process, or do not respect the standard when it is published. This goes right back to the definition; if there is no realistic or lasting agreement, there is no effective standard.

Cost or investment?

Standards are prepared, almost without exception, by committees composed of representatives of industry and academia, together with, for example, representatives of consumer interests in appropriate cases. There are still some people who believe, quite wrongly, that British Standards are written by BSI staff. Clearly, for an organization to take part in standards-making, there is a cost involved, in terms of the time spent by personnel of that organization in attending meetings, and studying and commenting on documents between meetings. However, against this cost must be set the advantages gained from being able to influence the content of standards, and advance information on their content and date of introduction, which, if intelligently fed back, both to those concerned with product development and those concerned with marketing planning, can produce effective cost savings far in excess of the cost of participation. When successful (and it often is successful), this strategy makes standards work an investment, not an expense. Perhaps it is significant in this context that the Japanese national committee is one of the most active in ISO and IEC standards work.

The alternative

The recent changes in the standards-making process have been prompted by the following powerful forces:

- increasing pressure to harmonise national standards, to promote free trade
- increasing reference to standards in legislation, following the realisation that the direct inclusion of complex technical requirements in the legislation itself is impracticable and undesirable (because it is difficult to get it right and even more difficult to amend it)
- the need for standards-making to match the increasing speed of technological development

The result of these forces is that, once the need for a standard is perceived by a sufficient number of people, it will be produced, practically regardless of who decides not to participate. As explained above, the resulting standard may be imperfect, in which case it will have nuisance value, possibly quite a lot. In other words, if there is standards activity in your area of operations and you do not do it, someone else will, and you may well not like the result! A good example is non-broadcast closed-circuit television (CCTV), which is used in quite a number of different fields. Only the security systems industry has seen fit to invest in the production of European standards for methods of measurement and performance requirements. Because of the non-duplication principle, it will be difficult for another industry sector to secure support for the production of CCTV standards more suitable for its needs.

Standards-making bodies

We can usefully identify about five levels of standardization, distinguished by their areas of authority, and illustrate them by examples of standards-making bodies functioning at those levels:

International level

Most familiar to many IOA members is ISO, whose title is one of the shibboleths of the standards experts: you have to know it is the International Organization for Standardization, not the International Standards Organization! ISO is an organ of the United Nations, and is based in Geneva. Although its remit is supposed to exclude electrical technology, this is no longer the case: it deals, for example, with automobile electrical systems. Electrical technology is primarily the province of the International Electrotechnical Commission (IEC), which is also a United Nations organ, and also based in Geneva.

In addition to these, there are numerous specialist international bodies, such as the International Organization for Legal Metrology (OIML). Relatively peripheral to the activities of the IOA (at least until now) are the subsidiary bodies of the International Telecommunications Union (ITU), which were until recently the International Frequency Registration Board (IFRB), the Comité Consultatif International de Radio (CCIR) and the Comité Consultatif International Télégraphique et Téléphonique (CCITT). The IFRB has recently been reconstituted, while the CCIR has been replaced by the Radiocommunications Agency of the ITU (not to be confused with the Radio Communications Agency of the British Government's Department of Trade and Industry). Strictly, neither the CCIR or the CCITT overtly produce 'standards', but their 'recommendations' effectively act as such in the fields of broadcasting and telecommunications.

Representation at ISO and IEC is through the national standards bodies ('national committees') of the member countries. Delegates and Working Group members nominated by the relevant BSI committee are normally particularly welcome, because almost all of the work is done in the English language (the other official languages being French and Russian) and it is becoming increasingly necessary for the texts to be written clearly, briefly and unambiguously. It is also necessary to eliminate expressions that cause difficulty in translation.

Regional level

The introduction of a supra-national level in standards-making may prove to be nearly as great a triumph for the EC as the Common Agricultural Policy. There are three main bodies: CEN, CENELEC and the European Telecommunication Standards Institute (ETSI). CEN and CENELEC are organs of the Community, and participation is via the national standards bodies, but ETSI is a private agency, open to a wide range of bodies that can pay the membership fees. CEN parallels ISO and CENELEC parallels IEC, while ETSI is supposed to parallel CCITT and the former CCIR, but has a strong tendency to interpret 'telecommunications' very widely indeed, and to attempt to exert its influence in areas where it has no provenance and no expertise. There are signs of the same paternalistic attitude re-appearing as one thought had disappeared for ever with the liberalization of telephone communication. After some initial political squabbles, CEN and CENELEC are now committed to co-operation with ISO and IEC, and no contrary or duplicating activity: at least, that is what is supposed to happen, but there is still a strong tendency in some quarters to fall back on a 'Fortress Europe' stance as soon as the international work deviates from what would be ideal for Europe (or for one country in it).

Supra-national, non-regional level

This level is represented mostly by the standards activities of internationally-active learned societies, such as the Audio Engineering Society. There can be difficulties, because from outside the host nation, the society may appear as a way of giving a national committee two votes, while inside the host nation, the national committee and the society may take opposing views on certain matters!

National level

Almost all developed countries have a national standards body, whose role in the past was to produce standards for that country. Now, the greater task is rather to co-ordinate national opinion and present it most effectively to the regional and international bodies. Some national standardization continues, of course, but the amount is generally decreasing. In Britain, the national standards body is the British Standards Institution: another shibboleth, 'Institution' not 'Institute'!

Industry level

Although apparently the lowest level of standardization,

industry standards can be very influential. In fact, only a few survive to become widely known and used. Exactly what triggers such a success is, happily, undiscovered. If it were discovered, the big and powerful would inevitably become involved in sterile conflict.

Convergence of technology

The standards business has been cynically likened to the building of the Tower of Babel, not least because of the language difficulties (which are not so prevalent now that everyone speaks English of a sort). Before the growth and diversification of digital technology, equipment for use in one industry sector bore little resemblance to that for use in another. That is certainly not true now. I do not know whether a sound level meter add-on (with spectrum analyser, of course) is available for the Psion Organizer, for example, but one certainly could be made! This is called 'convergence of technology', a phrase which has become well-known because the concept is simple enough even for politicians to understand. In standards work, it represents a considerable complication, because in the past one industry sector could more or less produce its standards in isolation, but now, what one committee agrees may provoke considerable justified protest from another. There is, however, a strong tendency for committees to become protective of their areas of interest.

A well-known painting of the building of the Tower of Babel shows work underway at four sites, at each of which a massive girder is rising to converge towards the centre of the tower, just like the Eiffel Tower. This is a good analogy of the present situation: while the four sites were more or less independent, there would be few communication problems, but when the girders converged, everyone would have to be able to communicate. ISO and IEC have attempted to solve the problem as far as 'information technology' (another phrase most useful to politicians) is concerned by setting up JTC1, a huge committee which has produced virtually innumerable subcommittees and working groups. It has not been without success, but it has been a very costly business, and there is no indication that costs will do anything but grow.

Making a standard

The procedures for making ISO and IEC standards have recently been revised and harmonised, with shortened time-scales. Also, the procedures for approving new work have been tightened: previously it was possible for just one person to start a committee on a long and complex project with no formal approval at all. The following details have been somewhat simplified, because there are a number of special provisions and minor aspects which would take far too much space to set out.

Projects are divided into six stages:

Stage 0 - Preliminary: This is an optional stage, which registers a committee's intention to work on a subject and to conduct informal discussions among experts. There is no progress schedule, but a vote of national committees is necessary to begin the work.

Stage 1 - Proposal: This is the normal first stage, and requires a vote of national committees on a New Work Item Proposal (NWIP), which is supposed to include progress schedule dates.

Stage 2 - Preparatory: Here is where the bulk of the making is done, usually in a Working Group (WG), whose members are nominated by national committees but serve as experts in their own right. The Group prepares Working Drafts (WD), until the Convener, or the Committee secretary, considers that no significant further improvement can be made. The work may be allocated to a Project Leader, who normally works with a sub-set of the Working Group members and other experts.

Stage 3 - Committee: The final draft text from the WG becomes a Committee Draft (CD), which is circulated to all national committees for comment: a time of three to six months is usually allowed for this. The comments are then considered, either by the Committee or the WG, and further CDs are circulated until the Committee considers that no significant further improvement can be made. At this point, the ISO and IEC procedures diverge. In ISO, the next stage is for national committees to vote on the latest text as a Draft International Standard (DIS). In IEC, the latest text is circulated as a Committee Draft with Vote (CDV) and a time of at least four months is allowed for voting. If an IEC CDV is approved, the text, perhaps after editing, is then circulated as a DIS.

Stage 4 - Approval: DIS texts are normally circulated in English and French. Six months is allowed for voting by ISO, but only four by IEC, because there is the extra CDV stage in the IEC procedure. No technical changes are allowed at this stage: if there are significant technical errors, the text must go back to Stage 3 or Stage 2. In ISO only (now), there is a procedure for voting again on minor technical changes (Two Months Procedure).

Stage 5 - Publication: In theory, this stage should not require any work outside the publishing office, but texts still arrive at the DIS stage, and are approved, wherein some expressions defy interpretation, in either language! Each committee is supposed to have an Editing Committee to prevent such problems, but not all do, and it is very difficult to find people who are both willing and competent to do this work.

Standards and the IOA

There are nearly 100 standards on acoustics in the current ISO catalogue, and at least some IOA members must be interested in each one. In addition, there are more than twenty IEC standards, and some British national standards, which are also significant. At present, the IOA is represented on few of the relevant BSI committees (still less on CEN/CENELEC and ISO/IEC), and has no formal system for ensuring representation or communicating with its representatives. This communication should be two-way: reports from representatives for the information of other members, and briefs to representatives on the corporate or consensus views of the Institute as a body. Perhaps the time has come for a change in this respect.

John M Woodgate is principal of J M Woodgate & Associates, Electronics Design, Standards & Marketing Consultants, 3 Bramfield Road East, Rayleigh ❖

ACOUSTIC PERFORMANCE OF TRAFFIC NOISE BARRIERS - A STATE OF THE ART REVIEW Part 1

Greg Watts FIOA

Introduction

For many years barriers have been erected alongside major roads to screen residential areas from high levels of traffic noise. In Europe, North America, Japan and Australia many different types of barrier have been installed using a wide variety of materials including wood, steel, aluminium, concrete and acrylic sheeting. Some of these designs have absorptive facings on the traffic side which reduce reflected sound and are claimed to improve screening. Barriers over 8 m in height have been used for some applications and novel capped barriers and angled barriers have been tested.

A review of literature world wide has identified a wide range of noise barrier systems. Some of the more useful summaries are given by Jackson [1], Bar [2], Rocchi and Pederson [3], Bowlby and Cohn [4], Yamashita and Yamamoto [5], Weiss [6], and West [7]. Barriers that may offer improved performance over simple reflecting barriers and therefore are worthy of consideration can be grouped under the following broad headings:

(i) Absorbing barriers - ie barriers incorporating sound absorbing elements that absorb a significant proportion of incident sound and hence reduce reflected sound which could contribute to overall noise levels in the vicinity.

(ii) Capped barriers - ie barriers that have a specially shaped top section which is claimed to reduce the sound power contribution from acoustic waves diffracted over the top of the barrier.

(iii) Double barriers - ie two parallel simple barriers built along one side of a road so that the sound from the traffic stream is diffracted over the top edges of both barriers.

(iv) Longitudinal profiled barriers - ie barriers that vary regularly in height along their length and are designed to reduce noise by creating destructive interference effects behind the barrier.

(v) Angled barriers - ie barriers that are tilted away from the vertical in order to reflect traffic noise upwards and away from residential areas.

(vi) Dispersive barriers - ie barriers that have contoured surfaces angled so as to disperse the noise, the aim being to prevent strong sound reflections into the area where screening is required.

(vii) Embankments and earth mounds which may be used in combination with a conventional barrier.

(viii) Vegetative barriers - ie barriers made partly or wholly from vegetation which is rooted in a retained soil mound. The mound can be retained by various means, eg woven willow branches.

(ix) Covers - can take many forms eg a grid or set of louvres set horizontally over a cutting or a complete cover screening both sides and the area above the road.

In Europe earth mounds, wooden barriers and absorbing barriers of various constructions are widely used. At present only relatively small amounts of vegetative barrier have been constructed. In the USA a wide range of materials are also used, with masonry block walls accounting for over 30% of the 700 km of barrier constructed by 1988, Weiss [6].

This paper examines and reviews the current state of the art of roadside barrier design. In particular the paper concentrates on the acoustic performance achieved by different designs and recommends further research which should be carried out in order to establish the cost effectiveness of promising prototypes.

Theory of Barrier Attenuation

Figure 1a shows the possible significant sound propagation paths over flat ground for sound radiating from a line or point source S to a receiver position R. In the absence of a barrier the noise level at point R resulting

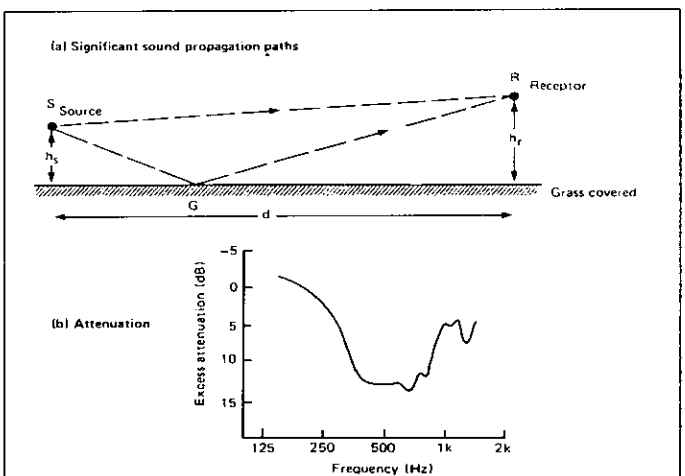

Fig. 1. Excess attenuation with frequency for propagation over grassland (Hutchins et al [9])

from a traffic source at S is the sum of the contributions from the direct path SR and the reflected path SGR. The direct and reflected rays interfere and ground and surface waves may be generated which add to the complexity of the situation, although the latter effect is unlikely to produce a significant change in level. The frequency range over which destructive interference occurs (ie where there is a lowering of sound level) is critically dependent on the air flow resistivity of the ground surface which dictates the phase change that occurs on reflection (Delany and Bazley [8]). Hutchins et al [9], using scale model experiments where grassland was simulated,

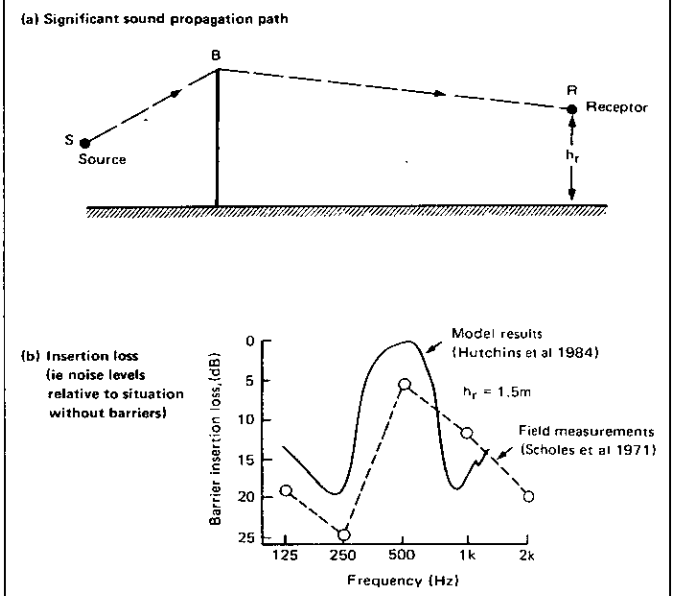

Fig. 2. Insertion loss of 4.9 m barrier when placed 10 m from source on grassland (Hutchins et al [9])

showed that interference effects create excess attenuation over the free field propagation in a band centred close to 500 Hz (see Figure 1b). When a barrier is placed between source and receiver as shown in Figure 2a the direct contribution is replaced by the diffracted path over the top of the barrier and the contribution is much reduced. However, wave interference does not take place to a significant degree as path SGR shown in Figure 1a is prevented by the barrier. Consequently, the barrier's effectiveness measured in terms of extra attenuation over that obtained without the barrier (the insertion loss) is reduced in the 500 Hz region as can be seen in Figure 2b. Experimental confirmation of this effect has been demonstrated by Scholes et al [10].

Various prediction techniques have been developed to allow calculation of noise levels where barriers are present and several are based on Maekawa's results (Maekawa [11]). The amount of sound energy reaching the receiver from the source is chiefly dependent on the path difference between the direct ray from source and receiver and the rays grazing the top of the barrier. In Figure 2a this is the difference (SB + BR) - SR. The sound level drops rapidly as the receiver position moves from the 'illuminated' zone, where the sound rays can pass directly from source to receiver, to the 'shadow' zone where the barrier is between source and receiver. Figure 3 shows the dependence of barrier screening performance for a traffic source on this path difference (Department of Transport and Welsh Office, [12]). To be efficient the barrier should largely prevent the direct transmission of acoustic energy. In practical situations this will occur if the sound energy that leaks through the barrier is more than 10 dB below the energy that is diffracted over the top of the barrier and round its edges. If the attenuation in dB(A) afforded by the barrier (A), based on the path difference, is known then the minimum mass per m^2 (M) of a simple wooden or masonry barrier needed to effect the required attenuation can be estimated using the formula:

$$M = 3 \cdot 10^{-(A-10)/14} \text{ kg/m}^2$$

(Department of Transport [13]) For most practical cases the structural strength of the material used for the barrier, rather than its acoustic property, is likely to determine the minimum mass required. It should be noted that barriers do not attenuate sounds of different frequencies to the same degree and Maekawa's experimental results show a clear reduction in screening efficiency as wavelength is increased. This explains the common observation that noise barriers are relatively less efficient at reducing the low frequency components of traffic noise.

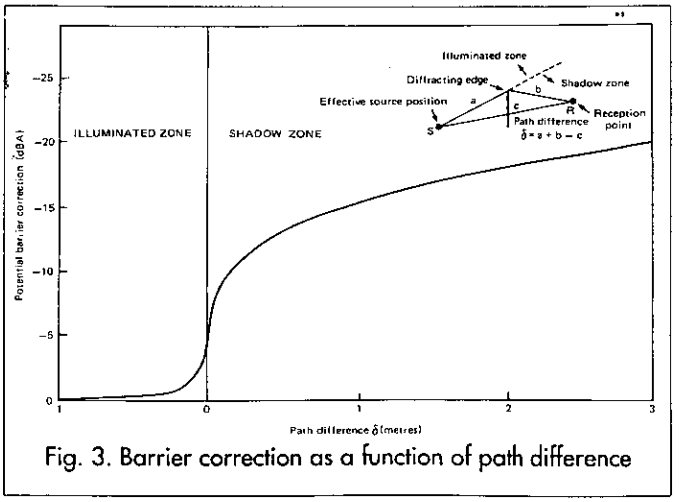

Fig. 3. Barrier correction as a function of path difference

Absorptive Barriers

Where plane vertical barriers exist on both sides of the road they are normally parallel to each other and in this situation sound is reflected back and forth between the barriers causing a reverberant build up of sound energy between the vertical faces of the barriers. This effectively causes a reduction in the path difference created by the screening barrier and a corresponding reduction in the screening performance. Figure 4 illustrates this effect. In this case, it can be seen that a single reflection from barrier, A, can lead to increased noise levels at a receptor position, R, located behind a second barrier, B. Clearly, multiple reflections between the barriers will tend to cause an even greater deterioration in the screening performance. Such effects have been investigated by Menge [14], Slutsky and Bertoni [15], Bowlby et al [16], Hajek and Kwan [17].

Absorbing panels located on the sides of the barriers

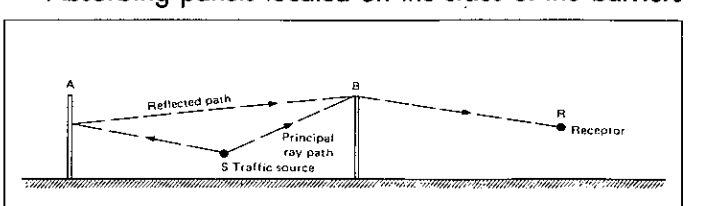

Fig. 4.Significant propagation paths for parallel noise barriers

facing the traffic can reduce this reflected contribution by absorbing the sound energy from the incident wave. This process usually involves the dissipation of the acoustic energy in the material through the transformation of acoustic energy ultimately into heat through frictional loss.

Types of absorbing barrier

There are several types of system that are used for sound absorbing barriers. Briefly, they are:

(i) Hollow box systems containing fibrous material. For this system the barrier panels are designed so that the side facing the traffic is perforated in order to allow the transfer of acoustic energy into the fibrous material contained within the box. The opposite side of the barrier is not perforated so that sound cannot readily be transmitted through the panel. The fibrous material usually consists of glass fibre or mineral wool and is often protected by a thin layer of glass fibre or other stable material that is not degraded by ultraviolet radiation. This is also considered to improve durability of the material to soaking and wind. Figure 5 shows a cross-section of such a barrier panel.

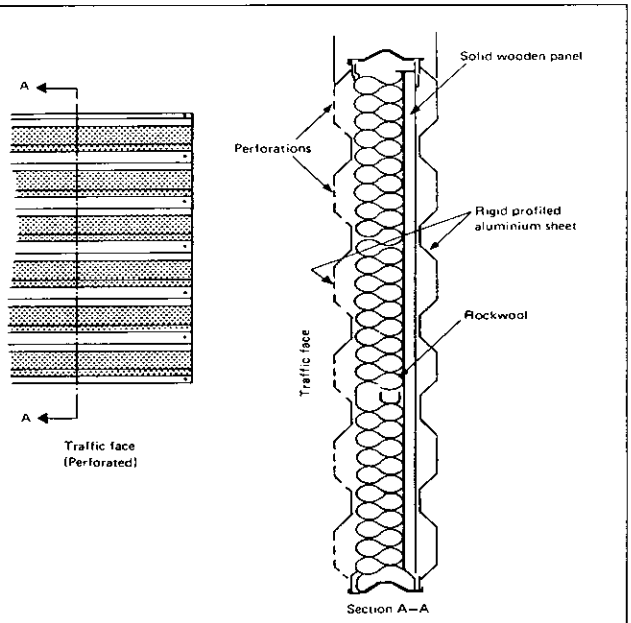

Fig. 5. Absorptive barrier constructed from perforated aluminium sheet and Rockwool fill material (Tobutt & Nelson [19])

(ii) Systems which use panels constructed with open-textured porous materials. For these materials, absorption is achieved via a combination of processes which include inertial and frictional losses in the connected voids of the permeable layer. Examples include panels constructed from specially fabricated concrete which results in a relatively light open porous structure, panels made from treated and compacted wood shavings bonded with cement and panels constructed from compressed coated flint particles. Unless of sufficient thickness a solid impermeable backing is usually required with these systems to prevent sound being transmitted through the panel.

(iii) Systems containing resonant cavities. The traffic side of the barrier contains slots or holes which connect with internal cavities. Sound is absorbed at selected frequencies depending upon the dimensions of the cavities. Fibrous or foam fillers can be included in the cavities to broaden the frequencies of the sound that is absorbed. Figure 6 shows an example of a slotted masonry block which can be used to construct a wall with absorbing resonant cavities.

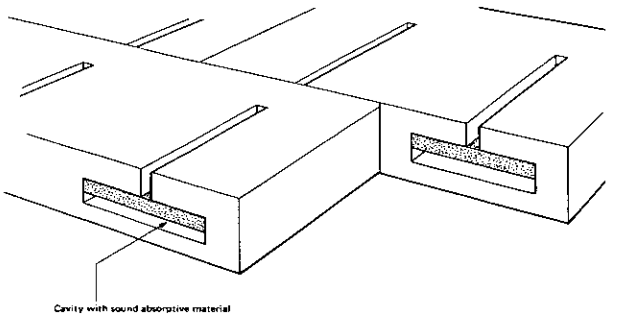

Fig. 6. Slotted masonry block

Assessment of acoustic performance

A measure often used to characterise the absorptive properties of barrier panels is the random incident absorption coefficient measured in a reverberation room. The test methods used by several countries include the use of tests derived from the International Standard ISO 354-1985 (Measurement of sound absorption in a reverberation room). For example, in the German test method (see Der Bundesminister für Verkehr [18]) a representative portion of the total barrier system, ie panels, posts and seals, is constructed in a similar manner to that used alongside the carriageway so that the acoustic performance that is likely to be achieved in practice is measured. The absorption coefficients are determined for each third octave frequency band in the range from 100 Hz to 5 kHz. Figure 7 shows absorption spectra obtained for some of the barrier systems described above. It should also be noted that some of the values plotted in Figure 7 are greater than unity. This anomalous result can sometimes occur if highly profiled and absorbent panels are tested. Strictly the reverberation test is only appropriate

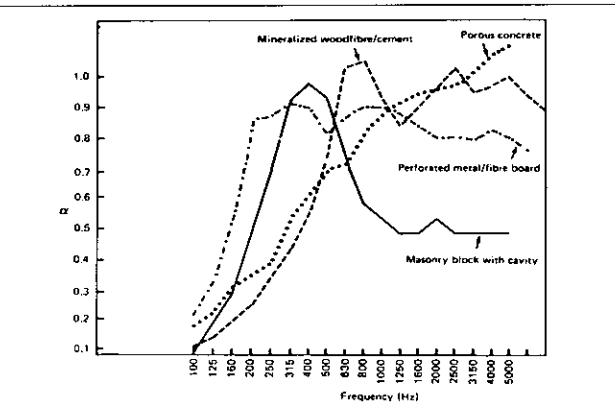

Fig. 7. The random incidence sound absorption coefficients for different materials obtained using ISO 345 - 1985 test method

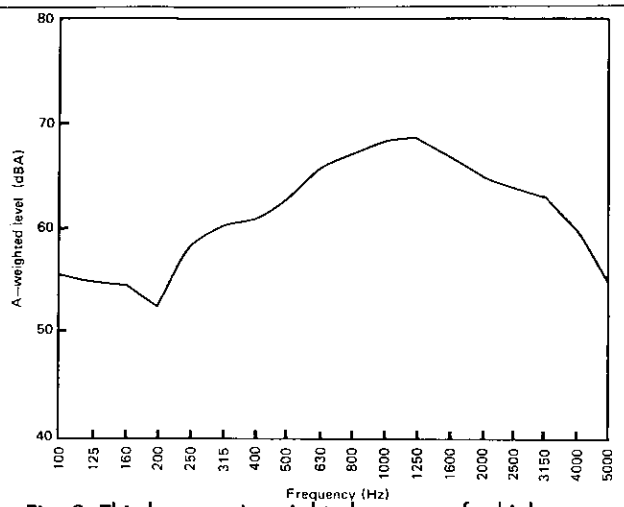

Fig. 8. Third octave A-weighted spectrum for highway traffic running on a bituminous road surface

for samples which are effectively flat. In practice it is often assumed that values determined using the reverberation test and found to exceed 1.0 are corrected by setting the α values equal to 1.0.

Clearly, to be effective the barrier material must be highly absorbent at frequencies that are significant in highway traffic noise spectra. Figure 8 shows a typical A-weighted spectrum which was obtained from measurements taken close to a rural dual carriageway road surfaced with a conventional hot rolled asphalt. It is clear that the frequency spectrum is broad band, ie it does not exhibit any significant tonal characteristics. The highest sound levels occur at frequencies close to 1 kHz. For effective performance, therefore, traffic noise barriers should absorb strongly over a wide range of frequencies

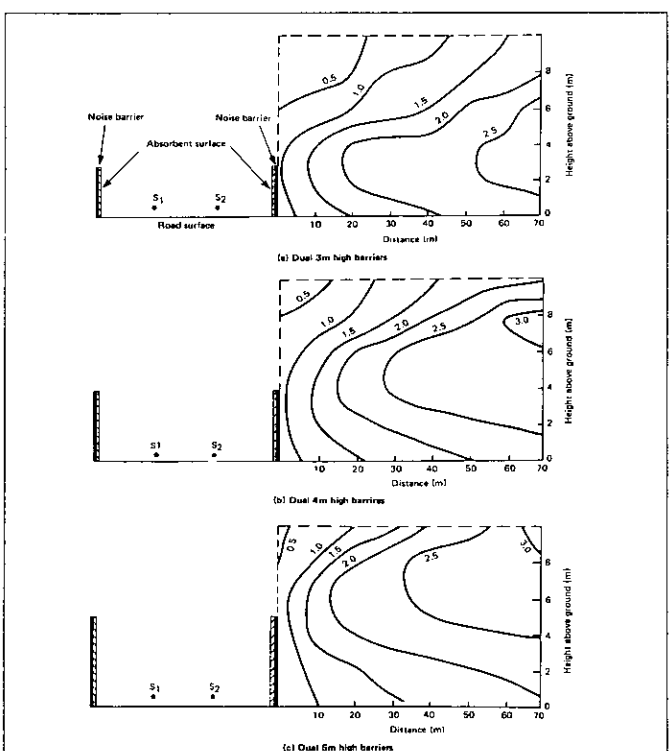

Fig. 9. Differences in L_{A10} dB for dual barriers with and without absorbent. (Posted values are L_{A10} [without absorbent] - L_{A10} [with absorbent]) (Tobutt & Nelson[19])

between say, 100 to 5000 Hz.

An overall measure of performance of absorbents used on noise barriers can be obtained by forming a weighted mean (see Der Bundesminister fur Verkehr, [18]) using the values determined at each 1/3rd octave frequency band. According to this German Standard, barrier materials can be classified as 'highly absorbing' only if the material achieves a high standard of absorption over a wide frequency range. The method allows the user to reduce the absorption coefficient data to a single number index which can then be compared against agreed criteria in order to classify the absorbent qualities of the material. For example, the absorption spectra shown in Figure 7 meet the requirement specified in the German Standard for 'highly absorbing' material apart from the masonry wall with resonant cavities. This material exhibits absorption coefficients which peak at relatively low frequencies and therefore would not be expected to have a significant effect on screening highway traffic noise. It should be possible, however, to extend the performance of this material to higher frequencies by adjusting the size of cavity and fill material.

There are difficulties in producing practical systems that will reduce low frequency noise ie <100 Hz since at these frequencies the wavelengths of sound are similar or greater than the dimensions of the barrier. It should be noted that for traffic streams moving at relatively low speeds, exhaust and engine noise tend to dominate and the peak in the typical A-weighted spectrum for this noise is found at these lower frequencies. Under these conditions, therefore, barriers may be less effective than along high speed roads.

Currently a European Standard (EN) is being prepared in Technical Group CEN / TC226 / WG6 / TG1 to establish common test methods for barrier materials throughout Europe. The ISO method referred to above will form the basis of the Standard although other in-situ measurement methods may be needed to allow checks on barriers that cannot be tested inside a reverberation room because of practical difficulties, eg vegetative barriers consisting of living shrubs and soil fill.

Parallel barriers

Tobutt and Nelson [19] gave examples of the effectiveness of absorbing parallel barriers using a computer model that has been validated against experimental data. Figure 9 reproduces contour plots showing the difference in noise level (L_{A10} dB) between barriers 45 m apart with reflecting and absorbing faces. At a distance of 50 m behind the barrier and at a height of 3 m the differences are in the range 2 - 3 dB(A); the exact value depends on the height of the barriers.

Slutsky and Bertoni [15] using a model specifically developed to predict the effects of absorptive treatments and angled barriers where parallel barriers are employed also clearly demonstrated the advantage of using absorbing elements on the traffic faces of the barriers. They found that with barriers 45 m apart and of height 4.5 m the insertion loss when using absorbing barriers was increased by 4 dB at 45 m from the barrier over hard ground (height of receiver not given). This com-

pares favourably with the results of Tobutt and Nelson for a similar geometry. They also showed that when the barriers are only 18 m apart the gain in insertion loss resulting from the use of an absorbing treatment rises to approximately 6 dB at the same distance.

It should be noted that field trials involving parallel simple reflecting barriers 3 m high and placed 74 m apart (Hajek [20]) showed no significant barrier performance degradation due to the opposing barrier. This was partly explained by the large separation and this seems a reasonable explanation given the reduction in performance between absorbing and reflecting barriers with increasing separation distance noted by Slutsky and Bertoni. However, a study by Nelson et al [21] on the M6 motorway in the UK also failed to show a significant degradation where barriers were estimated to be only 33 m apart. Clearly further full scale experiments are required where full account is taken of uncontrolled variables which are likely to affect noise levels, such as wind speed and direction, before definite conclusions can be reached concerning the size of any degradation in insertion loss.

Barrier/vehicle reflections

It may not only be in parallel barrier installations where absorbent treatments are likely to be effective. Clairbois [22] has suggested that due to multiple reflections between vehicles and noise barriers the effective height of the source rises, resulting in higher than expected levels on the far side. This would be most likely to occur where high sided commercial vehicles pass close to the barrier face. Figure 10 shows a possible series of reflections between a barrier and vehicle for a source located close to the road surface. S2, S4 and S6 denote the positions of image sources created by 2, 4 and 6 reflections between the side of the vehicle and the barrier. It can be seen how multiple reflections progressively reduce the screening performance of the barrier.

Since in general the heaviest vehicles emit the highest noise levels it is likely that the peak noise levels rather than the average level will tend to be decreased by the greatest amount when absorbers are employed in this type of situation. Clairbois suggests that the maximum A-weighted level would decrease by up to 6 dB and that the average, or L_{Aeq}, would be reduced by up to 3 dB if an efficient absorber was placed on the barrier face.

Diffraction effects

In addition to reducing reflections that can degrade the attenuation of barrier systems it appears that absorbing elements can reduce the amount of energy diffracted over the edges of the barrier (Butler [23], Rawlins [24]). By solving the wave equation for the problem of plane sound waves incident on a semi-infinite plane screen, Rawlins showed that there were significant improvements if the screen was absorbent. He concluded that if the absorbing material was located near the edge of the barrier it need only be of the order of a wavelength wide to have approximately the same effect in the shadow zone as a

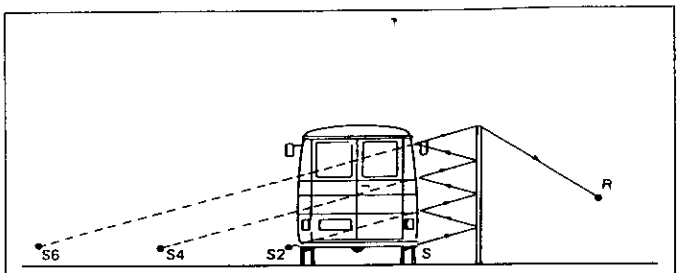

Fig. 10. Possible reflections between a non-absorbent barrier and the rigid sides of a high sided vehicle (Clairbois [22])

semi-infinite absorbing barrier. Butler's analysis of a similar problem also indicated this effect. Although no details are given, tests with scale model work for frequencies 1.6 - 12.5 kHz showed that improvements in attenuation of up to 5 dB were possible.

May and Osman [25] report a field study of a single barrier with reflective and absorbing faces. The barrier was 4 m high and was built 7.4 m from the edge of a 12 lane highway. Measurements were taken at distances up to approximately 100 m from the barrier. The absorbent material on the traffic face of the barrier was a wood/fibre/cement mixture. The absorbing face was then covered with hardboard in order to make the barrier reflective. Measurements were also taken at a central point close to a highway so that insertion losses under the two conditions could be adjusted for source strength variation produced by differences in traffic conditions. There was considerable variability in the relative insertion losses of these two treatments at the various measurement locations and there was no clear evidence that the absorbing face had any beneficial effects on the insertion losses. It is possible that wind speed and direction may have altered over the experiment resulting in changes in insertion loss that masked any effects due to the absorbent treatments. Such changes may not have affected levels at the control position which was adjacent to the highway. An indication of the variation in noise level at this site due possibly to meteorological factors can be seen by examining the data taken at a measurement position located approximately 20 m behind the barrier. Repeated measurements at this site showed that the measured insertion loss varied from 9 to 13 dB with a reflecting barrier in position and 5-13 dB for the absorbing barrier. Another possible explanation for the observed scatter could be that the background noise level varied since a second road ran 40 m behind this measurement point.

Clearly there is a need for further trials where account is taken of both meteorological factors and variation in traffic levels using suitable controls before definite conclusions can be drawn on the effectiveness of absorptive materials.

Part 2 of this article will appear in a later issue of Acoustics Bulletin.

References

[1] G M JACKSON, 'A review of highway noise barriers', The Highway Engineer, November, 13-16, (1979).

[2] P BAR, 'Matériaux utilises dans les écrans acoustiques en bordure de voies routières', Bulletin PCM, 4, 19-23, (1980)

[3] S E ROCCHI & S PEDERSON, 'Feasibility of transparent noise barriers', Transportation Research Record 1255, (1985).

[4] W BOWLBY & L M COHN, 'Sound-absorptive highway noise barriers', Federal Highway Administration, report FHWA-TS-86-214, (1986).

[5] M YAMASHITA & YAMAMOTO, 'Sound barriers - how are they used?', Proceedings of Internoise '87, (1987).

[6] M WEISS, 'Summary of highway noise barrier construction in the United States', Transportation Research Record 1176, Washington DC, (1988).

[7] P J WEST, 'The development of innovative traffic noise barriers 1989', National Transport Conference, Melbourne, The Institution of Engineers, (1989).

[8] M E DELANY & E N BAZLEY, 'Acoustical properties of fibrous materials', Applied Acoustics 3, 105, (1970).

[9a] D A HUTCHINS, H W JONES & L T RUSSELL, 'Model studies of barrier performance in the presence of ground surfaces. Part I - Thin, perfectly reflecting barriers' JASA, 75, 6, 1807-1816, (1984).

[9b] D A HUTCHINS, H W JONES & L T RUSSELL, 'Model studies of barrier performance in the presence of ground surfaces. Part II -Different shapes', JASA, 75, 6, 1817-1826, (1984).

[10] W E SCHOLES, A C SALVIDGE & J W SARGENT, 'Field performance of a noise barrier', Journal of Sound and Vibration, 16, 627-642, (1971).

[11] Z MAEKAWA , 'Noise reduction by screens', Journal of Applied Acoustics, 1, 157-173, (1968).

[12] DEPARTMENT OF TRANSPORT and WELSH OFFICE, 'Calculation of Road Traffic Noise', HMSO, London, (1988).

[13] DEPARTMENT OF TRANSPORT, 'Noise barriers - standards and materials', Technical Memorandum H14/76, (1976).

[14] C W MENGE, 'Sloped barriers for highway noise control', Proceedings of Internoise '78, (1978).

[15] S SLUTSKY & H L BERTONI, 'Analysis and programs for assessment of absorptive and tilted parallel barriers', Transportation Research Record 1176, Washington D C, (1988).

[16] W BOWLBY, L F COHN & R A HARRIS, 'A review of studies of insertion loss degradation for parallel barriers', (1987).

[17] J J HAJEK & L KWAN, 'Effect of parallel highway noise barriers', Proceedings of Internoise '80, (1980).

[18] DER BUNDESMINISTER FFR VEKEHR, 'Zusatzliche technische Vorschriften und Richtlinien für die Ausfuhrung von Lärmschutzwenden an Strassen', ZTV-LSW 88, Bonn, (1988).

[19] D C TOBUTT & P M NELSON, 'A model to calculate traffic noise levels from complex highway cross-sections', Report RR 245, Transport and Road Research Laboratory, Crowthorne, (1990).

[20] S I HAYEK, 'Efficiency of double walled noise barriers', Proceedings of Internoise '80, (1980).

[21] P M NELSON, P G ABBOTT & A C SAVIDGE, 'Acoustic performance of the M6 noise barriers', TRRL Report LR 731, Transport and Road Research Laboratory, Crowthorne, (1976).

[22] J P CLAIRBOIS, 'Road and rail noise - corrective devices', Seminar on 'Acoustic barriers - the engineered solution to road and rail noise pollution', I Mech E, London, (1990).

[23] G F BUTLER, 'A note on improving the attenuation given by a noise barrier', Journal of Sound and Vibration, 32, 3, 367-369, (1974).

[24] A D RAWLINS, 'Diffraction of sound by a rigid screen with an absorbent edge', Journal of Sound and Vibration, 47, 4, 523-541, (1976).

[25] D N MAY & M M OSMAN, 'The performance of sound absorptive, reflective and T-profile noise barriers in Toronto', Journal of Sound and Vibration, 71, 1, 65-71, (1980).

 TRL is planning a one-day meeting on road traffic noise barriers for 21 October 1993: further information from Greg Watts at TRL, Tel 0344 770414.

Greg Watts FIOA is Senior Project Manager at TRL. ❖

MEDALS AND AWARDS 1994

The Institute of Acoustics annually honours people whose contributions to acoustics have been particularly noteworthy.
The awards under consideration for 1994 are the Rayleigh, Tyndall and A B Wood Medals all of which will be awarded to acousticians from the UK.
Nominations for these honours and for the Simon Alport Prize and Honorary Fellowships are now sought from the membership and should be sent in the first instance to the President at the Institute office marked "Medal Nomination: Confidential". Information on these awards follows below.

Rayleigh Medal
John William Strutt, Third Baron Rayleigh (1842-1919) is remembered as a most versatile physicist, both as an experimentalist and as a theoretician.
A graduate, fellow and finally Chancellor of Cambridge University, he was early elected to Fellowship of the Royal Society of which he was President from 1905 to 1908. He received the Nobel Prize for physics in 1904.
Rayleigh's work covered practically every branch of physics and he was the co-discoverer of the rare gas argon. In acoustics, he published over 100 articles and his book The Theory of Sound remains a land mark in the development of the subject.
The Rayleigh Medal, of gold-plated silver and bearing the portrait of Lord Rayleigh, is awarded without regard to age to persons of undoubted renown for outstanding contributions to acoustics.
The award is normally made to a United Kingdom acoustician in even numbered years.
The Institute is pleased to have honoured these acousticians with the Rayleigh Medal:

P H Parkin UK 1975
L M Brekhovskikh USSR 1977
E G S Paige UK 1978
E A G Shaw Canada 1979
P E Doak UK 1980
K U Ingard USA/Sweden 1981
G B Warburton UK 1982
E J Skudrzyk USA/Austria 1983
J E Ffowcs-Williams UK 1984
P J Westervelt USA 1985
E J Richards UK 1986
M R Schroeder Germany 1987
D G Crighton UK 1988
H E von Gierke USA 1989
F J Fahy UK 1990
M Heckl Germany 1991
Sir James Lighthill UK 1992
M Bruneau France 1993

Tyndall Medal
John Tyndall (1820-1893) was active in acoustics before Rayleigh, and indeed Rayleigh actually succeeded Tyndall as Professor of Natural Philosophy at the Royal Institute.
Born in County Carlow, Ireland, he studied chemistry, physics and mathematics at Marburg University (under Bunsen) and was elected a Fellow of the Royal Society in 1852. Later he investigated the acoustic properties of the atmosphere and his volume of lectures On Sound has been reprinted many times.
Tyndall was a distinguished experimental physicist but is remembered primarily as one of the world's most brilliant scientific lecturers.
The Medal named after him, a silver-gilt medal, is awarded to a citizen of the UK, preferably under the age of 40, for achievement and services in the field of acoustics.
The following is the list of recipients:

M E Delany 1975
H G Leventhall 1978
R K Mackenzie 1980
F J Fahy 1982
R G White 1984
J G Charles 1986
M F E Barron 1988
N G Pace 1990
S J Elliott and P A Nelson1992

A B Wood Medal
Albert Beaumont Wood was born in Yorkshire in 1890 and graduated from Manchester University in 1912.
In 1915 he became one of the first two research scientists to work for the Admiralty on anti-submarine problems and he later designed the first directional hydrophone for use in submarine detection.
He was well known for his many contributions to the science of underwater acoustics and for the help he gave to his younger colleagues.
The A B Wood Medal and Prize, instituted after his death and as a result of the generosity of his friends on both sides of the Atlantic, is aimed at younger researchers whose work is associated with the sea.
The silver medal, parchment scroll and cash prize were awarded from 1970, prior to the formation of the Institute of Acoustics, by the Institute of Physics. The award is made alternately to acousticians domiciled in the UK and in the USA/Canada.
Recipients of the A B Wood Medal are as follows:
P A Crowther UK 1976
P R Stepanishen USA 1977
A D Hawkins UK 1978
P H Rogers USA 1979
I Roebuck UK 1980
R C Spindel USA 1981
M J Buckingham UK 1982
P N Mikhalevsky USA 1983
M J Earwicker UK 1984
T K Stanton USA 1985
P D Thorne UK 1986
D Chapman Canada 1987
V F Humphrey UK 1988
M G Brown USA 1989
A P Dowling UK 1990
M B Porter USA 1991
C H Harrison UK 1992

The Simon Alport Prize
This prize is awarded from time by the Institute to young acousticians for notable work in the field of computation applied to acoustics.
It was established, and donated, by Cirrus Research plc, for whom Simon Alport worked and who died at a tragically young age.
The prize of £250 is awarded to the person who, in the opinion of the judges, has published the best recent paper describing work that involves the application of computers to any branch of acoustics.

Honorary Fellowships
Honorary Fellowships are awarded to distinguished persons intimately connected with acoustics, or a science allied thereto, whom the Institute wishes to honour for exceptionally important services in connection therewith, and any distinguished person whom the Institute may desire to honour for service to the Institute or whose association therewith is of benefit to the Institute, shall be eligible to become Honorary Fellow of the Institute.
The total number of Honorary Fellows shall not exceed 2 per cent of the number of persons elected as Corporate Members of the Institute.
Honorary Fellows are:

J Lighthill UK 1978
W A Allen UK 1978
E J Richards UK 1978
W Taylor UK 1980
F Ingerslev Denmark 1981
C A Taylor UK 1985
B Pippard UK 1985
P V Bruel Denmark 1986
C M McKinney USA 1986
M E Delany UK 1989
P Lord UK 1992
B L Clarkson UK 1993
D W Robinson UK 1993

CALL FOR PAPERS

1993 Autumn Conference
Environmental Noise

Organised jointly by the Industrial Noise, Environmental Noise and Building Acoustics Groups

Hydro Hotel, Bowness on Windermere
18 - 21 November 1993

Two years ago at Windermere, during the Noise in the Nineties conference, the discussion sessions left many matters clearly in need of further consideration. These included clay target shooting assessment, vibration impact analysis, BS4142 efficacy etc. The 1993 conference, which will be organised into formal and poster sessions together with a number of workshop sessions, is an opportunity to continue the process. Since 1991:

- The publication of the revision to DOE Circular 10/73 has progressed, and various PPG documents issued. Comprehensive research on the impact of aircraft noise on sleep has been published and the implication for Policy could be significant.
- The Building Regulations have been revised and Central Government's intentions confirmed in their White Paper: This Common Inheritance : 2nd Year.
- The Government has: issued guidance to local authorities and the police on the control of noise from noisy parties, introduced new regulations for noise insulation in properties converted into flats, issued a consultation paper on the control of aircraft noise, revised a booklet providing guidance on dealing with noise nuisance, issued a consultation paper containing proposals to strengthen the law on noise including new powers to cover noise in the streets.
- Further research on noise is planned and the government proposes to: implement an EC Directive on aircraft noise by mid 1993, issue revised planning guidance on noise to local authorities and endorse codes of practice on several topics relating to noise.

Offers of contributions are invited on any aspect of environmental noise affecting people in and around buildings; suggested topics include:

- issues arising from latest planning guidelines
- noise impact of mineral workings
- noise impact of aircraft at night
- noise impact assessment of non-standard noise producers, eg. car parks, motor boats;
- sound proofing schemes
- new techniques for predicting, monitoring and controlling environmental noise

Papers of sufficient technical merit, whether presented in the formal or poster sessions, will be published in Volume 15 of the Proceedings of the Institute of Acoustics (1993), available at registration. Abstracts of not more that 100 words should be sent to the Conference Organiser by 31 July and completed papers, normally of up to 8 pages in length and for which camera ready paper will be supplied, are required by 18 October 1993.

Conference Organiser
Jeff G Charles FIOA
Bickerdike Allen Partners
21 Salusbury Road, London NW6 6RG

Programme Committee Chairmen:
Dr L Fothergill FIOA, Building Research Establishment
Dr R J Peters FIOA, NESCOT

INSTITUTE DIARY 1993/94

15 JUN
IOA NAMAS meeting, 1 day (new date)
NPL

16 JUN
Helicopter Noise Certificn; London Br evg mtg
NESCOT, Epsom

18 JUN
IOA CofC in Env Noise Measurement; first exam
Four Centres in the trial

25 JUN
IOA CofC in W'place Noise Ass't Advisory Committee
47 Belgrave Square, London

1 JUL
Text required for the July/August Bulletin

9 JUL
IOA CofC in Env Noise M'ment; Advisory Committee
St Albans

13 JUL
IOA Diploma Working Party
St Albans

15 JUL
IOA Executive Committee
St Albans

21 JUL
Noise Council Meeting
IEHO, London

31 AUG
IOA Diploma results mailed out

15 SEP
Acoustic Properties of Advanced Materials for Underwater applications - Underwater Acoustics Group 1 - day Meeting
Bath

23 SEP
IOA Membership & Meetings Committees
London

1 OCT
IOA CofC in Env Noise M'ment; 2nd exam
Accredited Centres

6 OCT
IOA Executive Committee
St Albans

7 OCT
IOA Medals & Awards, Publications Committees, am
St Albans

7 OCT
IOA Council, pm
St Albans

15 OCT
IOA CofC in W'place Noise Assesm't exam
Accredited Centres

20 OCT
Noise Council meeting
London

28 OCT
Reproduced Sound 9, 4 days
Windermere

11 NOV
IOA Education Committee
St Albans

12 NOV
IOA CofC in W'place Noise Assess't Adv Committee
London

18 NOV
IOA 1993 Autumn Conference, Env Noise, 4 days
Windermere

2 DEC
IOA Executive Committee
St Albans

2 DEC
IOA Membership & Meetings Committees
St Albans

9 DEC
IOA Medals & Awards, Publications Committee, am
St Albans

9 DEC
IOA Council, pm
St Albans

20 DEC
Short Range Propagation, Communication and Telemetry - Underwater Acoustics Group 2-day Meeting
University of Birmingham

1994

8 FEB
The Safety & Health at Work Exhibition 1994, 3 days,
Olympia, London

11 FEB
IOA CofC in Workplace Noise Assessment, exam
Accredited Centres

11 MARCH
IOA CofC in W'place Noise Ass't Advisory Committee
47 Belgrave Square, London

19 APRIL
ACOUSTICS '94, 3 days
University of Salford

20 MAY
IOA CofC in Workplace Noise Assessment exam
Accredited Centres

7 JUNE
RoSPA International Safety & Health Exhibition, 3 days
NEC, Birmingham

10 JUNE
IOA CofC in W'place Noise Ass't Advisory Committee
47 Belgrave Square, London

16 JUNE
IOA Diploma exams, 2 days
Diploma Colleges

MEMBERSHIP

The following were elected at the Council Meeting held on 27 May 1993

Member
Ash, S
Butterfield, D A
Capper, J J
Diston, S J
Dowdall, M A
Felgate, N J
Goring, P
O'Keefe, J
Porter, M J
Purdue, A J
Smith, C P
Stewart, M A
Timpson, P G
Watts, D L
Wharmby, J S
Williamson, S A
Windle, R M
Wright, D A

Associate Member
Allen, V J
Askew, K D
Barnett, J
Ferrigato, A
Knight, R D
Knowles, A E
Moran, J C
O'Shea, D
Smeatham, D
Toh, C T
Yu, C W

Associate
Arnott, S P
Dye, G M
Gottfried, J
Lau, T Y
Naqvi, A
Paddon, I V
Russell, M J
Travers, P D

Student
Attwood, P E W
Budd, R W S
Driver, O C
Farren, J M
Lee, H E
Liddell, A G
Mercy, S E

Non-Institute Meetings

1993
July
5-8
Ultrasonics International '93, Vienna, Austria
5-9
NOISE & MAN '93
6th International Congress on Noise as a Health Problem, Nice, France
7-9
International Symposium on Pump Noise and Vibration, Paris, France

August
24-26
INTER-NOISE 93, Leuven, Belgium
31-2 September
4th Conference on Intensity Techniques, Senlis, France

September
2-3
Biennial Conference of the New Zealand Acoustical Society, Wellington, NZ
14-16
Environmental Health Exhibition, Blackpool
14-16
Gear Noise, Ohio State University, USA
15-17
10th International FASE Symposium, Bucharest
21-23
Environmental Engineering Conference, De Montfort University, Leicester

October
4-8
126th Meeting of the Acoustical Society of America, Colorado, USA

November
8-10
IOSH 93, Harrogate
9-10
Annual Conference of the Australian Acoustical Society, Glenelg, SA
10-11
International Conference on Instruments in Support of Health and Safety Legislation, London

1994
February
21-22
OFFSHORE 94, London

May
2-6
3rd French Congress on Acoustics, Toulouse, France

June
5-9
127th Meeting of the Acoustical Society of America, Massachusetts, USA

August
23-25
5th Western Pacific Regional Acoustics Conference, South Korea
29-31
INTER-NOISE 94, Yokohama,Japan

November
28-2 December
128th Meeting of the Acoustical Society of America, Texas, USA

1995
May
31 - 4 June
129th Meeting of the Acoustical Society of America, Washington DC, USA

June
INTER-NOISE 95, California, USA

MOMENT EXCITATION AND MOBILITY MEASUREMENT IN STUDIES OF STRUCTURE-BORNE SOUND EMISSION

Barry Gibbs FIOA and Björn Petersson FIOA

Introduction

The control of structure-borne noise remains a major challenge in acoustics. Machines often cause vibration of the supporting or surrounding structure which, in turn, can give rise to excessive mechanical strain in structural elements or give rise to radiated sound of an undesired level at locations, sometimes far removed. The task is to identify the key characteristics of machines and installations as vibrational sources and receivers, respectively, which influence structure-borne emission and thereby control by selection or design. It is clear from the seminal work of Cremer [1], begun over fifty years ago, that structure-borne emission depends not only on source activity, which can be represented by the velocity at the contact points of the free source, but also on the dynamic characteristics of the source and receiver structures, preferably given as a function of the ratio of source and receiver mobilities at the contact points [2]. In seeking an engineering solution, it is often assumed that forces only contribute to the transmission process. There are relatively few problems in estimating applied forces and the associated translational velocities and there are draft international standards for force excitation and registration for the measurement of translational components of mobility [3].

However it is increasingly recognised that moments can contribute significantly to structure-borne emission. Moreover, it is worth noting that three quarters of the mobility elements involve moments and rotations and, for example, techniques such as experimental modal analysis rely heavily on correct estimates of moment mobility. While rotational velocities are relatively easy to measure, problems remain concerning moment excitation. As early as the 1950s the importance of moment mobility was recognised [4] and various approaches for its measurement have been proposed since then. In Figure 1 is shown the moment mobility at a mount point on a medium sized centrifugal fan. A prototype moment exciter was employed which operated by magnetostriction. A matched pair of giant magnetostrictive alloy rods, excited out of phase with each other, produced a substantial moment over a small indenter area. The measurement shown allowed an estimate of the relative importance of components of vibration, including vertical force, on a power basis. In Figure 2 are shown the source descriptors for the same fan mount point. The source descriptor is a function of free velocity and component mobility at the source point and has the unit of power. It can be described as the ability of the source to deliver power [2] and it can be seen from the figure that force induced power is likely to dominate at low frequencies but that moments assume increased importance with increase in frequency. This observation could not have been possible without the use of a moment exciter.

Moment excitation

The requirement is for excitation where a near pure moment is imparted and an accurate measure of the generated moment is obtained. Methods proposed so far have involved indirect techniques ie where the moment

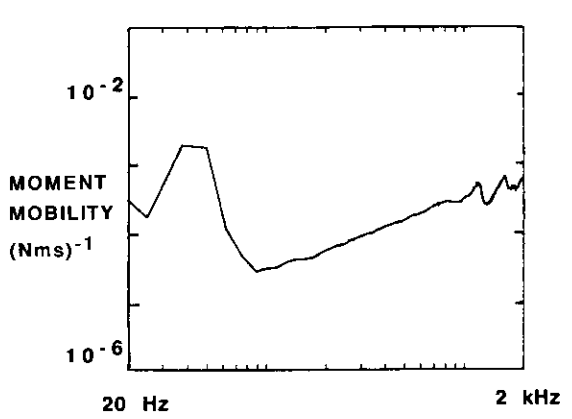

Fig. 1. Moment mobility at a mount point on a flange of a centrifugal fan.

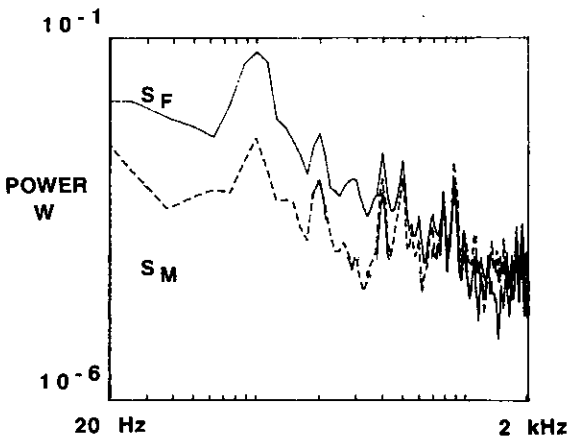

Fig. 2. Force source descriptor SF and moment source descriptor SM at the mount point of Fig. 1.

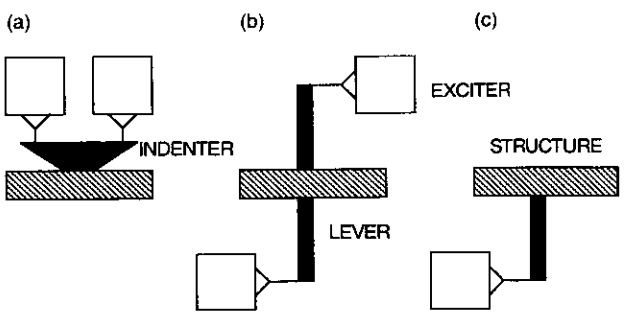

Fig. 3. Conventional moment excitation methods; (a) twin shakers, (b) symmetrical cantilevers, (c) one-sided cantilever.

mobility is extracted from other directly measured quantities and have involved the use of commercially available exciters and sensor transducers. This implies the use of force exciters and transducers, driving the structure eccentrically. In Figure 3 are shown some configurations, the practicalities of which have been investigated by Petersson [5] and Petterson and Sanderson [6].

The twin shaker arrangement requires accurate matching of the exciters and of the accelerometer pairs and problems of both access and loading of the measurement object result from too large an indenter which also limits the excitation at high frequencies. The symmetrical cantilever systems are intrusive and involve modification of the test structure. They also pose problems with respect to access, particularly with the twin shakers, and there are resonance effects in the levers at high frequencies. Single sided cantilevers introduce extraneous forces because of non symmetry. In general there are four categories of problem in developing an experimental technique for measuring moment mobilities; size of arrangement, attachment of the exciter, registration of the excitation and numerical problems. The last arises in indirect techniques and the precision in the associated direct measurements must be extremely high. In addition, indirect techniques require specific arrangements in order to make the numerical procedures possible. A direct technique is thus desirable. Recently, Petersson proposed a moment exciter employing the magnetostriction phenomenon [7] and prototypes have been used with some success, including those presently in operation at the Acoustics Research Unit at Liverpool University.

Magnetostriction

For ordinary translatory force excitation, a controlled excitation of structures requires sufficient force for good response signal. The conventional force producing mechanisms are to be found in electro-dynamic and hydraulic shakers. Previously, piezo-electric, thermal, magnetostrictive and acoustic mechanisms were rejected since they did not offer sufficient power. Registration is normally obtained through the piezoelectric effect but there are alternatives which employ capacitive, optical, thermal and piezo-resistive mechanisms and magnetostriction. In principle therefore, magnetostriction offers the possibility of both force generation and registration provided sufficient power can be imparted.

It was already known, at the beginning of the 1960s that rare earth metals possessed extraordinary magnetic properties [8]. In the 1970s magnetostrictive materials were found which operated well at room temperature. The material used in the development of a prototype moment exciter according to a design by Petersson [7] was Terfenol D ($Tb_{0.27}\,Dy_{0.73}\,Fe_{1.95}$). The magnetostriction originates from the magnetic anisotropy energy dependence on the strain. In order for the crystal to minimise its energy, it deforms when a magnetic field is presented to it. Conversely, deformation of the crystal results in a change in the interior magnetic characteristics. An alternating strain results from an alternating magnetic field through the rod produced by an electrical coil around it, driven at the desired frequency. A pre-load is advantageous in most applications and can be obtained mechanically in interaction with the required static magnetic field produced by powerful permanent magnets at the ends of the rods. The permeability of Terfenol varies with stress and offers the possibility of force registration. The alloys are powerful and the size of the excitation arrangement can be kept small. Small indenter size improves access and allows a direct single sided non intrusive measurement.

Actuator design

The moment exciter is shown in sketch in Figure 4 and in use in Figure 5. Two identical, parallel rods of Terfenol are pre-compressed between the seismic mass and a moment distributing indenter. The application of the moment exciter is basically the same as that of an ordinary electro-dynamic exciter for force excitation. However it should be appreciated that the measurement of moment mobility is physically not as straightforward. In Figure 5 the moment exciter is shown in measurements of moment mobilities at the mount points of a fan unit. Registration and system response are obtained by two matched pairs of accelerometer transducers (see Figure 6). The first pair registers the moment exerted which

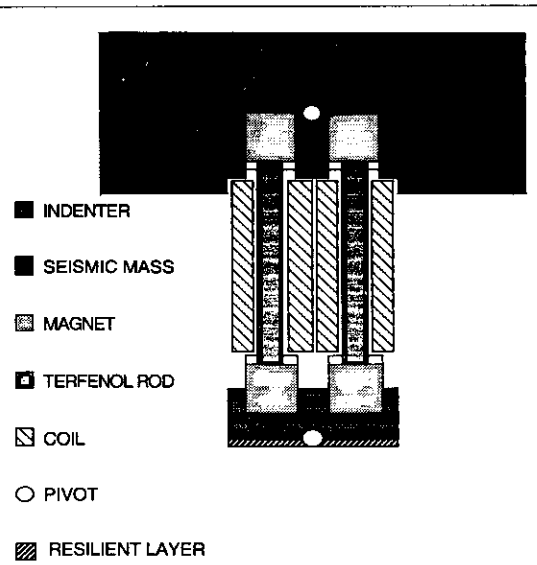

Fig. 4. Cross-sectional sketch of moment exciter (side straps not indicated).

is proportional to the rotational acceleration of the seismic mass while the second pair is used for the determination of the rotational acceleration of the object. The differential amplifiers are included in both circuits and the measured mobility is presented as a transfer function on a dual channel FFT analyser. If our-channel signal processing is available, various corrections to the four signals can be easily implemented. It should be emphasised that the influence of spurious excitation from mass loading and incorrect force couple matching is highly dependent on the measuring object but the re-conditioning of the estimates can be more or less comprehensive. Moment mobility is also strongly dependent on the manner in which the moment is applied ie the size, shape and rigidity of the driving device, and it is necessary to approximate as closely as possible the actual situation for which the mobility is required.

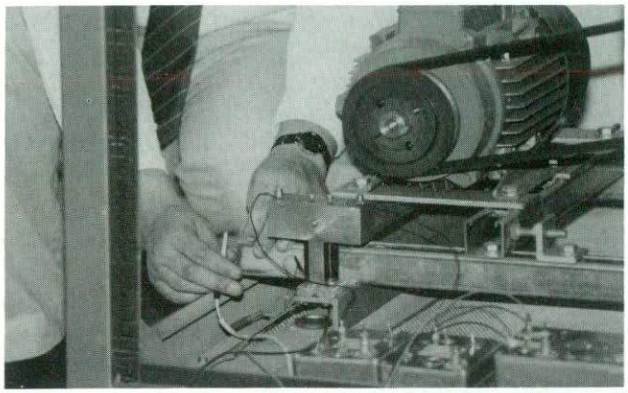

Fig. 5. The moment exciter in use.

Direct registration of the moment has not yet been achieved in the development of the prototype but remains an important goal and efforts continue to finance such research. The inherent non-linearities in the material properties of iron-rare-earth-metal alloys pose problems with respect to manageability. Alternatively, the bias-field can be obtained by means of a dc-field superposed on the ac-field but this has the drawback of heating the Terfenol rods.

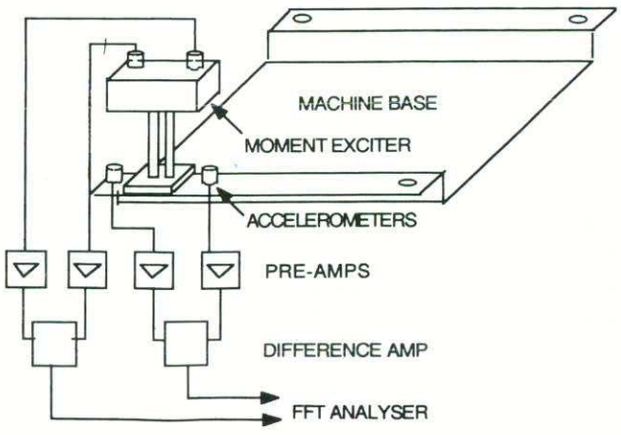

Fig. 6. Test arrangement for moment mobility measurement.

References

[1] L CREMER, M HECKL & E UNGAR, 'Structure-borne Sound', Springer Verlag, Berlin (1973).

[2] J M MONDOT & B A T PETERSSON, 'Characterisation of structure-borne sound sources: The source descriptor and the coupling function', Journal of Sound and Vibration, 114 (3), 507-518 (1987).

[3] ISO/DIS 7626/2, 'Vibration and Shock - Experimental determination of mechanical mobility - Part 2: Measurement using single-point translation excitation with an attached vibration exciter', (1987).

[4] L CREMER, 'Berechnung der wirkung von schallbrucken', Acustica 4, 273-276 (1954).

[5] B A T PETERSSON, 'The use of giant magnetostrictive devices for measuring moment mobility', Proc. Recent Advances in Structural Dynamics, Southampton, (1988).

[6] H PETTERSSON & M SANDERSON, 'Measurement of moment mobility', Report E 90-08, Chalmers University of Technology (1990).

[7] B A T PETERSSON, 'On the use of giant magnetostrictive devices for moment excitation', Journal of Sound and Vibration, 116,191-194 (1987).

[8] A E CLARK, 'Ferromagnetic Materials', Ch 7, Editor E P Wohlfarth, North-Holland Publishing Co, New York (1980).

Barry Gibbs FIOA is Reader in Acoustics at Liverpool University and he and Björn Petersson FIOA are at The Acoustics Research Unit, School of Architecture and Building Engineering, PO Box 147, Liverpool L69 3BX. Björn Petersson is also Senior Scientist at TNO, Delft. ❖

CORKY THE COCKEREL

Stephen Peliza MIOA

Introduction

The judgement of the case of 'Corky' the Cockerel in March 1993 appears on face value to ring the death knell for the countryside as we know it. This is the mistaken impression reflected in some local and national press articles. However as we all know, the average lay person can find it very difficult to understand the difference between varying noises or noise levels, unless they can experience the sounds at first hand. Press reporters are no different and can easily cloud the relevant issues.

I will thus attempt to explain the circumstances of this case which appears to have struck some sensitive chords in country areas. For me this type of case is not the mainstream of my workload. Although I spend a lot of time on work relating to rural areas, the more common sources of noise are primarily from transportation systems, industry and farming diversification. I understand however that this case has been received with interest by the legal profession concerned with nuisance. It should be noted that although 'Corky' is referred to as a cockerel the bird is in actual fact a fully grown cock.

Early days

The story starts in May 1975 when a Mr Ritchings, who was working abroad at the time, visited the rural village of Stoke in Devon not far from the coast at Hartand Point. He discovered a building plot in a pleasant location which was somewhat sheltered from the prevailing winds by a hillock. He decided to have a house built to his specifications on this plot. Mr Ritchings and his wife settled in their new home in September 1984.

Alongside one boundary lay some land with the property 'Trevarren' located about 50 metres away where a Mr and Mrs Johns lived. In the spring of 1990 Mr Ritchings became aware of a cock which was located in a compound with some chickens 3 metres from his boundary. The crowing would wake him and his wife in the early hours of the morning and this became progressively worse over the next few months. Mr Ritchings raised the matter with Mr Johns who gave Mr Ritchings the impression that the compound was a temporary arrangement.

The fowl compound was extended and during the spring of 1991 the noise appeared more vociferous and greatly disturbed Mr and Mrs Ritchings' sleep.

Eventually Mr Ritchings' complaints became more serious and although Mr and Mrs Johns were said to have carried out some measures, the situation remained unresolved as a local Environmental Health Officer, Mr Utting, was summoned to the scene.

Statutory Proceedings

The EHO, after an initial site visit and some unsuccessful mediation attempts, carried out a site measurement exercise and decided that in his opinion there was a statutory noise nuisance. The District Council then served an Abatement Notice in November 1991 under the Environmental Protection Act 1990 specifying a maximum level of 38 dB(A) at the boundary. Mrs Johns appealed on the grounds that no nuisance was being committed and that the notice was unreasonable.

The appeal was heard at Bideford Magistrates Court in May 1992 and the Notice was dismissed. Some inconsistencies were unchallenged, including a statement to the effect that 'to keep a cock's noise down to 38 dB(A) was totally ludicrous when the ticking of an alarm clock in a room could exceed 60 dB(A)'. There had also been a significant amount of local press interest before the hearing which had expressed concerns about the potential threat to the countryside as we know it.

The Bench took the view that in a small rural hamlet the sounds emanating from such an environment will obviously contain all contrasting elements of the country scene. Those who choose to live in the countryside should have the attitude of being prepared to make the most of all it offers, and that, according to the Bench was an issue of paramount importance.

Civil Action

Mr Ritchings was concerned, rightly so as it transpired, that the Statutory Proceedings would not resolve his problem. He thus instigated proceedings for a Civil Action arising out of a noise nuisance.

In April of 1992, His Honour Judge Cotterill served an interim injunction forbidding Mrs Johns 'From housing a cock closer to the Plaintiff's property than a line incorporating the eastern boundary wall of the defendant's bungalow'. This in effect meant that if the cock was to be kept on the land it had to be closer to Mrs Johns' property than Mr Ritchings' property.

Noise Advice

Solicitors, Seldon Ward and Nuttall, advised Mr Ritchings to appoint an acoustic consultant and as such I was instructed to provide assistance. By this time the cock had been removed from its compound and from the surrounding area. Attempts were made to return the bird to its compound in order that I could assess the noise aspects. Seldon Ward and Nuttall applied for a court order to facilitate a noise evaluation exercise, since the other party would not co-operate, but the order was not given. Eventually, with the trial date impending last minute arrangements were made. As many a member will have experienced, after a very early start to ensure that I did not miss the first crow, difficulties were experienced on site. Firstly a gale force wind was blowing and secondly the cock was locked up in a pen. Although the cock's crows were audible, this did not have the same

effect as being outside in the open wire mesh compound. When it was eventually let out, I was able to experience the sounds at first hand but the cock soon ceased to crow so I was unable to carry out reliable measurements.

County Court

The case was heard before his Honour Judge Cotterill at Taunton County Court in March 1993. My evidence used in support of the Plaintiff was based on the District Council's noise measurements and covered two main aspects. In a situation perhaps not envisaged by its authors, I firstly carried out an assessment generally in line with the BS4142 approach. The difference between the background level and the noise of the crowing was of the order of 32 dB(A), and this was substantially more than 10 dB.

Secondly, I compared sound levels inside the bedroom, of other rural sounds such a sheep located in a field adjoining the property boundary and birds singing. In my opinion the timing pattern of the crowing, the level, the repetitive nature and the frequency spectrum all combined to cause a noise nuisance and my view was consistent with that of the Environmental Health Officer.

The defence cited an extract from Kennaway v Thompson (1987): 'Nearly all of us living in these islands have to put up with a certain amount of annoyance from their neighbours. Those living in towns may be irritated by their neighbours' noisy radios or incompetent playing of musical instruments and they in turn may be inconvenienced by the noise caused by our guests slamming car doors and chattering after a late party. Even in the country the lowing of a sick cow or the early morning crowing of a farmyard cock may interfere with sleep and comfort. Intervention by injunction is only justified when the irritating noise causes inconvenience beyond what other occupiers in the neighbourhood can be expected to bear.'

The question was whether the neighbour was using his property reasonably, having regard to the fact that he has a neighbour. The neighbour who is complaining must remember too that the other man can use his property in a reasonable way and there must be a measure of 'give and take, live and let live'. The defence also suggested that Mr Ritchings should close his windows, draw his blinds and close his shutters, or in the extreme event move to another bedroom.

In summing up the Judge considered that the case was not about the right of country folk to keep livestock and not about the right of newcomers to a village to dictate to others how they should run their lives or their affairs. He stated that we are all free to use our televisions or our hi-fi equipment or our grass cutters but only if we have regard to the fact that our use of these things may affect other people. The Judge decided that the Plaintiff had proved his case and was entited to a final injunction which forbade Mrs Johns from permitting the cock to crow after night-fall and before 7.00 am to a level exceeding 10 dB(A) above the background noise level. This was to be related to a maximum level at the boundary. The apt and overriding theme as noted towards the end of the judgement was summarized in the expression 'each should live and let live'.

Cock Crows

The cock crows are high pitched sounds centred at around 2000 Hz. Crowing can commence at the very early hours of the morning and continue at a significant rate. For example 96 crows were recorded on a morning between 5.07 hours and 6.40 hours. The onset of daylight will normally cause the bird to crow, with the result that the early morning crows coincide with the likelihood of open windows in the summer.

The levels measured inside the bedroom were about 38 to 39 dB(A) with the window open, and external background noise levels in the order of 26 dB(A). From measurements which we carried out on other similar birds, we established that 'Corky' was not unusually loud. The sound level of the crows was generally similar for different birds (of the same type) and for the different crows from the one bird.

The sound has a very piercing and alarming character especially at close quarters. It rises very sharply and after a slight wavering, falls away. These characteristics are softened significantly over a distance of say 50 m and the sound could then almost be described as more pleasant.

Ramifications

According to the Advocate acting for the Plaintiff, Mr D O'Mahony, who specialises in nuisance cases, the decision is valuable because the Judge offered a sensible restatement of the common law on nuisance which is applicable in any other situations where householders complain about the level of noise or other subjective nuisances which arise where neighours, whether residential or commercial, engaged in traditional pursuits on adjoining land.

He states that the learned Judge was prepared to accept that the earlier legal authorities which suggested that the subjective element in noise nuisance (which has hitherto made it very difficult to prove noise nuisance) should now be disregarded in view of the scientific advances which made it possible to offer objective judgements in support of the complaints.

The order which the learned Judge made also supports the practice of Environmental Health Officers in setting the noise level in notices by reference to that which can be measured at the boundary to the defendant's land.

Stephen Peliza MIOA is a Director of Kelston Consultants at Raleigh House, 9A The Wellsway, Keynsham, Bristol BS18 1HS. Kelston Consultants is a member of the Association of Noise Consultants ❖

appropriate in view of their collaborative research in the field of active noise control. The quality and innovation of the research of Dr C H Harrison in ocean acoustics was recognised by the award of the A B Wood Medal. Professor P Lord who has worked for many years for the development of acoustics, including service to the Institute, became an Honorary Fellow.

The President has encouraged the membership to be more active in nominations for medals and awards. In future there will be no limitations on the age or country of origin of nominees for the Simon Alport Award. However the published work should still be concerned with the use of computers in acoustics.

Engineering Division

In 1992 a further 14 members gained registration as Chartered Engineer through the Institute route. Towards the end of the year it was made clear that the Engineering Council proposed to cease recognition of a route to the qualification of Chartered Engineer through the Institute. This decision did not result from any reservations about the quality, or selection procedure of candidates but from a general policy decision about the minimum size of nominated institutions. Vigorous objections to this decision have been made. Recent discussions with the Engineering Council have identified a potential solution which it is hoped will allow the Institute's affiliated status to continue subject to certain administrative changes. In the meantime measures are being taken to protect members who have obtained the qualification by the Institute route.

Specialist Groups

The Institute as a whole reflects the broad span of the science of acoustics and a number of Groups have developed to foster closer contacts between members in various specialisms.

Building Acoustics Group

The Group's main contribution in 1992 was a joint meeting with the RIBA on 'Acoustics, Architecture and Auditoria'. Over 130 people attended the meeting, some from Japan and the west coast of North America, and heard a wide range of research and experience based papers from leaders in this area of architectural acoustics.

Electroacoustics Group

Until now activities associated with the field of Electroacoustics have been serviced mainly through the established conferences on Reproduced Sound. However, the recently formed Electroacoustics Group is looking to expand their activities by holding a one day meeting in London in 1994.

Industrial Noise Group

In addition to helping to organise the 'Euronoise' Conference, a number of workshops and meetings have been organised by committee members, including the forthcoming events on 'External Vehicle Noise' and 'Impending Legislation and Background Noise Measurements in Planning and Nuisance'.

In future it is expected that the Industrial Noise Group will concentrate its efforts on workplace noise, hearing conservation, machinery noise, noise prediction and noise control engineering, but there is confidence that Group members will also be interested in and will support much of the work of the new Environmental Noise Group.

Musical Acoustics Group

The Group's activities have again centred on the production of the Newsletter. The wide geographical spread of members is somewhat of a deterrent to the organisation of group visits, though the idea has not been abandoned. Preparations have been made for the participation of the Group at the Spring Meeting in 1993.

Physical Acoustics Group

During 1992 the Group Committee has actively sought to establish links and joint activities with other organisations which have members with interests in ultrasonics. Early results of these efforts have been the Group's participation in a meeting on 'Non Destructive Evaluation of Advanced Ceramics' organised by the IEE Professional Group S6 and a session on 'Lamb Waves - Theory and Technology' at the 34th Theoretical Mechanics Colloquium. The Group's 'Annual Review of Progress in Physical Acoustics and Ultrasonics' was held at Magdalen College, Oxford.

Speech Group

In March, a very well attended meeting was held in Cambridge on the topic of 'Large Vocabulary Speech Recognition'. Later in April, a one day meeting was held in Essex on the use of 'Intonation in Speech Technology'. A demonstration was given of a language learning aid developed in the Esprit SPELL Project. In November, the Speech Group held its biennial 'Speech and Hearing' conference in Windermere. Throughout the year the Speech Group has again been very well served by its SpeakEasy newsletter. The STAG sub-committee of the Speech Group has continued to meet regularly to discuss issues of assessment in speech technology.

Underwater Acoustics Group

A one-day Tutorial meeting was held on 'Non-linear Acoustics' at the University of Bath. The Institute sponsored book on Transducer Design received much International acclaim being reviewed and praised by several overseas journals. The academic material for a second book is virtually complete.

Regional Branches

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

Eastern Branch

The first meeting of the Branch was in February in Cambridge on auditory warning systems used in aircraft. In April a Hi-Fi meeting was held in Norwich at Sound Approach. Two joint meetings have been held with the Institution of Environmental Health Officers, one on the draft PPG 'Planning and Noise' and the other on the subject of Clay Target Shooting noise. Evening meetings were held at Mildenhall Airbase and at Colchester where CEL displayed some of their new equipment. After the AGM held at Lotus Cars, Hethel, members heard about various new ideas to improve vehicle safety.

London Branch

During the year the Group held meetings on a wide range of technical subjects ranging from audiology to BS4142. The most popular meeting was concerned with studio and auditorium acoustics which attracted an audience of 57. Despite taking place in February in muddy conditions, the half day visit to the Lime House Link development site proved interesting, as was the one day meeting on 'Planning and Noise', held in May.

North West Branch

The branch held five events during the year. The first was a lecture by Professor Peter Lord entitled 'An Acoustician's Retrospective', an often humourous account of some of the activities he had been involved with during his career. The second was a lecture given by Geoff Chisholme of HSE on 'Good Vibrations' which brought members up to date with current standards and practice. The remaining meetings were visits to BAe, Wharton, Rolls Royce, Derby and Cheswick Silencers, Blackpool.

Southern Branch

The Southern Branch had a relatively quiet year in terms of technical meetings. However the AGM and Transportation Meeting held in March at the Guildhall, Winchester was very successful. Following their presentations the three speakers held a discussion session with the 30 members who attended.

Grade	1991	1992	Applied	Elected
HonFellow	10	11	-	-
Fellow	214	220	12	9
Member	1015	1077	104	84
Associate Member	266	348	125	124
Associate	286	249	22	22
Student	29	25	3	3
Totals	1820	1930	266	242
Key Sponsor	3	3		
Sponsoring Organisation	16	16		

Table 1. Details of Institute Membership

	1991	1992
Underwater Acoustics	142	133
Industrial Noise	743	789
Speech	89	87
Musical Acoustics	116	114
Building Acoustics	500	546
Physical Acoustics	111	99
Electroacoustics	86	124

Table 2. Group Membership

	1991	1992
East Midlands	150	162
Eastern	137	145
London	375	393
North East	53	52
North West	212	215
Scottish	82	78
South West	131	129
Southern	301	270
Yorks/Humberside	89	91
Hong Kong	113	131
Overseas	109	119

Table 3. Details of Branch Membership

	1991	1992
Architectural Practice	20	17
Consultancy	371	357
Industry/Commerce	295	250
Education - School	5	4
Education - University	156	149
Education - Polytechnic	53	52
Public Authority	344	330
Research & Development	196	190
Other	114	109

Table 4. Details of Employment Category

Meeting	Attendance
Control of Noise at Surface Mineral Workings, *London 16/1/92 (workshop)*	18
Draft Planning Policy Guidance: Planning & Noise, *London 12/2/92 (workshop)*	91
Clay Target Shooting, *London 11/3/92 (workshop)*	53
Acoustics, Architecture & Auditoria, *Birmingham, 18-19/3/92*	130
Planning & Noise, *London, 19/5/92*	53
Non-linear Acoustics, *Bath, 8/7/92 (tutorial meeting)*	33
Euronoise '92, *London, 14-18/7/92*	249
Reproduced Sound 8, *Windermere, 29/10/92 - 1/11/92*	120
1992 Autumn Conference, Speech & Hearing, *Windermere, 19-22/11/92*	126

Table 5. Meetings Attendance

IOA Groups

BUILDING ACOUSTICS
Chairman, Jeff Charles FIOA, Bickerdike Allen & Partners, 121 Salusbury Road, London NW6 6RG, Tel. 071 625 4411
Secretary, Dr Les Fothergill FIOA, Building Research Establishment, Garston, Watford WD2 7JR, Tel: 0923 664614

ELECTROACOUSTICS GROUP
Chairman, Dr M alcolm O J Hawksford FIOA, 40 Broome Grove, Wivenhoe, Colchester, Essex, Tel. 0206 872801
Secretary, Dr James Angus FIOA, University of York, Electronics Dept, Heslington, York YO1 5DD, Tel: 0904 432361

ENVIRONMENTAL NOISE
Chairman, Steve Turner MIOA, Rendel Science and Environment, Gt Guilford House, 30 Gt Guildford Street, London SE1 0ES Tel 071 962 9884.
Secretary, Brian Parker MIOA, Portsmouth City Council, Civic Offices, Guildhall Square, Portsmouth PO1 2AL, Tel 0705 822251

INDUSTRIAL NOISE
Chairman, Dr Bob Peters FIOA, School of Environmental Engineering, Epsom, Surrey KT17 3DS, Tel. 081 394 3166
Secretary, David Bull FIOA, School of Engineering Technology, Sheepen Road, Colchester CO3 3LL, Tel. 0206 761660

MUSICAL ACOUSTICS
Chairman, Dr Bernard Richardson MIOA, Physics & Astronomy Department, College of Cardiff, P O Box 913, Cardiff CF2 3YB, Tel. 0222 874144
Secretary, Dr Jenny Zarek MIOA, 56 Westfield Road, Surbiton, Surrey

PHYSICAL ACOUSTICS (Joint with the Institute of Physics)
Chairman, Dr Daryl Almond, School of Materials Science, University of Bath, Claverton Down, Bath BA2 7AY, Tel. 0225 826826
Secretary, Professor Richard Challis, Dept of Physics, University of Keele, Staffs ST5 5BG, Tel. 0782 583315

SPEECH
Chairman, Dr Steve Young FIOA, Engineering Department, University of Cambridge, CB1 1PZ, Tel. 0223 332654
Secretary, Dr Briony Williams MIOA, CSTR, 80 South Bridge, Edinburgh EH1 1HN, Tel. 031 650 2790

UNDERWATER ACOUSTICS
Chairman, Dr Peter Dobbins MIOA, BAeSEMA, Marine Division, P O Box 5, Filton (FPC 901), Bristol BS12 7QW, Tel. 0272 318056
Secretary, Dr Lynn Lipscombe MIOA, Seacoustics Ltd, The Well House, Lower Noarhill Farm, Selbourne, Hants GU34 3LW, Tel. 0420 50485

IOA Branches

EASTERN
Chairman: David Bull FIOA, School of Engineering Technology, Sheepen Road, Colchester CO6 3LB, Tel. 0206 761660 Extn 27632
Secretary, Terry Metcalfe MIOA, 1 Elliot Close, Thetford, IP24 1UW, Tel. 0473 311833

EAST MIDLANDS BRANCH -
Branch is awaiting reorganisation, contact: David Snow MIOA, Tideswell, Park Road, Plumtree, Notts, Tel. 0602 830591

LONDON
Chairman, John Simson MIOA, 20 Osborne Drive, Fleet, Hants GU13 9LL, Tel. 071 962 9884
Secretary, John Miller MIOA, 19 Needham Terrace, Cricklewood, London NW2 6QL, Tel. 081 450 5591

NORTH EAST
Chairman, Brian Oakes FIOA, 21 Hermitage Park, Chester-le-Street, Co Durham DH3 3JZ, Tel. 091 3883851
Secretary, Stephen Arnott MIOA, 17 Marden Road South, Whitley Bay, Tyne & Wear NE25 8RE, Tel. 091 295 3700

NORTH WEST
Chairman, Michael Ankers FIOA, 36 Glendale Road, Worsley, Lancs M28 4AZ, Tel. 061 234 4916
Secretary, Mrs Nicola Alexander MIOA, 32 Catherine Road, Swinton, Manchester M27 3FX, Tel. 061 491 3100

SCOTTISH
Chairman, Patrick Corbishley MIOA, HSE, Belfont House, 59 Belfont Road, Edinburgh, Tel. 031 247 2089
Secretary, Ronald McLaughlin MIOA, Glasgow Caledonian University, Cowcaddens Road, Glasgow G4 OBA, Tel. 041 331 3645

SOUTHERN
Chairman, Graham Parry MIOA, DNV Technica, Lynton House, 7/12 Tavistock Square, London WC1H 9LT, Tel 071 388 2684
Secretary, Dr Ian Flindell MIOA, ISVR, The University, Southampton SO9 5NH, Tel. 0703 593423

YORKSHIRE & HUMBERSIDE -
Branch is awaiting reorganisation

HONG KONG
Chairman, Dr Westwood Hong FIOA, Arup Acoustics, 56th Floor, Hopewell Centre, 183 Queens Road East, Hong Kong, Tel.010 852 5283031
Secretary, A Li, University of Hong Kong, Pokfulam Road, Hong Kong, Tel. 010 852 8592621

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BACKGROUND NOISE MEASUREMENT IN PLANNING AND NUISANCE

South Bank University, London, 5 April 1993

Fifty six delegates attended this one day workshop meeting organised by John Seller of South Bank University and chaired by Bernard Berry of the National Physical Laboratory.

Three presentations were given in the morning session to elicit discussion for the afternoon. The day commenced with John Seller discussing examples of noise measurement close to the M25 in Hertfordshire. He examined the importance of using the time weighting 'F' for background noise measurements. The formula for combining L_{A90} levels was detailed. A general question was raised as to the best way of dealing with L_{A90} levels varying over different days and meterological conditions.

Robert Hood of Ashdown Environmental detailed the various indices that have been used to measure noise. He described the Environmental Impact Approach to identify significant environmental effects in terms of the severity of the impact and importance of the receptor. He proposed that the significant effects could be measured by absolute levels, intrusion methods as in BS 4142 or noise changes. Dr Hood suggested the use of noise change as the most effective method to evaluate the significant effects since, in his view, absolute level methods were really most suitable for mitigation purpose and the BS 4142 intrusion method was not suitable for transportation noise and had a large variability in L_{A90}. Dr Hood preferred the use of L_{Aeq} to measure background noise since it better fulfilled the criterion of a stable index that was easy to measure and calculate.

Ian Sharland of Ian Sharland Ltd rounded off the morning session with a discussion on his own problems of measuring background noise in accordance with the method of BS 4142:1990. It was his opinion that the revised standard was a great improvement on the old version although he had a couple of points to make. These related to the background noise sampling period, the choice of the background noise criterion and whether the rating noise level should include the background noise since a listener judges the total encompassing noise at any one time.

The afternoon discussion involved a variety of topics although the main emphasis seemed to return to BS 4142:1990. Bernard Berry explained the current action on the development of the standard. A working party is aiming towards producing an amended version with the objective of clarifying certain areas of the revised standard, eg traceability requirements etc.

The difficulties of the use of possible conflicting procedures for nuisance assessment, planning applications, BS 4142 and 10/73 were raised. The problems of the selection of noise sources contributing to the residual noise was considered with deliberations on whether, in the event of more than one noise source, one source could contribute to the background noise measurement of the other. We were then directed towards the more fundamental question of the need for noise standards as a framework for the assessment of noise. Finally the discussions focused on amplified music and the wording of legal noise abatement notices. This was extended to plant noise.

The day was interesting, enjoyable and at times the background noise level was raised!

Nicole Porter MIOA

Northwest Branch

Meeting on Planning and Noise 31 March 1993

A well attended and lively technical workshop was held at the offices of Building Design Partnership (BDP) in Manchester. This was what it is hoped will be the first of a series of technical discussions aimed at all members of Northwest Branch. The purpose of these workshops will be to allow all interested parties to air their views on, and discuss, the latest acoustic standards, methods, procedures and equipment.

The topic for this first debate was 'Planning and Noise', with discussions centred around the revised edition of Circular 10/73, which is known as PPG XX 1992.

The meeting was led by Peter Sacre of BDP, who started the proceedings by outlining the differences between the PPG document and Circular 10/73.

Two Environmental Health Officers, John Dinsdale of Oldham MBC and Stuart Gregory from Manchester District Council, then reviewed the various documents that are available and that they have used in the past to assess noise problems, or to advise planning departments on the noise aspects of planning applications.

Finally a lively question and answer session was held with many questions covering all matters relating to the noise and vibration aspects of planning applications being raised.

It was felt that the evening was highly successful, and has hopefully acted as a launchpad for further workshops on other acoustics related topics.

Many thanks to Peter Sacre and John Dinsdale for their efforts, and to BDP for providing the venue. ❖

NON-INSTITUTE CONFERENCES

THE EDITOR WOULD BE PLEASED TO RECEIVE REPORTS ON NON-INSTITUTE MEETINGS AND CONFERENCES ATTENDED BY MEMBERS

Contributions

Environmental Noise Survey for MAPAC

A survey was undertaken on behalf of MAPAC, (Manchester Air Pollution Advisory Council), as a follow - up to its 1985 study on Environmental Noise.

The aim was to carry out the same survey, seven years later, to evaluate any changes in response to environmental noise from residents in the MAPAC area. The study was a postal survey as before, with the aim of analysing 1000 completed forms. A total of 1281 forms were distributed and the questionnaire, using the same design as in 1985, asked various questions about people's attitude towards noise and annoyance. The average return rate was 71%, providing 846 completed forms for analysis.

The survey has shown that fewer people in 1992 described their area as noisy or very noisy, 30%, compared to 60% in 1985.

An annoyance index, calculated from the response to the questionnaires showed that road traffic noise is still by far the most annoying source of noise. Neighbour noise has displaced motor cycle noise as the second most annoying source. Alarms on both cars and houses have become a source of annoyance not previously highlighted in the 1985 survey. Aircraft noise in some areas of MAPAC made a significant impact on the survey results.

News from Austria

Letter received

In 1991 the Austrian Working Party on Noise Control (OAL) published an Assessment Guide for Doctors on 'The Effect of Noise on Man' (OL Standard 6/18). The 36 page document covers both physiological and psychological effects and includes topics such as hearing damage, sleep disturbance, effects on concentration and memory etc.

The OAL will be holding a series of Seminars for doctors this autumn to discuss this Standard and would like to have it translated into English as there will be foreign participants. I have a copy and if anyone feels able to make a translation or at least a summary, or would like more information would they please contact me, George Vulkan FIOA, via the Institute Office.

The Timber Information Centre in Austria (PRO/HOL), have also just published a substantial catalogue of data on various timber constructions of walls, partitions and floors, covering not only sound insulation but also thermal insulation and fire protection. A copy of this has also been forwarded to me by the OAL and is available for inspection.

Barking can be avoided

This is the title of a new leaflet produced by the DoE in conjunction with the National Dog Wardens Association and the Association of Pet Behaviour Counsellors.

The leaflet provides guidance on dealing with barking dogs and where owners can get further advice. It also lists possible reasons why dogs may bark more than usual, and emphasises the need for proper dog training and the importance of responsible ownership.

The leaflet is available free from: DoE, PO Box 151, London E15 2HF Tel: 071 276 0900

Exercise Keevil: Noise levels of six military helicopters

For a number of years the National Physical Laboratory, supported by the Ministry of Defence, has been developing AIRNOISE, a mathematical model for computing aircraft noise contours. The model is now being extended to include helicopter operations. In order to provide basic source noise data for the model a special noise trial - Exercise Keevil - has been conducted at RAF Keevil in Wiltshire. One helicopter of each of six types performed a variety of flight operations over an array of microphones. Information on aircraft position and speed were obtained by video tracking techniques. A report has been published describing the trial and the results obtained.

Further information from: B F Berry and A L Harris, Division of Radiation Science and Acoustics, NPL, Teddington, TW11 0LW or R J Weston and D Steele, Environmental Noise Department, RAF Institute of Health and Medical Training, RAF Halton, Aylesbury HP22 5PG.

Wind Farms (continued)

Letter received

I read with interest the item on Wind Farms in the Bulletin Board section of the March/April issue (p 37-38). I note the comments on BS 4142: 1990 and in particular the questions over its applicability to wind farms.

I wonder if your correspondent is aware of the work currently being undertaken here at the National Engineering Laboratory (NEL) to develop procedures for the measurement and prediction of wind turbine noise generation and propagation.

The work is aimed at providing internationally agreed standards on wind turbine noise and we are actively participating in the International Energy Agency (IEA) and International Electrotechnical Commission (IEC) Committees on this topic.

The third edition of the IEA recommended practice on wind turbine noise measurement is due for publication in the near future and the IEC Standard 'Acoustic Noise Measurement Techniques for Wind Turbine Generator Systems' is currently at the draft stage. Both will be relevant to planning and development issues for wind farms and we would welcome any comments or input from interested parties.

A paper at Euronoise '92 summarises the recommended practises and the work carried out over the last few years. Should readers require more information copies of the various documents are available from me, Alistair Mackinnon MIOA at Flow Centre, NEL, East Kilbride, Glasgow G75 0QU.

MPG11

Now published and available from HMSO, price £4.00

Contributors: Miss Joanne Miller, George Vulkan FIOA, John Clegg MIOA et al, Bernard F Berry MIOA, Alistair Mackinnon MIOA , anon. ❖

Hansard

15 March 1992
Written Answers to Questions
Night Noise
Mr Simon Hughes: To ask the Secretary of State for the Environment whether the targets for night-time noise contained in the EC fifth action programme relate to individuals in existing noise-sensitive property; and what assessment he has made of the capability of current noise policy measures to attain those targets by 2000.
Mr Maclean: The EC fifth environment action programme states that the targets for night-time noise should include the phasing out of exposure of the population to night-time noise levels in excess of 65 dB(A). My Department's noise research programme includes projects to improve the measuring and monitoring of noise from various sources and to establish new methods of reducing noise at noise-sensitive premises.

22 March 1993
Written Answers to Questions
Noise at Work
Mr Terry Davis: To ask the Secretary of State for Employment how many prosecutions were taken against employers in 1990-91 and 1991-92 relating to the control of noise at work for each of the geographical areas of (a) the factory inspectorate (b) the agricultural inspectorate and (c) the quarries inspectorate; and what were the penalties in each case.
Mr McLoughlin: The information requested about prosecutions under the Noise at Work Regulations is provided in the following tables.
Factory inspectorate prosecutions under the Noise at Work Regulations 1989
1990-91
North East area
Four informations laid, four convictions with one fine of £200 and three at £100.
1991-92
London North area
One information laid, one conviction, fine of £100
East Midlands area
One information laid, one conviction, fine of £750
West and North Yorkshire area
Six informations laid, six convictions, two fines of £500, and one fine each of £250, £150, £75 and £50.
North East area
Two informatiosn laid, one conviction and one withdrawn fine of £200
No prosecution action was taken under these regulations in other Factory Inspectorate areas.
Agricultural inspectorate prosecutions under the Noise at Work Regulations 1989: No prosecutions action under these regulations during the years 1990-91 and 1991-92
Quarries inspectorate prosecutions under the Noise at Work Regulations 1989: No prosecution action taken under these regulations during the years 1990-91 and 1991-92.

25 March 1993
Written Answers to Questions
Aircraft Noise Control
Lord Brabazon of Tara asked Her Majesty's Government: What conclusions they have reached following consulation on the proposals in the paper Control of Aircraft Noise issued in August 1991.
The Minister of State, Department of Transport (The Earl of Caithness): We are publishing today the conclusions following extensive consultation on the proposals contained in the paper issued in August 1991, Control of Aircraft Noise. Five hundred and seventy five responses to the consultation paper were received from a variety of individuals and organisations representing aviation and local community and environmental interests.
The responses generally supported the principle that aerodromes should be responsible and locally accountable for taking all reasonable measures to minimise nuisance to local communities from their activities and for bearing the costs of doing so.
We will be taking various steps to reinforce this approach, building on the existing mainly voluntary system control at most airports. However it is still appropriate for me to retain a reserve power to take responsibility myself for noise control. This power is most likely to apply to major international airports.
We propose to develop national guidance about the sorts of measures that might reasonably be taken by the different types of aerodromes and will consult widely on it when a draft has been prepared. In the meantime views from interested parties on points that might be included are welcome. Virtually all the responses to consultation welcomed the proposals for guidance.
In line with the principle of local responsibility and accountability we will write to BAA to explore the scope for their taking on more direct responsibility for ensuriung that noise mitigation measures at Heathrow, Gatwick and Stanstead are properly observed for following up breaches and for responding to complaints.
We will also invite the consultative committees to give their views on how such a changeover of responsibility can be smoothly and effectively achieved.
We will also be considering with other aerodromes how they might review their existing arrangements to ensure that they are as effective as possible.
When Parliamentary time permits we will introduce primary legislation to amend the existing power for the control of aircraft noise. The changes will reflect the proposals in the consulation paper that aerodromes should have explicit powers to devise and enforce measures to minimise noise including ground noise. We will also introduce power to require an aerodrome to develop a noise mitigation scheme, to consult locally and to secure agreement to it with a lead local authority, with disputed points to be settled. Where the aerodrome is required to produce such a scheme, the lead authority will be responsible for ensuring that the noise control

measures are properly enforced. We will reserve the right to approve schemes where we judge it appropriate. The power will apply to all aerodromes including sites used temporarily by light aircraft or helicopters.
We would not expect these powers to be used widely. It is far better for aerodromes to adopt and enforce effective noise measures themselves and to be accountable voluntarily to local people about what they are doing. Generally this approach works well and we want to build on it.

Noise at Work
Mr Terry Davies: To ask the Secretaory of State for Employment how many improvement notices were issued against employers in 1990-91 and 1991-92 relating to the control of noise at work for each of the geographical areas of (a) the factory inspectorate, (b) the agricultural inspectorate and (c) the quarries inspectorate; and what were the penalties in each case.
Mr McLoughlin: Improvement notices do not impose explicit penalties. They require action to be taken to comply with the relevant statutory provision within a specified period of time. *(here follows a table showing the geographical breakdown into 19 areas of the totals of 489, 4 & 8 Improvement Notices served by the HSE's Factory, Agricultural and Quarries Inspectorates, respectively, in 1990-91; the corresponding totals for 1991-92 being 422, 19 and 20)....*

1 April 1993
Written Answers to Questions
Employment/Noise at Work
Mr Terry Davis: to ask the Secretary of State for Employment how many prohibition notices were issued against employers in 1990-91 and 1991-92 relating to the control of noise at work for each of the geographical areas of (a) the factory inspectorate, (b) the agricultural inspectorate (c) the quarries inspectorate and what were the penalties in each case.
Mr McLoughlin: Prohibition notices do not impose explicit penalties. They are issued when there is a risk of serious personal injury. They require specified remedial action to be taken usually immediately to comply with the relevant statutory provisions.
The following requirements were made on prohibition notices issued during the periods 1990-91 and 1991-92...*(here follows a table showing the geographical breakdown into 19 areas of the totals of 35, 1 & 1 Prohibition Notices served by the HSE's Factory, Agricultural and Quarries Inspectorates, respectively, in 1990-91; the corresponding totals for 1991-92 being 26, 0 and 0.)...*

Extracts provided by Rupert Taylor FIOA

Book Reviews

Active Sound Absorption by Claude T Mazzola, Namlak Publications. New York 1993. ISBN 0-9636316-0-8 Obtainable from NAMLAK, PO Box 804, Mamaroneck, New York 10543: Price $49.50

Reduction of an unwanted disturbance by negative feedback is of course now routine and relatively easy for scalar quantities, but with additional problems when applied to a three-dimensional phenomenon such as sound. This is the subject of the book.

Chapter I outlines the basic physics, which amounts to there being no reflection of a soundwave if the acoustic impedance of a surface is made, by feedback, to equal that of air. Chapter II rehearses ideal feedback theory; Chapter III introduces more practical constraints; and Chapter IV represents the acoustic matching criterion (mentioned above) in the form of a duality between radiation admittance and acoustic absorption. The treatment so far has been confined to plane waves incident normal to a plane rigid surface. This restriction is removed in Chapter V, but only for certain idealized special cases.

Your reviewer rather lost his way in trying to find the objective of the book, although deeper study of it might have resolved the difficulty. There is some nice physics and some pleasant mathematical derivations (some of which are applications of standard theory) sometimes rather for their own sake. A few numerical values are cited, but the treatment is not otherwise practical. Part of the problem is ambiguity; for example it is unclear whether the aim is maximum absorption of sound-energy, or minimum reflection or scattering from, respectively, an infinite plane barrier, or a sphere or cylinder.

This leads on to a question unanswered in the book, which is surely fundamental. The incident sound and the feedback both inject energy into the system; where does this energy go? In the example of the infinite plane barrier it is in fact easily seen that all this energy is radiated from the back surface. In a practical situation this back-radiation would still need to be absorbed somehow.

As to presentation, the author uses statements like 'no intensity flows' (p11) whereas this reviewer understands the concept of flow to be restricted to entities obeying a conservation law, such as matter and energy. Unfortunately, the book fails to define properly some of its algebraic symbols, stating instead that they have their 'usual meaning' (p5); this is impermissible because it excludes people who do not share the author's conventions. Hyphenation is badly needed to resolve concatenations such as 'transducer coated infinite plate'.

Peter Fellgett FRS FIOA

Developments in acoustics and ultrasonics Edited by M J W Povey and D J McClements, Institute of Physics, 1992, price £34.50 ISBN 0 7503 0245 3

This book consists of papers presented at a meeting organised by the joint IOA/IOP Physical Acoustics Group at Leeds in September 1991. The meeting aimed to review the progress of the last ten years of Ultrasonics and Acoustics in the realms of the Physical, Medical, Biological, Chemical, Food and Oceanographic sciences. The scope is limited to low intensity ultrasound; high power applications such as ultrasonic cleaning, emulsification, machining etc, now mostly well established techniques, are not covered.

The major part of the book consists of eight longer papers that serve to introduce the application of ultrasonic methods in the various sciences. These are followed by a larger number of shorter papers on more specialised topics. Much of the subject-matter consists of methods for the measurement of velocity and attenuation of ultrasound, often over wide bandwidths, and the use of this data to investigate composition, particle sizes and various physical changes in materials. The media studied often takes the form of suspensions of solid particles in liquids, though many other systems, including liquid in liquid, solid in solid and gas in liquid, have been studied. The same themes tend to recur in all realms of application, such as the basic scattering mechanisms and the complete, multiple scattering recurring in strongly scattering systems, generating insolvent acoustic radiation, which, it is now being realised, is not detected by conventional piezoelectric transducers, which are phase sensitive.

This gives the book a remarkable unity of theme in spite of the variety of fields of application explored by numerous authors. Even sonar fish counting brings in multiple scattering. Developments in electronic technique receive substantial attention, notably in Doppler blood flow measurement and materials study.

The eight longer papers all have high tutorial quality, giving a clear introduction for the reader who has not specialised in this branch of acoustics. Ultrasonic technique seems to be capable now of considerable development and expansion in new realms of application, particularly biological and food. This collection of well prepared papers makes an excellent introduction to a subject likely to grow in importance.

D J Small

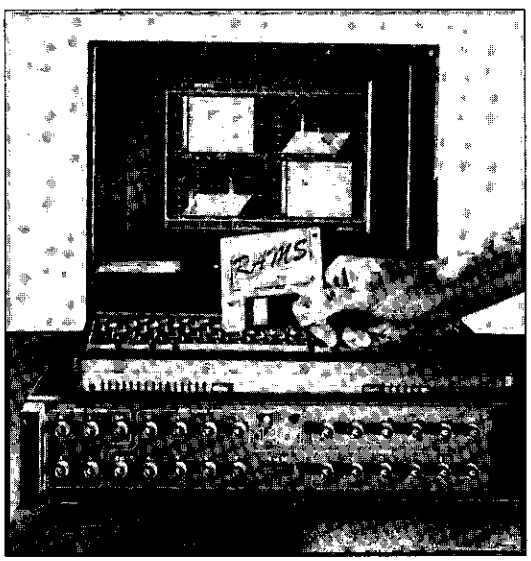
New Products

ANTHONY BEST DYNAMICS LTD

RAMS

Anthony Best Dynamics (ABD) launched a new version of the company's PC-based RAMS multi-channel system for analysing industrial noise and vibration problems.

Utilising an intelligent interface capable of handling up to 330,000 samples per second, the range of analysis on the RAMS system has been doubled to offer cost-effective analysis of eight separate signal channels, each to 15 kHz.



The signals analyzed by the RAMS system are provided by sensors such as microphones and accelerometers suitably placed around the source of the noise or vibration problem to give the data necessary for the solutions to be found. The expanded range is particularly useful for analysing noise signals.

ABD can supply the system as a turnkey package comprising both software and hardware. Alternatively, the customer can buy RAMS software to run the system on their own personal computers, particularly IBM AT machines.

Further details from Paul Millard, Anthony Best Dynamics, Holt Road, Bradford on Avon, Wilts. BA15 1AJ, Tel: 0225 867575, Fax: 0225 864912.

THE NOISE CONTROL CENTRE

Soundcheck and Phonoroc

The Noise Control Centre have announced two new sound absorption systems. Both are ideally suited for a wide range of architectural applications where superior sound reverberation control is desired. Whilst both systems offer very similar acoustic performances and can be installed directly onto builders work, their physical characteristics could not be more dissimilar. SOUNDCHECK is a stretched fabric system with a soft luxurious finish. In complete contrast PHONOROC is a rigid solid faced system exhibiting superb mechanical strength, perfect for damage prone areas such as corridors and walkways.

Each 600 mm x 600 mm PHONOROC panel is formed by compressing and bonding together thousands of tiny pigment stone pebbles, resulting in an acoustically transparent rigid panel said to be capable of achieving a very impressive 0.95 at 125 Hz.

The PHONOROC system is aesthetically appealing and is available in 12 standard colours. Other significant benefits include being non-flammable and unaffected by water absorption, humidity and steam.

SOUNDCHECK is the original system to employ the innovative 'top hat' uPVC extruded track, that anchors the stretched fabric in two positions, thus ensuring a secure and taut finish to the installation.

SOUNDCHECK's other unique characteristic is the use of Melatech (Basotect) foam for the acoustic infill, which as well as vastly improving the quality of the finish and performance, eliminates any possible health concerns as regards fibre departiculation, as might happen with rock and glass based systems.

For further information please contact Ken Hopkins, Sales & Project Manager, The Noise Control Centre, Charles House, Toutley Road, Wokingham RG11 5QN, Tel: 0743 774212, Fax: 0734 772536.

ENTROPIC RESEARCH LABORATORY, INC

Hidden Markov Model Toolkit

Entropic Research Laboratory Inc has announced the availability of HTK, the Hidden Markov Model (HMM) Toolkit. HTK provides the software tools needed to build HMM pattern classification and continuous speech recognition systems, and marks the first time these capabilities have been made available in a single, commercial product.

HTK has broad applications in the field of speech processing, such as speaker verification, automatic speech transcription, and key word spotting. Other applications include bioacoustics research, target identification, tracking, detection, and financial time series analysis. Products built using HTK could be incorporated into a wide range of advanced systems, such as: voice operated computer interfaces, telephone call processing, medical report dictation and financial transaction reporting.

Speech recognition is based on comparing new speech sounds to stored models of all possible sounds and selecting the best match. The latest generation of recognition technology, HMM's, are probabilistic sound models and have been shown to be more accurate than previous techniques.

The technology has been embraced by a number of industry leaders, including NTT, IBM, Apple, AT&T, Dragon, SRI, and BBN. Entropic's HTK gives users the tool needed to create HMM models and recognize speech without the need to write any computer programs.

Extensible and modular in design, HTK simplifies the development of user-written tools. It offers an easy-to-use interface and advanced signal processing functions, and includes HMM training and testing tools, language modeling support, and scoring software. HTK allows users to incorporate segmental K-means algorithms, Baum-Welsh algorithms, and Viterbi decoding into their work, and supports multiple network processors in classification training.

HTK is currently available on SUN, HP, DEC and SGI computers running UNIX.
For further information contact Ken Nelson, Director of Sales and Marketing, Entropic Research Laboratory Inc, 600 Pennsylvania Avenue S E, Washington D C, 20003, Tel: 0101 202 547 1420, Fax: 0101 202 546 6648.

HARTNELL & ROSE LTD

Acoustic Barriers

'Soundstop' is a multipurpose acoustic barrier suitable for many applications where breakout of sound is a problem. In construction it can be hung as a curtain in ceiling voids or within partition walls. Easy to handle, it is formed by bonding lead foil between two layers of 'Coustifoam'. and will therefore mould to most contours, with a thickness of only 13 mm it takes up the minimum of space.

'Soundblockers' are designed to prevent the transmission of sound through suspended ceilings into adjoining areas. They are also claimed to stop or reduce the sound from services in the ceiling void penetrating to rooms below.
For further details contact Hartnell and Rose Ltd, 4 Lever House, Lever Street, Bolton BL3 6NY Tel 0204 380074, Fax : 0204 380957.

News Items

Assessment Services launches new Midlands EMC test facility

A UK independent test laboratory, Assessment Services, is launching a new Midlands based electromagnetic compatibility (EMC) test facility to support the growth of its business in the region. The new facility, located at a former British Telecom site in Bearley near Stratford on Avon, is equipped to carry out the full range of EMC tests. Its acquisition represents an investment for Assessment Services of £700,000 over five years.

The Bearley site comprises an all weather open area test site with a 5 m diameter, 3 ton turntable and a 20 m x 12 m ground plane, as well as a 8 m x 5 m x 5 m RF anechoic chamber. The company plans to expand the services at Bearley to replicate those currently available at their Titchfield site in Hampshire. These include numerous shielded enclosures, two open field sites for EMC testing and extensive facilities for environmental, telecomms, radio and product safety testing. Geoff Matthews, Assessment Services' Director and General Manager, explained that the Bearley site was acquired as part of the company's business plan for growth to enable it to handle the increase in EMC testing which will be required leading up to 1996 when the European Directive comes into force.
Further information from Kate Tucker Tel: 0329 443350.

New Noise Instrument Catalogue from CEL

The latest catalogue from Lucas CEL includes a number of new products including the CEL 593 Sound Level Analyser and a building acoustics system developed to make use of CEL standard range products to provide cost effective measurement

system for reverberation time, decay rates and sound power calculations. The free CEL catalogue is available from Lucas CEL Instruments Ltd, 35-37 Bury Mead Road, Hitchin, Herts. SG5 1RT, Tel: 0462 422411.

Lucas CEL Instruments is a Key Sponsor of the Institute

CEL supply University of Greenwich with Oni Sokki FFT analysers.

Six portable FFT analysers, the CF–4220 from Oni Sokki, are now in regular use at the University of Greenwich in the Department of Communications Systems to train students from a variety of disciplines including Computer Science and Electrical Engineering.

Over 230 students have the opportunity to use the equipment in the second year of their studies which includes investigation into the properties of data signals as well as amplitude and frequency modulated waves.

The CF–4220 offers a wide dynamic range, typically 85 dB, high speed real time analysis, and manual scaling of the y–axis. Operating functions include autoranging, time interval, range over cancellation, Y–axis auto scaling, curve fitting and direct reading functions, automatic plot print and auto recall. Information on the CF–4220 can be obtained from Lucas CEL.

EMC and Acoustics

Following the successful launch of its underground EMC test facility in a Cheshire salt mine, ICL has set up a subsidiary company, CF Europe Ltd, to provide a range of testing and consultancy services to help companies meet new environmental engineering regulations being introduced by EC.

The test facilities are the EMC test centre mentioned above, which is situated 200 metres below ground in a worked out region of a salt mine in Winsford, Cheshire (thus making it a virtually interference–free area), and an acoustics test centre including an anechoic chamber currently located in ICL's development centre in Manchester.

CF Europe's commercial testing service started in January 1992 and focuses on the markets of information technology; electronic, medical and scientific products; telecommunications equipment; and a range of microprocessor–based brown goods.

For further information please contact Ken Howe at the ICL press office, Tel: 081 788 7272.

Livingstone Hire Celebrates Quarter Century of Success.

Livingstone Hire is celebrating 25 years in business. Since 1967, when the company claim to have pioneered equipment rental in Europe, the company has held a prime position in the industry. Over this period the firm has updated and expanded its portfolio of products and rental services.

Further information from Graham Harris, Tel: 081 943 5151.

Items for reporting in the New Products section should be sent to John Sargent MIOA at BRE ❖

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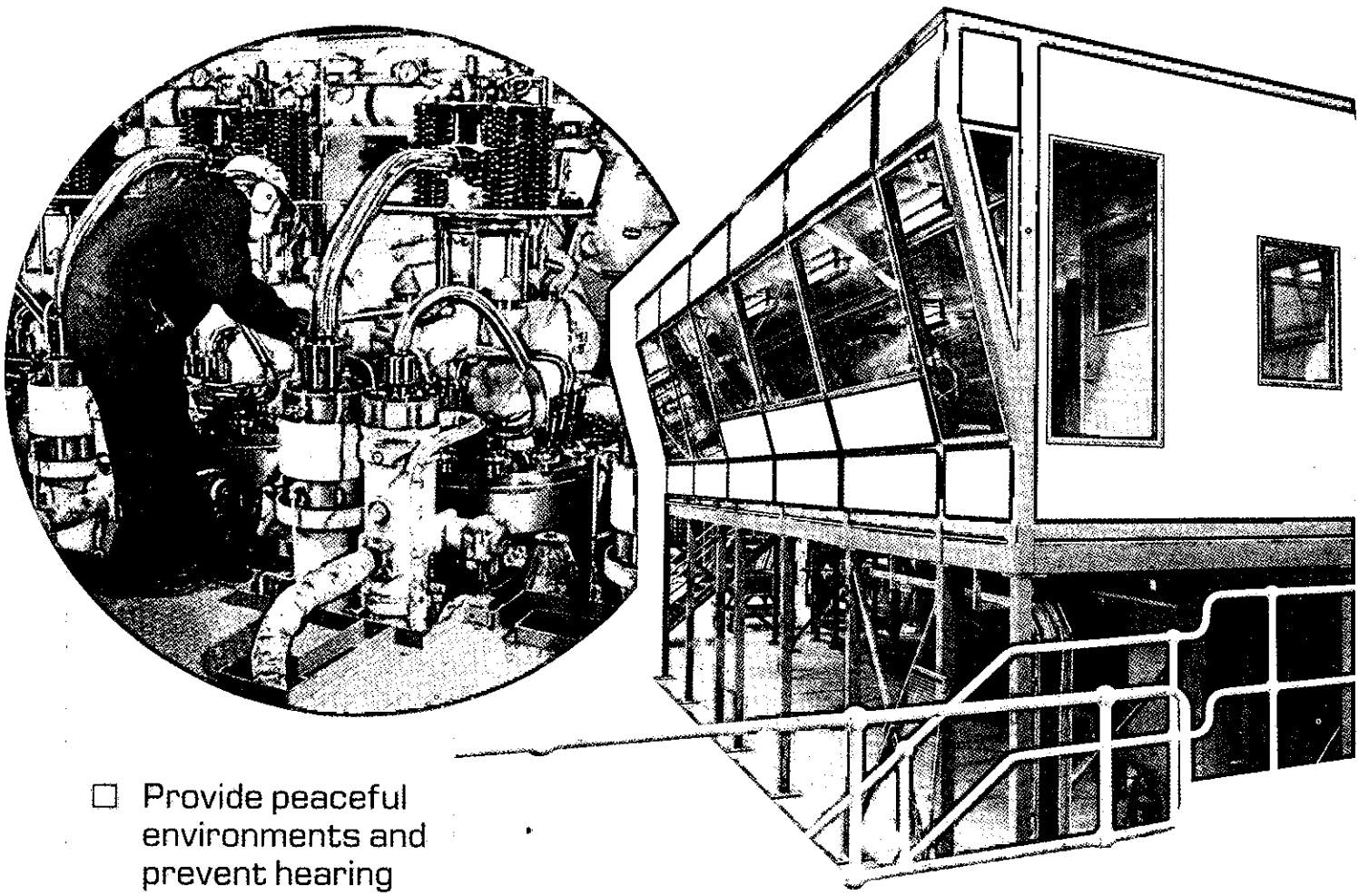

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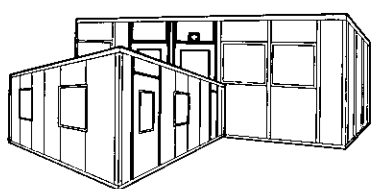

ECOMAX ACOUSTICS

Ecomax Acoustics Limited (Head Office)
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