

Acoustics

BULLETIN

VOL 30 No4 July/Aug 2005



Spring Conference 2005

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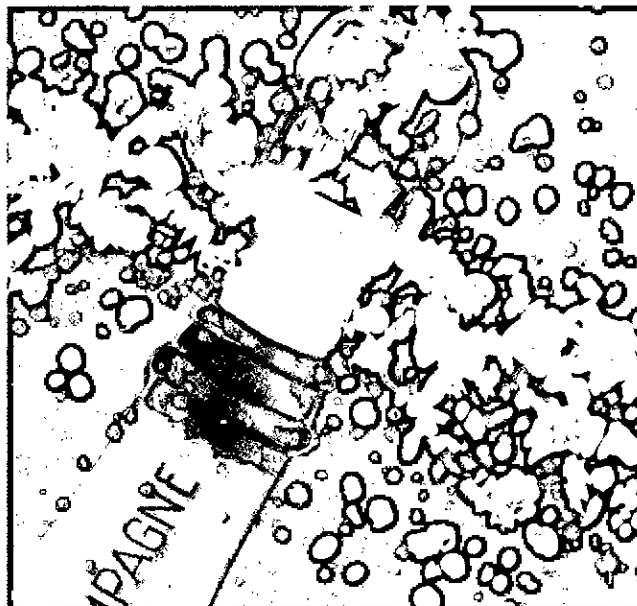
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The Institute of Acoustics was formed in 1974 through the amalgamation of the Acoustics Group of the Institute of Physics and the British Acoustical Society and is the premier organisation in the United Kingdom concerned with acoustics. The present membership is in excess of two thousand and since 1977 it has been a fully professional Institute. The Institute has representation in many major research, educational, planning and industrial establishments covering all aspects of acoustics including aerodynamic noise, environmental, industrial and architectural acoustics, audiology, building acoustics, hearing, electroacoustics, infrasonics, ultrasonics, noise, physical acoustics, speech, transportation noise, underwater acoustics and vibration. The Institute is a Registered Charity no 267026.

Acoustics

BULLETIN

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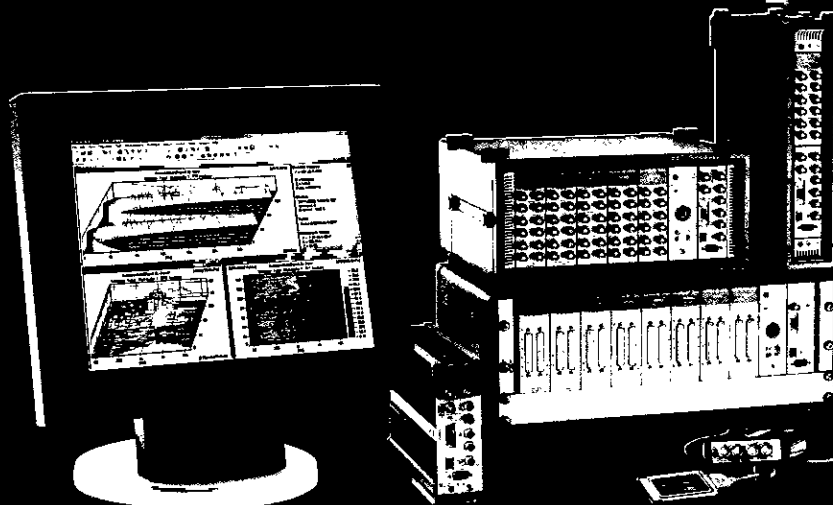
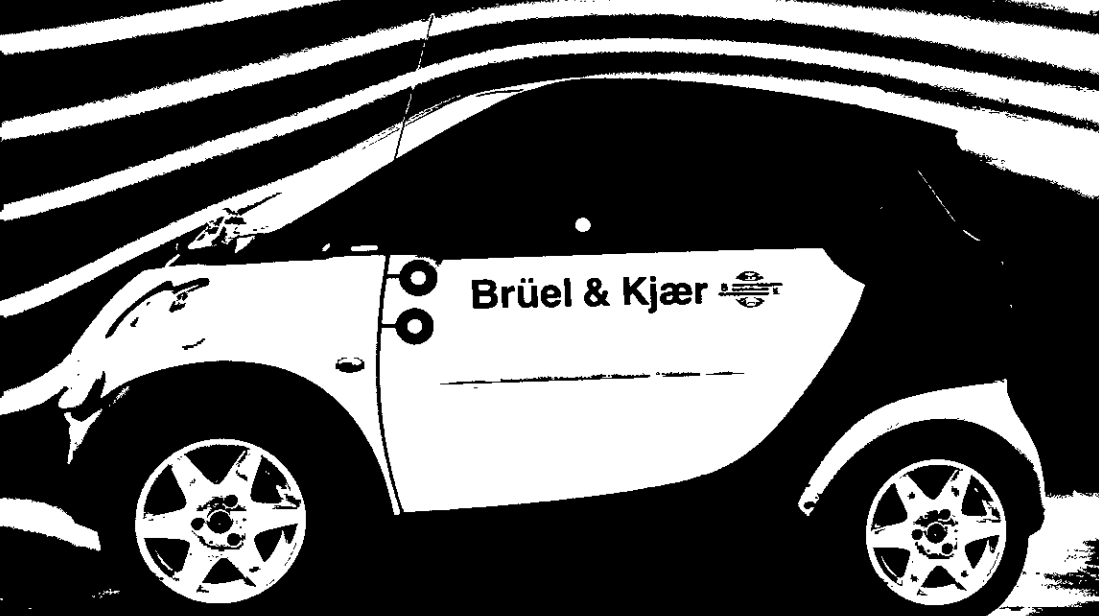
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Dear Members

By now I'm sure you will all have visited our 'new' web site, which has been operational since just before Christmas 2004, and I am confident you're finding it to be an indispensable source of news and information. You've probably noticed greater prominence there (and in other organisations' publications) to news and press releases about Institute events and services, resulting from the emphasis we are placing on publicity and information, for which Judy Edrich is responsible. Publicity relies on the supply of relevant material, so remember to keep Judy informed. As well as raising awareness of the Institute, the web site is also intended to facilitate communication within the Institute, for example by notifying Regional Branch meetings so that everyone can see what is on and where. Incidentally, regarding internal communications, I trust you have checked your proof entries for the 2005/6 Register of Members which were posted on the web site in mid June. As well as remaining there, these entries form the basis of the printed Register so, if by the time you read this it is not already too late, do tell Linda Canty about any amendments that need to be made to your organisation's entry. We have received very positive feedback from members and others about the web site, but nevertheless do not hesitate to acquaint the Publications Committee with your ideas for further improvements.

More encouragement comes from the strong demand for our professional courses, which are developed and controlled by our Education Committee. The Spring 2005 examinations for our three established Certificate courses, the most popular being Environmental Noise Measurement, resulted in 128 successful candidates. This year, in conjunction with the Scottish Executive and the Royal Environmental Health Institute of Scotland, we have also offered a new 'Certificate of Proficiency in Antisocial Behaviour etc (Scotland) Act 2004 Noise Measurements'. Scottish local authorities sent officers on these courses as part of their authorisation process for enforcement of the provisions of this recent legislation. The courses were delivered at Bell College and Strathclyde University, with 70 of the 76 candidates who took the examinations in May being successful. During this academic year, nearly 200 candidates have studied the Diploma in Acoustics and Noise Control via our six accredited centres in UK universities and colleges and the three distance-learning groups based at St Albans, Bristol and Edinburgh. Let us hope for good results from those who sat the exams in June. If you want to know more about our courses, then Peter Wheeler or Hansa Parmar would be delighted to hear from you.

Tony Jones
President

Environmental Noise Directive

IOA responds to consultation document on implementation

In the time available to prepare a response to the Consultation Document, the Institute of Acoustics (IOA) has held two one-day workshops for members to discuss the issues raised. The workshops were arranged and chaired by members of the Institute's Environmental Noise Group committee, in London and Birmingham.

The committee members assimilated notes of the discussions and have prepared the response below. In this way the views of approximately 50 IOA members are represented.

The following are the general comments from our members about the fundamental principles of the document.

Overall we feel local authorities (LAs) must be given a much greater role in the implementation of the END. A start towards achieving this could be made by it being implemented in a two-stage process in the first round of action planning, as follows.

A. For the first round of noise mapping **only**, the Secretary of State for Environment Food and Rural Affairs may be designated as the competent authority for the mapping of **all** sources. This will allow the designation of LAs as competent authorities for roads and agglomerations for future rounds. Involvement of LAs should not be on an 'all or none' basis. Those LAs that want to get involved and have the technical expertise and capability should not be constrained by the unwillingness or inability of other LAs to take a pro-active role, but should be empowered to do so.

B. Action planning: again LAs must be given greater roles. Much of the action planning will rely on an input from the LA which is the only democratically-elected body in a position to respond to local needs because of their knowledge of what actions to manage noise are likely

to be appropriate and feasible in the local situations. Effective action planning will also necessitate LAs being able to use noise mapping techniques to consider and contrast the noise benefits of alternative proposals for mitigation, *ie* running different 'what-if?' scenarios. A thorough understanding of the principles, processes and limitations of noise mapping and the underlying calculation methodologies will be essential. Realistically this can only be gained by involvement in the production of noise maps from start to finish.

C. Action planning in the first round should be a two-stage process with the Secretary of State for Environment Food and Rural Affairs producing an overall strategic framework action plan within which LAs can produce detailed local action plans.

D. It is appreciated that the provision of noise maps and the underlying data will necessitate the resolution of key Intellectual Property Rights issues with data providers such as Ordnance Survey. The Government should take a robust stance to help resolve these issues and ensure that the underlying aims of the Directive, *ie* the management and reduction of environmental noise for the benefit of the overall population, is not jeopardised by commercial interests. The approach adopted by the US FAA for airport noise modelling data sources would, for example, be welcomed.

E. Noise maps and all underlying data

must be provided to LAs for all sources in fully interactive formats. This will enable them to consider in full appropriate alternative actions to include in the Action Plans. It is considered imperative that consolidated noise maps for all sources (*ie* total noise levels) are produced.

F. Members feel that validation of noise maps should be incorporated, although it is recognised that noise maps will always have limited accuracy but will still be appropriate for strategic noise management purposes.

G. Data provision to the public is an underlying principle of the Directive. However, in whatever format the data are supplied, there must be appropriate 'health warnings' to ensure that the limitations of the information are clearly understood to prevent falsely raising expectations about noise levels. It is likely that the public will wish to zoom in on individual properties in which they have an interest, but the strategic maps required by the END are unlikely to be sufficiently accurate at this micro level. We consider it vital that for any planning application with noise implications, the noise mapping should only be used for screening, and a detailed site assessment should be undertaken to assess potential impacts or benefits.

H. Where reference to the Secretary of State is made it is considered that this should be the S of S for EFRA and not for other government departments



Register of Members 2005/2006

The Institute of Acoustics' Register of Members is the Institute's annual publication issued free to all members, in which companies and organisations with acoustical interests are listed.

Advertising space for the 2005/2006 issue of the Register must be booked through the Advertising Manager by 25 July 2005. Artwork for advertising must be ready by 1 August 2005. For more information about the publication, due to appear in late September 2005, or for advertising enquiries generally please contact:

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North-west Branch report

Prepare for new workplace noise regulations which will emphasise 'less process, more action'

Tim Ward of the HSE gave a thorough presentation on the new *Control of Noise at Work Regulations 2005* and their various implications to a large audience at the North-west Branch's April meeting: it was definitely a crowd puller!

The new Regulations, which replace the existing 1989 Noise at Work Regulations, will become effective from February 2006; the only exemption to this is the entertainment world (pubs, clubs etc) which is working towards a 2008 implementation date.

A fallout from the EU Physical Agents (Noise) Directive of February 2003, the *Control of Noise at Work Regulations* (CNAWR) have a decided focus on actual control. No longer will risk assessments be seen as a means to an end, instead the emphasis is most definitely 'less process, more action', and given the HSE's overriding target to eradicate noise induced hearing loss as an occupational problem by 2030 there is no doubt that noise action plans will be at the sharp end of inspection focus.

Supporting guidance

To help with this growing issue of actual control the HSE has been working hard on supporting guidance. The executive has been simplifying the steps of risk assessment and looking at the development of good practice, industry guides and the role of ensuring that the supporting systems such as training and health surveillance can be accommodated. This guidance will particularly help to encourage rapid risk identification and decision-making.

As for the numbers, the CNAWR also includes a review of the 1989 Action Levels and as a result we now have a Lower and an Upper Exposure Action Value (LEAV and UEAV). In simple terms this is effectively a 5dB reduction to the Action Levels in the 1989 Regulations. For those who want to see the numbers in black and white:

LEAV $L_{eq,8h}$ 80 dB and $L_{C, peak}$ 135 dB

UEAV $L_{eq,8h}$ 85 dB and $L_{C, peak}$ 137 dB

The immediate result of the changes will be a reduction of the upper Action Value from 90 dB to 85 dB. Potentially, this captures an additional 700,000 employees all of which may need hearing protection and further still, need to be the subject of a noise exposure reduction programme which has to go beyond the 'knee jerk' hearing protection response. In addition to the Exposure Action Values the Regulations also introduce a new Exposure Limit Value of $L_{eq,d}$ 87 dB and $L_{C, peak}$ 140 dB, where exposure above this is considered a criminal offence. The Exposure Limit Value applies 'at the ear' and thus employers can take account of any hearing protection in place.

Exposure calculation is still a requirement, leaving room for both actual measurement techniques and the use of information based on wider industry experience, manufacturer specification and industry good practice.



Noise action plans will be at the sharp end of inspection focus

Coupling these with the newly devised HSE nomograms and the HSE exposure website, the process is made much simpler for the SME's who may be more affected by this shift in action levels. Tim then went on to explain the concept of 'likely exposure' rather than the dependence upon pure numbers to prove or disprove exposure at the relevant action levels. In short, and given the general duties of employees to control risks from noise so far as is reasonably practicable, any time and effort spent trying to get out of the requirements is wasted time that could be spent on general improvement.

To summarise and close, Tim covered the most important points of the Regulations: assess your risks; decide your controls; produce your action plan; tackle your highest risks; implement good practice and industry standards; consider health surveillance; and finally ... never forget the general duties of an employer, as they are the ultimate caveat for the enforcing authority.

Midlands Branch report

Noise sourcing techniques at Rolls-Royce

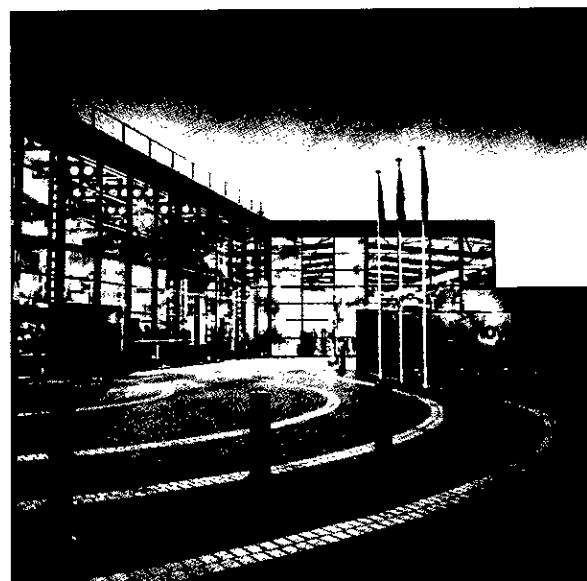
During the Midlands Branch half-day meeting on 18 May, Mike Swanwick MIOA, principal technologist - noise engineering at Rolls-Royce gave a presentation on practical acoustic source location techniques. Held at the Rolls-Derby Sinfon site, the discussion was followed by a guided tour of the Rolls Royce Heritage Museum.

Mike provided an interesting insight into a complicated and under-utilised method of identifying where major or protrusive noise sources emanate from a complex noise field composed of multiple sources. Although few members of the audience were likely to have access to the 100-plus microphones often used by Rolls-Royce, they went away with a better understanding of the methods used and the potential pitfalls. Following the meeting we were given a guided tour of the Heritage Trust Museum showing the evolution of Rolls Royce and its developments in aero engines from the first world war, through the evolution of the Spitfire's famous Merlin engine, to the latest Trent engines fitted to jumbo jets and the new Airbus.

The Trust is considered to be the world authority on the evolution of Rolls-Royce as a company, and on its aero engines and other products.

The meeting was well attended by both local authority representatives and acoustical consultants from around the region. In all 19 people attended, including one non-member.

Paul Shields



Editor's Notes



Ian F Bennett BSc CEng MIOA

This issue of the *Bulletin* is our 'summer special' with the idea of providing a little bit of everything at a time of the year when there are few conferences, and many people are thinking more about holidays than work. I was particularly taken with the 'international standard rainfall' described by Peter Rogers - don't we love equations with '10 log' terms in them! I am also grateful to Robin Dibble for his article on public address systems at racecourses, which the more eagle-eyed readers will notice is based on his presentation at *Reproduced Sound* last autumn. This drew my attention to an aspect of acoustics I, for one, had never considered. Coincidentally, last week I attended a race meeting for the first time (the first time with four-legged, as opposed to four-wheeled, competitors, anyway). I'll not divulge the location of the racecourse, in case the proprietors take exception to my comments, but I can certainly confirm that the PA system was no better than the beer. It was (just about) good enough to be able to make out the name of the winning horse after each race, and there may have been an equine element in the alcoholic refreshment too. The bookies have finished trembling with fear now that I have collected my £4 profit on the day's punting. I'll have to do better next time if I want to recoup the cost of the entrance ticket. Over the last couple of weeks I've been involved with one of the more stressful aspects of running a business: moving office premises! However, the purpose of this statement is not to have a 'moan' (I've always been grumpy, it's just that I'm getting older!) but to draw attention to the new contact details for the editor. I can now be reached on 0161 487 2225, but my mobile phone and e-mail details remain unchanged. Material for the September/October issue should reach me by 5 August, and offers of technical contributions or shorter pieces are always welcome.

Ian Bennett

Ian Bennett
Editor

Building Acoustics Group

Annual General Meeting

Held on Tuesday 19 April 2005

Fifteen months had elapsed since the previous AGM, held at the Oxford Hotel on 6 November 2003. The chairman of the BAG reported that 2004 had been a year of consolidation for the group with activities centred on preparations for the present two-day Spring Conference 2005. One half-day seminar on acoustics and sustainability was held on the 27 April 2004.

It was confirmed that the management committee over the past 15 months had been made up of N Antonio, M Barron, R Craik (*Chairman*), C Hopkins, J Kang, R Kelly, A Popplewell, P Rogers (*Secretary*), and A Somerville. Thanks were given to all active members for their considerable work for the Group over the year. Sean Smith had expressed his wish to retire, so new members were invited by the Chairman. Nominations for committee members had been received for Anne

Carey, South Bank University, London and Philip Dunbavin, PDA Ltd., which were approved by the meeting.

The management committee was to meet during the Spring Conference to discuss future activities, and would convene again in May. The possibility of further meetings and workshops on BB101, and the Code on Sustainable Design, was being investigated. Themes for future annual conferences would also be considered. Peter Rogers reported that the group's efforts to increase student involvement in the conference had not been successful. He asked the Institute to consider this matter further and decide how best to address it. The President of the Institute responded saying that the membership committee was aware of the challenge, and was considering how to tackle it. The historical success of 'student sessions' was cited as a possible model.

EXAMINATION RESULTS

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AUTUMN CONFERENCE 2005

Our theme: 'what noise annoys?'

What noise annoys?, the IOA's prestigious Autumn Conference for 2005, will be held at the Oxford Hotel, Wolvercote on 18 and 19 October and is being organised by the Measurement and Instrumentation Group. The theme this year concerns any form of noise which needs reduction or alteration in order to achieve a quieter local environment. Topics - including

current and pending legislation, methods involving prediction and measurement, and an improved understanding of sound propagation - will be covered in four sessions of presentations.

There will also be an audience-participation workshop on the first evening dealing with the perception of tonal sounds: are they pleasant or annoying?

For more information, please contact Richard Tyler at richard@avi.f2s.com or log on to www.ioa.org.uk



Both conferences will be returning to their established venue at the Oxford Hotel

Reproduced Sound 21 Feeding Back to the Future

Following the technical and social success of last year's meeting, the Electroacoustics Group of the Institute of Acoustics is organising a very special Reproduced Sound 21 conference which will take place in Oxford on 4 and 5 November 2005.

This 'coming of age' meeting promises to be a landmark in Reproduced Sound's history and will be an opportunity to look back - and forward - 'feeding back to the future!'

Those who have ever attended Reproduced Sound conferences will know that they represent the cutting edge of modern audio and acoustics, presented in an informal and convivial environment that allows

consultants, manufacturers, contractors and end users to mingle and share insights and information. For those that haven't yet been to one, it is an opportunity for business networking in an atmosphere that proves you can have 'highbrow' and 'informal' in one place at one time.

This year, as you would expect from such an important milestone, there are many key ingredients to whet the appetite. There will be a menu of impeccably served papers from the world's leading academics, consultants, suppliers and manufacturers in the field who will speak on the practical and theoretical aspects of a range of topics including:

- ☐ Room acoustics - studios;
- ☐ Surround sound - intelligibility;
- ☐ Acoustic enhancement - loudspeakers;
- ☐ Microphones - system optimisation;
- ☐ Measurement - modelling; and
- ☐ Perceptual domain - AMPS/DSP.

For the evenings, an audio 'Antiques Road Show' and a 'University Challenge' quiz are planned as part of the entertainment during the weekend.

If you want to hear the latest in audio technology from the industry's leading manufacturers and consultants then you cannot afford to miss RS21.

For further information regarding the event, please contact Linda Canty at the Institute, tel: 01727 848195 or visit the Reproduced Sound 21 website at www.reproducedsound.co.uk

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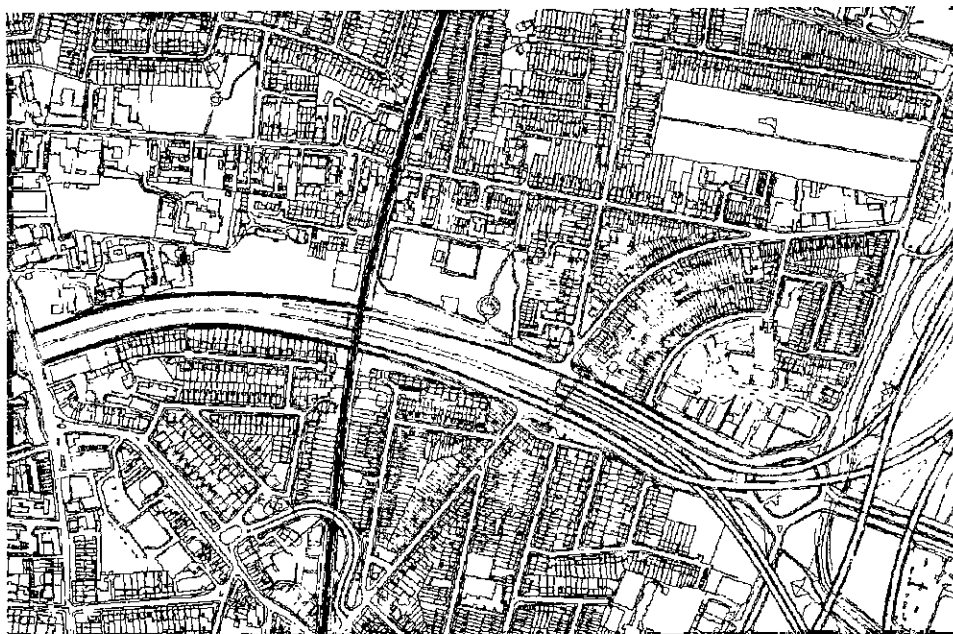
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The heart of building acoustics

what makes it tick?

The Spring Conference returned to the Oxford Hotel, Wolvercote on 19 and 20 April this year. Fifteen papers, including no fewer than three Medal Lectures, were presented by nationally and internationally regarded authors.

The venue was somewhat stretched this time, but still managed to provide the now-familiar backdrop, and there was the added twist of a sound insulation testing workshop across a sample bedroom partition by a selection of delegates. This took place in a distant wing of the hotel (which sometimes seemed to be halfway to Banbury!).

The conference was very well attended, attracting over 120 delegates on each day. The Building Acoustics Group was very pleased with the response to the programme, and is planning another similarly-structured conference in Autumn 2006, taking the content to the next level.

The high quality speakers, and exceptionally well thought out programme were considered to be the reasons for a particularly good turnout.

Bob Craik and Alistair Somerville ran a 'live' paper on sound insulation, in which data for tests on one particular partition were produced by a number of different testers. The results were presented at the end of the conference as an interesting statement on the repeatability of insulation testing. The experiment is reported elsewhere in this issue - turn to pages 28-29.

The five technical sessions, on room acoustics, studios, sustainability, acoustics in schools, and sound insulation,

followed the theme of getting to the key issues in building acoustics - the 'heart' of the matter.

Both the Institute's and the Building Acoustics Group's AGMs were held on the first evening, before the pre-prandial drinks gave the hotel staff the opportunity to change the lecture theatre into a dining room for the conference dinner. Previous conferences at this venue had delegates dining in the mezzanine restaurant, a room notable for its acoustically reflective surfaces and resulting unacceptably high noise levels. The transition to a carpeted room with an acoustically tiled ceiling was a vast improvement! The principal after-dinner speaker at the conference dinner was Michael Vorländer.

The Institute Annual General Meeting: (left to right) Roy Bratby (Chief Executive), Tony Jones (President), Raf Orlowski (Hon. Secretary), Keith Broughton (Hon. Treasurer)



Technical Sessions

☐ Room acoustics

The opening technical session was chaired by **Adrian Poplewell**. The first presentation was the *Rayleigh Medal Lecture*, on the subject of 'retrospective room acoustics', given by **Heinrich Kuttruff** (Institute of Technical Acoustics, RWTH Aachen University). He presented an overview of the development of room acoustics during the second half of the past century, beginning by describing the state-of-the-art in the early fifties, a time when a definite demand arose for new and larger auditoria with excellent acoustics.

He then discussed the ideas which arose in the sixties and later, describing how these influenced our present picture of room acoustics. By systematic psychoacoustic investigations the relation between the objective sound field structure and the subjective assessment of acoustical quality had become well established. On the other hand, modern computing facilities had greatly improved the measuring techniques in room acoustics and created new and powerful tools for the acoustical design of large rooms.

Although the significance of reverberation time (RT) was (and still is) beyond question, it is obvious that it does not yield a complete description of listening conditions in rooms. According to the Sabine equation, the RT should be independent of the room's shape and of a listener's position in it. This is in contrast to our experience that the subjective acoustical impressions may vary considerably in different parts of a large hall. Therefore, great efforts

were undertaken to define additional objective parameters suited to fill this gap.

The traditional formula for the steady state energy density is based on Sabine's theory and predicts constant energy density and hence a constant level for all distances exceeding the 'characteristic distance' which in a large hall was typically a few metres. This formula often fails to yield true results: everybody knows that the sound level in a large hall, in a theatre or in a factory is all but uniform. The reason for this failure is lack of sound field diffusion.

A traditional way to examine the acoustical effects of a particular room shape was the construction of sound rays and their reflections. Another well-established method was the experimental examination of scale models. The advent of digital computers has ended the era of acoustical measurements in scale models. Krokstad et al determined the spatial and temporal distribution of sound by a method which today is known as 'ray tracing'. The process starts with numerous hypothetical 'sound particles' being released from a sound source with a prescribed directional distribution. Each of them travels at sonic velocity and carries a certain amount of energy. Whenever it hits a smooth wall a new direction is determined either from the law of specular reflection (smooth wall) or from two random numbers modelling the scattering characteristics of the wall. The absorption can be accounted for by reducing the particle's energy by a factor of $(1-\alpha)$. The particle is followed up until its energy has fallen below a certain limit.



A full and attentive audience for the technical sessions

Quite a different method of sound field prediction is based on the old concept of image sources. It may be explained by considering an infinite flat room formed by two parallel planes. A ray reflected from one plane seems to originate from a virtual source, which is the mirror image of the original source with respect to the reflecting plane. Similarly, a ray which has undergone two reflections seems to originate from a second order image, which is the mirror image of a first order image source. By repeating this process over and over infinitely many image sources of increasing order are created. The resulting energy density at a point is obtained by adding the contributions of all image sources, with the absorption of the boundaries taken into account by multiplying the energy of each contribution with the appropriate factor $(1-\alpha)$ whenever the ray crosses the image of one of the original planes.

The author devoted the last section of his paper to a rather prosaic branch of room acoustics: sound in work spaces. The interest in such rooms stemmed from the fact that most people spend more of their lifetime in offices, workshops or factories than they did in concert halls and theatres. The goal of acoustic design in work spaces is noise reduction, and hence it is the steady-state level which was in the forefront of interest.

Mike Barron (University of Bath) then presented his thoughts on the room acoustic enigma and the state of diffusion. A diffuse sound field was a reference point in room acoustics. Yet defining what was meant by diffuse remained problematic. Schultz made the analogy between defining humour and diffusion: we know what they mean but cannot express them in words. A commonly heard definition was that in a steady state diffuse sound field there was equal probability of energy flow in all directions and random angle of incidence of energy upon the boundaries of the room. This was probably adequate from a conceptual standpoint, but offered no help from an operational point of view. We could not measure the quantities contained in the definition.

In the derivation of most reverberation time formulae, it was necessary to assume diffuse sound fields, but in practice few spaces in fact had fully diffuse fields. The only examples in which diffuse conditions were sought and test results depended on the state of diffusion were reverberation chambers. These were unusual, since for their size they contained little sound absorbing material.

The issue of diffusion was beset by questions. How do we measure it? How important is it in certain spaces, such as auditoria? Can there be too much diffusion in a concert hall? How are listeners aware in auditoria of the state of diffusion?

A traditional technique for assessing the degree of diffusion was to consider the correlation of the sound between two microphones over a range of separations

between the microphones. This was tedious to implement and has only been applied in laboratory studies. Mike went on to explore the suitability of a measure related to reverberation time measurements for indicating the degree of diffusion. The study was made in the absence of other measurements relating to the degree of diffusion, so the assessment had to be based on assumptions about diffusion in different spaces.

Next, **Rob Harris** (Arup Acoustics) presented the *Engineering Medal Lecture* on the acoustic design of the Operaen Copenhagen. He included many excellent pictures, adding to the paper's impact on the audience. The new opera house in Copenhagen was handed over in October 2004, less than four years since the project's inception. The first opera production was *Aida*, performed by the resident Det Kongelige Teater (The Royal Theatre) in January 2005.

The building contained a main auditorium seating around 1450 for major opera and ballet performances. There was a flexible orchestra pit with three elevators for up to 104 musicians, and six stages, including an acoustically-isolated rehearsal stage. The acoustic design of the Operaen was based upon the balances inherent in opera theatre design, and a modern variant of the acoustically-successful horseshoe form had been adopted. The room volume was around 10,500m³. The mid-frequency reverberation time (average 500 Hz and 1 kHz octave bands, with a typical stage set) was 1.55s in rehearsal and 1.4s with a full audience. The spatially-averaged objective occupied clarity values were $D_{50} = 0.62$ (stage source) and $C_{80} = 2.1\text{dB}$ (pit source).

The main finishes of the auditorium were timber. Thick timber and board composite walls provided sufficient control of low frequency sound absorption. A variable sound absorption system was provided for electronic opera and possible musicals. Considerable emphasis had been placed on the elimination of noise from the auditorium, and the building services noise met PNC 6. The stage machinery was probably the quietest in any opera house.

A studio theatre for an audience of 200 had adjustable acoustics to suit a wide range of performance types. There was a full-scale (22 by 20 by 10 metres) orchestral rehearsal room, also with simply adjustable acoustics. Other rehearsal spaces had well-controlled acoustic responses. The quality of workmanship on the project had resulted in high levels of sound insulation between the acoustically-critical spaces: many of these were box-in-box constructions. The orchestra pit was built so that its size was as flexible as possible. At its maximum, it was the second biggest in Europe (although percussionists still complained it was too small!).

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The heart of building acoustics what makes it tick?

continued from page 9

□ Studios

Roger Kelly chaired the Studios session. Studios are being built at a furious pace. Many broadcasters, such as the BBC, have been building large facilities both in London and in the regions. Many schools and universities have incorporated media and music recording qualifications, creating the need for industry standard recording and broadcast studios, and the world wide web and cable TV have also increased massively the numbers of individuals and companies writing and recording music and visual material.

This session allowed three industry experts in the field of studio design to present their up-to-date knowledge on the subject. *Phased and diffused: the problem of measuring and designing semi-reverberant, partly diffused spaces*, was discussed by **Andy Munro** (Munro Acoustics). Andy has designed well over 500 studio complexes and his paper focused on the difference between theoretical calculated acoustic parameters and measured data. Although the equations had been modified for semi-reverberant spaces there was a significant error produced by the strength of both early reflections and room modes. A comparison of theory and measurement applied to film mixing theatres led to some interesting conclusions.

In the course of setting up and measuring a number of large and medium sized film dubbing and mixing theatres it became apparent that the rooms were considerably less reverberant than normally accepted practice dictates.

This was noticed more in the ratio of direct and early to reverberant energy than in the computed value of T_{60} , which was more or less as predicted. This effect was well known in concert halls and various modifications had been made to the classical Hopkins-Stryker equation.

Five studio theatres of various sizes and shapes were analysed. The paper made many interesting observations and drew fascinating conclusions from the comparative studies. The modified version of the Hopkins-Stryker equation attempted to correct the critical distance (radius) at which the direct sound fell to the same level as the diffused sound field. An architectural modifier M_a took into account the absorption within the coverage angle of the source (speaker system), which was usually greater than the average for the auditorium. The equation produced more accurate results but failed to describe fully the loss of reverberant energy. All time domain measurements and calculations were for the mid frequency band 500 Hz to 2kHz.

New ways for seeing and hearing in studio design were then presented by **Ian Thompson** and **Ian Knowles** (Arup Acoustics). Exciting tools are becoming available to architectural acoustic designers, offering new methods of evaluating problems and presenting answers and advice. These tools provided means for visualising or auralising acoustic behaviour, which were potential routes for bringing an increased objectivity to an area which was often mainly subjective. Traditionally, much of the work in architectural acoustic consultancy followed a core pattern: establishing a brief, looking at criteria and standards, then specification of systems or components to meet the particular performance needs. Visualisation and



Convivial atmosphere at the Conference Dinner



Tony Jones introduces the guest speakers at the dinner



Raf Orlowski reads the citation for Geoff Leventhall's RWB Stephens Medal award

Paul Trew and Phil Dunbavin raising a glass to your Editor



Our camera captures some informal highlights

Informal discussion of the sound insulation test workshop



What did they put in the orange juice, Rob?



A cheeky little vintage: slightly presumptuous perhaps, but eminently palatable

auralisation tools could play a part in each of these stages. The paper looked briefly at the background to these techniques and described the authors' recent experience of applying them in examples of studio and listening room design. Their application in the development of room shaping, agreeing standards, and specification of sound absorption provisions were covered.

The paper focused closely on techniques in communicating the acoustic performance of rooms to clients by using easy-to-understand visualisation and auratisation techniques. The techniques were rapidly converging and also provide quick methods of optimising designs for studios and other acoustically important spaces.

Mark Gaudet (Bickerdike Allen Partners) then presented a case study in reporting the design and construction of the new drama studio at BBC Broadcasting House. The building is located just to the north of Oxford Circus, between the Bakerloo and Victoria underground railway lines. This, along with the very stringent BBC criteria for sound separation and allowable intrusive noise levels, meant that the design of the studios had to adopt a complex box-in-box technology.

Where most of the studios passed their approval tests with flying colours, the Drama Studio and its associated cubicle (control room) failed to attain the sound insulation performance requirements. The case study described some of the particular challenges presented during the design of the suite. Identifying the construction issues affecting the sound insulation were discussed: detailed investigation eventually led to the problem, which was dense blockwork. It proved possible to increase the sound insulation performance by 10dB purely by sealing the dense blockwork, and other solutions allowing the sound insulation performance to be increased to 68dB were described.

□ Sustainability

The session on sustainability in acoustics was chaired by **Peter Rogers**. Two speakers provided an overview for what is an emerging field that cannot be ignored any longer. Design teams are beginning to be driven by the assessments for sustainable buildings, and a Code of Practice on sustainable buildings is due out for consultation later this year. The purpose of the session was to re-open the debate and get a better understanding of what 'sustainability' might mean for the acoustician.

The first speaker was sustainability consultant, **Courtney Hyde Peyton** (Thirdwave), who provided a good overview of the complexities in defining the term, and reminded delegates of what normally drives design teams on projects. The built environment was at the heart of the sustainability agenda. Globally, construction was responsible for 40% of the 7.5 billion tons of raw materials extracted annually. Every year, the construction and use of buildings consumed 16% of global water withdrawals, 40% to 50% of the world's energy production, and 25% of the global wood harvest.

The actions of the construction industry were of particular concern because they were largely irreversible within normal planning time-scales. In a world increasingly driven by organisational accountability and corporate social responsibility, as well as risk, productivity and cost, buildings were coming under extensive scrutiny.

The author reflected on these drivers and what they meant in design terms, with examples especially relevant to acousticians. She also examined, through Thirdwave's

work with clients and their design teams across all stages of the building process, how it had been possible to improve their commercial understanding and realisation that applying sustainability could achieve benefit to their projects, their businesses, their stakeholders and the environment. She went on to identify some of the challenges and opportunities for acousticians, in an attempt to prompt discussion on where this specific area of technical expertise could contribute to sustainability, at the level of an individual building and the broader environmental, economic and societal levels.

The second speaker, **Richard Cowell**, used his particular style to throw open the topic for debate from an acoustician's perspective. Patterns of understanding of the meaning and implications of 'sustainability' took many forms. It was clear that the concept of improving the sustainability of our world and its inhabitants had a vital foothold, and we in building acoustics were increasingly involved in sustainable design. The position of acoustics in this context, and the consequent contributions we could make, were explored in his paper.

Amongst the many tools used to evaluate sustainability, Arup had developed an appraisal routine to carry out



Discussion on sustainability in acoustics

balanced assessments of projects, with particular emphasis on continuous improvement. This had been used as a reference to widen consideration of the role of acoustic design in achieving sustainable outcomes. At one level, sustainable acoustic design was just good design, but in a number of key areas our actions could have particular impact: they were familiar areas such as design for low energy buildings, careful selection of materials, hearing protection, and neighbourhood noise control.

Less obvious contributions included the use of sound and communication for social inclusion and amenity, the impact on ecology of the aural environment around buildings, and the influence of carbon trading and water use on the choice of materials. Effectiveness in contributing to sustainable design had to be strongly rooted in education about the implications of the choices. It was often uncertainty over the real impact of a decision that was the limiting factor. Richard suggested that more data collection about the many relevant aspects of sustainability could help enhance the quality of building acoustics designs.

A number of important and slow-burning questions were raised, and the need for further thought about the topic became abundantly clear. A group discussion on sustainability followed. The IOA will seek to comment on the Code of Practice on sustainable buildings later this year, and aims to build on the foundations laid down by this session.

continued on page 13



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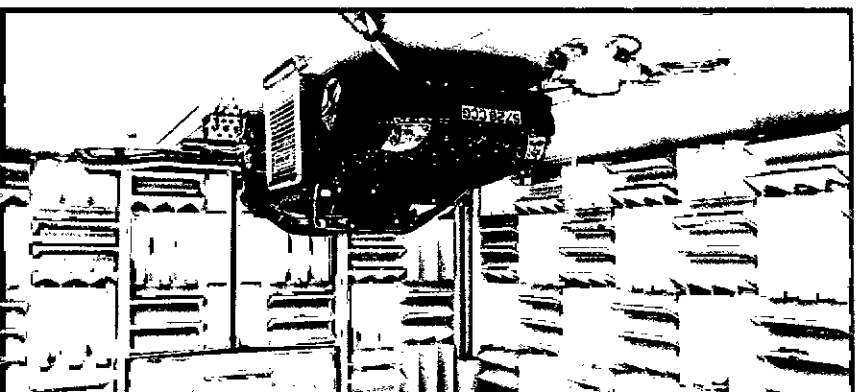
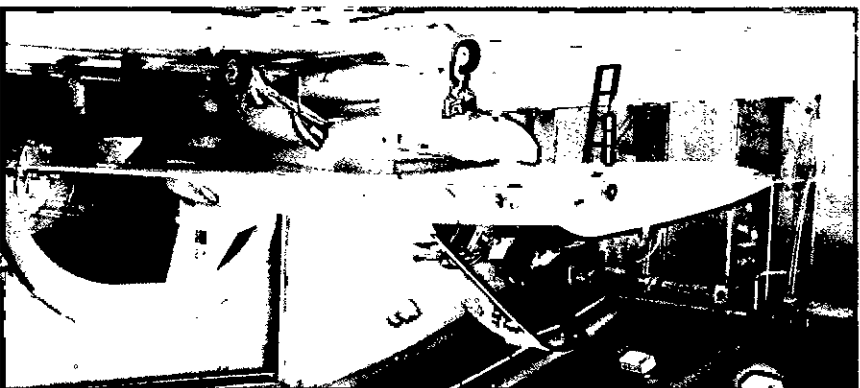
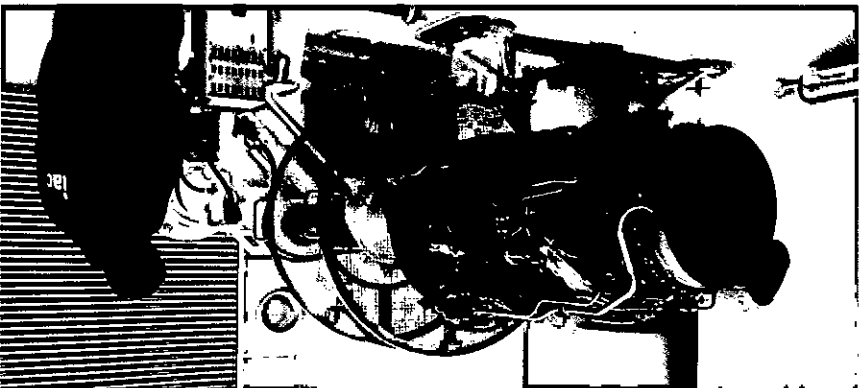
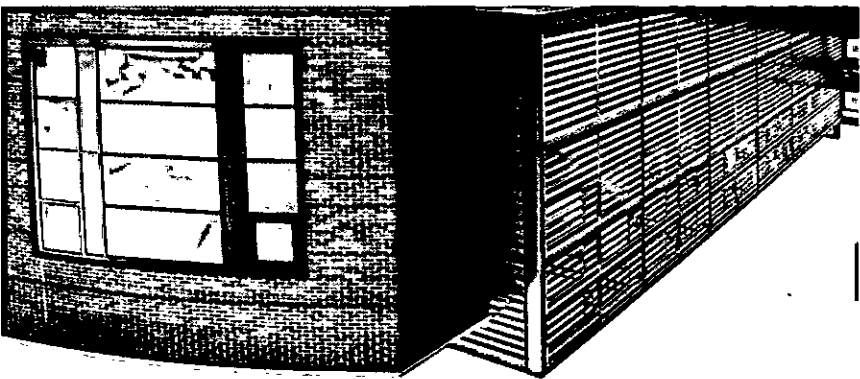
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The heart of building acoustics what makes it tick?

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□ School acoustics

School acoustics remains a hot topic. On the one hand, research is being carried out, along with the worldwide research interest in the field. On the other hand, many interesting practical issues have arisen since the publication of BB93. Four invited papers were presented in this session, which was chaired by **Jian Kang**.

Anne Carey and **Bridget Shield** (London South Bank University) presented the results of *A large scale survey of acoustic indices in classrooms*, and discussed the practical situation of sound field systems in the UK. The project investigated the effects on children's learning and teachers' health of room acoustics, remedial acoustic treatments, and the use of sound field systems in the classroom.

As part of the project an extensive survey of room acoustic characteristics of primary school classrooms was carried out. The classrooms studied include rooms which had been acoustically treated, untreated rooms, and classrooms in which sound field systems had been installed. Their paper presented some of the results, and examined the relationship between speech transmission index and reverberation time in classrooms. The survey also allowed the effects of remedial acoustic treatments to be studied.

There was currently a trend among education authorities to overcome listening problems in classrooms by installing sound field systems, regardless of the acoustic conditions of the room. Among the classrooms with sound field systems in the survey, examples of both good and bad practice in their installation and use were found. Based on these examples, the authors were able to make suggestions for guidance in the installation of sound field systems. They concluded by categorising classrooms according to their construction and volume, in order to simplify the identification of rooms which may be suitable for the installation of sound field systems and those which might require further acoustic treatment.

Andrew Parkin (R W Gregory) examined *The integrated approach for good sound insulation and ventilation, towards a sustainable school environment*. Building Bulletin 93 had established set noise level criteria (indoor ambient noise levels) for teaching and other critical spaces within school premises. As part of Building Regulations, these noise levels must be maintained throughout a school day, regardless of traffic flow or other activities externally. Maintaining those levels was relatively simple in a controlled, air-conditioned climate, but this was not a desirable approach as it involved large capital outlay for plant, high running costs, and a non-sustainable approach to energy use.

The challenge was to use passive ventilation whilst maintaining the target noise levels. In conjunction with the new Part F of Building Regulations, Building Bulletin 101 (to replace the existing ventilation section of BB87) was

currently being drawn up, which would tie up some loose ends within Building Bulletin 93 and allow some additional freedom in designing passive systems. The challenge to the acoustics industry was to work with other designers to provide good internal environments for learning, in as sustainable a way as possible. We therefore needed an appreciation of what criteria need to be met, under what conditions they could be achieved, and by what means. For example, how noisy must it be outside so that passive ventilation was no longer an option? The paper reviewed the requirements of BB93 in the light of the proposed BB101, and suggested a synergistic approach.

Adrian James (Adrian James Acoustics) discussed *The acoustic design of music rooms in schools*, by presenting a number of design principles and examples. The revised Approved Document E of the Building Regulations came into force in July 2003. It required new and refurbished schools to meet specific standards for noise levels, sound insulation and room acoustics which were set out in (DfES) Building Bulletin 93 'Acoustic design of schools'. These were, by definition, only minimum standards, and in some

cases higher standards were needed: music practice rooms and studios used for rock and pop music were two examples.

Adrian discussed some cases in which simply complying with BB93 was not appropriate. Acoustical consultants were often faced with an initial design which, for reasons having little to do with acoustics, they knew would not work. Common examples were school theatres with inadequate stage space, studios which were simply the wrong size

for the intended use, and howlers such as music rooms with no access for a grand piano. His paper proposed a few guidelines on the operational, rather than the acoustical, aspects of performance areas for schools.

Finally, **Bridget Shield** (London South Bank University) and **Julie Dockrell** (Institute of Education, University of London) presented *The effects of noise on education in urban schools*, based on a large scale survey, where acoustical, social and economic issues were all considered. Many studies had shown that chronic exposure to environmental noise had detrimental effects on children at school. The authors reported some findings of a recent study of the effects of noise on children and teachers in primary schools in London.

Noise surveys showed that schools in some areas were exposed to high levels of environmental noise, mainly from road traffic. Children were aware of external noise and often annoyed by it. They were also aware of noise interfering with their ease of listening in the classroom. External noise levels were related to children's academic attainments, as measured by school SAT scores; these relationships were maintained when socio-economic data were taken into account. Noise also affected teachers' health and their classroom strategies.

It was known that many urban areas had high levels of social deprivation, which was inversely related to educational achievement. Schools in these areas were also likely to have relatively high numbers of pupils who

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The conference was particularly well-attended

The heart of building acoustics what makes it tick?

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were particularly vulnerable to the effects of noise. It was therefore particularly important that the acoustic design of schools in urban areas minimised noise levels, in order to mitigate against the negative impacts of noise on all pupils.

The session was followed by a panel discussion. The panel members included Bridget Shield, Andrew Parkin and Adrian James. Several issues, including acoustic indices in schools, design guidelines and social/economic considerations, were discussed.

□ Sound insulation

This session, chaired by **Alastair Somerville**, comprised two papers and an up-to-the minute review of the previous day's workshop session.

Robust Details - the first six months, was presented by **Phil Dunbavin** (Inspectorate Director of Robust Details Ltd). He described the first six months' use of Robust Details as an alternative way of satisfying the requirements of Approved Document E 2003 of the Building Regulations. He looked at how the house building industry had taken up the concept of Robust Details, and the mix of robust details actually being used. The second edition of the handbook had just been published and the new details together with some

clarifications on the existing ones were considered. The significance of the changes was explored.

More than 80,000 examples of Robust Standard Details were currently being tested - many more than had been expected. The construction details in EWM 04 and EFC 01 were the most popular amongst builders. The inspection regime was then discussed: this had adopted a green/amber/red coding, as follows:

Green indicated that there were no problems with the design and implementation of the method.

Amber indicated that there were some deviations, but the shortcomings were easy to correct. Remedial work had to be carried out within 28 days of the test.

Red, as might be guessed, indicated that there was a significant deviation from the required standard, with a partition or separating floor showing a significant loss of performance. This was described as a 'show stopper', since clearly the problems were such that an acceptable result was unlikely to be obtained. Red accounted for 4.5% of inspections, which it was felt was not particularly high.

An inspector's view of Robust Details, given by **Ed Clarke** (Alan Saunders Associates) followed. The scheme's first six months had provided an interesting insight into the new build housing process to the acoustical consultants who formed the Robust Details Inspectorate. Organisation of the vast numbers of plots registered to the scheme had been a monumental task in itself, leading then to random spot check visual inspections, followed by sample sound insulation testing.

RWB Stephens Medal lecture

Michael Vorländer,
this year's medallist,
addresses conference
delegates



Following the School Acoustics session, IOA president Tony Jones announced this year's *RWB Stephens Medal* recipient, **Michael Vorländer** of Aachen University (RWTH), whose distinguished career was reviewed by IOA Honorary Secretary, Raf Orłowski of Arup Acoustics. Michael Vorländer then gave the *RWB Stephens Medal* lecture, entitled *Buildings - how they sound*. He presented auralisation tools his team had developed for various airborne and impact sounds, with interesting demonstrations.

In building acoustics, the situation in the laboratory and in the field was investigated by measurement and prediction. The description of the problem was then simplified by using single-number quantities, for instance R_w or D_{nTw} , in order to communicate with acoustically untrained people and in reference to noise control regulations. In many situations, however, existing single numbers did not reflect all the dimensions of the problem. The use of single figures to describe cognition and perception was very limited: Michael gave as an analogy the example of an RGD description of Leonardo's Mona Lisa, which was unrecognisable!

A general demand for acoustic comfort, however, could hardly be defined since the circumstances of the particular noise problem, the activities of the humans affected and their context must be considered too. The link between the engineering acoustics discipline on the one hand, and annoyance research on the other was, at best, a single number to be obtained from objective measurements or prediction models. In particular the technique of auralisation could be beneficial for subjective tests on acoustic comfort. The technique of auralisation was well known in room acoustics, but to date, not in building acoustics. It was based on the elements of sound generation, transmission, radiation and reproduction. Coupling between the elements needed special attention in case of structure-borne sources such as impact noise or service equipment.

Auralisation of sounds in buildings was possible on the basis of standardised input data from prediction models. The sounds created were plausible to a listener, and quite accurate in levels and third-octave band spectra. The method made it possible to demonstrate effects, and in teaching, could be used to investigate sound effects and annoyance, by varying construction parameters and conducting systematic listening tests or psychoacoustic analysis. The rating of sound insulation could be studied much more easily than with recordings or measurements from real buildings.

As to the future, Michael postulated 'audio' adverts for floating floors, and suggested that a model could be used to test new measurement parameters and how well they related to reality (for example, $D_{nTw} + C_{tr}$).

It has become commonplace at conferences nowadays to use audible elements in a PowerPoint presentation, but this paper was a prime example of what could be achieved by an expert presenter.

Ed discussed the results of the inspections in detail, and examined a number of common workmanship issues in the context of compliance with the scheme. The lessons learned had been useful in providing feedback to Robust Details Ltd for subsequent publicity and training programmes for site personnel and building control bodies. Site testing had recently begun at the time he wrote the paper, and although insufficient data were available for statistical validity, the preliminary indications were encouraging.

The inspector was beginning to be seen as a 'critical friend', the quality of workmanship was directly linked to builders' increasing understanding of the reasons behind the detail. Ed and his associates had learned that the initially poor level of awareness and documentation in the industry had markedly improved after the first six months. Their experience had raised issues for future editions of the RSD handbook, which would evolve to address them.

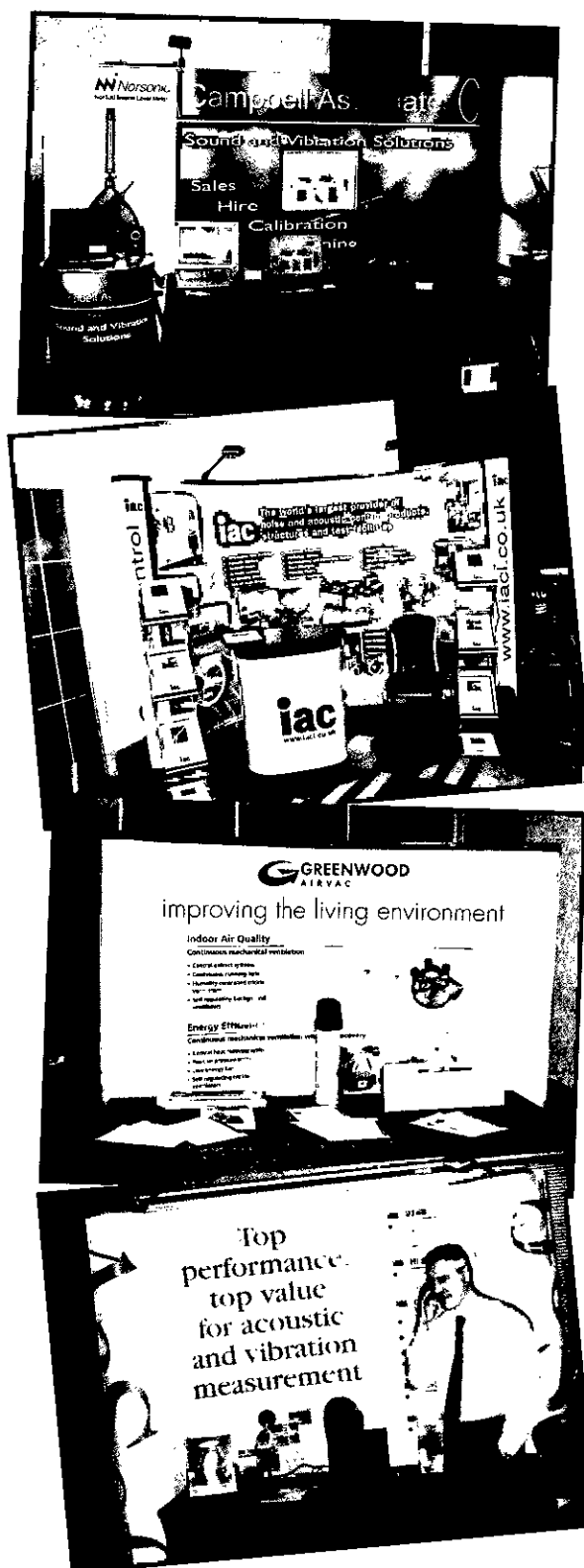
Bob Craik's review of the sound insulation testing workshop brought the session to a close: this is reported more formally on pages 28-29 in this issue of *Acoustics Bulletin*. However, Bob made a few off-the-cuff observations which bear repeating here!

Ten tests had been carried out, but their correctness was a judgement and not a fact. The differences arose from random positioning of the source, random positioning of the microphone, calibration errors and calculation errors. The results showed a 5 to 6 dB variation in the third-octave $D_{nT,w}$ index, with an average standard deviation of 1.5. The ISO claims a 4 to 5 dB variation at low frequencies to be expected in a laboratory test (on the same construction, using the same kit but with different people operating it). The ISO also claims 9dB variation at low frequency between different laboratories. The IOA tests were not as good as the ISO standard for standard deviation, but it was not realistic to expect this without fixed repeatable microphone and source locations. The average $D_{nT,w}$ was 43.8dB, and the average $D_{nT,w} + C_{tr}$ was 38.1dB.

A panel discussion with Phil Dunbavin, Ed Clarke and Bob Craik followed. Two points of particular note arose. The 't'ai chi' or rotating boom methods were not actually taking many samples relative to wavelengths at low frequencies (for example, 3.5m at 100Hz). Lightweight block constructions were affected less by the C_{tr} correction than other construction methods.

The conference was supported and enhanced by the presence of acoustical product and instrument manufacturers at the exhibition. Their input (not least in financial terms) as always made a valuable contribution to the success of the conference.

Thanks are gratefully offered to the hotel management and staff for their services, to the organising committee of the Building Acoustics Group, and to the indefatigable Ken Dibble for providing the PA system and sitting at the 'desk' throughout the proceedings. Finally, the behind-the-scenes efforts of the Institute staff must not be forgotten: Linda, Judy and Roy were always on hand (even though the female members of the team were reluctant to have the fact recorded on camera).



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Heinrich Kuttruff receives the Rayleigh Medal

Rayleigh Medal 2005 Professor Heinrich Kuttruff

Over a period of fifty years Heinrich Kuttruff has made a major contribution to the development of our understanding of the behaviour of sound in enclosed spaces and its interaction with reflecting, scattering and diffusing bodies and surfaces. He has achieved this by means of a substantial and systematic programme of theoretical modelling and analysis supported by experimental measurement. Much of his early work was aimed at improving the process of modelling sound propagation in reverberation chambers in order to provide a rigorous basis for the interpretation of measurements in these

spaces and for improving the methodology of reverberation room measurements. Later, he turned his attention to sound propagation in auditoria and made studies on wall and ceiling reflectors and scatterers, coupled reverberant spaces, diffusivity and audience absorption. His work on multiple scattering has had a seminal influence on the development of models and software for the computational simulation of sound propagation in auditoria and in 'disproportionate' enclosures such as industrial workspaces, and for modelling the multiple scattering of 'outdoor' sound by objects such as tree trunks.

He has made his knowledge and expertise available in successively updated and enlarged editions of his book *Room Acoustics* (4th edition published in 2000) which is universally used by teachers and students of room acoustics. Such dedication to the dissemination of knowledge marks him out as an outstanding contributor to the understanding and development of acoustics.

He has also made important contributions to the field of ultrasonics, both by research and through his book *Ultrasonics* (Elsevier 1991). Particular contributions include the development of an absolute calibration method for underwater transducers, and the development of measurement techniques for studies of cavitation and sonoluminescence. Heinrich Kuttruff has supervised more than thirty doctoral students and has acted as doctoral examiner to many more. Research is fruitless without dissemination through reputable journals. Heinrich has worked tirelessly in this cause, having been German manuscript editor of *Acustica* from 1972 to 1995 and co-editor of *Applied Acoustics* from 1974 to 1996. He also served the international acoustics community as member and secretary of the International Commission on Acoustics from 1979 to 1986. He was President of the German Acoustical Society (Deutsche Gesellschaft für Akustik eV) from 1991 to 1994. In recognition of his undoubted renown for outstanding contributions to acoustics, the Institute of Acoustics is proud to present the Rayleigh Medal for 2005 to Professor Heinrich Kuttruff.

R W B Stephens Medal 2005 Professor Michael Vorländer

Michael Vorländer is Professor and Head of the Institute of Technical Acoustics at the University of Aachen. He was appointed to this post in 1996 in succession to Professor Heinrich Kuttruff whom the Institute of Acoustics is also honouring this year.

Michael's main professional interests are teaching and research into room acoustics, building acoustics, binaural technology and acoustical measurements. His contributions include detailed investigations into room acoustical ray tracing models, maximum-length sequence reciprocity calibration of microphones in reverberation chambers, and the definition and measurement of random incidence scattering coefficients. In all, he has published over 30 papers in refereed journals, over 50 papers in conference proceedings and has made contributions to four books. Michael started his university education in the field of physics and was awarded a Diploma in Physics by the University of Aachen in 1984. He stayed on at Aachen to carry out research on acoustical ray tracing models for which he was awarded a PhD in 1989. Subsequently, he moved to the Physikalisch-Technischen Bundesanstalt

in Braunschweig where he soon became the Head of the laboratory of building acoustics. In 1996 he was offered chairs at both the Technical University of Dresden and the University of Aachen and chose to return to Aachen.

Michael has a fundamental interest in promoting Acoustics in Europe. In 1998 he joined the Executive Council of the European Acoustics Association (EAA) and also the General Assembly of the International Commission on Acoustics. In the same year he became Editor-in-Chief of the journal *Acta Acustica united with Acustica*, in which capacity he served for five years.

Between 1999 and 2002 he acted as the founding chairman of the EAA Technical Committee on 'Room and Building Acoustics'. In 2002 he was the General Structured Session Chairman of Forum Acusticum in Seville and in 2003 he was the General Chairman of the annual conference



The President presents Michael Vorländer with his R W B Stephens Medal

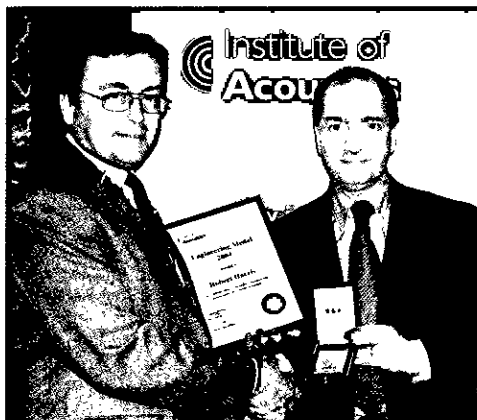
of the German Acoustical Society and EAA Symposium. Now in his capacity as the President of the EAA, his work for Acoustics in Europe continues, with many objectives including producing an *Acta Acustica* archive on CD-ROM and establishing further EAA Technical Committees. For his outstanding contributions to teaching and research, and also recognising his leadership in acoustics, the Institute of Acoustics is proud to present the R W B Stephens Medal for 2005 to Professor Michael Vorländer.

The Institute of Acoustics Engineering Medal 2004

Robert Harris

Following the award of an honours degree in physics from Warwick University, Rob Harris enrolled for a Master of Science course at the Institute of Sound and Vibration Research at Southampton University. Here he embarked on his first large-scale auditorium project, namely St Paul's Cathedral and the design of its speech reinforcement system. Since then, Rob has worked on an enormous range of auditoria, particularly opera houses and concert halls, and also on many other types of space such as convention centres, cathedrals, airport termini and office buildings.

After a spell at Acoustic Technology Ltd, where he worked on the design of high power sound systems, Rob joined Peter Parkin, Derek Sugden and Richard Cowell at the fledgling Arup Acoustics. Here, with Derek Sugden, he undertook his first important opera project - the Britten Opera Theatre at the Royal College of Music. This was followed by work on the first new major opera house in England for 60 years, namely Glyndebourne Opera House, which since its completion in 1994 has become a benchmark in acoustic quality in the opera world.



Rob Harris receives his inaugural Engineering Medal from the President

A major concert hall design followed, the Bridgewater Hall in Manchester, where Rob developed a design which, for the first time, combined the acoustical qualities of both the shoebox and vineyard terrace forms - the hall has been widely acclaimed internationally for its acoustics. The next major project was the refurbishment of the Royal Opera House, Covent Garden, which not only involved improvements

to the acoustics of the main house but included major engineering work such as the installation of 11 enormous acoustic scenery doors and sophisticated box-in-box isolated structures.

Rob subsequently expanded his horizons to include Scandinavia and was appointed to design the acoustics of both the Copenhagen and Oslo opera houses. The Copenhagen project has recently been completed and the acoustics have been acclaimed as being 'second to none'. Widening his horizons still further, Rob has been engaged to work on the acoustics of the re-design of the opera theatre at the Sydney Opera House - one of the world's most iconic opera venues.

Rob has not only directed his skills to auditorium acoustic design but since 2000 has been the leader of Arup Acoustics in the United Kingdom and has overseen the delivery of many high quality acoustic engineering projects as well as inspiring the work of more than 50 acoustical consultants.

For his contributions to acoustical engineering, particularly in relation to design, the Institute is proud to present its first Engineering Medal to Robert Harris.

Honorary Fellowship of the Institute of Acoustics

Hubert Geoffrey Leventhall

Geoff Leventhall joined the staff at Chelsea College, London in 1959 as a lecturer following completion of a part time MSc course in acoustics at the College. Dr R W B Stephens from Imperial College had given the lectures on this course. Subsequently, Geoff became Reader in Acoustics and Head of the Applied Acoustics Group at Chelsea, responsible for the development of teaching and research in acoustics. He helped establish two respected Master's courses; one in Applied Acoustics and the other in Acoustics and Vibration Technology.

During his 22 years at Chelsea, Geoff's research interest included the measurement of damping materials, the noise assessment of gas flames noise from domestic appliances, building acoustics,

low frequency noise and active noise control. Together with R W B Stephens, he edited *Acoustics and Vibration Progress* between 1974 and 1976. His interest in low frequency noise led to a contributory chapter to *Infrasound and Low Frequency Vibration*, edited by Dr Bill Tempest. Together Geoff and Bill organised, and continue to organise, a successful series of conferences on low frequency noise and vibration. Geoff also carried out fundamental work in active noise control. He supervised more than 30 PhD students in the area of the effects of noise and its control and has been external examiner for doctoral degrees in acoustics for Universities in the UK, Denmark and Sweden.

Geoff left Chelsea College in 1982 to become Head of Acoustics and Technical Director at W S Atkins, putting into practice much of what he had researched and taught others. He went back to an academic post in 1988 as Professor and head of the Institute of Environmental Engineering at South Bank Polytechnic, which he left in 1992 to return to consultancy. Geoff has also made substantial contributions to acoustics activities both in

the UK and internationally and was the 1978 recipient of the Institute's Tyndall Medal. He was President of the IOA from 1984 to 1986 following service as Council Member, Treasurer, Chairman of Meetings Committee and Chief Examiner for the Diploma.

From 1986 to 1989 he was a Director of the International Institute of Noise Control Engineering. He has served as Honorary Secretary to the Association of Noise Consultants and as a member of the BSI committee on building acoustics. He was the Deputy Chairman of the UK Noise Council, a member of the Noise Review Working Party (Batho Report 1990), the Mitchell Committee on Railway Noise (1991), its follow-up Working Group developing the Calculation of Railway Noise (1995) and the Government 'noise forum'. Geoff has also served on an international committee advising the Swedish Research Council on noise research. In September of this year he was made an Honorary Member of the ANC. Geoff Leventhall's extensive acoustic career encompasses research, teaching and practice. A former student and colleague of Dr R W B Stephens, he had maintained the high standards set by his mentor. He has introduced many students to acoustics and had subsequently equipped them with a knowledge and enthusiasm for the subject which serves them well in their career in acoustics. In recognition of these achievements Geoff Leventhall is awarded an Honorary Fellowship of the Institute of Acoustics.



Geoff Leventhall is presented with his Hon. Fellowship by the President

Public address systems on horse racing courses in Great Britain

RJ Dibble

Eighteen years ago, Peter Barnett presented a paper at *Reproduced Sound 2* on the design of a high quality audio installation at a Hong Kong racecourse. Today, UK racecourses are still reluctant to make that level of investment in their public address systems. With a couple of notable exceptions at Sandown and Newbury, most courses' public address systems rely on traditional 'commercial' type loudspeaker installations. This article aims to show that, when the requirements for the system are taken into account, and the system is properly designed, this need not necessarily be a bad thing.

The technical side of horse racing

There are 59 horse racing courses in Great Britain, or 60 if you count the two courses at Newmarket, where there are two finishing straights from the same course. All race meetings on these courses are run under the rules of racing, policed and upheld by the Jockey Club. There are Jockey Club stewards present at all race meetings to ensure the safe and fair running of races. Despite articles recently published in the press, to a large extent they are successful in keeping the sport free from foul play and corruption.

Technical facilities are provided to assist the stewards in keeping the sport as fair as possible. These include the starting stalls for all flat races (races not run over jumps), the photo finish operation, and what has become known as 'camera patrol'. This consists of a sophisticated, fully digital outside broadcast unit and four or five cameras placed at strategic parts of the course to capture the racing from all angles. Each of these cameras is individually recorded and displayed on a separate monitor in the steward's room, in order that the stewards can see from different angles any antisocial antics the jockeys get up to during a race, therefore making as fair a judgment as possible about the running of the race. Pictures from the OB truck are also sent to BT Tower via a private fibre-optic network for worldwide distribution, and are used to show the racing on televisions located in all rooms, bars, restaurants and suites on the racecourse.

Public address

Overview

Public address systems on racecourses serve a number of purposes. First, there is an obvious need for a system to aid evacuation, but it is also an important information service. Apart from the race commentary telling punters what is happening when a racing pack may be out of sight, important information is given about the betting odds for the placed horses in each race. Judges' decisions, photo finish results and stewards' notices regarding the running of each race are also announced. All this information is essential for the punting public to help them make their judgements on which horses to back, and when to claim their winnings.

This was not always the case. Public address systems did not make an appearance on UK race courses until 1952, when the first race commentary was given at Goodwood Racecourse. The Jockey Club, now as then, also dictates what information is allowed to be given over the public address system: these days they are fairly relaxed, but once upon a time only the commentary and judges' announcements were allowed.

Public address system setup

Loudspeakers are permanently installed on the racecourse, and cabled back to the curiously-named 'broadcast office'. This room, usually too small, is located in the weighing room building, where the jockeys are weighed and checked under the watchful eye of the Clerk of Scales, who is responsible for the running of all races on the day. On the morning of the race meeting, a technician will turn up, and connect the amplification and processing equipment to these loudspeaker circuits, and operate the system. All equipment other than the loudspeakers is, in most cases, carried by the technicians and installed on a day by day basis. Some of the larger courses do have the control and amplification systems permanently installed, in which case the technician merely installs the front end, *ie* microphones, mixer and other paraphernalia. *Figures 1 and 2* show the

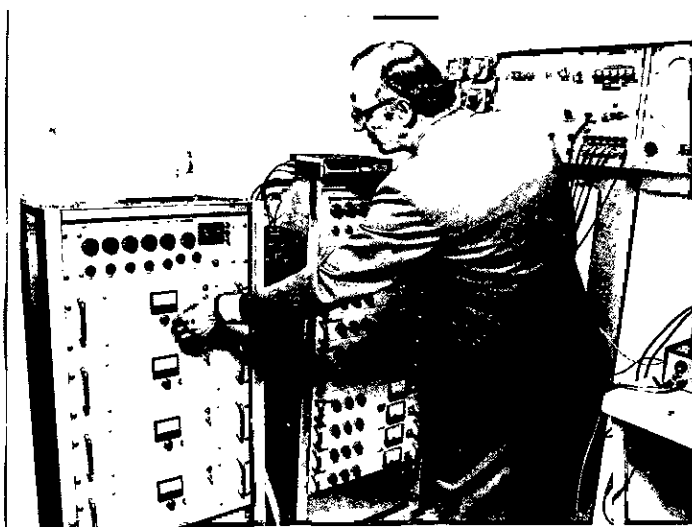


Figure 1: early audio equipment

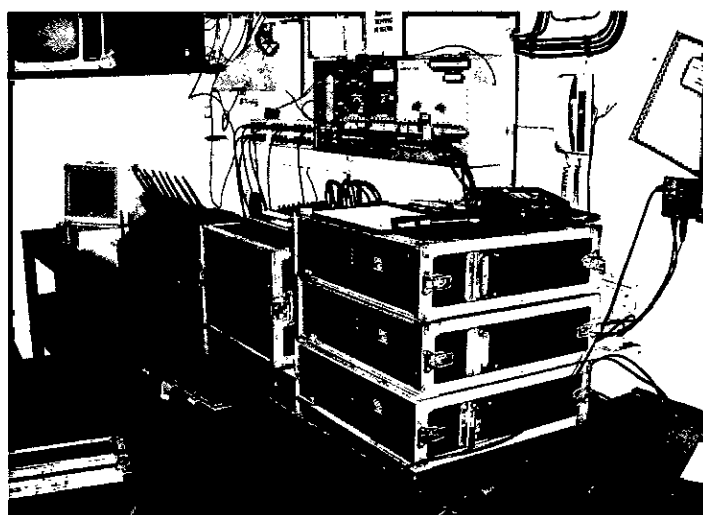


Figure 2: a more recent installation

audio equipment used from two eras. Interestingly, the equipment shown in *Figure 1* was still in use until six years ago!

Audio feeds come in to the broadcast office at line level from the commentator, via the commentator's switch box, and from microphones supplied to the judge, race day announcer and the winners' enclosure. In some cases pre-recorded announcements and fanfares are played back from minidisc. All audio passing through the system is also recorded to minidisc, in case of later confusion or enquiries by the stewards.

Use of high quality microphones and good quality front end equipment ensures the best possible quality signal is fed to the loudspeakers. Traditionally, rather poor equipment was used in the belief that this was of no consequence with the limited bandwidth and quality of the loudspeakers being used. In fact, the better the front end quality and the lower the distortion reaching the loudspeakers, the more chance they have of producing intelligible and comfortable sound.

Compressors are used in order to restrict the dynamic range of over-enthusiastic commentators and presenters. It is not unusual to be applying 24dB of compression on a commentator, reducing a 30dB increase in level between the start of the race and the final furlong down to a 6dB difference. Output level limiters and band pass filtering are used in multi-channel DSP's to protect amplifiers and loudspeakers from damage due to being overdriven and maximise the available sound pressure level from the installation.

Owing to the large number of loudspeakers and the long cable runs on a racecourse, the loudspeaker circuits are obviously run at high impedance and driven at 100v level to minimise losses.

On most racecourses, the same programme material is sent to all external areas. On some courses however, the parade ring and winners enclosure have separate feeds. The parade ring is an oval walkway where the horses parade before a race, to allow the punters to view the animals before they run. For special events happening in the parade ring and for presentations to the winners, there is sometimes a separate system around the ring fed with its own separate mix from that feeding the rest of the course.

Internally, all corridors, toilets, lifts and general circulation areas are fed the same sound as is fed to the main external PA system. In the bars and restaurants, locally installed amplifiers or multi zone systems relay the sound from the racecourse's television programme through high density ceiling loudspeaker installations. This means the sound on the television sets does not have to be turned up, which is undesirable as it results in distorted sound from the televisions blaring out in an area local to the televisions, and people further away from the screens being unable to hear.

In the event of an emergency, the sound to all areas of the racecourse can be overridden from the broadcast office, such that all areas and televisions carry security or emergency messages. All audio equipment is powered from the mains, with either battery, UPS or generator backup for use in the event of a power outage.

PA for open areas

Designing audio systems on tight budgets for use in the open areas of racecourses is made a great deal simpler by only having to deal with speech band reproduction, as

continued on page 20

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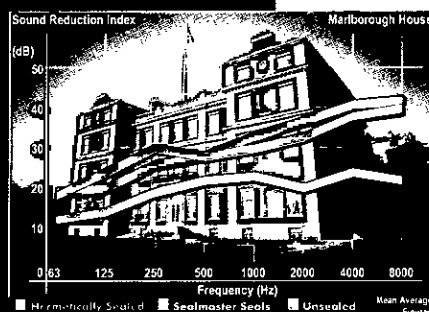
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Design Council's Chief Executive, Sept. 1999

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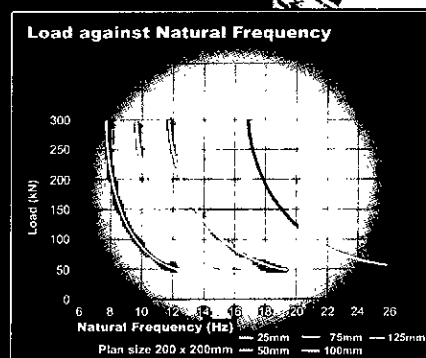
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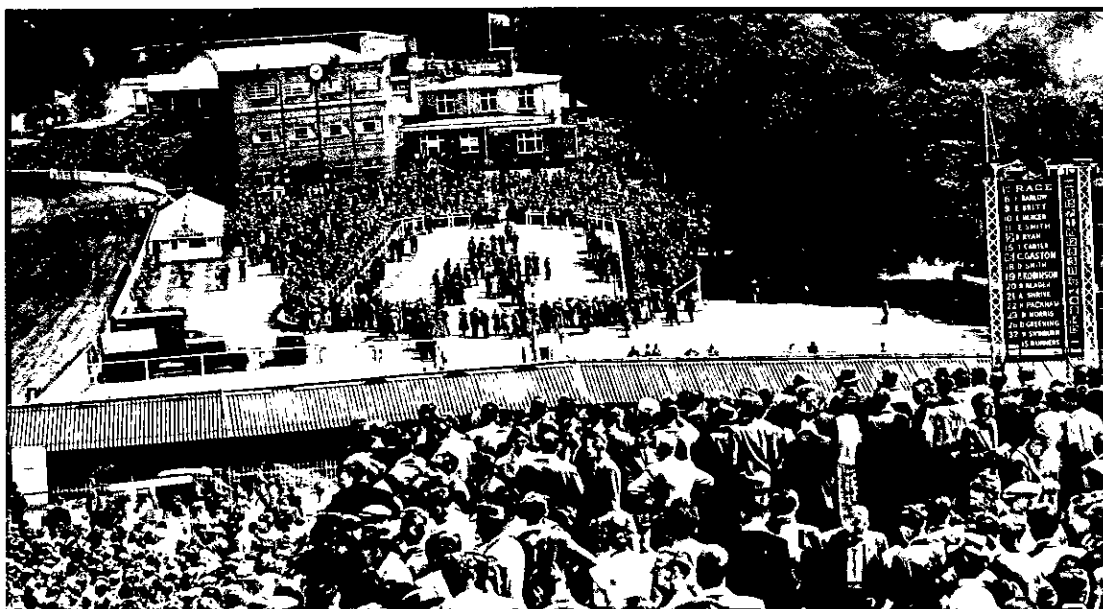


Figure 3: Goodwood in the 1950s

Public address systems on horse racing courses in Great Britain

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music is rarely used, and not having a great many of those problem causing surfaces to worry about!

The main aim with speech reproduction is again intelligibility rather than hi-fi quality, as the system is used to impart information, rather than to entertain. However, a traditional 'railway station' approach is clearly unacceptable, and intelligible coverage of all areas is a must. Therefore the loudspeaker installation must be designed properly for optimum coverage of public areas, with as little as possible overspill into areas where delicate thoroughbred racehorses are likely to jump if the PA system suddenly sparks into life! Clearly, the old 'horns on poles' approach is not going to achieve this.

Although few details remain of the public address system installed at Goodwood for that first occasion in 1952, *Figure 3* shows a photograph from the period. Note the exponential horns on top of the number board to the right.

As the bandwidth we are trying to cover is only that shown in *Figure 4*, these devices are not quite the anachronism they at first appear to be. *Figure 7a* shows a response for a similar type of loudspeaker. As can be seen there is remarkable similarity between the two figures.

The large straight exponential horn and others of the same type are an ideal method of relaying speech information over a large distance to a large number of people. They require very little audio power input for a prodigious output over their operating bandwidth. Although

of a restricted frequency range, they cover the speech band easily with great intelligibility. They have a narrow coverage angle and therefore project the sound energy forwards very efficiently. They are, however, not very good at near field coverage for exactly the same reason, so the installation in *Figure 5* is a little ill-advised!

However, when these units were used as intended, their high efficiency meant that low power amplifiers could be used effectively, certainly a major consideration when amplifier power was scarce and expensive. When

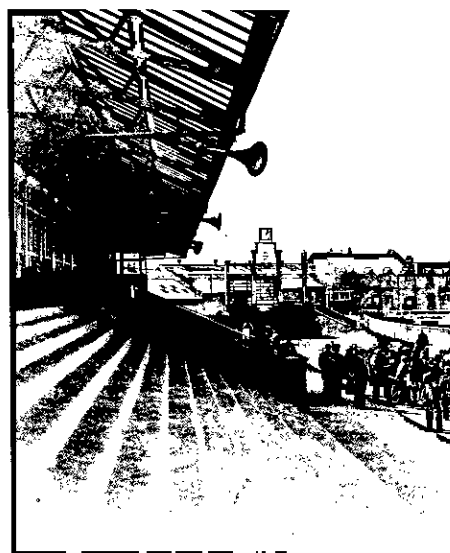


Figure 5: how not to use the exponential horn!

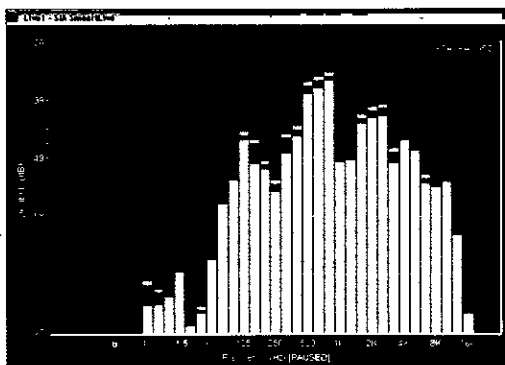


Figure 4: the bandwidth covered

devices such as these are used as part of high impedance distributed loudspeaker line, such as the UK standard 100v distribution system, this also has the advantage of presenting a small load to the feeding cable installation, allowing for long cable runs in cable of manageable proportions with minimal loss.

Of course, architects hate these things, and therefore for long throw applications a more aesthetically pleasing solution has to be found these days, and it is usually custom-painted white!

Figure 6 shows the response of an alternative

interpretation of the straight exponential horn, a properly designed re-entrant horn of high quality, with an air column length of 46" fitted with a good quality compression driver designed for speech applications.

With a decent compression driver, horns of this size also have a reasonable response down to the 250Hz region, allowing for some subjective warmth in the speech, making these devices not unpleasant to listen to for speech reproduction purposes. They certainly do not have the peaky, screechy sound so common to many public address systems.

As with all loudspeaker designs, care has to be taken with deployment of these re-entrant horns if they are to be used to best advantage. The polar plots for the same re-entrant horn are shown in *Figure 7b*. The unit is marketed as a 'wide angle' horn. Although the polar plots demonstrate clearly

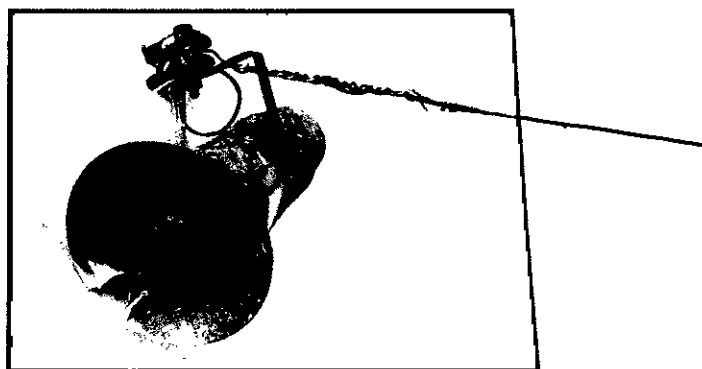


Figure 6: a properly designed re-entrant horn

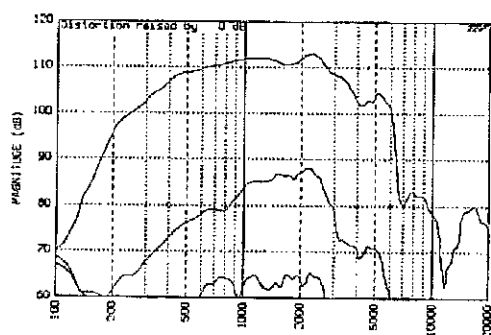


Figure 7a:
frequency
response
for a typical
exponential horn

Frequency Response (1W/1M)

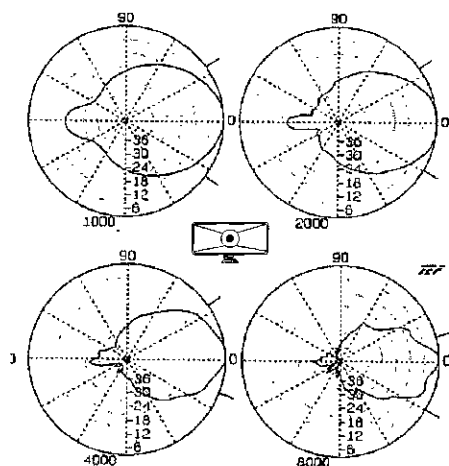


Figure 7b: polar
plots for re-
entrant horn

Horizontal Polars Are Normalized To Zero On Axis

that this is not the case, it is a useful device where a narrow dispersion angle and therefore good projection is required.

Despite the involvement of marketing departments, at least manufacturers are now making this type of data

available for 'commercial sound' loudspeakers. In fact, the manufacturer of this particular device also includes EASE data on its web site. This is becoming more and more common in the commercial sound sector. It may be late in the day for this data to become available, in comparison with data for 'professional' sound products, but we now seem to be getting there. It was not very long ago that optimising the coverage of a racecourse system would have been done by ears and guesswork, with no predictive material available for use. Even if the curves have been through the marketing department's patented 'curve flattening' machine, it all helps.

So we have a more compact, architecturally acceptable device (when painted white) for projecting speech over a distance, which when used with a 60W compression driver and correctly band-pass filtered has a 1 metre maximum output of 128dB, or 94dB at 50m distance in ideal conditions. The trade off against the straight horn is an increase in distortion. However, such a practical selection of device has not always applied on racecourses.

The revolting item shown in *Figure 8* is a small, 15w re-entrant horn. For some reason these were very popular at one time on racecourses, used for everything from an internal loudspeaker in a highly reverberant betting hall to an external long throw loudspeaker, two of which would be expected to cover an area of 50m by 50m (tapped at 5W each, of course!).

PA under cover

Racecourse grandstands have areas known as the 'steppings', where the punters stand with their binoculars and watch the race, or these days, the large video screens. The listener is in much closer proximity to the loudspeakers in these areas, and therefore a subjectively softer, wider dispersion device is obviously required. These areas are often over hung by balconies or canopies, and are therefore semi-enclosed. Compression driven horns do not work well in this environment, as they sound subjectively harsh, and are usually of too narrow dispersion.

It used to be done as indicated in *Figure 9*. The loudspeaker cabinets shown hanging are housing paper coned 6" by 3" elliptical loudspeakers, tapped at 3W per pair of drivers in a 'V' cabinet. This is actually a better example

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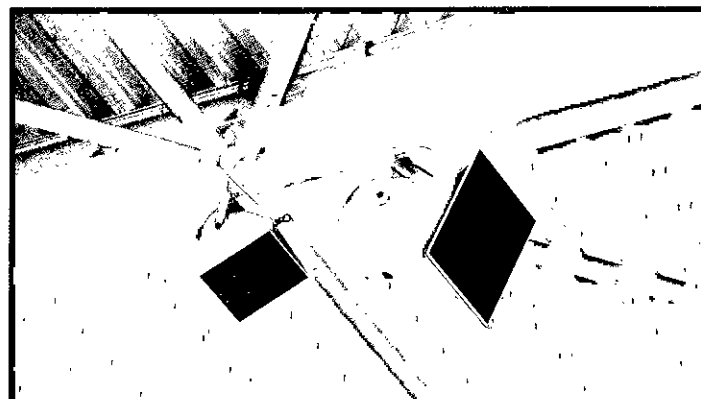


Figure 9: arrangement for softer, wider, dispersion

Public address systems on horse racing courses in Great Britain

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of the breed, since usually only one of those cabinets would have been used for that size area. These are not the worst examples to be found on a racecourse. There are still in existence on some courses, heavily varnished wooden cabinets, containing KEF B200 bass drivers - a superb bass unit, but not much use over the speech band, with a response tailing off sharply at 3.5kHz and a broadband sensitivity of 85dB/W/m. These would be tapped at 2 or 5 watt, giving a maximum SPL of 92.5dB at 1m, or 72.5dB at 10m. Not very helpful, but used originally due to their weather resistant 'Bextrene' cones and rubber surrounds. There are examples of these loudspeakers being tapped at the heady level of 10W, when they would be used to cover (or not) distances of up to 50 metres!

With the shorter throw requirement, less efficient loudspeakers with a broader bandwidth can be used. For source to listener distances up to 15 metres, a preferred type of device is that which goes under the name of 'music horn'. These devices are generally small, cone driven horns or two way units, with a cone driver firing into a reflex horn, and a forward-firing HF unit housed in the low frequency driver chamber. They are not ideal for perfect time alignment, but for these purposes they work well. With a little equalisation these can sound quite pleasant, and even make a reasonable hash of music reproduction. An example is shown in Figure 10, with its response plots shown in Figure 11.

When source-to-listener distances drop below 5 metres, small, single driver loudspeaker enclosures are used. These typically use a four-inch weatherised cone loudspeaker, with response tailored for speech. Whilst not of particularly

high audio quality, they do achieve good intelligibility when used correctly and within their limitations.

PA inside

There are often large, open bars and betting halls in racecourse buildings. Architects currently seem to favour large, flat surfaces such as tiled floors, rendered walls and plasterboard ceilings in these areas, which are no help when trying to install a loudspeaker system that will give intelligible speech reproduction, especially when the bars are full of people chatting, placing bets, scraping metal chairs across hard floors *etc.*

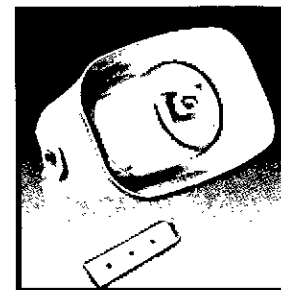


Figure 10: a 'music horn' meets shorter throw requirements

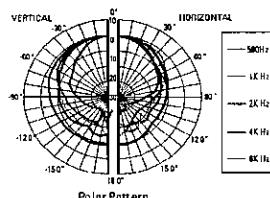


Figure 11: response plots for 'music horn'

The first course of action when a drawing for a room such as this is seen is to ask the architect to refer to an acoustician before any further progress is made, pointing out to the consultant that the room needs to be suitable for amplified speech with at least a modicum of intelligibility.

Once the architect has ignored the consultant's advice because it is jeopardising his RIBA award for the building, it is usual to resort to a high density ceiling loudspeaker installation, in order to minimise the source to listener distance. There is little else to be done in these situations. To be fair, the architect is usually persuaded to apply at least some treatment to the room, where it will not make to much aesthetic impact, although Figure 14 shows a room where all pleas for leniency were ignored. The treatment that seems to improve the acoustic environment in areas such as this the most is a decent carpet, as this not only stops the early



Figure 14: large open bars and betting halls are typical in racecourse buildings

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Case study Newbury Racecourse

Newbury is one of the UK's premier racecourses. Over the last five years, a rather ageing and dilapidated loudspeaker installation has been replaced. This started with a new grandstand, shown in *Figure 12*, built in 2000/2001. The first problem to cover the area in front of the stand was a distance of some 60 metres between the stand and the course, potentially full of punters. In this instance, we were able to install three full range, horn loaded loudspeakers of asymmetric coverage pattern. At the bottom of the vertical pattern the horizontal dispersion is 70 degrees, and at the top of the pattern this narrows to 40 degrees. This pattern is ideal in this particular arrangement, as there is a broader pattern in the nearer field, covering a wider area, and greater projection from the narrower angle for the far field. Smaller two-way horn loaded devices were used to cover the stepped area out to the first five meters of the tarmac area, with 'music horn' units used as under balcony fill. This combination has resulted



Figure 12:
Newbury's new
grandstand, built in
2000/2001

in extremely even coverage of the area, from 70 Hz to 10 kHz ± 4 dB. The STI figures are given below, taken off-axis of the loudspeakers, to give a worst case scenario.

Under balcony 0.65
Mid steppings 0.66
Front steppings 0.66
10m from stand 0.66
20m from stand 0.70
30m from stand 0.59

The subjective quality of this system is obviously high, and is well suited for the occasional music reproduction which is called for on the front of this stand.

Once this installation was completed, it became very obvious that the only place on the racecourse where you could clearly hear the commentary and announcements was in front of this stand. And so, with a considerably smaller budget than was given for this one stand, the loudspeaker installation was replaced on the rest of the course.

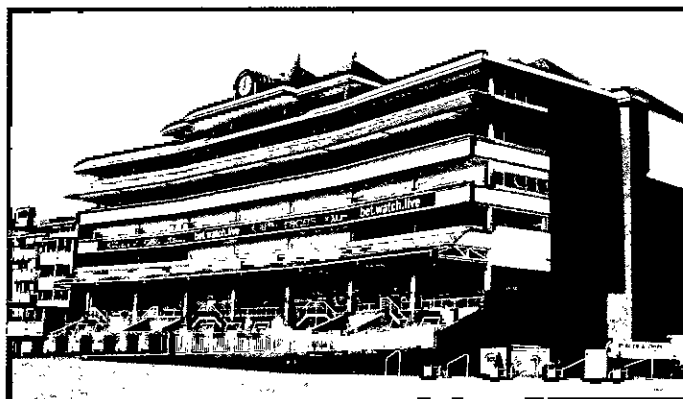
The Hampshire Stand, shown in *Figure 13*, was tackled with the primary objective of achieving good intelligibility.

Here at the front of the stand we see use of both the re-entrant horn discussed earlier, coupled with a 50W compression driver and a single 4 cone driven 30 watt music horn. The loudspeaker behind the pillar is a 6W single driver device as mentioned earlier. The music horn is used to cover the near field, the re-entrant the 45m distance to the running rail. The STI values achieved with this combination are as follows, again showing the worst cases.

Rear steppings (6W devices) 0.60
Front steppings (30W devices) 0.59
Forward horns @ 10m 0.70
Forward horns @ 20m 0.72
Forward horns @ 30m 0.73

As one would expect, the subjective audio quality is not as high on this stand, although the intelligibility is in fact higher, subjectively as well as measured.

Figure 13: the
Hampshire stand,
where good
intelligibility was the
prime objective



reflections bouncing off the floor, but also stops the sound of clanking and scraping furniture.

Apart from these nightmarish scenarios, other rooms are usually fairly favourable environments in which to install an effective audio system. Often in the constant search for extra revenue, the more comfortable areas of the grandstands such as restaurants, members' bars and private boxes are now multifunctional rooms. The open bars as described above are often used as exhibition spaces, the more comfortable areas are used for meetings, conferences and functions. These are therefore of a rather softer acoustic, and easier to deal with. Typically, STI levels of 0.58 and above are achieved in these rooms, with a response ± 3 dB from 125Hz to 8kHz.

In the larger new stands on major racecourses, centralised multi-zoned systems tend now to be installed, allowing audio sources to be connected in each room and relayed through the installed loudspeaker system. These systems are usually DSP based, and allow room equalisation and dynamics processing to be applied to each area, and give the ability to have control panels in each area to select audio sources and volume level. This may be old news to most of the professional audio community, but has come as bit of a shock to the racecourses, who are more accustomed to a 100W mixer amplifier stashed behind the bar and

covered in beer (or champagne, depending on whether it is a members' or public bar!).

Conclusion

Although it was rather overdue, public address facilities on the UK's horseracing courses are being dragged slowly into the 21st century, by applying the same design techniques that have been used in this country for many years on high end audio installations, but never really applied in the so-called 'commercial sound' market. Significant increases in quality and intelligibility are achieved without large budgets, to improve the overall experience for the race-going public and the racecourse owners.

Acknowledgements

I am indebted to the following people for permitting the use of their material:

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Goodwood Racecourse (www.goodwood.co.uk)

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Sound insulation and ventilation in schools

a coordinated approach

A Parkin MIOA

The purpose of this article is to review requirements for Indoor Ambient Noise Levels (IANLs) from *Building Bulletin 93* (BB93) for schools, and specifically, how they can be met with a range of external noise level conditions. The complicating factor is ventilation; this, along with glazing, will invariably determine the sound insulation properties of a building's external envelope. In the absence of its ventilation counterpart BB101, IANL requirements have been open to interpretation due to the term 'adequate ventilation' in BB93 not being formally interpreted. BB101 is due for release in late 2005, and sets definitive criteria for IANLs under varying ventilation rates.

It is always desirable, whenever practicable, to provide ventilation in schools by passive means. The challenge comes in passively ventilating buildings which are subject to significant levels of external noise, as there is a significant risk of compromising sound insulation against road traffic and other sources. This is a challenge for acoustic designers and, as both acoustic and ventilation requirements will form part of Building Regulations, is something that needs to be considered in a coordinated fashion.

BB93 requirements ***Indoor ambient noise levels***

The IANL is defined in Section 1.1.1 of BB93 as the $L_{Aeq,30mins}$ within critical school areas during the time when external noise is normally at its highest (during school hours). The IANL is to be made up principally by noise break-in attributable to external sources and noise generated by building services. Where ventilation is by passive means, the IANL will be dictated generally by noise ingress through ventilation openings.

Ventilation

For mechanical ventilation, the IANL will be when the systems are under maximum operational duty. This is likely to be when equipment is on high speed or full load.

For passive means, windows or ventilation must be assumed to be opened sufficiently to provide 'adequate' ventilation. The term 'adequate' is not defined in BB93, which has led to a fair degree of confusion between designers and enforcers. As with any such undefined

wording found in regulatory documents, the meaning of the word can be interpreted and exploited by users of the document to suit their best interest.

In November 2003 the DfES issued an explanatory note (see Teachernet website) which stated that 'adequate' could be taken to be the base ventilation rate, *ie* 3 litres per second per person, until such time as Part F of Building Regulations was updated to give a firm definition. This would invariably result in noise levels within critical areas being significantly higher than stated IANLs when greater ventilation rates were required (*eg* during hot weather) and windows were opened.

Whilst this makes design of ventilation simple and easily achievable, there are possible significant conflicts in many building contracts, where the designer/contractor is required to comply with all relevant British Standards. BS.8233:1999 states that for reasonable listening conditions in classrooms, noise levels should be no greater than 40dB(A). It is therefore possible to comply with the explanatory note for BB93 but be in breach of contract by virtue of BS.8233, during periods of purge ventilation.

Part F of Building Regulations is due to be released in late 2005, and in the same way that BB93 was embedded in Part E, the new schools ventilation document, BB101 will also be issued in late 2005 and will form part of the Approved Document.

BB101 requirements

BB101 is currently in its draft stages, but the acoustic requirements are unlikely to be changed when the document is finalised. BB101 is clearly intended to make passive means the key method of ventilating schools. This will be in line with Part L of Building Regulations and the increased awareness of energy usage and sustainability.

In addition to the base ventilation rate of 3 li/s per person, classrooms should be capable of being ventilated at a rate of 8 li/s per person as a purge rate when the room is under full occupation. In recognition of the difficulties surrounding achieving the IANLs with passive ventilation, BB101 will permit these to be raised by 5dB during purge ventilation, *ie* up to 40dB(A) within classrooms, which is in line with the upper limit defined

in BS.8233:1999. For mechanical ventilation, there is no permissible increase under purge ventilation rates and IANLs should be achieved under maximum design duty.

With BB101 in place, forming part of the updated Part F of Building Regulations, the DfES explanatory note on ventilation and BB93 will no longer be appropriate.

Designers are therefore faced with even more stringent ventilation requirements than at present, with a clear drive to provide passive solutions. To assist in the acoustic design, the 5dB grace will be afforded to reduce the risk of passive solutions being shelved due to impossible noise level targets.

Noise levels in context

It is important to appreciate when passive solutions can be achieved, and when external conditions will all but force mechanical ventilation to be installed.

Opening windows to provide ventilation

In the most basic of ventilation schemes, opening windows is the primary source of fresh air. It is commonly recognised that an open window can provide anywhere between 8 and 14 dB of attenuation of the A-weighted level against external sources, depending on its size and extent of opening. In order to provide an IANL within a classroom of 35dB(A), therefore, the external noise level can be no greater than 49dB(A). Under BB101 this could rise to 54dB(A).

Research funded by the DfES shows that 90% of rural residential and suburban school sites have external noise levels ($L_{Aeq,30mins}$) in excess of 49dB(A), where the façade is within 30m of a main road. As many as 98% of urban residential sites exceed this noise level.

Even with the proposed 5dB grace, it can be seen that practically all schools will have at least one façade where it will not be possible to rely on opening windows for the sole source of ventilation. In reality, schools are usually located in built-up residential areas adjacent to busy roads and even airports. It is no surprise, then, that most sites have been found to be in excess of Noise Exposure Category A as set out in PPG24:1994.

Even when school buildings are set sufficiently back from noisy roads or shielded by other buildings and structures, there is the risk of noise ingress from school activities such as PE being held on playgrounds - or even the dreaded ride-on lawnmower! Such activities could reasonably be classed as everyday circumstances and, as such, should be designed against. The strategic arrangement of school buildings and areas is therefore critical if a simple passive ventilation solution is to be implemented successfully.

Attenuated forms of passive ventilation

The next step up from opening windows is to provide attenuated openings against external sources. This is a challenge to product manufacturers as, historically, this has only been possible on a small scale for residential requirements.

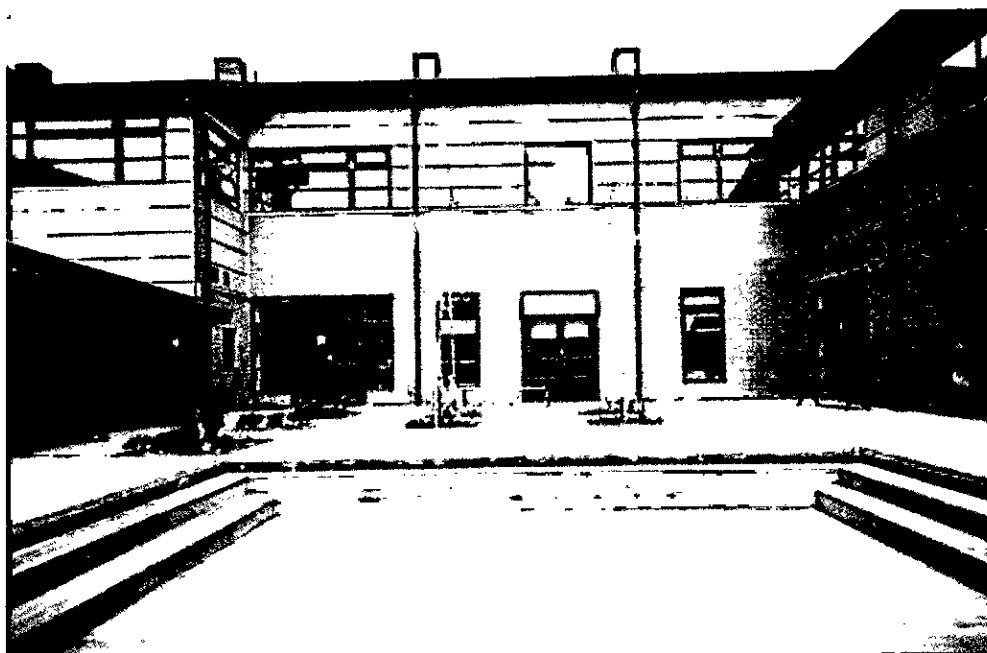
This gap in the product market prompted a number of bespoke ventilator designs, examples of which can be found in BB93. Generally, low level ventilation openings in the external wall, coupled with high level extract openings to promote a passive stack effect is found to be a workable option. The limiting factors are size of ventilation opening, and practicalities such as physical siting. If ventilation openings are too big, the attenuation is minimised, but if they are too small the air flow is impeded and the pressure drops are too high. Practical considerations include ease of operation and maintenance, durability, and susceptibility to abuse.

The use of complex passive systems makes design much more difficult. Not only is acoustic calculation and modelling required, but thermal simulations showing stack effects and ventilation flow are often necessary to prove their suitability prior to installation. Care should also be taken to ensure that no additional cross-talk problems are caused by through-wall ventilators to corridors or other teaching spaces.

Many manufacturers are adapting existing designs, and developing new products, to include discrete acoustically lined low-level inlets, combined sun pipes and wind catchers, quarter-wave resonators and lined plenums to

continued on page 26

Designers are faced with even more stringent ventilation requirements than at present



Sound insulation and ventilation in schools

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continued from page 25

name but a few. The industry appears to be rising to the challenge posed by new regulation, which is promising.

Reduction of noise level at the building façades is also a practical method of attenuation. Providing noise barriers and bunds along site boundaries, or an arrangement of massive constructions nearest to noise sources, can also be used to good effect, but they are often shunned by architects and clients on the ground of security and aesthetics.

These engineering solutions can provide anywhere between 20 and 40 dB of attenuation against external noise, making them effective for external noise levels up to 70dB(A), which includes the 'high' Noise Exposure Category C (PPG24:1994). This should cater for most school locations in busy urban areas.

Mechanical ventilation

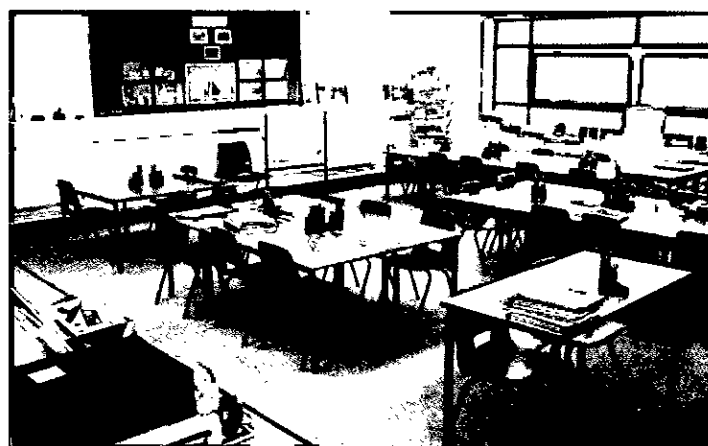
Mechanical ventilation should be incorporated as a last resort, unless there are overriding reasons that leave no other option. As mentioned above, excessive external noise (70dB $L_{Aeq,30mins}$ and above) will invariably leave no option than to provide mechanical ventilation to achieve both background and purge ventilation rates.

The role of the acoustic designer in such instances is greatly simplified, as only plant and airflow noise has to be controlled. Traditional methods such as in-line attenuators (room-side, atmosphere-side and cross-talk), acoustically lined flexible ductwork and anti-vibration mounts are well understood and their attenuation characteristics well documented.

As an alternative to the traditional supply and extract ducted systems, new methods of providing mechanical ventilation, specifically with cooling, are being used. If energy must be expended in providing mechanical ventilation, then it is a designer's responsibility to investigate passive methods of cooling.

Ground source heat pumps (using geothermal energy for heating) and ground water cooling (using the constant ground temperature of 10-12°C as a regulator for variable temperature external air) are becoming more prevalent, especially as funding becomes available for non-PFI contracts. Other similar systems include ground-air heat exchangers that use the same moderating influence of ground temperature. They bring air through ground-borne pipes that can provide attenuation against noise by distance, and other losses.

There is a growing trend to use thermal mass and night cooling in schools. Whilst this is very advantageous in its low energy use, there are significant impacts on the acoustic design. The benefits are that glazing and the external fabric are usually very well



Increased regulation in school design has made meeting all the relevant criteria potentially complex

insulated, which provides very good protection against external noise. However, because the structure is used for radiant cooling, there is a requirement for all hard finishes which makes achieving the necessary T_{mf} values a challenge, especially in primary schools and rooms for use by the hearing impaired where values are very low (≤ 0.6 seconds).

The use of emerging technologies and complex systems requires the acoustic designer to be aware of the fundamentals of operation and their limitations regarding methods of noise and reverberation control.

Conclusions

Increased regulation in school design has made meeting all the relevant criteria (acoustic, thermal, ventilation *etc*) a potentially complex exercise.

The acoustic designer, like any other member of a design team, cannot approach acoustic design from an isolated position, but must bear in mind other disciplines and their requirements when preparing strategies for a Building Control submission. With increasing elements of school design being regulatory rather than design guidance, there is little room for derogation and deviation without exceptional extenuating circumstances.

A coordinated approach to acoustic and ventilation design must therefore be seen as a challenge which needs to be met. This will have a knock-on effect on the manufacturers of acoustic products, and prompt them to create systems which up until now have largely been bespoke in nature and costly.

Andrew Parkin is with R W Gregory LLP, Birmingham



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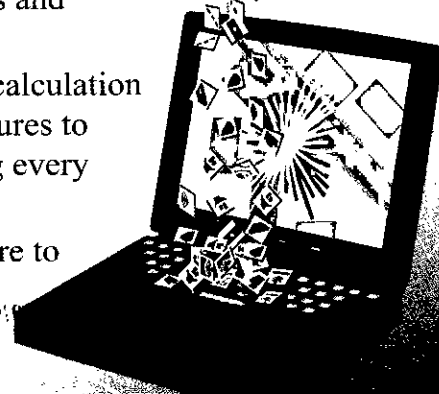
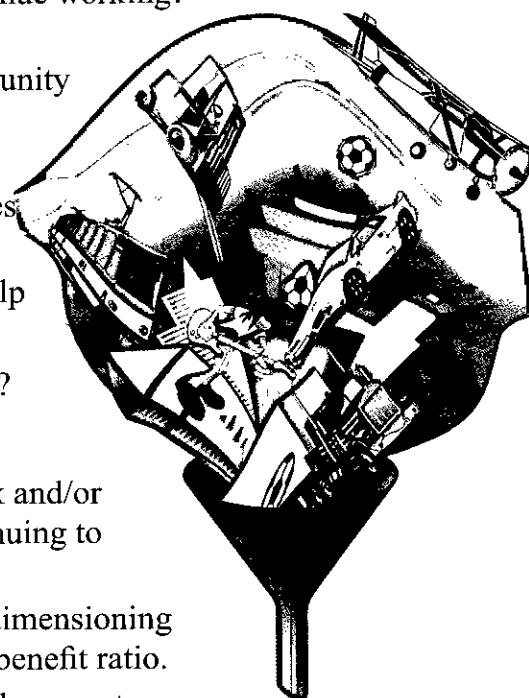
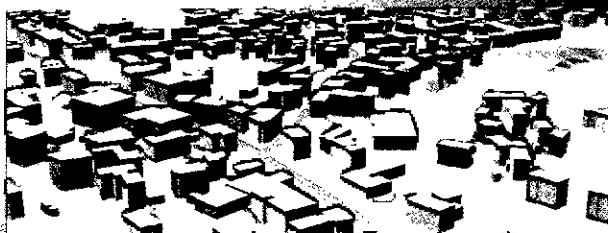
- ☐ How can I efficiently map the transportation and industrial noise from an agglomeration?
Can the software calculate in the background while I continue working?
Can I use a PC network to distribute the calculations?
- ☐ What is the most cost effective method to minimize community noise?
- ☐ How loud is it inside a building? Which sounds dominate?
Can the noise breakout be minimized with new doors, gates or window applications?
- ☐ Can I document my data sufficiently? Will the software help me comply with ISO 9000 quality control?
- ☐ Will I get the hotline support I might need in my language?

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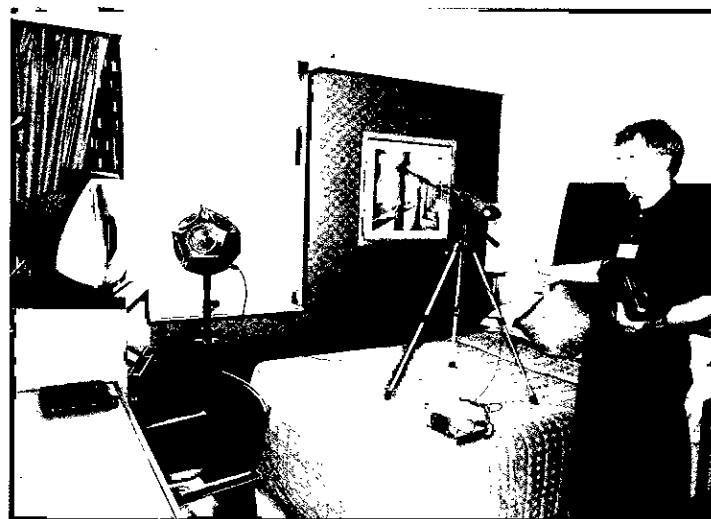
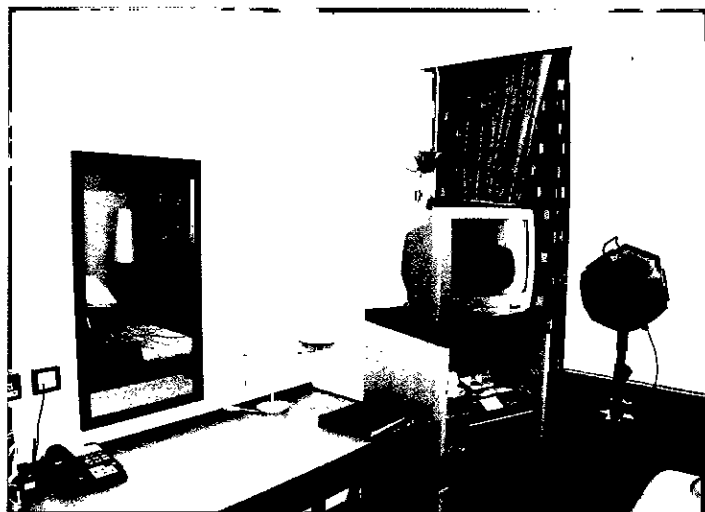
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Sound transmission workshop



Above: The practicalities of sound insulation testing in a bedroom

Left: One of the ten set-ups in the pair of hotel bedrooms used for sound insulation tests

a benchmarking exercise

R J M Craik and A Somerville

As part of the 2005 IOA spring conference a sound transmission workshop was arranged during the first day. Ten different people (sometimes with helpers) carried out a sound transmission test between two bedrooms. These tests enabled the individuals to cross check their method as well as providing an element of training for the observers. Two people were accredited as testers during the workshop.

The method for measuring sound transmission is described in ISO 140 part 4 (1). The method was generally followed, although the smallness of the test rooms and the limited time made available for each test made strict adherence to the test standard difficult. A number of different sets of equipment was used, resulting in a wide variety of test methods being adopted.

This paper presents the test results from the workshop and compares these with similar published results.

Test method

The test was carried out between two hotel bedrooms each with a volume of 28m^3 and with a common wall area of 11m^2 . The test method was left to the individual and generally followed the ISO standard (1).

Amongst the variations in test method was the decision

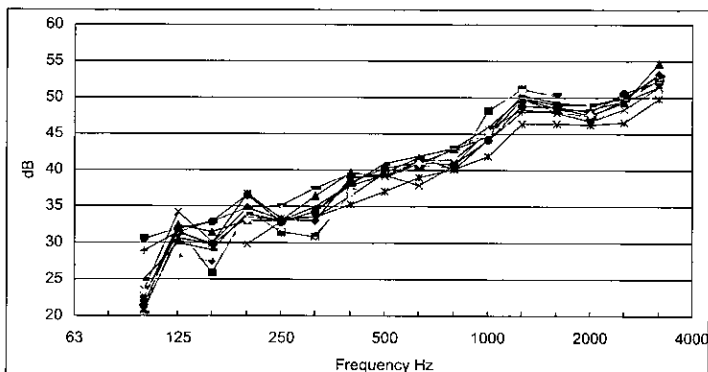


Figure 1: Ten individual test results of D_{nT}

whether or not to have the tester in the test room during the measurement. In every case except one the tester was in fact in the room, and in eight out of the nine cases there were different numbers of people in the rooms at different stages of the test. In one case five additional people moved back and forward between rooms as they were interested in learning about the test.

Five people used fixed microphone positions (three of them being the operator who stood still and held the meter, as a human bipod) whilst the remainder used the 't'ai chi' method of slowly waving the sound level meter around the room to provide spatial averaging.

Everyone used two loudspeaker positions. Two people used gunshots to measure the reverberation time.

Test results

The individual test results are shown in *Figure 1*. As would be expected there is broad agreement but some variation.

In order to see this variation more clearly the arithmetic mean value of D_{nT} was computed, and the variation of the individual results about that mean was computed and is shown in *Figure 2*.

There are no clear trends and in no case was an individual test consistently high or low.

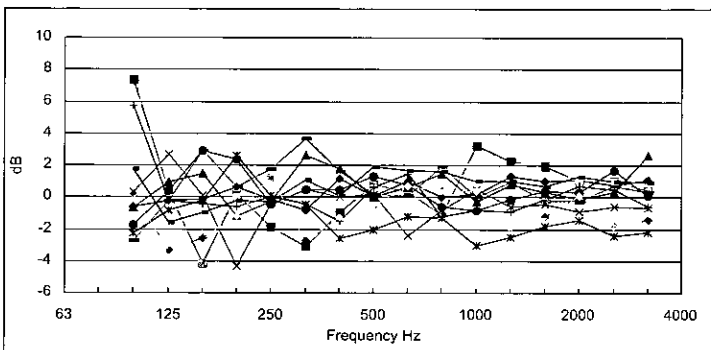


Figure 2: Variation in the individual results of D_{nT} about the mean

The standard measure of variation about the mean is to calculate the standard deviation, and this is shown in Figure 3. It can be seen that the standard deviation varies with frequency from about 3dB down to 1.5dB.

Also shown for comparison is the standard deviation given in ISO 140 part 2 (2) which would be expected for (a) different repeat tests on the same construction that would be appropriate for a number of people following a company wide standard method, and (b) different repeat tests carried out by different people on different but nominally identical constructions such as a standard wall being tested in different laboratories.

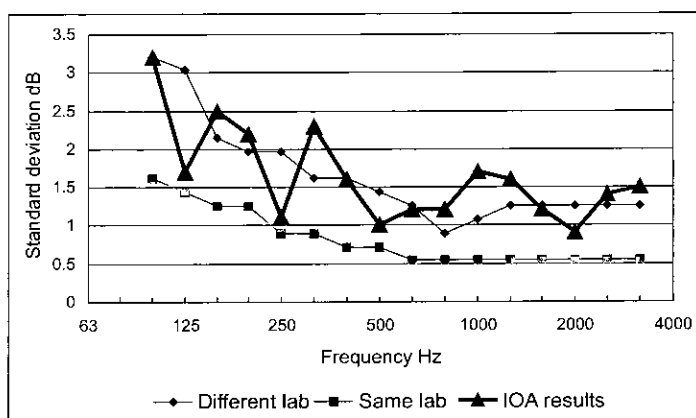


Figure 3: Standard deviation of the measured test data compared with the expected values from ISO 140 (2)

It can be seen that the actual variation is larger than would be expected for repeat tests on a single construction, but this would be a predictable result as slightly different methods were being adopted.

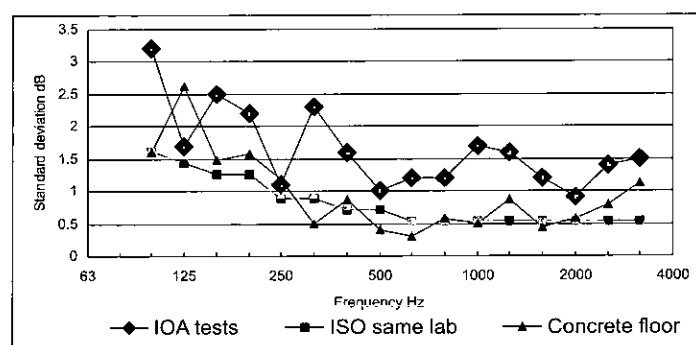


Figure 4: Measured standard deviation from the IOA tests compared with the standard deviation from 10 tests by the same operator on the same concrete floor (3)

It is, in any case, difficult to meet the expectations of the standard. Figure 4 shows the standard deviation of the IOA workshop data together with the standard deviation of ten separate measurements on a single concrete floor by a single person (3), which also does not fully meet the guidance of ISO 140 (although it is close).

Single figure numbers

In addition to the measured spectrum two single figure indices were computed, D_{nTw} and $D_{nTw} + C_{tr}$ in accordance with ISO 717 (4).

The results of the ten tests are given in Table 1. Since each of the D_{nTw} numbers is rounded down, further statistical analysis is difficult because of the rounding effects. Therefore the D_{nTw} values were recomputed moving the standard curve in steps of 0.01dB to allow more detail to be seen. Similar calculations were carried out for $D_{nTw} + C_{tr}$.

The mean values were computed from the average of all the D_{nT} values.

Table 1 Single number indices for the test data

test	D_{nTw}		$D_{nTw} + C_{tr}$	
1	43	43.9	38	38.0
2	42	42.8	38	37.9
3	44	44.3	38	38.3
4	43	43.2	38	37.7
5	44	44.6	39	38.8
6	42	42.3	37	36.8
7	43	43.8	38	37.9
8	43	43.7	39	38.9
9	44	44.5	38	37.8
10	43	43.3	37	37.2
mean	43	43.8	38	38.1
Standard deviation		0.75		0.64

From the more detailed calculations it can be seen that the standard deviation of the D_{nTw} values is 0.75dB, and for $D_{nTw} + C_{tr}$ it is 0.64dB.

These results are not unexpected and are not dissimilar to the values that Craik measured (3) of 0.4dB for measurements on the same concrete floor and 1.3dB for measurements on similar but different floors.

Discussion

It is likely that the variation in the measured values is typical of the routine measurements of sound transmission. Different people use slightly different methods and procedures and there are inevitably random errors introduced by the sampling of the sound field. In addition, there will be small discrepancies introduced by, for example, having someone standing in the room during some of the measurements.

If it is assumed that the probability distribution is normal then it would be expected that 95% of readings will lie within ± 2 standard deviations or ± 1.5 dB. Thus single number indices, though suggesting an exact value, should be more properly thought of as being the mid-point of a band of uncertainty of width 3dB.

References

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- 4 ISO 717: Part 1 (1997) Rating of sound insulation in buildings and of building elements. Part 1: Airborne sound insulation. *British Standards Institution*



Bob Craik produces his report on the testing workshop in real time

Workshop participants

E Clarke
A Conrad
I Critchley
O Downey
C Greene
M Hayden
G Irvine
A James
R O'Duill
A Popplewell



Rain drops keep falling on my roof !

Peter Rogers MIOA

To collect empirical data, Sound Research Laboratories Ltd (SRL) has built a new rainfall noise testing rig. The release of the draft ISO (ISO/CD 140-18:2004) has provided the opportunity to develop a standard large scale test setup to explore the effectiveness of a variety of roof and ceiling treatments. Calculations and measurements, illustrated here, will be needed to demonstrate adequate control of rain noise at design stage. These are based on measured test results. This is the first commercially available test rig to apply the draft ISO standard in the UK which, it is understood, will shortly become available as a full ISO standard

Advice on the control of rainfall noise has usually been limited to providing a mass of 20 to 25 kgm⁻² in the roof system. Alternatively, resilient materials can be included in the construction reducing noise transfer through isolation. The effectiveness of noise control measures for this very variable noise source is a subjective art, and will remain so until objective design targets can be set and performance calculated. For this to happen more data must be collected.

Rainfall noise is impulsive in nature, and depends on the size of water droplets and rate of fall. Many of the roof systems in use today are lightweight, with atria to open offices being a common feature in many buildings. These designs provide poor protection from noise if underlining systems are not there as a second line of defence.

What is an acceptable level of noise from rain within a space ?

Rainfall as a source of noise is not usually considered because of its irregular and variable nature. Objective targets for external environmental noise break-in are not applied to it. There is no clear consensus on the internal noise target to be achieved in the design of new buildings. However the Building Research Establishment's Environmental Assessment Method (BREEAM) for schools now requires that the noise from rainfall should not exceed 5dB above the ambient noise target for the space. This is worth a significant 25% of the points available for noise in the rating. With the lack of information on rainfall noise on light roofs this level of control is usually achieved using a concrete slab. It is within schools that most of the advances towards tackling rainfall noise more formally have been prompted.

Building Bulletin 93, Acoustic design guide for schools (BB93) states that the roof construction should be considered at the early part of the design to 'minimise the disturbance inside the school' from rain noise. This is purely subjective. BB93 also makes reference to the draft ISO standard, and proposes that 'when manufacturers are able to provide product data from laboratory measured data, that comparison of the insulation of constructions will be possible'. The SRL test rig allows this data to be available for the first time, and offers a marketing opportunity for manufacturers. However, it is most often the client who specifies in his contract that the noise of rain falling must be controlled.

British Standard 8233 states that rooflights and lightweight roofs should be 'avoided in critical situations', and that manufacturers' advice should be sought. Rain noise data can now be collected by manufacturers, helping them to remain competitive with products backed up with technical performance data. Controlling speech intelligibility in areas where speech is critical (such as call centres) is perhaps the most sensible design aim that can be set. In spaces where consistently good speech intelligibility or low background noise is important (*eg* schools, offices, hotels, performance spaces *etc*) the noise from rainfall should be designed so as not to interfere with the function of the space. The BREEAM level relative to ambient noise target is one attempt at this, but is perhaps too restrictive for a transient noise source.

There is no consensus on an objective standard and agreement on this must be sought.

Predicting the noise level in a room due to rainfall

For a proposed roof structure there needs to be test data, or the noise level inside needs to be predicted.

The following equation can be used to predict the level in a room below, based on the standard for 'heavy' rainfall:

$$L_{pr} = L_{Wref} + 10 \log T - 10 \log V + 14 + 10 \log S$$

Where L_{pr} is the rain noise sound pressure level in the room, dB

T is the reverberation time in the room, seconds

V is the volume of the room, m^3

S is the room area, m^2

L_{Wref} is sound power level (when $1m^2$ of roof is excited), dB

Worked example (supported by recent test data)

An office 5m long by 4m wide by 2.3m high has a light-weight roof with 24mm thick absorbent ceiling tiles hung beneath. The reverberation time is 0.7 seconds at all frequencies. Calculate the octave band sound pressure levels over the frequency range 63Hz to 8kHz, and the A-weighted sound level.

The sound pressure level is calculated using the prediction equation:

$$\begin{aligned} L_{pr} &= L_{Wref} + 10 \log 0.7 - 10 \log 46 + 14 + 10 \log 20 \\ &= L_{Wref} - 1.5 - 16.5 + 14 + 13 \\ &= L_{Wref} + 9 \end{aligned}$$

	octave band centre frequency								
	63	125	250	500	1k	2k	4k	8k	Hz
L_{Wref}	50	49	52	53	53	45	38	30	dB
L_{pr}	59	58	61	62	62	54	47	39	dB
overall level 65dB(A)									

This result is based on 'heavy' rainfall, which is a 'worst case'. In the UK this flow rate happens only a few times a year.

Rainfall rig: the measurement method

The draft ISO standard (ISO/CD 140-18: 2004) was at committee working draft stage, but provided a useful starting point. It is understood at the time of writing that the standard has now reached its final stages prior to publication. The draft version is only summarised here for the purposes of explaining the process that had to be gone through to produce a successful and consistent result for 'heavy rainfall'.

The standard requires a test room of volume at least $50m^3$, with the test aperture being a roof of certain dimensions. The construction needs to be sufficiently low that flanking noise and external break-in levels allow the measurements to be taken. Above the roof a perforated tray is suspended at various heights, depending on the type of rain simulation required. The classification splits rainfall type into four categories, as defined below:

classification	fall height (m)	drop diameter	flow rate *
moderate	~1m	0.5 - 1.0 mm	up to 4 mm/h
intense	~1m	1 - 2 mm	up to 15 mm/h
heavy	~3.5m	2 - 5 mm	up to 40 mm/h
cloud burst	~3.5m	>3 mm	>100 mm/h

continued on page 33

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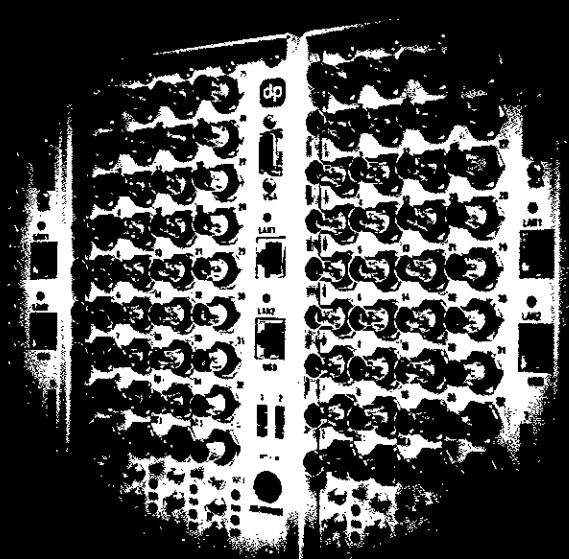
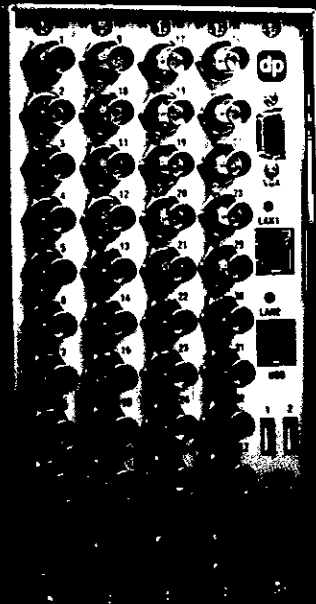
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Rain drops keep falling on my roof !

continued from page 31

The standard gives a 2mm/h tolerance for flow rate, and a 0.5mm tolerance for median droplet diameter. Requirements for the fall velocity are also given, but it was considered that this was dependent on the droplet size and would be acceptable provided that droplet size was correct.

The standard provides the relevant dimensions for two trays, with the 'heavy' condition being described as the mandatory test. It suggests hole diameters and spacings for 'intense' and 'heavy' rainfall categories.

In practice the challenge began once the prescribed rig had been built, and the simulated rain was found not to be very close to the requirements. Getting control of the parameters required significant development from the basic outline given by the standard, and a healthy amount of trial and error, to get within the tolerances on the given parameters.

The exit conditions to the underside of the tank were found to be crucial, and the surface and aperture needed to be such that that surface tension allows a droplet to form of the right size. Various methods were used to do this, and to maintain the validity of conditions during the test.

The setting-up of a test led to the sequence being critical. Initially the flow rate was set, using the head of pressure in the tank. The flow rate was measured by collecting water from one aperture over a known time period. Once the flow rate was established, measures could be taken to adjust the droplet size. This was initially done for an 'intense' rainfall simulation, as a fork-lift truck was able to provide the necessary 1m elevation above the test roof. The tray was then altered to provide 'heavy' rainfall, which required a crane to provide the 3.5m drop height above the test roof.



Rainfall testing rig

During the test, the parameters were checked periodically to make sure that they were within the requirements. It was noted that particulate build-up, corrosion and calcification at the apertures provide change, which required ongoing maintenance to avoid the conditions falling outside the requirements.

The measurement procedure is consistent in the main with ISO 140 parts 4, 6 and 7, with five microphone positions used. An average sound pressure in the room is calculated from the sound power levels produced by simulated rain over three different areas on the test roof.

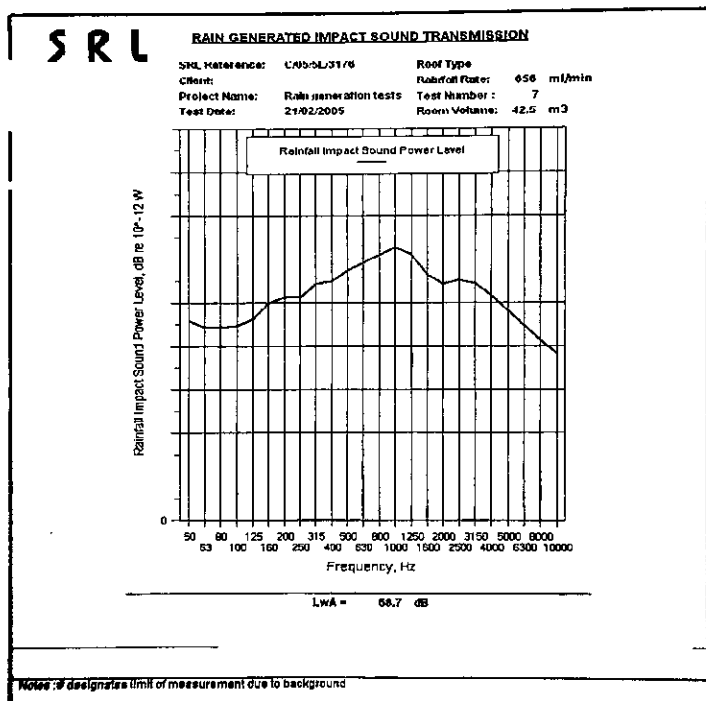
The graph shows a sample result taken at one position, with a characteristic 1kHz peak noticeable.

The way forward for ISO rain tests

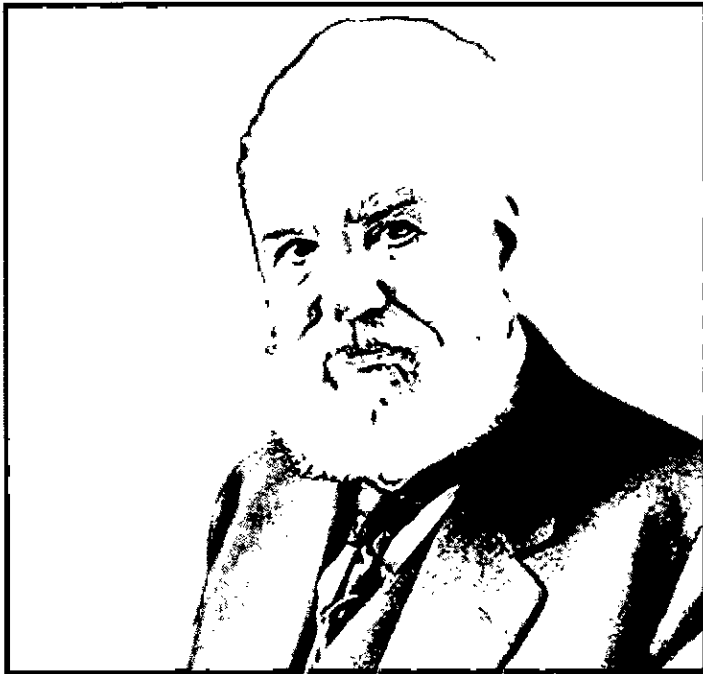
The ISO standard appears to be on the verge of being published and moving from the working committee draft, which after some interpretation SRL has been able to use to achieve an effective test rig for 'heavy' rainfall simulations. This information will be fed back to the standards committee to aid progression of the standard towards a more robust tool for obtaining good objective data.

SRL is now able to offer manufacturers the ability to get measured insertion loss data for their products for 'heavy' or 'intense' rainfall. Also, the company can offer sampled rain noise from the laboratory tests to help clients in reaching a subjective as well as an objective result to the tests. This will allow the industry to progress in this area, as the awareness and need increases.

Peter Rogers is with Sound Research Laboratories Ltd, Holbrook Hall, Little Waldingfield, Suffolk.



The graph shows a sample result taken at one position, with a characteristic 1kHz peak noticeable



Alexander Graham Bell

1847 - 1922

'Leave the beaten track occasionally and dive into the woods. Every time you do so you will be certain to find something that you have never seen before. Follow it up, explore all around it, and before you know it, you will have something worth thinking about to occupy your mind. All really big discoveries are the results of thought.'

Alexander Bell was born into a family of passionate communicators. His grandfather and namesake Alexander Bell had a reputation as an impressive actor and orator, although he was not employed as often as the reputation might suggest. He had a commanding speaking voice and a considerable physical presence, and perhaps because of these capabilities he was especially concerned for those for whom speaking was a challenge. He worked with such people extensively, and published books including *The Practical Elocutionist* and *Stammering and Other Impediments of Speech*. By 1838, he was known as 'the celebrated Professor of Elocution' in the press.

He fostered a similar interest in the methods and mechanics of vocal communication in his two sons, David and Melville. One became a teacher of speech in Dublin, and the other joined his father as an elocutionist. As time went by, Melville met and fell in love with a deaf woman, and this probably made his interest in speech pathology all the more passionate. Although Eliza Grace Symonds was ten years his senior, her intellect and temper, and not least her skill as a miniaturist painter, attracted his devotion and the couple married. Eliza's world was almost silent, but she nevertheless became an accomplished pianist. They had three sons, Melville, Alexander and Edward.

Young Alexander Graham Bell (the name Graham was taken in 1858 as a mark of respect to Alexander Graham, a friend of the family), or Alec as he was known to his family, took to reading and writing at a very early age. Family tradition has it that he insisted on posting a letter to a family friend well before he had any understanding of the alphabet. As he grew up, Alec developed his grandfather's characteristically expressive, flexible, and resonant speaking voice.

It was through the use of this impressive voice that Alec formed a unique bond with his mother. Most people spoke to Eliza Bell through her ear trumpet, but Alec communicated with her by speaking in low, sonorous tones close to her forehead. He supposed that she would 'hear' him through the vibrations induced by his vocal intonation. This significant early insight led Alexander Graham Bell to develop more elaborate theories regarding the characteristics of sound waves. It would also support

his opinions on how those who were hard of hearing could find their places in a world of sound.

In the mid-nineteenth century, Edinburgh was a major centre of scientific development, and Alexander Graham Bell was an attentive observer and keen participant. The belief underpinning progress in the Victorian age was that improvements in the human condition came through science and technology.

When he was only 14, Bell came up with a device designed to remove the husks from wheat, by combining a nail brush and paddle into a rotary brushing wheel. It was at about that time that he visited London with his father, and stayed for a year with grandfather Alexander. During this visit young Alec was fascinated by a demonstration of Sir Charles Wheatstone's speaking machine (*Acoustics Bulletin* vol.27 no.2, March/April 2002). When they returned to Edinburgh, he and his elder brother Melville were challenged by their father to produce one of their own.

Working at home, they created an apparatus which had a mouth, throat, nose, manoeuvrable tongue, and bellow lungs, and actually produced passable human sounds. Encouraged by success, Alec succeeded in manipulating the mouth and vocal cords of his Skye terrier so that the dog's growls were heard as words.

Alexander Graham Bell's intellect continued to broaden, and by the time he was 16, he was teaching music and elocution at Weston House Academy, Elgin, a boys' boarding school. The three brothers travelled through Scotland impressing audiences with demonstrations of their father's 'visible speech' techniques: this was a form of universal alphabet that reduced all sounds made by the human voice into a set of symbols.

Between 1864 and 1866 Alec attended the University of Edinburgh and also continued to teach in Elgin, where he experimented with vowel pitches and tuning forks. His academic success was darkened, however, by a major scourge of nineteenth-century life: his younger brother Edward fell ill with tuberculosis and died in 1867 aged only 19.

The following year found our Pioneer in London, teaching speech to the deaf at Susanna Hull's school, and attending University College. Here he became intrigued by the writings of German physicist Hermann von Helmholtz (*Acoustics Bulletin* vol.28 no.2, March/April 2003).

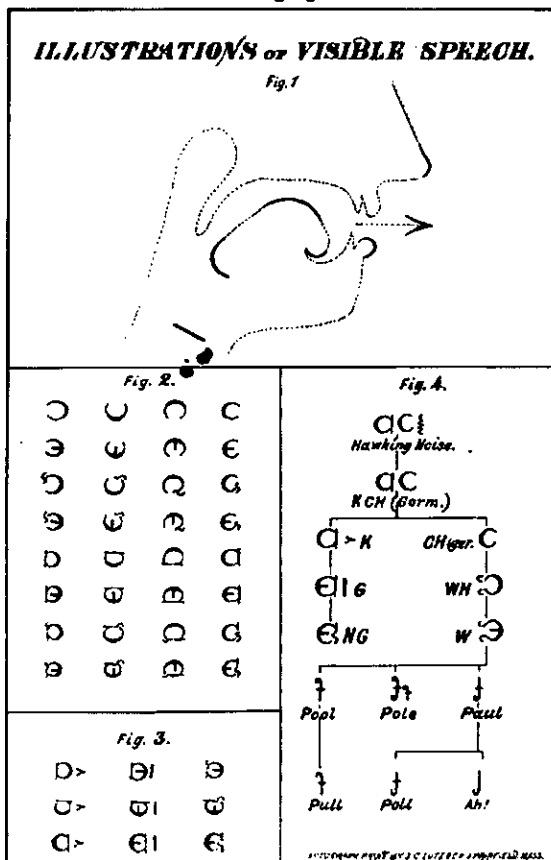
Helmholtz wrote in his thesis, *On the Sensations of Tone*, that vowel sounds could be produced by a combination of electrical tuning forks and resonators. Bell could not read German but consumed this information avidly. It led to what he would later describe as a 'very valuable blunder.' Bell had managed to interpret Helmholtz's findings as a statement that vowel sounds could be transmitted over a wire. Much later, he admitted that 'It gave me confidence. If I had been able to read German, I might never have begun my experiments in electricity.'

Tuberculosis struck again when his elder brother Melville died of the disease in 1870: he was 25. Alexander Graham contracted TB before the family emigrated to Canada in July of the same year, but survived. He convalesced in his 'dreaming place' - a large farmhouse in Brantford, Ontario.

In 1871, Bell began giving instruction in visible speech at the Boston School for Deaf Mutes. Attempting to teach deaf children to speak was thought to be revolutionary, especially since Bell rejected the signing and institutionalisation which he felt excluded the deaf from society. His work with deaf students in Boston would prove to be a life-changing event. One of his pupils, Mabel Hubbard, and her father, one Gardiner Greene Hubbard, were to play major roles in his life and work. Mabel became his wife in 1877, but long before then, Bell had found his vocation and would consider himself a teacher of the deaf above all else. He and Mabel spent a year in England shortly after their marriage, and their first daughter Elsie May Bell was born in May 1878. The couple had four children, although their two sons were to die in infancy.

However, this family digression has jumped ahead of the scientific chronology. Bell's ideas about transmitting speech electrically began to develop during his Boston

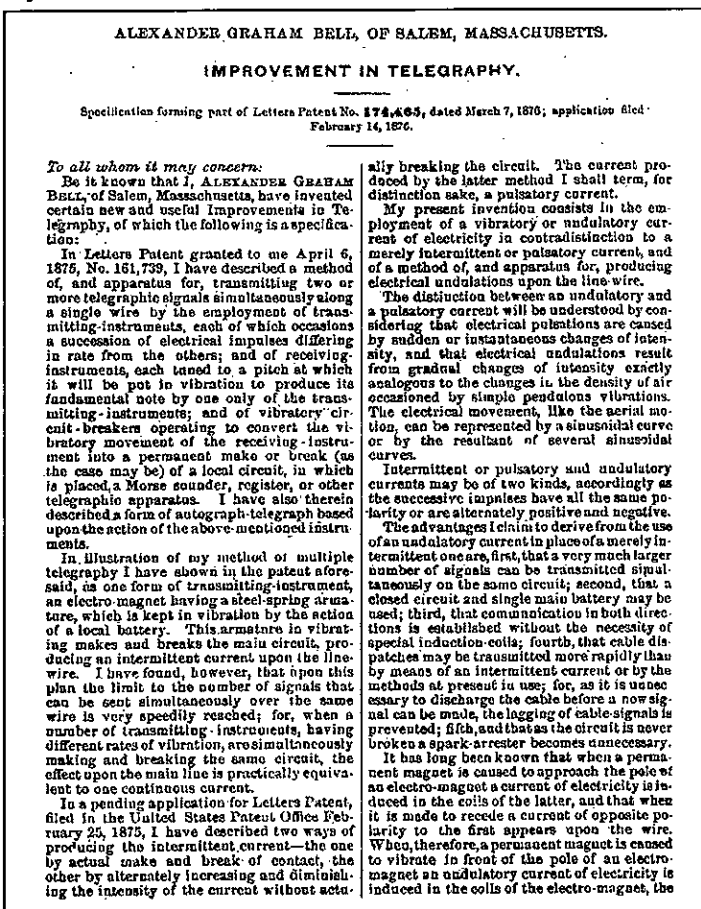
Work with deaf students in Boston would prove to be a life-changing event



years. He read extensively, and attended numerous lectures, on physics, science and technology, and began to build what he called his 'harmonic telegraph.'

Samuel Morse had completed his first telegraph line in 1843, and telegraphy was a fully-fledged industry. Near-instantaneous communication between faraway points was a leap forward, but successful telegraphy depended on delivering messages by hand from senders to telegraph stations to recipients, and only one message could be transmitted at a time. Bell arrived at his idea of the 'harmonic telegraph' by drawing parallels between multiple messages and multiple notes in a musical chord. This was the origin of the device which was to make his name unforgettable - the telephone.

One of the most fortuitous meetings in history happened by chance, when Alexander Graham Bell and Thomas



Watson met at Charles Williams' electrical machine shop. Watson was skilled in devising tools to improve the efficiency of many different instruments, and began to collaborate with Bell on the harmonic telegraph. They were financed by Thomas Sanders, a wealthy leather merchant whose deaf son Bell had taught, and Gardiner Green Hubbard.

On 2 June 1875 the partnership of Bell and Watson produced something new. Watson was working in the transmitter room, trying to free a reed that had been wound to the pole of an electromagnet too tightly: it emitted a loud 'twang'. Bell came running from the receiver room, eager to hear it again. He thought the complex overtones and timbre of the twang were similar to those in the human voice, and was encouraged sufficiently to believe that speech really could be sent through a wire. He filed a specification with the United States Patent Office in Washington, and on 7 March 1876 was issued patent

continued on page 36

Alexander Graham Bell

1847 - 1922

continued from page 35

number 174,465 for his 'Improvements in Telegraphy'. Meanwhile, he had discovered that a wire vibrated by the voice while partially immersed in a conducting liquid would vary its resistance and produce an undulating current. The signal could be transmitted by wire.

Three days after the patent had been granted, Bell and Watson were testing this finding. Bell knocked over a jar of their transmitting liquid, which was battery acid. He supposedly shouted 'Mr Watson, come here. I want you!' although the actual words may be apocryphal. Nevertheless, Watson heard Bell's voice in the next room, through the wire: he had received the first telephone call.

It did not take the partnership very long to develop a practical device from these beginnings. Alexander Graham Bell, keen to promote the new invention, introduced the telephone at the Centennial Exhibition in Philadelphia in 1876. Sir William Thomson (Lord Kelvin) was duly impressed, and Brazilian Emperor Dom Pedro is supposed to have exclaimed 'My God, it talks,' as Bell intoned Hamlet's soliloquy - over the line from the main building a hundred yards away.

In 1878, President Rutherford B Hayes was the first to have a telephone installed in the White House. His first call was to Alexander Graham Bell, who was waiting some 13 miles away. The president's first words are said to have been 'Please speak more slowly.'

A flood of patent lawsuits and corporate manoeuvres came in the wake of Bell's invention of the telephone. The Western Union Telegraph Company was not content to



Bell inaugurates the long-distance telephone service between New York and Chicago in 1892. The telephone began as a local service and expanded rapidly, so that by 1915, there was a transcontinental service

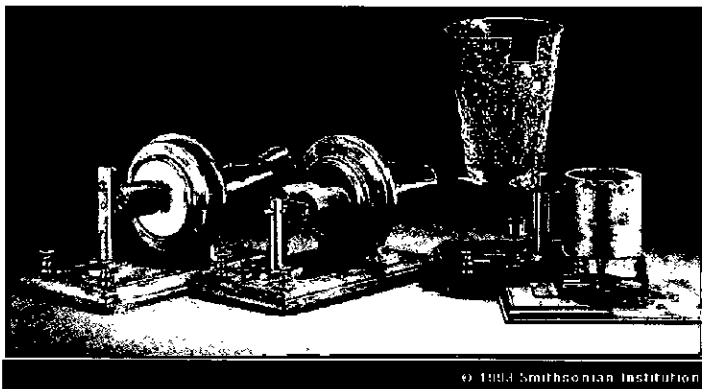
sit on the sidelines while the Bell Telephone Company was in the spotlight. Two prominent inventors, Thomas Edison and Elisha Gray, were engaged to enable Western Union to catch up: Gray had filed a patent application for a telephone just hours after Bell's 'Improvements in Telegraphy'. The Bell Company (now AT & T) sued Western Union in order to protect its patents, and won. In the coming years, the Bell Company would be forced to defend its patent in over 600 legal challenges. In every case, the patent withstood the attack, thanks in no uncertain terms to Alexander Graham Bell's clear and convincing evidence.

Bell was not very interested in running the company bearing his name. Now rich and famous, he preferred to pursue an active cerebral life, and came up with many other inventions. However, in October 1892 he was present when the first long-distance telephone service, between New York and Chicago, was inaugurated.

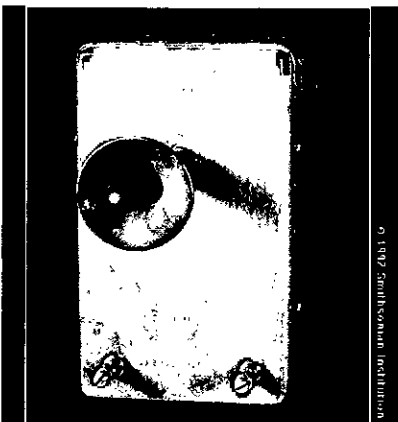
On 3 June 1880, Alexander Graham Bell transmitted the first wireless telephone message on a new invention - the 'photophone' - which he believed to be his most important invention. The device allowed for the transmission of sound on a beam of light. Eighteen patents were granted in Bell's name alone, and he shared twelve more with his collaborators: no fewer than four were for the photophone.

It worked by projecting the voice through an instrument so that vibrations in the voice caused similar vibrations in a mirror. Bell directed sunlight into the mirror, which reflected the mirror's vibrations. The vibrations were transformed back into sound at the receiving end of the projection. The photophone functioned in a similar way to the telephone, but used light instead of electricity to transmit the information. Despite its great importance, the significance of the photophone was not recognised until much later. The problem with the original photophone was that it did not protect transmissions from outside interference, so until modern fibreoptics provided a secure light transport system, Bell's invention did not realise anything like its full potential.

In 1881 Bell constructed in some haste an electromagnetic device called an induction balance, to



Early telephone equipment. Several of Bell's early experimental telephones (right of picture) depended on creating variable electrical patterns in wires as a needle moved up and down in a liquid. This approach led to problems with static. Later models (left of picture) relied on magnetic induction



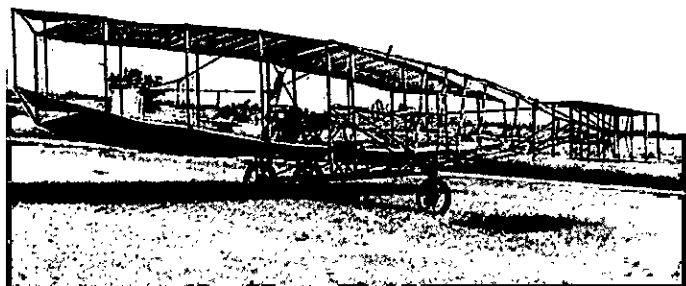
Left: A commercial Bell magneto-telephone from 1877: one of the first which both transmitted and received, rather than there being two separate instruments

try and locate a bullet put into President Garfield by an assassin. He later improved the device and constructed a telephone probe, which would make a telephone receiver 'click' when it touched metal. In the same year, Bell's newborn son Edward died from respiratory problems, and Alexander Graham Bell responded by designing a metal vacuum jacket which, when placed around the chest, administered artificial respiration to facilitate breathing. This was a forerunner of the iron lung used in the 1950s to help polio victims.

The inventions would later be refined by others, but Bell's contributions to the world of science and technology never abated. He was a student of nature's mysteries and became fascinated with the notion of motion, in the air and on the water. Working with partners, he experimented with manned kites and hydrofoils, powered flight, tetrahedral structures, sheep-breeding, desalinisation and water distillation.

In 1915 the first heavier-than-air flight over Canadian soil was achieved by the Silver Dart, an aeroplane designed and built by the Aerial Experiment Association, founded by Bell and four associates. Four years later he and Casey Baldwin, one of the associates, built a hydrofoil which set a world water-speed record. It was not broken until 1963. Bell invented the audiometer to detect hearing problems, and conducted experiments on alternative fuels and the recycling of energy.

Always eager to enthuse in others a love of science and the natural world, he gave considerable financial and editorial support to the magazines *Science* and



In 1915 the first heavier-than-air flight over Canadian soil was achieved by the Silver Dart, an aeroplane designed and built by the Aerial Experiment Association, founded by Bell and four associates

National Geographic. In 1897, on the death of Gardiner Green Hubbard, Alexander Graham Bell succeeded him as President of the (US) National Geographic Society. He was elected a Regent of the Smithsonian Institution the following year.

In 1922 Bell told a reporter: "There cannot be mental atrophy in any person who continues to observe, to remember what he observes, and to seek answers for his unceasing 'hows' and 'whys' about things". When he died on 2 August 1922, America's telephones were silenced for a minute in tribute to their inventor, a man whose lifelong passion to communicate had made them possible.

A testament to his work and his kindness is that the deaf and blind Helen Keller dedicated her autobiography to him. She had met Bell when she was six years old in 1887, and he had helped her family to find a private teacher, thus paving the way for her own achievements. However, the greatest scientific immortals have a unit named after them: Bel(l) joins Hertz, Henry, Newton, Joule, Pascal, Volt(a), and Ampere in that distinguished company.

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7 April 2005

Hearing loss

Mrs Brooke: To ask the Secretary of State for Defence what assessment his Department has made of whether an additive relationship exists between noise-induced hearing loss and age-related hearing loss; and if he will make a statement.

Mr Caplin: The Ministry of Defence's clinical practice in this area is based on publicly available knowledge that an additive relationship does exist between noise-induced hearing loss and age-related hearing loss.

This is based on information in the following references:

King P F, Coles R R A, Lutman M E, Robinson D W (1992) *Assessment of Hearing Disability*, Whurr Publishers, London

Coles R R A, Lutman M E, Buffin J T (2000) *Guidelines on the diagnosis of noise-induced hearing loss for medicolegal purposes*, Clin. Otolaryngol. 25, 264-273

Copies of these will be placed in the Library of the House.

Mr Heath: To ask the Secretary of State for Defence how many members of the armed forces are recorded as having sustained noise-induced hearing loss on service in Iraq since March 2003.

Mr Caplin: [holding answer 4 April 2005]: Information on specific injuries sustained on Operation Telic is not held centrally, and could be provided only at disproportionate cost.

7 April 2005

Digital hearing aids

Mr Burstow: To ask the Secretary of State for Health, pursuant to the answer of 24 March 2005 on digital hearing aids, what mechanisms are in place to monitor the 18-week target from referral to patients receiving their digital hearing aids.

Mr Hutton: We are expecting activity and waiting times information for pure tone audiometry to be collected for the first time as part of local delivery plans. Strategic health authorities and primary care trusts are currently developing their plans and these will be agreed with the Department shortly.

24 May 2005

M1 motorway

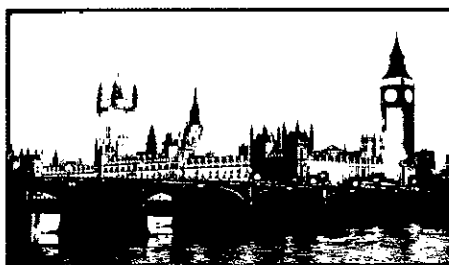
Mr Knight: To ask the Secretary of State for Transport for what reason the fencing being erected north of junction 11 alongside the southbound carriageways of the M1 motorway are not being set back to allow for future planned widening to take place.

Dr Ladyman: While the Government has announced its intention to widen the M1 in this area, the plans are still at an early stage, requiring land outside the current boundary. The fencing at junction 11 is being erected inside the highway boundary to give the residents of Luton relief from severe noise problems. The construction of the fence allows the infill panel to be re-used at a later date, should the widening scheme proceed.

24 May 2005

Motorcycle noise

Norman Baker: To ask the Secretary of State for Transport if he will make a statement on maximum noise levels from motor-powered two-wheeled vehicles.

**Commons Written Answers**

Dr Ladyman: Under the Road Vehicles (Construction and Use) Regulations 1986 and the Motor Cycles etc. (EC Type Approval) Regulations 1999, motor powered two wheeled vehicles must be constructed to meet the following maximum noise levels in dB(A) when subjected to a drive-by noise test.

date of first use	mopeds	motor cycles
pre 1 April 1983	No requirement	No requirement
1 April 1983 to	> 1/2	up to 80cc: 79dB(A) 81-125cc: 81dB(A)
31 March 1991	74dB(A)	126-350cc: 84dB(A)
	1/2	351-500cc: 86dB(A)
		over 500cc: 87dB(A)
1 April 1991 to		up to 80cc: 78dB(A)
16 June 2003	75dB(A)	81-175cc: 80dB(A)
		over 175cc: 83dB(A)
	up to 25km/h: 66dB(A)	up to 80cc: 75dB(A)
from 17 June 2003	over 25km/h: 71dB(A)	81-175cc: 77dB(A)
		over 175cc: 80dB(A)

Maximum noise levels for motor powered two wheel vehicles

Measures are also in place to ensure that these standards are maintained as far as possible in service by ensuring that inappropriate after-market/replacement silencers that would make motorcycles significantly noisier should not be sold or fitted and by enforcement of such measures at MOT, at the roadside and at point of sale.

25 May 2005

Aircraft noise

Mr Brazier: To ask the Secretary of State for Transport what steps he has taken to measure trends in numbers of complaints related to aircraft noise at the UK's major airports; whether the Government has commenced implementation of EU Directive 2002/49/EC on noise mapping; and what measures the Government introduced to promote research and development into new low noise engine and airframe technologies.

Ms Buck: Operational noise complaints (as distinct from representations about policy) are properly a matter for individual airports, many of which regularly publish their own summary statistics of complaints or enquiries. Any complaints received by the CAA or DfT are referred back to them. We do not operate a 'complaints database'. EU Directive 2002/49/EC relating to the assessment and management of environmental noise is being implemented separately in England, Scotland, Wales and Northern Ireland. Public consultation has occurred or is ongoing in all the Administrations. It is expected that

regulations will be in force early next year, whereupon noise mapping will commence to meet the requirements of the directive.

The Government's commitment to supporting technological developments to address the environmental impact of air transport is recorded in *The Future of Air Transport* White Paper. The Government, in conjunction with the industry, has adopted stretching European targets (from the EC Advisory Council for Aerospace Research in Europe) for environmental performance of new aircraft and engines by 2020. We continue to maintain pressure for technological development through national strategy research support and through work in international forums.

7 June 2005

Flight path changes (consultation)

Mr Yeo: To ask the Secretary of State for Transport how many complaints he has received regarding poor consultation procedures for aircraft flight path changes.

Ms Buck: I refer the hon. Member to the answer of 25 May 2005, where I indicated that the Department does not maintain a noise complaints database. It does however regularly receive representations about aircraft flight paths. Most concerns relate to the effect of noise

on correspondents. As part of this, some comment adversely on the way in which they became aware of changes. I am aware of a judicial review case on airspace changes affecting Suffolk.

Airspace changes are primarily the responsibility of the Directorate of Airspace Policy at the Civil Aviation Authority in the light of Guidance and Directions from the Secretary of State for Transport under section 66(1) of the Transport Act 2000. These are designed to ensure that changes are only made where it is clear, after consultation, that an overall environmental benefit will accrue, or where airspace management considerations and the overriding need for safety allow for no practical alternative.

8 June 2005

EU Committees

Angus Robertson: To ask the Secretary of State for Environment, Food and Rural Affairs how many times during the (a) Italian, (b) Irish and (c) Dutch Presidency of the EU the Committee for the approximation of the laws of the member states relating to noise emission in the environment by equipment for use outdoors met; when and where these meetings took place; what UK Government expert was present; and if she will make a statement.

Mr Morley: The Committee for the approximation of the laws of the member states relating to noise emission in the

environment by equipment for use outdoors falls within the responsibility of Secretary of State for Trade and Industry. This committee did not meet during the Italian, Irish or Dutch Presidencies.

9 June 2005

North London line

Sarah Teather: To ask the Secretary of State for Transport what assessment he has made of the effect of noise vibrations from trains on the North London Line on residential properties; and if he will make a statement.

Derek Twigg: Measures to mitigate the effects of noise vibration from trains are a matter for the railway industry. In response to concerns raised by residents who live near the North London Line, Network Rail has undertaken to carry out a number of measures to reduce noise vibration on this line. This will include carrying out grinding and joint removal work to improve the track surface. Network Rail will also look at a number of potential contributory factors in the area, including the speed of trains and local environmental conditions and will continue to engage in discussions with freight operators and the local authority to keep them advised of any relevant findings.

Sarah Teather: To ask the Secretary of State for Transport how many trains operate between midnight and 7am on the North London Line.

Derek Twigg: An average of 86 trains operate between midnight and 7am on weekdays on the North London Line.

13 June 2005

Low-frequency noise

Mr Todd: To ask the Secretary of State for

Environment, Food and Rural Affairs if she will revise the advice given to local authorities on handling complaints relating to low-frequency noise to assist them in detecting the source of low-frequency noise.

Mr Bradshaw: The Department published University of Salford guidance for local authorities on its website on 24 May which provides a methodology for assessing complaints of low frequency noise. This guidance, produced on behalf of Defra, is supported by reports on the development of the methodology and its field trials by local authorities. The guidance gives advice to local authorities on how to assess complaints of low frequency noise, from taking into account the personal circumstances of a case to using the methodology for detecting and measuring a low frequency noise which would otherwise be difficult to assess. This will help local authorities to decide whether action should be taken under section 80 of the Environmental Protection Act 1990.

13 June 2005

Railways

Hugh Robertson: To ask the Secretary of State for Transport whether home owners who suffer (a) noise pollution and (b) vibration damage following the introduction of the high speed line on the North Kent Coast line in 2009 will be eligible for compensation.

Derek Twigg: The new rolling stock that will be introduced in Kent from 2009 will operate at speeds of up to 140mph on the Channel Tunnel rail link and at slower speeds on the existing network, including the North Kent Coast.

Householders who are affected by noise from new or altered railway lines are entitled to noise compensation and amelioration measures on the same basis as householders who live next to new roads. However, there is no provision for compensation or abatement measures when use of a railway line intensifies or changes. Successive Governments have taken the view that those who choose to live adjacent to roads or railways do so in the knowledge that the volume or composition of the traffic may change, and that the householder must therefore bear that risk.

14 June 2005

Quieter road surfaces

Tom Brake: To ask the Secretary of State for Transport whether the target in the 10-year plan for transport on quieter road surfaces remains a Government target.

Dr Ladyman: The ten-year plan for transport included an illustration of the delivery programme possible by 2010-11, given the levels of investment set out in the plan. Included in the illustration was the installation of quieter surfacing on over 60% of the strategic road network. The Highways Agency had surfaced approximately 27% of the network with quieter surfacing by the end of March 2005 and is currently on target to resurface 60% by the end of March 2011.

Tom Brake: To ask the Secretary of State for Transport when he expects the Quiet Lanes Regulations to be published.

Dr Ladyman: The Department for Transport expects to publish the Quiet Lanes and Home Zones Regulations in autumn 2005.

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Leading the way in noise abatement

The Environmental Pioneer award was presented to County Durham based developer, Banks Group, by the Noise Abatement Society (NAS) during an event celebrating Noise Action Week, which was held at the company's Delhi Surface Mine in Northumberland.

The event – called *Noise Action Works* – took place on the Blagdon Estate where

the surface mine is located, and used Banks' pioneering noise abatement work to help demonstrate technological innovation and best practice in controlling noise pollution. It provided environmental companies and local authorities from across the UK with the chance to showcase innovative new technology. Banks led the demonstrations with

its 150 tonne Caterpillar 789B dumper trucks, which have been modified by the company's own engineers to reduce substantially their noise emissions. Peter Wakeham, director of the Noise Abatement Society, said that the judges had been extremely impressed with measures put into place to protect the environment and the local community. If the neighbours were happy, everybody was happy. Matt Ridley from the Blagdon Estate, who lives just 300 metres from the mine, expressed his delight at the Society's award to the company for noise suppression. It was not surprising, because he had lived next to this site for a number of years, and had seen the way Banks pioneered new environmental standards. This was not just in the suppression of noise and dust, but also in meticulous attention to the details of ecological restoration. As advisor to the government, industry and the general public, the Noise Abatement Society aims to raise awareness of noise pollution issues, and thus reduce or eliminate them.

Get a little extra help!

with Castle's noise and vibration training solutions

Noise and vibration in the workplace are complex subjects that require thorough knowledge of current legislative guidelines, as well as acoustic and vibration principles. Indeed, to carry out an effective survey, the current guidelines say that you must be a 'competent person'.

As industry leaders in providing affordable instruments for noise and vibration control, Castle Group's professionals have utilised their considerable experience to develop rigorous courses that lead to 'Competent Persons Status' upon successful completion. Most courses carry CPD points and CITB grant approval.

Each course has clearly articulated aims and objectives, so participants can be confident of the learning outcomes expected. Of modular structure, they are designed to offer maximum flexibility to busy professionals who can complete

each module at a pace that suits individual circumstances.

Theoretical content of each course is brought into focus during the extensive practical experience of noise and vibration measuring instrumentation. This enables delegates to return to their workplace with the necessary knowledge and skills to become effective immediately.

A recent delegate comments that 'the written material provided is of the highest standards. The whole course was well structured and the learning support was first rate. I would have no hesitation recommending this course to others'. Copies of the Training Solutions brochure are available free from Castle Group Limited. For individuals who wish to enhance their professional capabilities, these courses are a must.

Further details: Dianne Hamblin, tel: 01723 584250 fax: 01723 583728 email: dianne@castlegroup.co.uk



Current guidelines say that you must be a 'competent person'

40th UK conference on Human Response to Vibration 13-15 September 2005, Liverpool Marriott Hotel

This annual conference provides an opportunity for the exchange of information on all aspects of human response to hand-transmitted vibration, whole-body vibration, and low-frequency motion. Scientists, engineers, medical doctors, psychologists, physiologists, health and safety specialists, consultants and others from government,

industry and educational establishments are expected to attend.

Although this annual meeting takes place in the UK, there is always international participation from many countries, with overseas delegates most welcome. During 2005, legislation is being introduced to control vibration risks in

workplaces across Europe. To mark this, the conference is to be hosted this year by the Health and Safety Executive.

Call for papers

Titles and abstracts for papers are now invited. Information on submitting an abstract or on registering to attend the conference can be found on the conference web page at www.hse.gov.uk/vibration/events.htm

For information regarding the technical programme contact Chris Nelson at HSE on 0151 951 4826 or e-mail chris.nelson@hse.gsi.gov.uk

Sound and Thermal KTP project seeking bespoke solutions for existing dwellings

Napier University and BCA Insulation are currently undertaking a DTI-funded Knowledge Transfer Partnership investigating bespoke solutions for sound and thermal insulation in existing dwellings.

There are currently 24 million dwellings in the UK, with 2.2 million of them in Scotland. The construction format and types found across Scotland provide a wide spectrum of dwellings for study.

The project, which to date is 50% complete, is analysing the potential benefits of combined thermal and acoustic solutions when upgrading existing dwellings. Currently, improvement grants are available for thermal insulation of existing dwellings, but none is yet available for sound insulation. The drivers for thermal improvements are the Kyoto Agreement and the Energy White Paper.

The primary objectives being investigated by Russell Macdonald (KTP Associate) are the development of system solutions including exterior flanking walls, separating walls and floors and communal zones.

Both thermal and acoustical insulation performance of dwellings influences the quality of life for occupants. Sound transmission and poor levels of sound insulation between attached dwellings are major complaint issues for local authorities and housing associations in older dwelling stock. There are numerous cost benefits in carrying out thermal and acoustical remedial works at the same time.

Recently Dr John Reid, Minister of State for



Pictured (from left): Dr Sean Smith (BPC, Napier University); Dr John Reid MP (Minister of State for Health); Wilson Shaw (Managing Director, BCA Insulation); Karen Whitefield (MSP, Airdrie and Shotts); Russell Macdonald (KTP Associate)

Health, visited the project team with Karen Whitefield MSP. Academic partners for the project, due for completion in 2006, are John

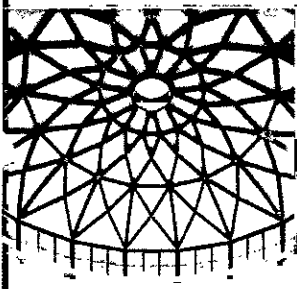
Currie and Dr Sean Smith, both based at the Building Performance Centre, Napier University.

NPL acoustical calibration

The NPL acoustics team provides traceable acoustic measurement services to both public and private sectors. For more than a century NPL has developed and maintained the UK's primary measurement standards. These support an infrastructure of traceable measurement nationally and internationally, ensuring accuracy and

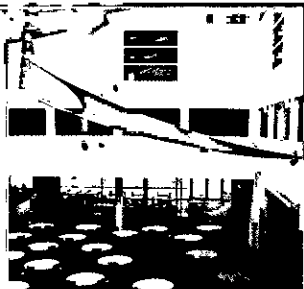
consistency. Compliance to international and national standards is required for the periodic verification of the performance of instruments from sound level meters to audiometers. NPL also offers calibration services for all the ear simulators specified by the IEC for pure tone audiometry. For more information visit www.npl.co.uk/acoustics/services

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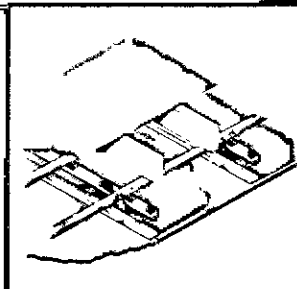
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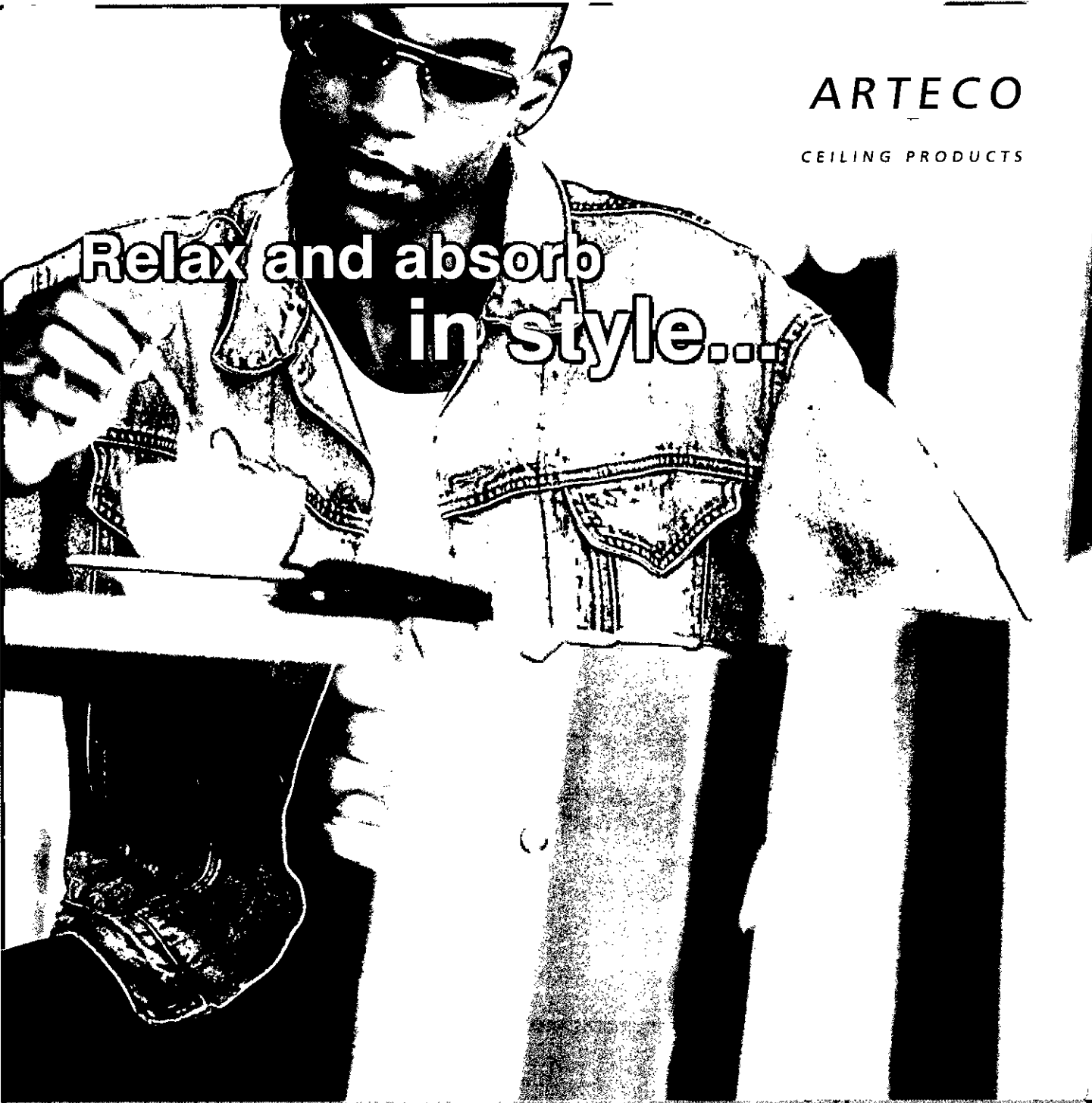
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IAC**'Phonezone' booth – a haven of quiet**

Those running a facility where there is a good deal of noise can now pamper their customers by providing a haven of quiet in which they can make that vital mobile phone call. The PhoneZone from IAC provides the answer. As world-leading experts on keeping noise out, and in, the company has built many thousands of soundproofed environments including TV and radio studios for the BBC and other broadcasters world-wide.

The PhoneZone provides a genuinely quiet environment in which phone users - whether on a payphone or a mobile - can chat happily and privately, undisturbed and without disturbing others.

The unit is suitable for shopping centres, hospitals, factories, hotels, leisure centres, railway stations, football grounds, exhibitions and other noisy public places. It has a robust steel construction, while its smooth curved exterior provides an ideal surface for custom-designed eye-catching graphics advertising products and services, all of which IAC can provide as part of the package, if desired.



Further details: Jason Saunders, tel: +44 (0)1962 873027 email: jasons@iac.co.uk or visit the Studios section of the IAC website: www.iac.co.uk

Ashtead Technology**New web site for rental instruments**

Ashtead Technology is a member of Ashtead Group plc, one of the world's largest equipment rental companies. Since its inception, the company has grown enormously, a success which general manager James Carlyle, attributes to three factors, namely: technical advice on what to rent and how to use it; high availability of instrumentation; and the fact that all equipment is tested and ready for use. A new web site www.ashtead-technology.com has just been launched, specialising in the rental of technical equipment in the fields of non-destructive testing, remote visual inspection, and environmental monitoring.

The site offers a wealth of information on which products to use and how to use them, and is backed up by telephone technical support. Unusually, it offers customers an Extranet facility which is tied into the company's mainframe computer. This is able to display instantaneous information on current and historical rentals, including both product and financial information.

Further information: James Carlyle, tel: 0845 270 2707 email: james.carlyle@ashtead-technology.com www.ashtead-technology.com

AGS Noise Control**Bespoke installation specialists**

AGS Noise Control Ltd dates to 1977 when the company was founded as AG Services, manufacturing light sheet metal fabrications for the noise control industry. The company name was recently changed to reflect its increased range of products and services.

While industrial and commercial noise control products such as enclosures, screens, test facilities, anechoic chambers and sound havens still form the business' core, the company can also offer attenuators, louvres, silencers and a wide range of acoustic materials to fulfil almost any noise control requirement, either as single products or as part of a complete package.

The company specialises in bespoke installations: a variety of products is used to provide the most cost effective solution to any acoustic problem, using in-house fabrication workshops and

directly-employed teams of skilled fitters. Full contract management facilities are available to co-ordinate installation of air conditioning and electrical systems, ground works and structural steelwork to provide a turnkey project with minimum of disruption to the client's ongoing business. The company also markets and installs Isolamin panels, a Swedish-made prefabricated laminated panel system widely used for noise barriers, large enclosures and acoustical screening.

Further information: Phil Dent, tel: 01664 568728 fax: 01664 481190 e-mail: sales@agservices.co.uk

LMS**TestLab rev.6 introduced**

The new release of TestLab rev.6 from LMS International is claimed to increase testing productivity by 30%, and deliver better engineering insights in shorter time. This integrated software suite for noise and vibration testing and engineering offers solutions for structural, rotating machinery and acoustic testing, environmental testing, vibration control, test data processing, reporting and data sharing.

The latest version introduces new capabilities and enhanced modules, further increasing the productivity of testing processes, reducing operational testing costs and supporting testing teams looking for the root causes of noise and vibration issues.

With its new architecture for rotating machinery testing, the total elapse time for data acquisition, analysis and reporting is reduced, despite covering even more demanding test scenarios. Extensive real-time visualisation capabilities are provided, while delivering a complete results set immediately after the measurement.

A new 'exterior pass-by noise testing' routine is the first to support the current and upcoming revision of the ISO 362 standard. The software gives on-line feedback to the driver on the progress and the quality of the measurement, guiding the user through the software in an intuitive way from test setup, through measurement and analysis to final data comparison and reporting. This increases productivity and reduces human errors.

LMS TestLab Structures represents a comprehensive solution for structural testing and analysis, covering both modal and operational modal testing applications. The latest version further expands its portfolio with MIMO sine testing capabilities, giving higher quality vibro-acoustic models and more reliable analysis results in less time. A new interactive 'modification prediction' routine offers capabilities for 'what-if?' studies to explore alternative designs.

LMS TestLab Environmental provides a powerful high-speed multi-channel vibration control system, which is easy to use and has extensive data analysis capabilities for random, shock, sine, and combined modes testing. The system also provides high performance on-line data reduction of random, sine, transient and acoustic signals. In the area of environmental testing, there is automatic test sequencing for smooth batch testing. This allows an automatic and unattended execution of long-duration tests, while guaranteeing full safety of the test subject.

Further details: Bruno Massa, tel: +32 16 384 200 email: bruno.massa@lms.be

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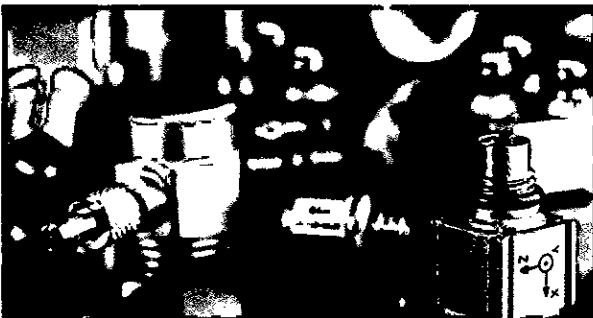
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Bruel & Kjaer broadens vibration sensors range

In adding more than 50 new types of product, including various accelerometers, force transducers and hammers **Bruel & Kjaer** has broadened its vibration sensors range.

This expansion reflects renewed commitment to offering the most comprehensive line of high-performance, high-quality, economical, rugged and lightweight uniaxial and triaxial sensors for almost any application. The company also supplies a wide variety of quality connectors, cables and mounting options that ensure optimum measurement integrity, ease of set-up and data reliability. This product expansion has been developed to meet growing customer demands for precision instrumentation. The company says it has increased the focus on product development, testing and quality to provide customer-dedicated solutions as well as a high level of pre-sales and after-sales support. Investment in new production facilities in Denmark has provided a manufacturing capability which enables the company to react faster to market demands for precision instrumentation and also gives the opportunity to perform exacting tests on new designs to optimise product quality. The company has strengthened its dedicated team of in-house engineering staff to support the continuous development of new accelerometers and sensors, including improvements to existing accelerometers, developing new versions and making customer-specific variants of existing designs.



The company plans continuous development of new accelerometers and sensors

The first two products to emerge from the new accelerometer development programme are the miniature triaxial *DeltaTron* accelerometer (type 4524), which is ideal for automotive applications, and the *DeltaTron* accelerometer (type 4511) developed to address aerospace requirements.

The type 4524 is a lightweight triaxial piezoelectric OrthoShear accelerometer to address the needs of the automotive industry. It is suitable for structural analysis measurements, multi-channel modal analysis measurements, and modal measurements for automotive body and power-train applications.

Ideal for use by civil and military helicopter manufacturers, the type 4511 is flight-test certified: all processes and materials

comply with MIL-STD-11268. The device's primary design objective has been reliability under extreme conditions, yielding very high robustness against mechanical, electrical and environmental influences. Applications include flight tests, measurement in harsh environments, health usage monitoring systems (HUMS), and gearboxes.

Both types of accelerometer were developed using the numerical modelling technique FEM (finite element modelling). Each accelerometer is individually calibrated and supplied with a comprehensive calibration chart, using state-of-the-art, random FFT technology, providing an 800-point, high-resolution calibration (magnitude and phase), ultimately giving a unique characterisation and securing the integrity of the vibration measurement.

Latest pulse innovations expand measurement possibilities

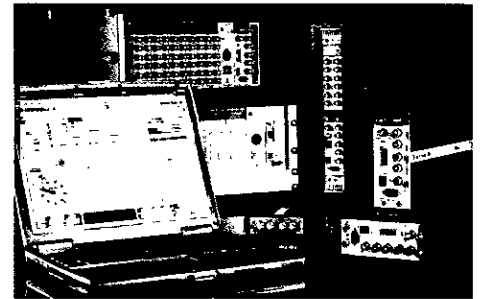
Bruel & Kjaer has expanded its market-leading Pulse PC-based sound and vibration analyser system with *Pulse X*, a new measurement solution which delivers innovative and unique technologies for safer, more productive operations, standardised data management, and product problem resolution. *Pulse X*'s revolutionary Dyn-X 6- and 12-channel input modules boost measurement performance and accuracy over an extreme dynamic input range - for the first time, 160dB. The measurement performance and accuracy of Dyn-X matches or

outperforms the capacity of today's high-quality transducers. Users no longer need to protect their measurements from overload or under-range situations, but are concerned only with selecting the right transducer for the measurement.

Dyn-X is therefore ideal for applications where an accurate measurement has to be right first time, or where many different transducers and unknown signal levels are involved, for example in crash testing, destructive testing, and rotating machinery (run up/coast down). Cutting-edge aerospace and automotive applications will benefit from Dyn-X's innovative real-time digital signal processing algorithms, combined with state-of-the-art analogue conditioning achieving the utmost quality and accuracy gains.

The new technology is also well suited to time-limited applications such as test cells, wind tunnels, road testing, and flight testing, as well as to high-dynamic applications such as structural measurements, impulsive testing, room acoustics and electroacoustics. For field or road testing, Dyn-X requires minimal user interaction, and reduces the skill level required for production line testing. It enables measurements not previously possible, and improves existing applications.

The new technology saves both time and money because trial runs, overloads and the necessity to re-take measurements



Pulse X is a new measurement solution become things of the past. A further innovation in *Pulse X* is an advanced Source Path Contribution (SPC) solution with the emphasis on usability, data management, and source-path-receiver model management. Bruel & Kjaer provides complete solutions, combining dedicated transducers for the measurement of operating and body characteristics with instrumentation and signal processing platforms, contribution analysis, and vehicle target management.

Type 2250 hand-held analyser wins Red Dot award

The Red Dot award for product design 2005 has been given to Bruel & Kjaer for its type 2250 hand-held analyser. This prestigious international design award, which is celebrating its fiftieth anniversary this year, attracted entries from 36 countries.

It is the second major design award for the company within a matter of months. Some 70 professional users from the UK and three other countries were involved in the development of the award winning instrument, which is easy and reliable to use, even under extreme conditions. The fourth-generation platform is specially designed to be adaptable to future needs, while meeting users' ergonomic requirements. Every year companies worldwide submit their product designs to the award's international jury. The coveted Red Dot trophy is regarded as the international seal of quality for outstanding design. An award ceremony for all winners took place on 4 July 2005 at the Aalto Theatre in Essen, Germany. All the winning product designs will be on show to the public at a special exhibition in the Red Dot Design Museum, Essen, which is the world's largest exhibition of contemporary design.

Further information contact: Nicola Parker, tel: 01438 739000 fax: 01438 739099 email: ukinfo@bksv.com web site: www.bksv.co.uk

Prof blows his own turnip

Salford University's Professor Trevor Cox has innovatively used a giant white radish as a 'clarinet' in the hopes of winning a place on TV. Trevor was one of 12 finalists in Channel 4's *Famelab* - a 'Pop Idol' style competition looking for a presenter to front their science programmes. The purpose of his entry was to give acoustics some high-quality exposure to the general public, and make science more generally accessible to non-scientists.

It was the limitations of the challenge that made him decide on a radish clarinet. "In *Famelab*" reveals Trevor, "I had four minutes to demonstrate some science. I wanted something very visual and very funny, and if I had gone in with a clarinet, it would have been boring."

His inspiration for the instrument actually came from much further afield. There really is a vegetable orchestra in Vienna, but they mostly make percussion, and he had to come up with an idea to demonstrate science. The thing about science communication is that it needs to be made fun. Having started off with carrots, he found a problem in that new season carrots were very small: hence the graduation to larger root vegetables.

But where was the science? It was, of course, in the way the instrument was made and its use of kitchen paraphernalia to make it play. While the funnel at the bottom was simply for amplification, the mouth piece, made from a piece of



Playing his radish 'clarinet' Prof Trevor Cox introduced acoustics to a TV audience

washing-up liquid bottle lashed on with rubber bands, used the Bernoulli Effect to make the sound. Just to remind those of us who are not professors of acoustics, that is the principle which not only makes the reed oscillate to break up the sound flow,

and make the notes in the clarinet, but also explains how wings on planes give lift, and even how the V1 engines in World War II worked.

For all his hard work, though, Trevor admits that the radish is difficult to keep in tune. He has to do all the work with his lips: normally, the different notes would be produced mostly by fingerings, but the instrument does not have particularly precise tuning. He felt this was acceptable since it was a science talent competition, not a make-your-own-clarinet competition.

In fact, the prize went to Dr Mark Lewney, a patent examiner from the UK Patent Office near Newport, south Wales. Dr Lewney gave a virtuoso demonstration of the science of rock - playing riffs from Vivaldi to Deep Purple - during his four-minute stint, and it is no accident that his doctorate at Cardiff University was on the acoustics of the guitar. His CV describes how he 'pursues sociological and anthropological research in his spare time by appearing in pubs throughout south Wales playing guitar in local band Fire Down Below'.

Whether Trevor will move onto more salad symphonies remains to be seen. Given enough practice, he might become a fantastically tuneful tuber player, but maybe now that the competition is over he should stick to more traditional instruments. See www.acoustics.salford.ac.uk/clarinet for instructions on making your own.

[Couldn't resist the temptation to repeat the terrible puns. A special 'get a life' award to anyone who can contribute others in the same vein - Ed.]

SLR expands acoustics team

Environmental consultancy SLR has increased its team with the appointment of Mike Brownstone as head of acoustics. He brings 13 years' experience in all aspects of environmental acoustics and vibration to his role as principal and has responsibility for that team. Mike, who is based at the company's Redditch office, is looking forward to increasing the depth of this section within SLR. The aim was to develop a wide-ranging acoustics team that is able to deliver a consistently high service to clients.

Mike, whose expertise lies in noise-related planning issues, is working with a top UK house builder on a number of planning inquiries. Previously with engineering consultancy Halcrow, he has also worked on a number of high profile projects including the A303 at Stonehenge and the Jubilee line extension. SLR has six other regional offices throughout the UK, employing over 180 people.

www.slrconsulting.co.uk



Darren Lafon-Anthony, senior acoustics consultant at SLR, welcomes Mike Brownstone (left) to the team

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Were Odysseus' Sirens really monk seals?

A German scientist claims to have found the Sirens of the Greek myth of Odysseus, who lured ships onto the rocks with their song: they are, in fact, monk seals. Karl-Heinz Frommolt, head of the Archive of Animal Sounds at the Humboldt Museum, believes he has identified the Sirens' lair on the Li Galli islands, off Sorrento on Italy's Amalfi coast. The island is known as Le Sirenuse, the Island of the Sirens.

His team identified a configuration of rocks which amplifies sound coming from the island. However, tests showed a human voice could not reach far enough out to sea - whereas a moaning monk seal's could. Dr Frommolt says the cries of monk seals are much louder than the song of humans. There is a clear acoustic phenomenon, supporting the theory that the Odyssey was real, and not only a poem by Homer.

In Homer's epic poem *Odysseus*, a warrior king returning from the sack of Troy to his native Ithaca, tells of a land inhabited by wicked women who lure sailors to their death with their beautiful song. *Odysseus* is warned that there is no homecoming for the man who draws near them unawares and hears the Sirens' voices. He could apparently have heard their music a great way off the island. He preserves his crew by giving them wax earplugs, but because he wants to hear the song for himself, orders his men to tie him to the mast.

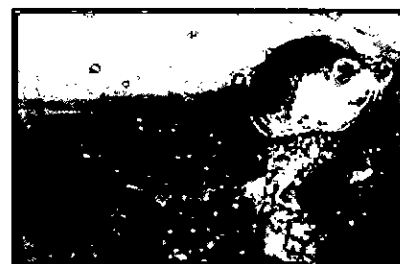
For centuries, historians have believed that



Odysseus would have heard the Sirens somewhere in the Li Galli islands area, hence their nickname. Dr Frommolt thought that if there was any truth in the theory, the islands must exhibit some kind of acoustic peculiarity. To test it, his team used a loudspeaker and transmitted artificial sounds. They then listened out at sea, as the sailors would have done. When they moved away from the loudspeaker, they expected the noise to reduce in intensity, and that is what happened: at 300 metres it was less intense than at 200 metres. However, when the boat was positioned between the two rocks, at the greater distance of 400 metres, the signal became louder. He explained that this was due to the 'specific constellation' of the islands, which consists of a long island, Gallo Grande, and two distinctive rocks, Castelluccio and La Rotonda. The two large rocks produced very strong reflections, and constituted a natural acoustic amplifier. *Odysseus* might have heard something before he could see the shore, and

before he could decide who - or indeed what - was causing the noise.

Homer refers to the ship having 'just come within call of the shore, when the Sirens became aware that a ship was bearing down upon them, and broke into their high, clear song', but a human singer cannot sing loudly enough to be heard offshore, even with the amplification effect of the surrounding rocks. Historians are reportedly not amused, since in their opinion the value of the tale does not lie in a literal interpretation of mythical figures.



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Noise Consultants

Flexible UK

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Environmental/Acoustics Manager

South East

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To lead and extend the existing team within the noise assessment/modelling field. Min. 5 yrs experience of PPC, EIAs and planning noise and vibration assessments. MIOA required. AB/C/13591

Acoustics Engineer (Perm or Contract)

Central South/South West

Candidates should have a degree in either Acoustics Engineering or Physics and 3-5 years' experience in env. and building acoustics with knowledge of modelling packages. AB/S/11903

Senior Acoustician

Yorkshire/Flexible UK

Senior specialist to help build and run environmental acoustics arm of this consultancy. Must have relevant Acoustics qualifications 5 yrs+ exp and be competent in assessment methodologies including DMRB, CRTN, BS4142, BS5228 and PPG24. AB/H/13983

Senior Noise Consultant

South Wales/Flexible

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The language of noise

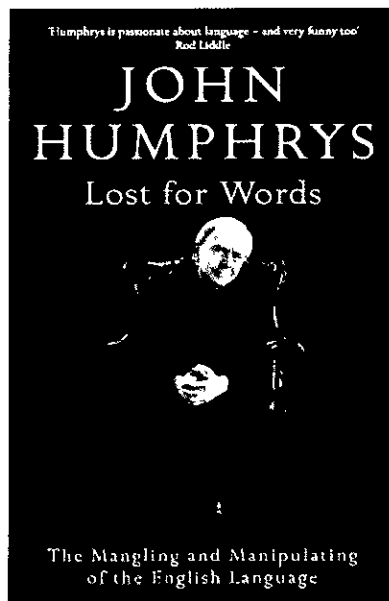
To misquote George Orwell, in his novel *Animal Farm*, 'All presents are welcome, but some are more welcome than others'

Someone who knew my love of the English language - and its history, development and evolving application - gave me the wonderful book *Lost for Words - The Mangling and Manipulation of the English Language* by John Humphrys (publ. 2004 by Hodder and Stoughton, London: ISBN 0-340-83658-X). The author is well known in the UK as a journalist, BBC reporter, radio interviewer, and scourge of politicians of all persuasions. In the book he exposes the depths to which he believes the language has sunk and offers many examples of what he calls 'the most common atrocities'. His case is that the language is under attack from all sides.

'Politicians dupe us with deliberately evasive language. Bosses worry about impacting the bottom line while they think out of the box. Academics talk obscure mumbo jumbo'.

He dispenses sensible guidance on how to use simple, clear and honest language.

"Well", I hear you say, "What has this got to do with noise control engineering as a profession?". The simple answer is that we all have a need and a duty to communicate clearly with others, who may range from experts in our own field, through those less familiar with our particular area of expertise, and on to the 'general public'. I am sure we all take great care in writing our scientific papers, technical reports and so on when we have a relatively clear idea of the target audience. Of course, many of the key issues in noise control engineering, such as the environmental impact of airports and sound insulation of homes, impinge on the lives of the 'general public' - whoever that might be. The situation is complicated by the fact that, even within the category of 'general public', we may face a large range of knowledge in our intended audience, from well-educated and technically aware



'The book *Lost for Words* serves as an entertaining and persuasive reminder of the care we should all take as the 'providers' of information'

Bernard Berry argues the case for simplicity and clarity in our communication with others

pressure groups, to concerned private individuals.

The book *Lost for Words* serves as an entertaining and persuasive reminder of the care we should all take as the 'providers' of information. But we should also bear in mind that we, as professionals, are often ourselves the audience. We should be ready to detect when politicians, and others, are, to use the eloquent words of a very senior British civil servant, 'economical with *la vérité*'. We may also find ourselves in the editorial chain between the initial author and the intended audience, and have the chance to improve the clarity of language in that context. I was recently in that situation, reviewing a draft conference paper in the area of environmental noise assessment and management, intended for an international audience, for whom English might not be the mother tongue. Many of the publications

with which we all deal are in that category. My eyes, but only part of my brain, took in the following words:

'Ambiguous assessment requirements may allow for significant interpretation as to the precise conditions that define the bounds of a representative data set'.

This could have come as an example straight from the book I have been discussing, but it did not. My own suggested 'translation' of the text is:

'We sometimes do not know what the client wants ... and neither does he'.

A further group of examples on this theme might be our propensity to use acronyms - the shorthand we all find ourselves using as part of our special language. I myself may even be a serial offender. I could quote a range of recent cases - from ACARE (Advisory Council for Aeronautics Research in Europe (www.acare4europe.com/html/links.shtml)) to the WHO (World Health Organisation).

Such language could be regarded of course as a necessary evil of our profession but, again, we need to ensure our audience knows the 'code'. Ironically, I have even had problems with the abbreviation of the name of a well-known magazine. If I use the term NNI with colleagues of a certain vintage, in the UK, some think I am talking about Noise and Number Index, a metric with a long history, for describing noise around airports, now replaced.

To summarise my message, I can do no better than quote the 2000-year-old words of the Roman rhetorician and orator Marcus Fabius Quintilianus:

'One should not aim at being possible to understand - but at being impossible to misunderstand'.

*This article in its original form was an 'Editor's View' written in the author's role as NNI European Editor. It was originally published in **Noise News International**, whose permission to use it is gratefully acknowledged.*

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18 - 19 October Measurement & Instrumentation Group Autumn Conference 2005 – What Noise Annoys? Oxford	15 November London Branch Workshop on PPS24 London
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Further details can be obtained from Linda Canty at the Institute of Acoustics Tel 01727 848195 or on the IOA website www.ioa.org.uk

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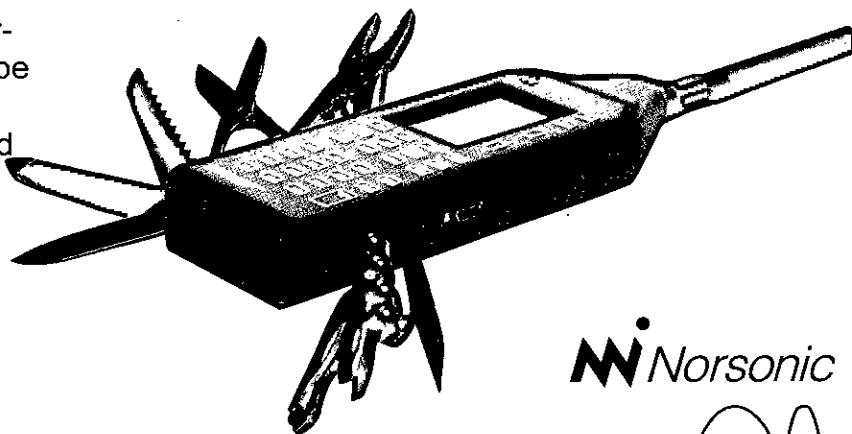
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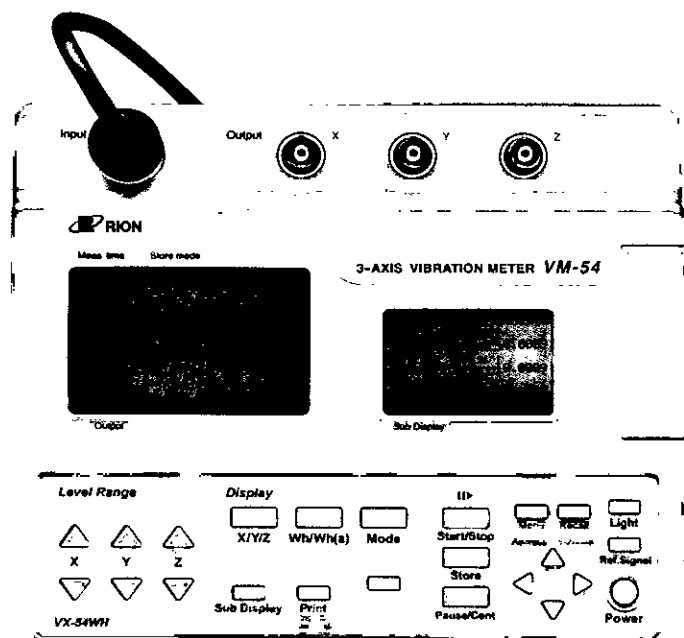
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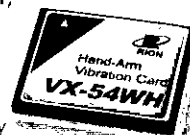


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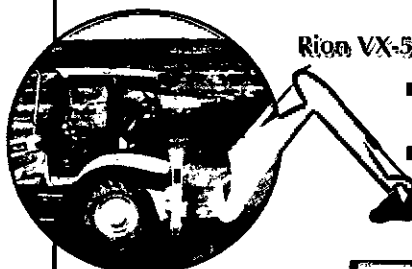


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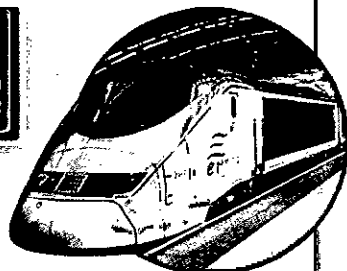


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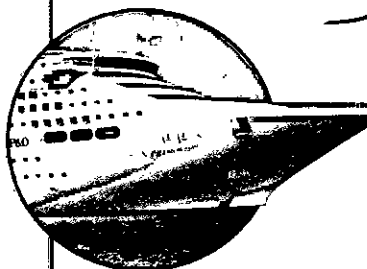
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