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ACOUSTICS BULLETIN

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Wind shear and its effect on wind turbine noise assessment

Institute of **Acoustics**

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Vol 37 No 4 July/August 2012

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Front cover photograph:
Capturing the sound of international rowing presents many difficulties for TV producers.

Institute of Acoustics

The Institute of Acoustics is the UK's professional body for those working in acoustics, noise and vibration. It was formed in 1974 from the amalgamation of the Acoustics Group of the Institute of Physics and the British Acoustical Society. The Institute of Acoustics is a nominated body of the Engineering Council, offering registration at Chartered and Incorporated Engineer levels.

The Institute has over 3000 members working in a diverse range of research, educational, governmental and industrial organisations. This multidisciplinary culture provides a productive environment for cross-fertilisation of ideas and initiatives. The range of interests of members within the world of acoustics is equally wide, embracing such aspects as aerodynamics, architectural acoustics, building acoustics, electroacoustics, engineering dynamics, noise and vibration, hearing, speech, physical acoustics, underwater acoustics, together with a variety of environmental aspects. The Institute is a Registered Charity no. 267026.

Conference programme 2012

27 September 2012
Organised by the Building Acoustics Group
Acoustic challenges in green buildings 2012
Watford

6 November 2012
Organised by the Building Acoustics Group
Acoustics 2012
Birmingham

14-16 November 2012
Organised by the Electro-acoustics Group
Reproduced Sound 2012
Brighton

27 November 2012
Organised by the Measurement and Instrumentation and Young Members' Groups
Basics of measurement – practical implementations
Watford

December 2012 (date TBC)
Organised by the Noise and Vibration Engineering Group and the Health and Safety Executive
Quiet-by-design for work machinery
Venue TBC

Please refer to **www.ioa.org.uk** for up-to-date information.

Dear Members

I am delighted to be writing my first President's letter to you. It is a very great honour to have been elected President and I am particularly proud to be the first woman to hold that office. I hope I will be the first of many. (I also find it interesting that the tallest President in the Institute's history is followed by the shortest!) I would like to thank my predecessors, particularly Trevor Cox and the previous immediate Past President John Hinton, together with the rest of Executive and Council, with whom I have enjoyed working for the past two years. I am sure that many members do not realise the enormous amount of hard work that is carried out by all our committees.

I am taking over in an exciting summer. By the time you receive this Bulletin the Jubilee celebrations will be over and we will be gearing up for the Olympics. You will see that this issue contains articles on acoustic aspects of sport. It will be interesting to see whether the Games give rise to any national news coverage of acoustic issues as happened with vuvuzelas during the last World Cup. Certainly many of our members have been involved in various projects around the planning and design of the Olympic site, and we look forward to hearing from them in due course.

The Jubilee leads me to reflect on the enormous cultural and technological changes over the past 60 years. I watched the Coronation on television – this involved a six hour train journey from Norwich to Birmingham as my grandfather was the only person we knew who had a TV! I remember sitting in the dark watching the tiny black and white screen. Members might have noticed that whereas televisions have got bigger over the past 60 years, other technical equipment has got smaller. If the Queen were to ask her local EHO to measure the aircraft noise at Windsor Castle today she would be amazed at the tiny amount of equipment required compared with what would have been used in 1952.

On a more serious note, we are going through a turbulent period in international finances. Things are changing so quickly as I write that who knows what will have happened to the eurozone by the time you read this letter. The economic situation of the past few years has affected our finances so I am conscious that we will need to watch our spending very carefully during my presidency. You might see some cutbacks, for example in the number and type of conferences and meetings that we hold. Another area where we could reduce costs is by making increasing use of the website, e-newsletter and email, rather than post, to pass information to members.

Returning to the happier subject of jubilees, I am especially looking forward to being involved in preparations for celebrating our own 40th anniversary in two years' time, and welcome suggestions from members. You will see information on the related history project elsewhere in this Bulletin. I am particularly keen that the anniversary is not seen solely as a celebration for older members who remember the early days of the Institute, but that younger members will also feel fully involved and see it as an opportunity to shape it for the next 40 years.

However, before 2014 there will be many other important and enjoyable events where I hope to meet as many of you as possible, and to hear your thoughts on the future of your Institute. Please also email me at president@ioa.org.uk with comments or queries on any aspects of the Institute.

Bridget

Bridget Shield, President

Bridget heralds in new era for IOA

Institute's first female President

New IOA President Bridget Shield has made Institute history by becoming the first woman to hold the post in its 38-year history.

Bridget, who took over from Trevor Cox in June, said: "It's a great honour and I am looking forward to carrying on Trevor's work over the last two years in raising our profile and that of acoustics generally.

"The fact that I am the first female President will, I hope, encourage more young women into the profession. Since I joined the Institute in 1974 there has been a significant increase in the number of women members, and I intend to ensure this continues.

"I am very impressed with the work carried out in schools by our acoustic ambassadors and I would like to encourage more members to take part to raise the awareness of acoustics as a career among young people."

Bridget said one of her other major aims during her two-year presidency was to make the running of the Institute more open to the majority of the membership.

"When I talk to members, particularly younger ones, many feel distant from how it is run. The feeling is that it is opaque, so I want to make it more transparent. One way to do this is to show people how they can get more involved in its affairs by, for example, putting themselves forward for membership of committees.

"I also want to establish closer links with other professional bodies, such as RIBA, and to disseminate our knowledge of problems in acoustics and noise to those people involved in devising solutions, for example architects and engineers.

"Another main objective is to ensure the Institute remains financially stable. We are living through difficult economic times so it is vital that we continue to look at how we can make our finances as healthy as possible.

"It has been exciting to be involved with the Sound Schools campaign during the past 18 months and I hope the Institute will continue to influence the government on new or revised legislation relating to noise and acoustics."

As President she will also pay a key role in helping to oversee the preparations to celebrate the Institute's 40th anniversary in 2014.

Bridget admits she came into acoustics "by accident". After studying pure mathematics at Birmingham University in the 1960s, a spell as a research assistant at Bristol University, where she was involved in an architectural modelling project, was followed by a year teaching in a Birmingham school.

"I did not enjoy my time in the school so when I was offered a research post involving acoustics at Birmingham University I jumped at it. It was a good time to make the switch as the Health and Safety at Work Act was just coming in and the famous "yellow book" (the Code of Practice on Noise at Work) had just been published. I was involved in a major project measuring and predicting factory noise, which I later wrote up as the thesis for my PhD."

After taking a few years out to have a family, Bridget taught maths at Thames Poly in London before returning to acoustics in 1986 when she was offered a temporary post as a lecturer in acoustics at South Bank Poly (now London South Bank University). Twenty-six years on she is still there, today as Professor of Acoustics in the Department of Urban Engineering in the Faculty of Engineering, Science and Built Environment.

During her time there, Bridget has established a world-wide reputation for her research, in particular on the effects of noise on children and how it affects their ability to learn. Her expertise in this area resulted in her being appointed as an editor of Building Bulletin 93 and she is currently involved in helping update the regulations governing acoustic design standards in schools.

Other highlights of Bridget's career at South Bank include research into noise annoyance caused by the newly opened Docklands Light Railway in the late 1980s, which influenced the drafting of the Noise Insulation Regulations for railways, and working with Trevor Cox in the 1990s on various "Public Understanding of Science" projects. This led to Bridget and Trevor curating a major exhibition on concert hall acoustics at the Royal Festival Hall in 2000. Bridget then had a very enjoyable year's sabbatical during which she researched the original acoustic design of the RFH, and set up the acoustics archive at the library of Southampton University to house the papers relating to it.

Bridget was a member of the Department of Health committee which wrote the 2010 report on the effects on health of environmental noise, and last year she chaired the 10th International Congress on Noise as a Public Health Problem in London.

Bridget has been succeeded as President-Elect by William Egan, Northern Europe Managing Director of Brüel & Kjær.

New IOA President Bridget Shield

Factfile

Born: Norwich, May 1947
Education: Birmingham University
Lives: Central London
Personal: Widowed. She has four children and three grandchildren and five step-children and 10 step-grandchildren
Likes: Theatre, music, opera, art, singing in a choir, yoga, calligraphy, reading and enjoying time in her house in Spain

Update from IOA Noise Working Group

Report by Richard Perkins MIOA,
Vice President (Engineering), Working Group Chairman

Regular readers of *Acoustics Bulletin* will have noticed the increasing frequency of articles and letters on the subject of wind turbine noise assessment in recent editions, covering such issues as enhanced amplitude modulation, wind shear, and "an alternative view" to wind farm noise assessment. It is therefore no coincidence that wind farm noise assessment should come to the attention of the Institute of Acoustics Council, who agreed in the summer of 2011 to work with the Government Oversight Group to provide guidance on technical matters, and set up a noise working group.

The group has been working for several months now to produce two documents with which to consult with members, the industry, and the general public. All being well, by the time this *Bulletin* reaches your doormats, the consultation will already be under way, or about to be released shortly. For those who have not been keeping up with the working group's remit and activities, these can still be viewed on the IOA website at **http://www.ioa.org.uk/about-us/news-article.asp?id=252**

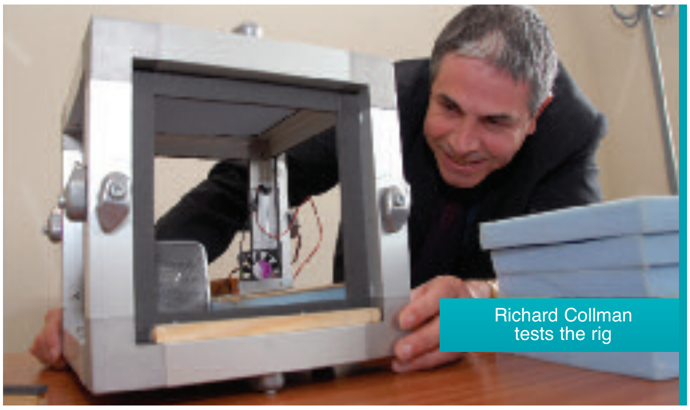
The working group has proposed a revised title for the document. This change reflects the good practice advice that the working group feels it can provide within the terms of reference which expressly excludes consideration of the appropriateness of the noise limits. In fact, it is worth noting that the documents do not imply any endorsements of the ETSU-R-97 noise limits by the noise working group. The strength of feeling amongst professionals that the aspects of noise limits and significance require revisiting is acknowledged. It is outside the terms of reference for this exercise to consider these aspects, but that in itself does not prevent the IOA from considering them. I think Trevor Cox put it best in his outgoing president's letter (*Acoustics Bulletin* May/June 2012) as to the IOA Council's current position on such matters.

Coming back to the consultation, and after our internal peer review group has given them a thorough going over, we will be publishing two documents. The first will be a draft version of the Good Practice Guide with aspects that the working group considers provides clarity on aspects that are expected to be non-contentious (although we may be proved wrong). The second document contains aspects that are not covered in ETSU-R-97, or where current understanding of the subjects has moved on since ETSU-R-97's publication. These include noise propagation, wind shear, how to deal with cumulative impacts, as well as aspects that the group felt required particular consideration and input from the acoustics community. Respondents to the eight-week consultation will be able to comment on all aspects of both documents.

Following the consultation, the working group will meet again to consider the responses, and will work to produce one final Good Practice Guide for publication. The final document will also require approval from the IOA Council. The subject of endorsement for any document that could potentially be used in a legislative context is a thorny one, and has yet to play out. First and foremost, the Good Practice Guide must be of benefit to IOA members, and IOA Council will provide those checks and balances. Wider endorsement will be for those bodies to consider separately. With the infancy of "Localism" in the planning regime, and a move away from prescriptive Government guidance, endorsement by the IOA may yet prove to be sufficient.

Whatever your feelings on the subject, I would encourage you all to contribute to the consultation, and I look forward to reading your responses. The consultation will be published on the IOA website.

Rock band exercise aims to attract pupils to acoustics



Richard Collman tests the rig

An innovative exercise in which school pupils have to sound proof a rock band's practice room using a test rig is being rolled out nationally by the IOA as part of its mission to raise the profile of acoustics and noise control engineering among young people.

The exercise and rig were devised a few years by noise consultant and IOA member Richard Collman who has since taken it into many schools in and around Hertfordshire with great success in his role as an STEM Acoustics Ambassador.

To reach out to a far greater number of pupils, the Institute has taken delivery of 12 rigs for potential use by fellow ambassadors which Richard demonstrated to them at a workshop at the IOA office in St Albans.

Called *You're Banned*, the exercise asks pupils to imagine that their band (named by each participating student group as its first activity) needs somewhere to practice ahead of a "head-to-head" play-off final against three other groups which, if successful, would clinch a prized spot on MTV.

They can use a room at the home of one of their members, but must not disturb anyone else. In order to come up with the most effective solution to soundproof the room, they have access to a grant of £4,500 for insulation materials

Each band – a group of up to six pupils – is given a test rig consisting of a drum and bass simulator, together with a framework into which they can fit a range of "costed" materials of differing P8

◀ P7 density and absorption characteristics such as foam, sheet steel, plywood, hardboard, plastic and wadding.

The test rig enables them to test partitions of single composite construction and to see how well the different constructions cope with airborne and structure-borne sound. A floating floor is also available as part of the test assembly.

Keith Attenborough, Institute Education Manager, said: ‘The Institute has a good track record with the graduate diploma and short course certificate provision but the workshop provided the first real opportunity for launching an IOA Schools Initiative after a long gestation period. It was well supported. Although, unfortunately, three ambassadors had to drop out from attending the workshop at the last minute, there is the potential for a national network of acoustics ambassadors which IOA Education Committee will be pleased to encourage and nurture.”

Alex Krasnic, one of the Acoustics Ambassadors who attended the workshop, believes the exercise will play an important role in getting more pupils to consider acoustics as a career. "It's a fun and engaging activity designed to challenge pupils to think about acoustic and engineering principles, whilst creating a bit of healthy competition amongst classmates,” he said.

Richard Collman was pleased with the response at the workshop and said it was “particularly interesting how well everyone engaged with the activity”. Each classroom activity for 30 children will require about six kits and a sound level meter (which will be provided also by the IOA). Given the limited number of kits available, a rota and booking system is planned for their use.

Contact **Education@ioa.org.uk** if you are interested.

Victory in IOA Sound Schools campaign

The IOA has welcomed the news that acoustics is among eight out of 24 regulations that are to be retained in the Government’s new School Premises Regulations due to be announced in September.

Professor Trevor Cox, outgoing President, said: “We are delighted that good acoustics is seen by the Government as crucial in the design of schools as there is a wealth of evidence that shows that the better pupils can hear a teacher, the better they learn, while poor acoustics has a detrimental effect on their progress, with pupils with special educational needs being particularly disadvantaged.”

The announcement by Mairi Johnson, Deputy Director-Design at the Education Funding Agency, together with the news that Section E4 of the Building Regulations is to be retained by the Department for Communities and Local Government, marks an important victory in the Institute’s Sound Schools campaign.

This was launched last year in the wake of the Government’s decision to review building controls in a bid to cut red tape. The Institute argued that this could lead to the removal of Section E4 which requires schools to be “suitable” acoustically.

In a letter to Ministers, Trevor Cox warned this could have “disastrous consequences” for future generations of pupils if it was not replaced by some statutory mechanism that carried as much weight.

The news that acoustics has escaped the deregulation “cull” coincided with an announcement by Education Secretary Michael Gove that 261 of the country’s most dilapidated schools will be rebuilt or completely refurbished under a Schools Priority Building Programme.

Acoustic commissioning testing will be mandatory as part of the contractual sign-off procedure for these schools. This will be enforced through the building contract, in the same way it is through BSF and the Academies framework, rather than through Building Control. The ANC Good Practice Guide for Acoustic Testing of Schools will be required to be followed as part of this process, which will now hopefully achieve standardised approaches for testing schools.

There is no clear route though for pre-completion testing for Free Schools or others procured through individual schools’ or education authorities’ capital expenditure routes, however. Although BB93 currently recommends it, this is not required unless stated in the contract or to achieve a BREEAM credit, which is optional.

For these schools, Ofsted, which will have the responsibility of enforcing the new regulations, will need to decide as to how it will deem if the acoustic conditions are suitable or not.

Peter Rogers of Cole Jarman, who led the Institute campaign, said: “The promise of the retention of acoustics with Document E and the School Premises Regulation is an encouraging sign that schools have the chance to give children the opportunity of good learning environments.

Good acoustics are vital in the classroom

“We’re now waiting to see what these changes will bring on the ground. The fact that the new regulations are to be enforced for all schools by Ofsted and local authorities is controversial as the question remains as to how they will know when the acoustics are not right. I can be certain that there will be a clear on-going role for acousticians, which should be a relief for parents.

“We will be watching this area with close interest as good governance forms an important part of the mission of the IOA, and crucial for making the future schools support learning for the next generation.”

Work continues in technical support of the National Deaf Children’s Society in Wales, as the Welsh Assembly considers whether their version of Building Regulations should go further and make testing mandatory for all schools.

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Norsonic

Acoustics 2012 – 'an outstanding success technically and socially'

Delegates flock to conference from around the world

Report by Keith Attenborough and David Sharp

Acousticians from across the world met in the city of Nantes in France in late April for Acoustics 2012, a pioneering joint conference organised by the Société Française d'Acoustique (SFA) and the Institute of Acoustics.

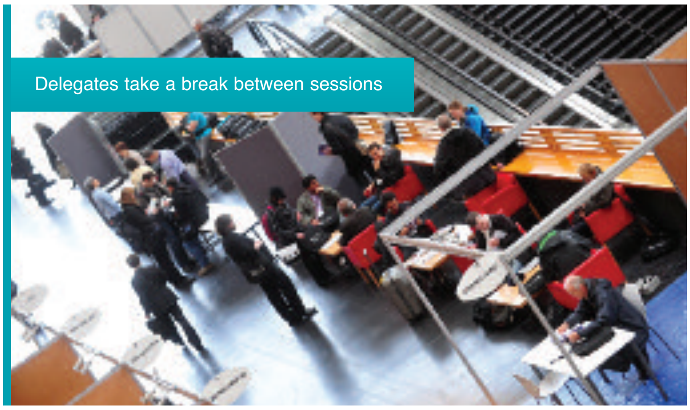
The conference organising committee was co-chaired by Michel Berengier (SFA) and Keith Attenborough (IOA), with the organisation of the technical sessions co-chaired by Judicael Picaut (SFA) and David Sharp (IOA). The event proved to be an outstanding success both technically and socially. The 847 abstracts submitted were distributed between general topics as follows.

Distribution of submitted abstracts between general topics

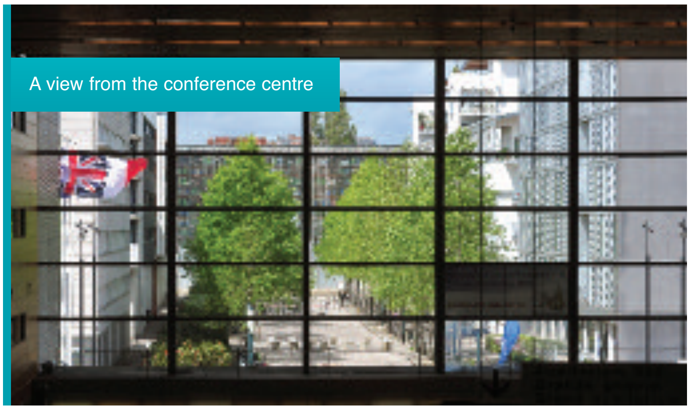
General Topic	Number of abstracts
Physical Acoustics and Underwater Acoustics	260
Musical Acoustics	95
Measurement and Instrumentation	90
Noise and Vibration Engineering	74
Environmental Noise	69
Aero and Hydro-acoustics	66
Architectural and Building Acoustics	57
Sound Perception	55
Electro-acoustics	32
Hearing and Speech	19
Other topics	16
Animal Bioacoustics	14
Total	**847**

After a stimulating warm up by the excellent University of Nantes Big Band, the opening ceremony on 23 April included brief welcoming remarks from Bertrand Dubus (President of the SFA), Keith Attenborough (on behalf of the President of the IOA), members of the organising committee, and brief in memoriam contributions about the late Walter Lauriks (by Bert van Roozen) and Phil Doak (by Stuart Bolton). Stuart, an ex-research student of Phil Doak, gave a longer review of Phil Doak's life and work at the start of the aero-acoustics session later in the week. The opening ceremony continued with two fascinating plenary talks. Professor Kirill Horoshenkov (Bradford University) talked about "Acoustical monitoring of water infrastructure", reporting results from EPSRC and industry-funded projects concerned with non-invasive inspection of pipes and channels. Professor Noureddine Attalla from the University of Sherbrooke in Canada, joint author with Jean-Francois Allard of the 2011 book on *Sound propagation in porous materials*, gave a talk on practical modelling of the vibro-acoustics of structures with attached noise control materials.

On each of the following four days, there were two concurrent keynote talks starting at 8am. This posed unfortunate problems for delegates who either wanted to attend both or to sleep in! On 24 April Professor Yui Wei Lam (University of Salford) gave the IOA Rayleigh Medal Lecture on computational room acoustics, emphasising time domain modelling and a status report on his formulation (together with Jonathan Hargreaves) of a time P12


Delegates take a break between sessions


IOA Chief Executive Kevin Macan-Lind welcomes a visitor to the Institute stand


A view from the conference centre


The University of Nantes Big Band

◀ P10 domain BEM code. The simultaneous keynote on aero-acoustics was delivered by Professor Daniel Juvé (Ecole Centrale de Lyon). The speakers on 25 April were Dr Carl Hopkins (Liverpool University) who gave the IOA Tyndall Medal Lecture on the importance of using both theory and data in building acoustics, and Professor Daniel Pressnitzer (Ecole Normale Supérieure, Paris) who talked about the "adaptive auditory mind". On 26 April Dr Stuart Bolton (Purdue University) gave a fascinating and enjoyable talk about noise control materials which included a "slide-based concentration break" showing his favourite park in Japan. Simultaneously Dr Marc Deschamps (Université Bordeaux 1) talked about multi-scale characterisation of materials using ultrasonics. The keynotes of 27 April were delivered by Professor Robin Cleveland (University of Oxford) on shock waves in tissues and Professor Murray Campbell (University of Edinburgh) who provided a number of musical demonstrations during a historical overview of the acoustics of lip-excited musical instruments.

Among the social events, on Tuesday 24 April delegates were able to attend a short concert from a local choir (which included the conference co-chair Michel Berengier) which finished with audience participation in the famous chorus *Va Pensiero* from the opera *Nabucco* by Verdi. This was followed by a participatory instrumental jam session led by members of the University of Nantes Big Band. Wednesday evening saw around 400 of the conference delegates boarding two luxurious riverboats to enjoy an excellent meal and an unstinting supply of wine while cruising on the River Erdre. On Thursday evening there was a concert/presentation by composer and World Soundscapes Project contributor Professor Barry Truax (School of Communication & School for the Contemporary Arts at Simon Fraser University in Canada).

It is an impossible task to summarise all of the 90 or so technical sessions (including 15 poster sessions) but below are brief reports from a few session chairs, to whom the authors of this report are extremely grateful.

Acoustical holography

This session included eight presentations. The two main problems tackled were (a) the reconstruction of sound fields in a confined domain where the free field hypothesis is not applicable and (b) the reconstruction of time domain acoustic signals in the case of non-stationary sources. Typically the papers used theoretical methods to address these interesting but difficult experimental problems. One important idea is to combine localisation and separation methods to check and highlight the phenomenon contributing to the source. A single paper concerned another application of NAH to the reproduction of pressure fields using an array of real or virtual sources.

Advanced techniques for transducer characterisation

The eight paper session started with a tutorial on nonlinear losses in transducers. The remaining papers were concerned with nonlinear behaviour, novel measurement techniques and advanced modelling of loudspeaker enclosures.

Education in acoustics

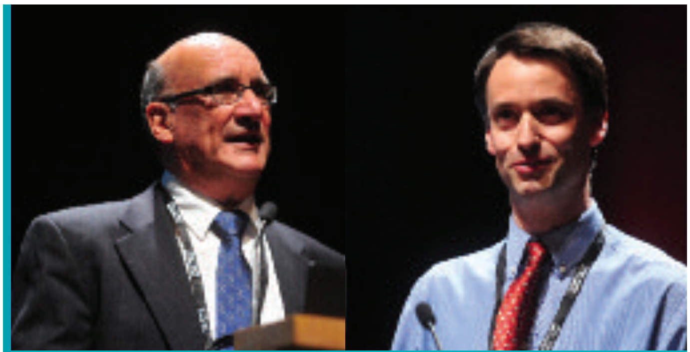
An excellent and unusual session included a live demonstration of a new innovative pedagogical methodology which involved 16 undergraduate students from Le Mans University, a talk on the use of the internet as an interactive education tool and submission of web-based reports as part of their assignments. The final paper was a presentation from London South Bank University on educating classical musicians and complemented the opening papers on how to encourage students to do a PhD.

Measurement techniques for studying musical instruments and speech

The instrument-related talks presented experimental devices for measuring reed properties of saxophones and bassoons, radiation from steel-pans, the vibrational modes of a Persian setar and the (internal) reflection of sound from the lips of a brass instrument player. The speech-related talks discussed the use of anemometry and flow visualisation to study turbulent structures in jets emerging from real and simulated vocal folds. The simulated folds used latex tubes.

Mid-frequency

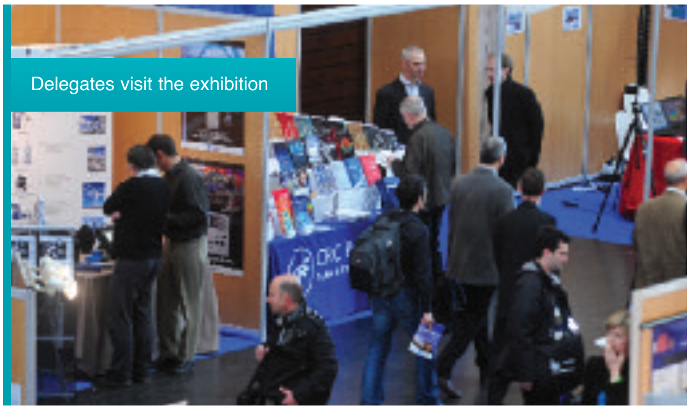
The four presented papers described different methods of addressing methods of vibration prediction and control in the ▶



Keith Attenborough David Sharp

A session in action

Stuart Bolton



Delegates visit the exhibition

middle frequency range. The methods included uses of entropy in statistical energy analysis, complex rays, wave decomposition and a hybrid FE-SEA. One paper was not presented.

Musical acoustics – general session

This general session reflected the diversity and quality of the many contributions submitted in the various fields of musical acoustics at the conference. The contributions at this session covered work on measuring radiation characteristics and directivity of musical instruments, investigating the vocal levels of classical singers for different laryngeal mechanisms, producing music for people with cochlear implants and public engagement through acoustical artwork.

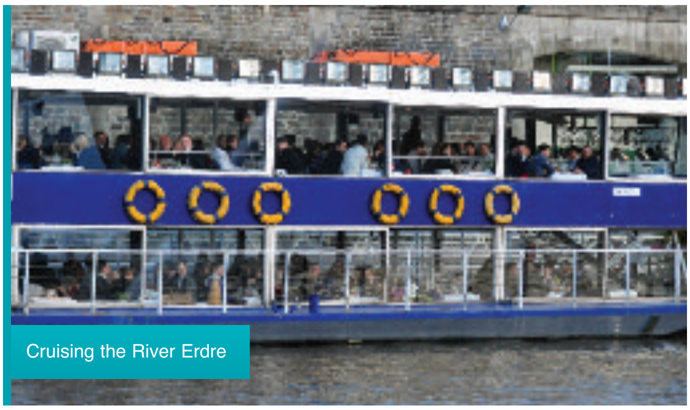
Outdoor sound propagation

Four of the 11 presentations in this session (there was one "no-show") concerned time domain methods which are increasingly popular since their computational demands are no longer completely prohibitive. One of these papers concerned the results of a French-government-funded project on greening cities for noise control (incidentally, this project duplicates aspects of a parallel EC FP7 project HOSANNA – see **www.greener-cities.eu**). An interesting aspect of the presentation was the attempt to take advantage of the processing capabilities of the graphics card unit in a PC by using an open source programming language "Python". The session included two presentations from the Open University, UK concerning the acoustical influence of roughness on hard ground (based on research for the HOSANNA project) and the remote monitoring of soil properties using acoustic-to-seismic coupling respectively.

Phononic crystals and metamaterials

Acoustics 2012 provided an excellent opportunity for a large number of researchers investigating phononic crystals and metamaterials to meet. The sessions on 26 and 27 April included some excellent contributions covering a variety of areas ranging from the effects of evanescent waves in phononic crystals with linear defects to acousto-optic interactions in 2D $LiNbO_3$ phoxonic crystals. There was an associated poster session offering high quality submissions on topics including Matryoshka locally P14


Michel Berengier


Cruising the River Erdre

◀P13 resonant sonic crystals, design of wideband attenuation devices based on sonic crystal and experimental study of a water wave "carpet" cloak i.e. a curved surface imitating the reflection of a flat surface.

Railway noise

The interesting session on railway noise held on 27 April made it clear that rolling noise is still an important focus of research. One of the contributions drew attention to the complexities of modelling impact noise from wheel-flats. Another covered different aspects of the "Stardamp" project which aims to devise standard methods for assessing wheel and rail damping solutions. Two PhD students at SNCF described experimental methods for rolling noise analysis. A final contribution presented "BRAINS", a prediction tool for interior and exterior train noise at an early design stage.

Transients in self-sustained musical instruments

This comprised a collection of five different techniques for studying phenomena not hitherto studied in pipe organs and reed instruments.

Ultrasonic imaging

This comprised a session of 14 up-to-date presentations covering medical imaging, elastography, harmonic imaging, Doppler imaging, underwater acoustics and micro-bubbles.

Violin-like instruments: from acoustics to perception

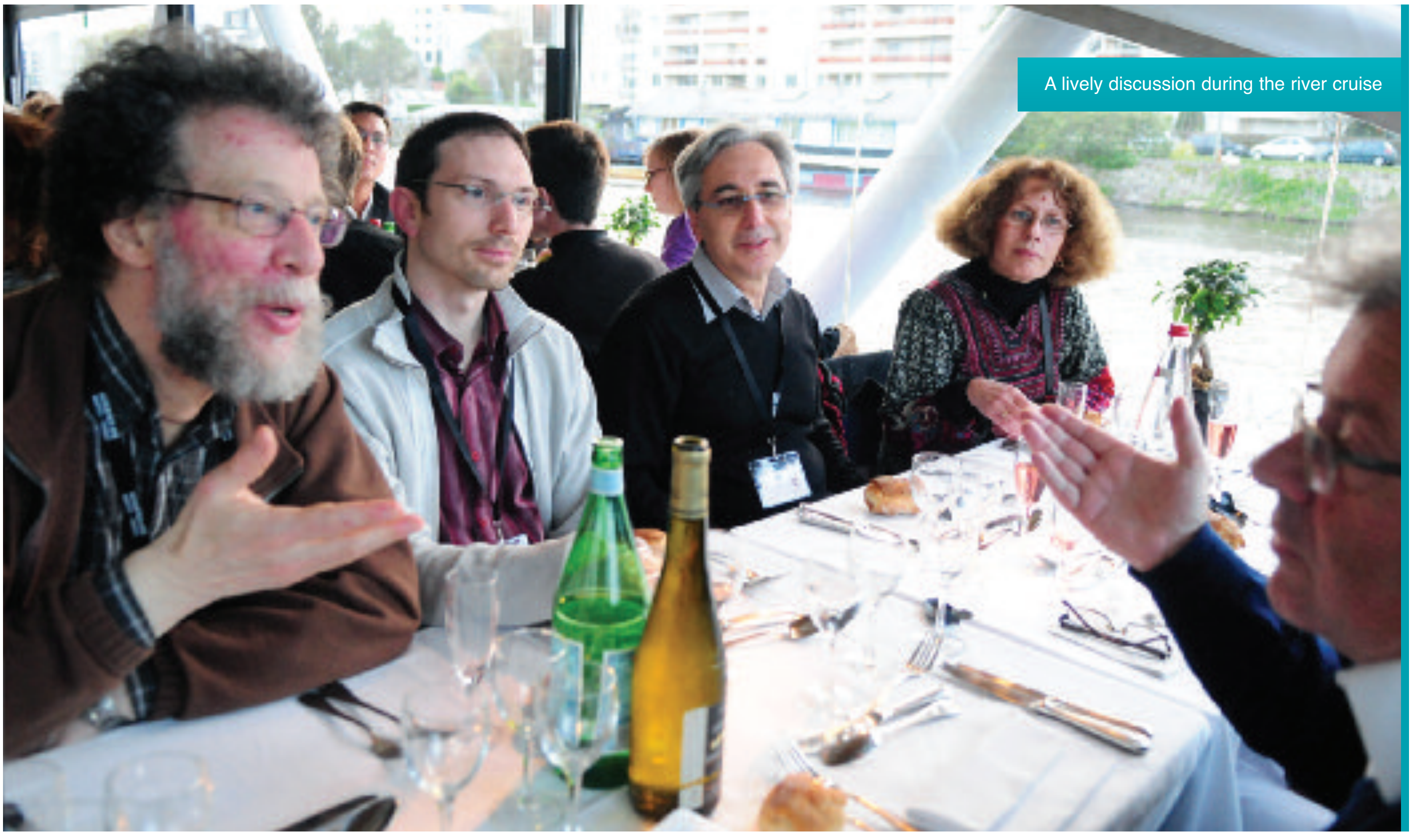
All of the talks concerned violins, except for one which was about Judean sarangis. This interesting and wide-ranging session detailed vibro-acoustical measurements, electric violins, finite element modelling, player performance, auditory and tactile perception.

Wall pressure fluctuations

Of the eight presentations in this session, the first two concerned measurement of wall pressure fluctuations without any microphones. One used tomographic particle image velocimetry which enabled full 3D reconstruction of the pressure field and the other used plate vibration measurement – essentially an inverse method linked to work on the synthesis of turbulent boundary layer wall pressure fluctuations by combining several loudspeakers.

Big draw: the exhibition

Although this was a joint venture by IOA and SFA – the IOA contributions being reflected in four of the conference room names (Raleigh, Doak, Barnett and Tyndall) and four of the nominated plenary speakers – most of the burden for organising this joint venture was carried by the SFA in general and Dr Michel Berengier and his IFFSTAR colleagues in particular. The success of the conference is in no small measure the result of their sustained diligence, hard work and enthusiasm.



A lively discussion during the river cruise

Professor Yui Wei Lam receives IOA's top award

Professor Yui Wei Lam has been awarded this year's Rayleigh Medal, the IOA's premier honour, in recognition of his outstanding engineering research, teaching and research leadership. He received the honour from Dr Bill Davies, Institute Vice-President (International), at Acoustics 2012 in Nantes.

An influential figure in acoustics for 25 years, he has worked across a number of different areas, and in each of them has contributed outstanding research work. The significance of his research on room acoustics modelling, sound transmission and outdoor sound propagation is widely recognised and has been embodied in many national and international acoustics standards. He recently become Editor in Chief of *Applied Acoustics*.

Professor Lam is a top class engineer who particularly excels at developing new numerical techniques. The quality and breadth of his work is evidenced by the range of externally-funded projects he has worked on.

Dr Lam began his career in acoustics by implementing a new boundary element model for machinery noise for his PhD at Birmingham University. He then worked in vehicle noise and vibration at MIRA. In 1988, Dr Lam joined the University of Salford, where he has worked to apply his research skills to real-world acoustic problems ever since.

In the 1990s, his work helped push diffuse reflection modelling to the forefront of geometrical room acoustic predictions, and set values for scattering coefficients that are still used. At about the same time, he investigated unexplained dips in the sound reduction index of metal cladding walls, developing a numerical model which is still widely used by manufacturers in their design work.

For the past 10 years, Professor Lam has worked with the defence industry to develop numerical models for the prediction of long range sound propagation. The work pioneered several innovative features, such as efficient grid-based ray models and semi-analytical models for scattering of rays in shadows. This model helps support both training and operation planning for the military.

For 11 years, Professor Lam was head of the Acoustics Research Centre at the University of Salford. Under his leadership the centre has grown rapidly: doubling the number of research active academics and taking the centre from a medium ranking to achieving a top rating for Research Power in 2008. In 2010, the BBC rated Salford as top overall for broadcast audio research in UK universities. Professor Lam successfully led the establishment of Salford as a lead partner in the BBC Audio Research Partnership.

Professor Yui Wei Lam delivers the Rayleigh Medal Lecture at Acoustics 2012

Carl Hopkins awarded 2012 Tyndall Medal

Dr Carl Hopkins, a Reader in Acoustics and Head of the Acoustics Research Unit at the University of Liverpool, is the 2012 winner of the IOA's Tyndall Medal, which is awarded biennially to a UK acoustician, preferably under the age of 40, for achievement and services in the field of acoustics. He was presented with the award by Professor Yui Wei Lam, head of Acoustics Research at the University of Salford, at Acoustics 2012, Nantes.

Carl's major contribution to the advancement of knowledge and understanding in acoustics is his monograph on sound insulation in buildings published by Butterworth-Heinemann in 2007. *Sound insulation* draws on his experience carrying out government-funded research on sound transmission at the Building Research Establishment over 12 years. Its 622 pages contain a detailed review of sound and vibration theory alongside the signal processing that is relevant to the prediction and measurement of sound insulation. Discussions of the fundamental assumptions in the theory are accompanied by experimental data to illustrate how theory translates into practice. The underlying theme of the book is that the inherent uncertainty in describing buildings at the design stage can be turned to the advantage of the acoustic engineer. It rigorously considers the limitations of both prediction models and measurement methods to demonstrate that often the most useful information lies neither in the model nor the measurement, but in a combination of the two. The aim is to show the reader that with in-depth knowledge of the respective strengths and weaknesses of prediction models and measurements it becomes much easier to make design decisions based on predictions, and to find solutions to the majority of sound insulation problems. An indication of the book's impact is that it has been praised in all its reviews in academic acoustics journals and is referenced in four International Standards on sound insulation. In addition to his monograph, Carl has also published 59 papers in peer-reviewed journals and conference proceedings.

Carl has an active role in academic publishing as a member of the editorial board of the *Applied Acoustics* and before that on the editorial board of *Building Acoustics*. He is also a peer reviewer of manuscripts for five international journals concerning research on sound and structure-borne sound transmission.

While at the Building Research Establishment, Carl was involved in making the most significant changes and extensions to the Building Regulations for England and Wales on acoustics in the last few decades. Their scope was extended to include pre-completion testing for sound insulation and to cover rooms for residential purposes and schools, as well as introducing new objective requirements for sound insulation, absorption in common internal areas and speech intelligibility in open-plan classrooms. As technical advisor on acoustics to the Office of the Deputy Prime Minister and Department for Education and Skills, he was involved in editing and writing the *Building Regulations - Approved Document E - Resistance to the passage of sound*, and *Building Bulletin 93 on the Acoustic Design of Schools*. These two documents dramatically increased the profile and importance of building acoustics in the UK, and led to significant P16

Dr Carl Hopkins delivers the Tyndall Medal Lecture at Acoustics 2012

◂P15 expansion and growth in the UK acoustic consultancy sector, as well as for UK manufacturers and suppliers of acoustic equipment and acoustic building products.

In standardisation, Carl has been actively involved in the creation and revision of international and European standards in building acoustics. Recognition of his role and standing in Standardisation is evident in his unanimous election to be Chairman of the British Standards Committee on Building Acoustics. Carl has also been elected as Convenor of one European and two international working groups to create and revise new ISO and CEN Standards on field sound insulation testing and the laboratory measurement of flanking transmission. The standards for these new working groups draw upon his more recent research on the measurement of low-frequency sound insulation, the efficacy of manual scanning with sound level meters, and the limitations of experimental statistical energy analysis in determining structure-borne sound transmission between building elements *in-situ* and in the laboratory.

Carl combines intellectual rigour in his research with the ability to apply the findings to the practical world and to communicate his findings to the expert and lay person alike, both in print and the spoken word. Carl's contribution to the field of acoustics thus ably maintains the traditions and standards set by John Tyndall. This makes him a deserving recipient of the Tyndall Medal.

Human response to vibration in residential environments

Midlands Branch meeting

Report by David Waddington

The evening began with a series of important announcements from our Chairman Paul Shields. Fortunately this allowed a little more time for location of additional seats for the capacity audience assembled at the first-rate venue kindly provided by URS Scott Wilson in Nottingham.

Dr David Waddington, of the University of Salford, chaired the technical contribution on the Defra NANR209 Project "Human Response to Vibration in Residential Environments" in the form of a conference session. Three vibrant and stimulating speakers, Eulalia Peris, Gennaro Sica and James Woodcock, presented excellent 20 minute lectures on scientific aspects of the work following David's introduction. His introduction consisted of a review of the seven-year history of the project, an insight into the role of the project steering group, the technical and policy considerations made during the progress of the project, and the contributions of the three contractors who delivered the scoping stage, the pilot stage and the main study.

David described how the research was funded by Defra with the aim of investigating the relationship between human response in residential areas, primarily in terms of annoyance, and combined effects from exposure to vibration and noise. The Defra project steering group consisted of Richard Perkins and Colin Grimwood on behalf of Defra, Colin Stanworth representing the interests of the British Standards Institute working group for BS6472, and Rupert Thornely-Taylor, representing the interests of the Association of Noise Consultants (ANC). In total, 1,431 case studies were conducted encompassing railway, construction, and internal vibration sources.

Eulalia Peris presented the first of the three technical lectures which focused on the equipment and methodology employed to measure vibration from different sources, and described the practical experience of implementing a vibration measurement protocol. The second of the technical lectures was presented by Gennaro Sica, whose main objective was to describe the different approaches used for calculating the different source-specific exposure.

The final lecture was presented by James Woodcock, who presented the results of analyses that were conducted to determine the most appropriate descriptor for vibration exposure in residential environments for the dataset generated by this project. Following this, the highlight of the evening for many, exposure-response relationships were presented for different vibration sources. A healthy debate involving many senior former British Rail acousticians rounded off the meeting before withdrawal for the traditional Midlands Branch curry.

Summing up, the work presented long awaited, high quality data from case studies comprised of face-to-face interviews and internal vibration and noise exposures determined by measurement and calculation. Important comparisons with published guidance were presented, in particular BS 6472-1:2008, the ANC guidelines, and BS 5228-2:2009, and the researchers from the University of Salford have contributed key findings from the research to the new ANC ground-borne noise and vibration handbook.

The Salford team: (l-r) David Waddington, Gennaro Sica, James Woodcock and Eulalia Peris

Aspects of Research at the Institute of Hearing Research

Midlands Branch meetings

Reports by Kevin Howell

A visit to the Institute of Hearing Research in Nottingham in March included two excellent presentations and a demonstration in one of the test facilities.

Chris Sumner opened proceedings with a presentation on "Linking the perception of sound and neural responses". He first explained that there are a number of different research groups at IHR. He is an electro-physiologist and his group work at the basic end of things, trying to answer the question: how do our neuron responses relate to our subjective perception of sound? Our ears carry out short term frequency analysis but "we actually hear with our brains not with our ears". One reason why we need to understand this relationship is to improve how we help people deal with hearing problems. Currently listeners with hearing aids or cochlear implants perform very poorly in complex listening environments. Chris described the auditory nervous system and then described some of the issues that they are working on. One such is the phenomenon of forward masking, in which a sound preceded by a louder one is more difficult to detect. This was initially believed to be an effect occurring in the cochlear but this has now been shown not to be the case. Another question is "How do we hear separate sounds in noisy environments?" popularly known as "the Cocktail Party effect" or, more technically, auditory string segregation. These issues and others are being investigated by comparing the results of listening tests on humans with studies of neuron activity in animals. Chris presented their recent findings. He concluded that the brain has a significant role in our perception of sounds and that it is a complex, high level phenomenon.

Ian Wiggins then presented a talk on "Spatial perception with hearing aids". He is looking at issues affecting people's ability to localise sound and the ability to understand speech when background noise is present, and how this ability is affected by impaired hearing and/or when wearing hearing aids. People with good hearing are able to localise sound well, in the horizontal plane by processing inter-aural delays and level differences, and in the vertical plain using the complex pattern of frequency peaks and troughs created by reflections from the individual's pinnae (outer ears). Hearing-impaired people perform very poorly at vertical localisation because of reduced audibility and frequency selectivity, but perform quite well at horizontal localisation. However, when wearing hearing aids they also perform poorly horizontally and even worse vertically. The reasons for these detriments are thought to relate to the location of the hearing aid microphones; the fact that the ear moulds disrupt pinna reflections; the combination of amplified and unamplified sound (via the hearing aid vent) may disrupt timing cues; and signal processing differences between the hearing aids may disrupt interaural cues. A current study is looking into the possible benefits of linking the compression characteristics of the two hearing aids. Early findings from a study (on people with normal hearing) suggest that the significant reduction in speech intelligibility observed when wearing hearing aids may be almost completely offset if the hearing aids' compressions are synchronised.

The meeting concluded with an excellent demonstration in the Simulated Open Field Environment anechoic chamber. Thank you to Chris and Ian for an excellent evening.

Improving Planning Decisions through the Effective Management of Uncertainty

April saw the Midlands Branch return to Atkins offices in Birmingham for this joint presentation by Colin Cobbing (ARM Environment) and Bob Peters (Applied Acoustic Design). Unfortunately, Bob was required for jury service and we are most grateful to Colin who presented Bob's part of the talk as well as his own.

Colin opened by calling for all of us in the acoustics profession, and elsewhere, to be more forthcoming about what we don't know and more prepared to explain the uncertainties in the assessment methods and procedures that we utilise. In general, we need to improve significantly our management of uncertainty, so that better decisions can be made leading to better outcomes. Colin discussed the multitude of areas in which uncertainties exist within any assessment methodology and ways in which they can be quantified where possible or at least clearly stated when not possible. This was an excellent presentation and I'm sure will have struck a chord with those present and provided much food for thought. The presentation was similar to that previously presented to the London Branch and reported in the Jan/Feb 2012 *Acoustics Bulletin*. Many thanks go to Colin and Bob, and to Atkins.

Student projects: music, speech and hearing

London Branch meeting

Report by Stephen Dance

Dr Stephen Dance (The Acoustics Group, London South Bank University) introduced three of his MSc students to present projects on music, speech and hearing. Each project was also put forward for the 2012 RBA Acoustics prize.

Tamara Potaz, who stood in at the last minute for Alba Losada, examined the effectiveness of environmental noise policy in Buenos Aires, the fourth noisiest city in the world. Starting with an on-line noise awareness survey and a paper questionnaire, Tamara gauged the feeling of the residents. Road noise was found to be the most annoying, followed by construction and road works. By comparing the noise levels measured at different locations in the city with those predicted in its 2005 noise map, she concluded that in most of the areas tested, the road-traffic noise levels had remained the same or worsened since the enforcement of the city's current acoustic pollution law in 2007. This was due to a number of reasons, including the fact that only 15 of the 41 noise monitoring stations in the city were found to be operational and the local government had delayed affirming the final decree on noise legislation for private vehicles. There were also significant delays in proposed improvements to public transport – the electric hybrid bus (Ecobus) and Metro extension. Measured road noise levels were found to be above 73 dBA along main avenues, as older buses were allowed to stay in service due to the economic conditions and pre-2000 cars were road tax exempt.

The second project was presented by Lorenzo Morales. His dissertation was an experimental study on the validation of the Speech Transmission Index (STI) in real spaces compared with the traditional test methods. For his investigation 88 native English speakers from the Royal Academy of Music with proven hearing acuity participated in the test. The test consisted of a standardised phonetically balanced word list, recorded anechoically and played through a high quality sound system in the reverberation chamber. Each student individually had to write the words heard from the recording, under a number of reverberant P18

◂P17 conditions. This approach to assessing speech intelligibility was then compared to that used on the current STI validations.

The final presentation was given by Matthew Brown. His project involved building an affordable head and torso simulator and testing the performance characteristics against the B&K 4100 HATS, as well as for audio recordings. This was a very practical endeavour, as he ended up building three heads which nearly met IEC 60318-7, or ANSI S3.36 or ITU-T P58. Objective and subjective comparisons were undertaken. Matt proudly showed that 92% of the IACC measurements were within the just noticeable difference of those measured with the B&K HATS. The Polyfilla-covered polystyrene head and silicon ears were then passed round the audience.

The branch would like to extend its thanks to Tamara, Lorenzo and Matthew for a very interesting and entertaining presentation. The committee would also like to extend their thanks to WSP for providing the venue.

Do you remember the opening of the Royal Festival Hall?

Report by Alex Burd

Earlier editions of the *Bulletin* have featured appeals for members to rack their brains and search their files for anecdotes, photographs, documents etc relating to the history of the IOA but, so far, nothing has been forthcoming. Much of the history is enshrined in Council minutes, committee minutes and records of meetings and these are being trawled through to extract facts. However we want to include memories as well as facts and although we (the working group) clearly have some memories, more of them reside in your “little grey cells”.

I am kicking off this part of the project with an appeal for your recollections of the pre-IOA history. Many bodies came together in 1974 to form the IOA but those I was most intimately concerned with are the Acoustics Group of the Physical Society, the Society of Acoustic Technology and the British Acoustical Society.

I make no apology for prefacing this article with the picture immediately below. My personal involvement with acoustics has been related to buildings and the Royal Festival Hall was part of my inspiration to join that world. I first heard a concert there in 1951 during the Festival of Britain; to be completely honest, I heard part of a concert as the four of us who had travelled down from Liverpool University had slept (badly) in our hire car the night before and the seats in the RFH were very comfortable

The Acoustics Group was formed in 1947 under the aegis of the Physical Society; Bill Allen (of BRS, and one of the designers of the RFH) and Alan Pickles (of the Admiralty Research Lab) saw the need for such a group, sought and received the approval of the society and organised the new group along the same lines as the Colour Group. The principle function of such specialist groups within a learned society was to organise lectures and subsequently, as confidence grew, symposia and conferences. As I study the names of those involved in the committees or who gave lectures, I am aware that the number of us who remember the early days of the Acoustic Group or the opening of the RFH (and who are still members of the IOA) is reducing as the years pass by. Join me with your memories if you are reading this!

The Society of Acoustic Technology was formed in 1963 by a group of people, many of them without professional qualifications but involved in the manufacture of acoustic products or the study and control of sound or vibration, who pressed for a body they could join to learn about the subject of acoustics in practical terms. It was based in Salford, where the Royal College of Advanced Technology had a thriving acoustic section, and it was a reaction against the London emphasis of the Acoustics Group. Only limited information regarding the organisation and activities of the Society has been recovered so far and recollections relating to this time will be welcome.

The formation of the SAT had not been a big enough step forward and in 1964 Sir Gordon Sutherland, the Director of the NPL, convened a meeting of representatives of a much wider range of interests which supported the formation of the British Acoustical Society. It was agreed that the proposed Society should be “to promote and disseminate knowledge of acoustics, which should be deemed to include all aspects of the science and technology of sound, hearing and vibration”. It was agreed that the promotion of acoustics would not entail the performance of a licensing function, at least initially.

More of you would have been actively involved in the British Acoustical Society and we look forward to a flood of memories, photographs and other memorabilia. Memories and offers of more concrete assistance should be sent to me (**alexburd@talktalk.net**) or to the *Bulletin* Editor, Charles Ellis (**charles.ellis@ioa.org.uk**). Thank you for your help.


The Royal Festival Hall shortly after its opening


The Royal Festival Hall as it is today

Accelerometers, geophones and seismometers – which to choose?

Report by John Shelton, AcSoft Ltd, Svantek UK Ltd

Recent years have seen a large increase in measurements of vibration, for a variety of applications, such that the diary of the busy acoustic consultant is just as full of vibration surveys, as noise measurements. Be it for health and safety applications, such as hand-arm and whole-body vibration, annoyance, such as ground vibration, or damage, such as building or blasting vibration, the methodology still seems more an art than a science.

All acousticians should have a firm grip on the performance of their sound level meters, and know how to use and calibrate them. Sadly, this does not always appear to be the case with vibration instrumentation.

Several instrumentation standards exist, the key one being BS EN ISO8041:2005, along with procedural standards such as BS 6472:2008, but sometimes it can appear very confusing. Can I calculate PPV from a spectrum? Can I measure VDV with a geophone? Should PPV measurements use W_d weighting?

This brief article goes back to basics, and addresses some of the more common questions we get asked, if only for a quiet life!

Transducers

Vibration transducers can be split basically into two types – accelerometers and geophones (or seismometers). Accelerometers have an output proportional to, er, acceleration, and geophones have an output proportional to velocity. So how can both be used to measure vibration?

There's a basic relationship between acceleration and velocity – the former being the rate of change, or the differential, of velocity. Therefore we can easily convert between the two by *integrating* an acceleration signal to yield a velocity signal. This is normally done in the time domain, using a filter (called an integrator), but it can also be done in the frequency domain by dividing an acceleration spectrum by 2πf, where f is the frequency. This effectively slopes the spectrum by -6dB/octave, so a velocity spectrum will appear to have a lot fewer high frequency components!

A typical triaxial geophone

Accelerometers

The majority of accelerometers for our applications are piezoelectric devices. A small piezoceramic crystal is sandwiched between the base and a seismic mass, so when the base is accelerated, the crystal is stressed, causing a proportional charge output. Because it is a simple mass/spring system, it will have a fundamental resonance – the crystal is very stiff, so this will be high, some kilohertz for most devices. Below that resonance, the response is virtually flat and linear, making an excellent transducer.

To make a sensitive accelerometer, make the mass and/or crystal bigger – but, this brings the resonance down, so there's a trade-off to be made. Thankfully, most requirements for sensitive accelerometers are at low frequencies!

The output of the crystal is a charge, which requires a specialised charge amplifier, with extremely high input impedance, in order to drive our measuring system. These used to be separate boxes, with specialised low-noise cabling, but nowadays, the charge amplifier is built into the accelerometer itself, and this uses a 'phantom' powering system known as IEPE (integrated electronic piezo-electric), also known by a variety of proprietary names such as ICP®, CCP etc. At least IEPE is standardised! This means that long cables can be driven, and as long as your instrument can provide the powering, you should be in business. But always check that you have an IEPE accelerometer rather than a charge accelerometer first!

Due to being a capacitor, such accelerometers do not have a DC response, and will roll-off at low frequencies. Make sure you select one suitable for your task, if you want to measure down to 0.5Hz for example.

P20 ▶

A typical triaxial accelerometer

A portable low frequency field vibration calibrator

P19 Accelerometers are rugged and will measure in any axis, but being a mass stuck to a piece of glass, the crystal can crack, not always obviously. This is particularly true for the sensitive ones with big seismic masses, so don't drop them on a concrete floor!

Geophones
A typical geophone is a moving coil device. Think of a loudspeaker backwards. A magnet is suspended in a coil (sometimes vice-versa), attached to the base of the transducer. As the base is moved, a current is induced in the coil, which can then be used as an output proportional to velocity.

Like an accelerometer, the geophone is a resonant device, but this time, the resonance is low frequency due to the mass (magnet) being suspended. Typically, this is around 3-4Hz, and the usable linear range is above this. This potentially gives an issue with measuring low frequency vibration – we are often interested in measuring vibration at just the frequencies that a geophone has a resonance. However, the design of geophones is a mature art, and careful damping and linearization will provide excellent performance.

Geophones are normally designed to operate in one axis, either vertical or horizontal, so they must be oriented to their design axis. If you have a triaxial unit, it will have one vertical, and two horizontal coils. Stick it to a wall instead of a floor, and you'll probably lose any signal, so they should always be mounted in the same orientation – on a bracket for example.

Conditioning an active geophone is very specific, but recent devices also support the IEPE system, already dominant in accelerometers.

A big plus of geophones is their lower price, and they are very rugged – hence their popularity in the mining engineer's toolkit – no fiddly microdot connectors!

Choose your weapons

The choice of transducer would seems to depend on what you want to measure – an accelerometer for measuring acceleration (VDV, MTVV, etc) and a geophone for measuring velocity (PPV). This complicates the instrumentation, so it would be nice to use one for the other.

We can get velocity by integrating the accelerometer output, so this would appear to be the ideal solution. Well, it works well, but the integrating can cause some side-effects. If you consider that the integration process emphasises low frequencies (think of the -6dB/octave slope in the spectrum), any noise present at low frequencies in the amplifier chain, or extraneous environmental effects can cause spurious results. Some accelerometers, due to their physical design, can be sensitive to temperature transients. This shows up as a very low frequency signal, which, when integrated, generates a large velocity output. Try blowing on your accelerometer and see what happens! This also applies to poor or badly maintained cables.

Careful design of high pass filters can mitigate these effects, but these can introduce phase errors, which might be important when trying to measure the peak amplitude of the velocity signal (PPV). It's interesting but beyond the scope of this article to compare the raw output of an integrated accelerometer and a geophone for the same signal and measure its peak!

Of course, integrating the acceleration signal in the frequency domain is a lot easier, but generally will not yield a PPV value, almost all spectra being RMS values.

A geophone is excellent for its design purpose. We could calculate acceleration by differentiating the signal, but often they have a limited dynamic range, compared to accelerometers, so this can result in noise being amplified. Also, as their resonance is often bang in the middle of the frequency range of interest, the phase performance becomes very significant, and needs careful design.

So which is best? Without resorting to Harry Hill to find out, it's probably best to start with an accelerometer, and integrate to velocity when you need to. This will cover the majority of applications with one transducer. But if your application is for PPV only, then the geophone may make a better choice. But either way, make sure you know the performance characteristics and limitations.

Future technologies

New technologies such as MEMS (MicroElectroMechanical systems) are now looking promising for use in both sound & vibration transducers. Recent developments at NPL have shown that a microphone meeting Class 1 is attainable, and the same can be said for accelerometers. MEMS accelerometers have been used for years in airbag sensors, and you've probably got one in your smartphone, so it knows when to change the display if you tilt it from vertical to horizontal.

The use of MEMS for measurement accelerometers is on the way and they have an advantage in their low price and stability/ruggedness. Already MEMS devices are being used for hand-arm and whole-body vibration, and very linear high sensitivity devices for ground vibration are on the near horizon.

A nice feature of MEMS accelerometers is their DC response – it makes calibration easy – by turning them upside-down the change should be 2g! Their low noise floor and lack of low-frequency resonance also makes integration easier

Calibration

No acoustician worth their salt will leave the house without a sound level calibrator. Its use is written into countless standards, and is your only contact with reality. Historically, this is due to microphones having often large dependencies on environmental effects, so field calibration was a must.

These days, microphones are very stable, and if you see a difference in sensitivity over a few measurements, then something is wrong somewhere.

Somewhat bizarrely, the same calibration habit doesn't seem to have caught on with vibration measurements. Perhaps this is due to the complexity and cost of vibration calibrators, or simply a belief that a transducer that looks like a hex nut couldn't possibly get damaged!

BS EN ISO 8041:2005 is the instrumentation standard which is cross-referenced in nearly every standard for human vibration measurement. It defines the performance of instrumentation (much like BS EN 61672 for sound level meters), and significantly almost forgets to mention geophones, concentrating on accelerometers as transducers (the Germans are ahead of us here – they have bolted that down in DIN 45669 for example).

The standard has a lot to say about calibration, for type approval, periodic calibration and field calibration, but very few practitioners seem to be aware. This is probably down to the limited availability of a practical calibrator which allows checks on performance at the frequencies of interest (often below 80Hz).

Most field calibrators operate at 159.15Hz – an odd frequency until you consider it is 1000 radians/second, which makes converting from acceleration to velocity and displacement easy, e.g. $10ms^{-2}$ acceleration is $10mms^{-1}$ at that frequency. These are handy devices (but often three or four times the cost of a sound level calibrator) and can be used to check the complete measurement chain, albeit at a high frequency – you just have to assume your filters and low frequency response is OK.

Another limitation is that ground vibration transducers are often large (high sensitivity), so such calibrators cannot be used – there is not enough power available.

The ISO standard recommends calibration at 15.91Hz and 79.6Hz for low frequency vibration instruments, *in the field*, as well as periodic calibration, for example. This allows the whole-body weighting filters and RMS/RMQ detectors to be checked too. This requires a much bigger vibration exciter, and such devices are now coming to market to address this need for field calibration.

Geophones give a particular problem. Vertical geophones can be field calibrated in the same way as accelerometers, but horizontal geophones cannot be mounted on a vertical calibrator, so the only solution is to send them to a laboratory equipped with a horizontal slip table – time consuming and expensive.

A new working group has been set up to address the issues of vibration transducers, but the standardisation wheels grind exceeding slow.

Conclusion

Hopefully this article will have given some insight into some of the issues practitioners should consider before equipping themselves with vibration instrumentation and heading out into the unknown. There are many more issues not covered here, but browsing the standards appropriate to the measurement will provide a wealth of information. Hopefully future articles in Instrumentation Corner will enlighten further!

***John Shelton** is a member of the IOA Measurement & Instrumentation Committee, and AcSoft Ltd is a sponsor member of the Institute.*

RBA acoustics prize goes to Argentina

Tamara Potaz, a student at London South Bank University, has been awarded the 2012 RBA acoustics prize for the best dissertation in the MSc in Environmental and Architectural Acoustics course.

The prize, which is awarded for, "Excellence in the Study of Acoustics and its Application to Real world Problems", was presented to Tamara at the Faculty of Engineering, Science and Built Environment prize giving ceremony in April.

Her study was entitled "Something (Not) to Shout About: An evaluation of the implementation of the City of Buenos Aires' acoustic pollution legislation and the measures applied to mitigate it".

Russell Richardson, of RBA Acoustics, presented the prize to Tamara and commented that, given an extremely high standard of work this year, any one of the shortlisted dissertations would have been a worthy winner. However, Tamara's detailed study provided that extra something which landed her the prize.

Bridget Shield, IOA President and Professor of Acoustics at London South Bank University, Tamara Potaz and Russell Richardson of RBA Acoustics

Unfortunately, and somewhat dramatically, the prize giving was cut a little short thanks to the appearance of smoke and the ringing of alarm bells, swiftly followed by the arrival of several fire crews and the evacuation of the building. Thankfully all the assembled staff and visitors left unscathed and celebrations carried on at an alternative local venue.

EU airport noise plans come under fire

European Commission plans to ease noise restriction measures around airports has been met with scepticism by the MEP in charge of the dossier in the European Parliament, who believes the EU executive is placing economic considerations above citizens' concerns.

The European Commission wants to end the "many inconsistencies" as to how noise restriction measures are put in place across the EU, saying they may hinder the development of extra capacity in the bloc's already crowded airports.

"Decisions on cutting noise levels have to balance protection for citizens living close to airports against the needs of those who wish to travel," the EU Executive said last year when it presented its *Better Airports* legislation package.

The proposals included a new EU regulation that seeks to bring more transparency in decisions over noise restriction measures, in line with guidelines developed by the International Civil Aviation Organisation (ICAO).

"Residents are entitled to be protected from excess noise from airports but it is necessary to take into account costs in terms of lost capacity and the impact on economic growth in a region," the Commission argued.

Together with more flexible airport slots and ground-handling rules, the EU executive hopes to unleash the development of Europe's airports, bringing €5 billion to the European economy and creating up to 62,000 jobs by 2025.

The European Parliament is now scrutinising the draft regulation in preparation for a vote in December. But the MEP in charge of the dossier appears sceptical about the Commission's motives.

"I think the motivation behind this regulation is to … have fewer restrictions than there are now. I think that is the real intention of the Commission," said Jörg Leichtfried, a socialist MEP from Austria who is in charge of steering the draft noise regulation through Parliament.

According to Leichtfried, the Commission has put economic considerations above all else when drafting the regulation, an

objective he does not adhere to. "Costs that are raised by noise restrictions – that shouldn't be the question," he said.

"I do not think personally that there are too many restrictions in place," he said

The EU executive, for its part, claims it wants to bring more transparency to the decision-making process and avoid noise restrictions measures that are "inconsistent" with other objectives , such as flight safety or the environment.

"This is not about targets, but about the decision-making process," the Commission says.

One key aspect of the new regulation is that it forces decision-makers to be independent from any stakeholder. "Airports would no longer be allowed to take decisions on operating restrictions," said Helen Kearns, spokesperson on transport issues at the European Commission.

In addition, "the consultation of citizens living around airports would become mandatory" she said, while local residents would have to be kept "regularly informed on progress of noise mitigating measures".

At the end of the day, national authorities will still be able to place restrictions on flights if they want. According to the EU executive, the new regulation, "gives the Commission a scrutiny role – it does not replace a member state's final decision".

Government commissions HS2 assessment

The Government has commissioned an Environmental Impact Assessment (EIA) before introducing the hybrid bill to authorise the London to West Midlands route of the HS2 high-speed line.

The EIA process is designed to understand in detail the effects of the scheme on the environment along the route and identify measures to mitigate these effects where possible.

It will involve a scoping stage, ongoing local engagement and the production of a report called an Environmental Statement, which will be deposited in Parliament with the hybrid bill.

The Environmental Statement will describe the scheme, setting out the likely significant effects the HS2 project may have on the environment, and proposals to avoid, reduce or remedy significant adverse effects that may be identified.

The responses received as part of the consultation on the Appraisal of Sustainability in 2011 have been used as a starting point for planning the EIA.

The Government expects to consult on the Draft Environmental Statement in spring 2013.

Train noise will be assessed in detail

School study shows the value of good acoustics

An in-depth study at an Essex comprehensive school has concluded that pupil behaviour and attentiveness improves as reverberation time decreases.

The experiment, at Sweyne Park School, Rayleigh, involved 400 pupils aged 11 to 14, including some who are hearing impaired, over six months, and used four different classrooms in the maths department.

Three classrooms were modified to achieve one of three standards:

- BB93 – the minimum standard in BB93 for secondary mainstream classrooms
- BB93 HI – the BB93 requirement for classrooms specially for use by pupils with hearing impairment
- BATOD, the most stringent standard, which is recommended by the British Association of Teachers of the Deaf.

The fourth classroom was used as a control and left untreated.

The overall impression from interviews conducted at the end of the experiment was a significant improvement in working conditions for both staff and pupils in the treated classrooms.

All teachers commented on the improved working environment and noted better classroom behaviour and comprehension, with less experienced staff reporting a reduction in stress levels.

Teachers and communication support workers, who help hearing-impaired pupils during lessons, commented that the improved acoustics allowed children with hearing problems to participate more equally with other children.

The study was funded by the local education authority, Essex County Council, the National Deaf Children's Society, the Federation of Property Societies and Saint-Gobain Ecophon. The research was carried out by David Canning of Heart2Learn, with the final report and summary being compiled by Adrian James Acoustics.

Commenting on the findings, Bridget Shield, IOA President, who helped set BB93, said: "This report is a very welcome and important addition to the literature on the need for good acoustic design in schools, providing conclusive evidence of the beneficial effect of improving the acoustic environment in classrooms."

EU 'must toughen up vehicle noise pollution laws'

An alliance of European pressure groups is calling on the European Parliament to bring forward its proposals to cut vehicle noise levels and make them even tougher.

Transport & Environment (T&E), the European Environmental Bureau (EEB) and the Health and Environment Alliance (HEAL) highlight the fact that traffic noise is associated with 50,000 deaths and a quarter of a million cases of heart disease year.

Their call to legislators follows the publication of a report by TNO, a Dutch research group, which says that reducing noise levels would save €89 billion in health costs by 2030, shave €8 billion off insulation expenses and add €229 billion to property values

In December 2011, the European Commission put forward a proposal to update vehicle noise limits which would require cars and vans to be four-decibels and lorries three decibels quieter five years after the new law is approved. The environment committee of the European Parliament will vote on the new rules in July.

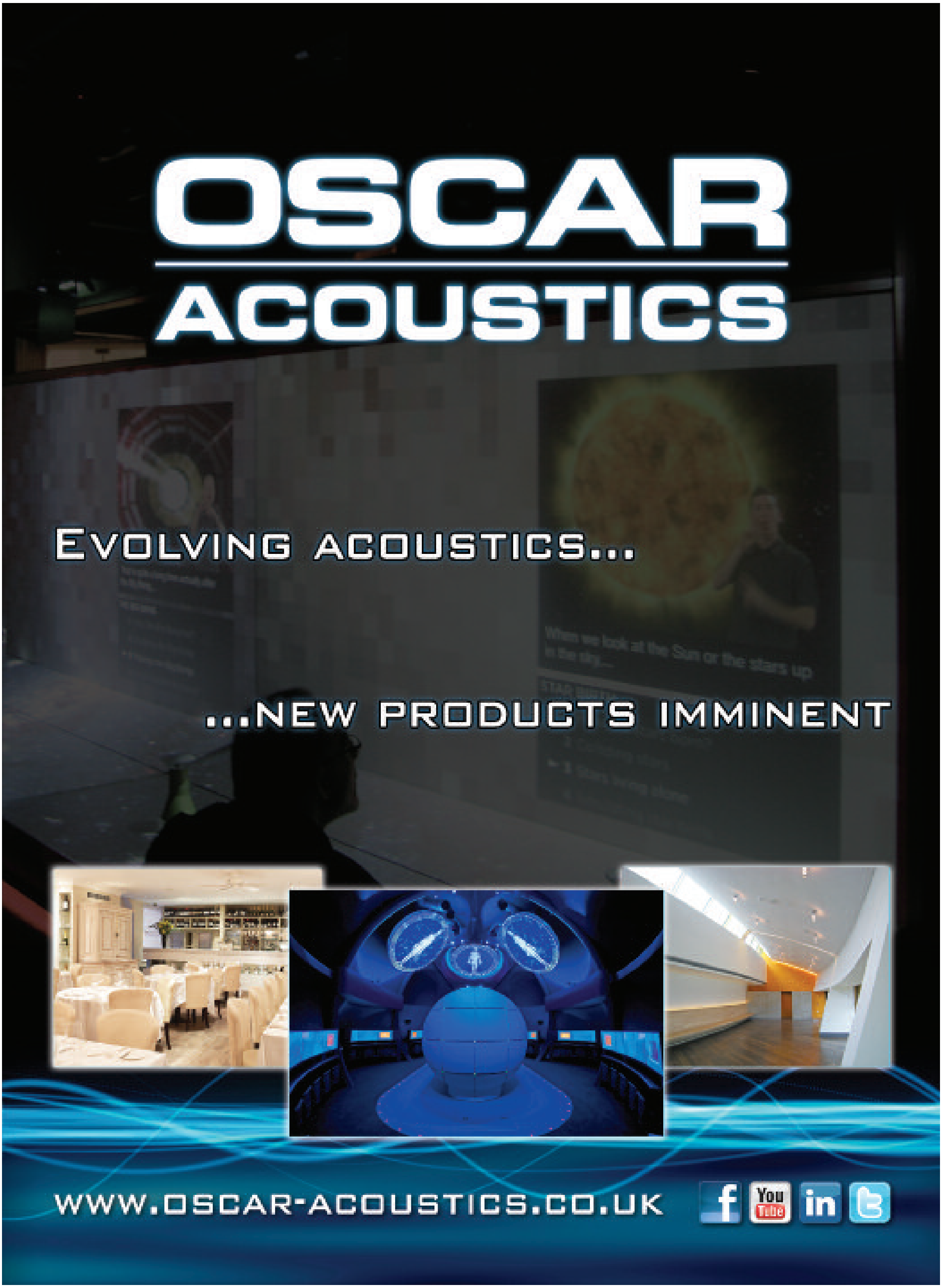
T&E, the EEB and HEAL want the revised legislation to be adopted faster and to go further in lowering traffic noise levels According to the environmental and health groups, Parliament should improve the Commission's proposal by mandating an extra two-decibel reduction for cars, vans, lorries and buses to come into force by 2020. These tighter standards would reduce the number of people highly affected by noise by 40% and the number of sleep-disturbed people by almost a third. A report for T&E, published earlier this year showed the benefits of ambitious vehicle noise legislation would outweigh the costs by thirty times.

Greg Archer, Programme Manager for Clean Vehicles at Transport & Environment, said: "The EU has turned a deaf ear to traffic noise for far too long. Traffic noise levels have been getting worse for fifty years, and vehicle noise standards haven't been changed for twenty. The European Parliament has a great opportunity to make a real difference to the lives of millions of Europeans by proposing stricter standards to enter into force as quickly as possible."

Louise Duprez, Policy Officer for Air Quality and Noise at the European Environment Bureau, said: "Traffic noise causes stress and disturbance to people all over Europe; interfering with their sleep, rest and study. EU leaders must grasp this opportunity to directly improve the quality of life of their citizens by cutting noise at the source and making vehicles quieter. They have nothing to lose, apart from their hearing if they don't take any action."

Anne Stauffer, Deputy Director at HEAL said: "Noise is not only an irritation, it also affects physical health. Research shows that vehicle noise pushes up the number of people suffering a stroke for the first time. For example, last year a study in Denmark involving over 57,000 people found that for every 10-decibel increase in traffic noise there was a 14% increase in the risk of stroke. Reducing traffic noise is a not-to-be-missed opportunity for health protection."

Environmental and health organisations are also calling for a labelling system to enable consumers to have more information on how noisy vehicles are, for test methods that better reflect real world noise emissions and for stricter limits for noise peaks of over 90 decibels.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New research could lead to first drug treatments to prevent development of tinnitus

Researchers in the University of Leicester's Department of Cell Physiology and Pharmacology have identified a cellular mechanism that could underlie the development of tinnitus following exposure to loud noises. The discovery could lead to novel tinnitus treatments, and investigations into potential drugs to prevent tinnitus are currently under way.

Dr Martine Hamann, who led the study published in the journal *Hearing Research*, said: "We need to know the implications of acoustic over exposure, not only in terms of hearing loss but also what's happening in the brain and central nervous system. It's believed that tinnitus results from changes in excitability in cells in the brain – cells become more reactive, in this case more reactive to an unknown sound."

Dr Hamann and her team, including PhD student Nadia Pilati, looked at cells in an area of the brain called the dorsal cochlear nucleus – the relay carrying signals from nerve cells in the ear to the parts of the brain that decode and make sense of sounds. Following exposure to loud noises, some of the nerve cells (neurons) in the dorsal cochlear nucleus start to fire erratically, and this uncontrolled activity eventually leads to tinnitus.

Dr Hamann said: "We showed that exposure to loud sound triggers hearing loss a few days after the exposure to the sound. It also triggers this uncontrolled activity in the neurons of the dorsal cochlear nucleus. This is all happening very quickly, in a matter of days"

In a key breakthrough in collaboration with GSK who sponsored Dr Pilati's PhD, the team also discovered the specific cellular mechanism that leads to the neurons' over-activity. Malfunctions in specific potassium channels that help regulate the nerve cell's electrical activity mean the neurons cannot return to an equilibrium resting state.

Ordinarily, these cells only fire regularly and therefore regularly return to a rest state. However, if the potassium channels are not working properly, the cells cannot return to a rest state and instead fire continuously in random bursts, creating the sensation of constant noise when none exists.

Dr Hamann explained: "In normal conditions the channel helps to drag down the cellular electrical activity to its resting state and this allows the cell to function with a regular pattern. After exposure to loud sound, the channel is functioning less and therefore the cell is constantly active, being unable to reach its resting state and displaying those irregular bursts."

Although many researchers have investigated the mechanisms underlying tinnitus, this is the first time that cellular bursting activity has been characterised and linked to specific potassium channels. Identifying the potassium channels involved in the early stages of tinnitus opens up new possibilities for preventing tinnitus with early drug treatments.

Dr Hamann's team is currently investigating potential drugs that could regulate the damaged cells, preventing their erratic firing and returning them to a resting state. If suitable drug compounds are discovered, they could be given to patients who have been exposed to loud noises to protect them against the onset of tinnitus.

These investigations are still in the preliminary stages, and any drug treatment would still be years away.

For more information, email Dr Hamann at **mh86@leicester.ac.uk**

New ANC officer team elected

Report by Robert Osborne

The ANC annual general meeting in May saw a major change in the officer team as four people were elected to the Board. Joining existing board members Phil Dunbavin, who takes over as Chairman, and Richard Mackenzie (RMP) are Andrew Parkin (Cundall Acoustics) as Vice-Chairman, Richard Greer (Arup Acoustics) as Treasurer, Matthew Hyden (Temple Group) as Secretary and Jack Harvie-Clark (Apex Acoustics) as a board member.

Leaving the board are Rob Adnitt, Russell Richardson and Steve Gosling, along with Adrian James who stepped down in March. Rob, Russell and Adrian had each served the maximum six-year term (someone called it a sentence!), sharing all the major roles of chairman, treasurer and secretary between them over that time. As usual, the meeting was followed by a dinner held at the Institute of Physics in London, with Dave Baker from Robust Details providing an entertaining after dinner speech.

The next event in the ANC calendar is the regular ANC bi-monthly meeting on 17 July, which will take place in Manchester and will include a presentation from Richard Perkins on the IOA Good Practice Guide on Wind Turbine Noise Assessment. Looking further ahead, work has started on the programme for this year's conference which takes place on 7 November at Austin Court, Birmingham.

On 16 May the new edition of the ANC Guidelines on *Measurement & Assessment of Groundborne Noise & Vibration* (known as the Red Book) was launched at a well-attended conference held at Arup in London. Eight presentations were made during a busy day and copies of most of these are available on the ANC website. This event was publicised through *Acoustics Bulletin* and was open to all IOA members, and we were pleased to see that more than a third of those attending came from those outside consultancy or from non-ANC companies.

The second edition of the Red Book is nearly 100 pages longer than its predecessor which was published in 2001. Following the publication of the first edition, BS 6472 has been revised, more dedicated monitoring and analysis systems have come to market, and good practice has improved. Also since the first edition, further research has been undertaken, other standards relevant to the field have been updated or issued for the first time and there has been growth in the number of projects requiring vibration assessment, particularly railway projects. The ANC working group responsible for drafting the book, headed by Rupert Thornely-Taylor, decided therefore not only to revise the guidelines in the light of the changes described above but also to change the focus of the guidelines. The second edition provides wider best-practice guidance in the field of vibration assessment and measurement, rather than guidance specifically in the context of BS 6472.

Copies of the Red Book may be purchased from ANC by obtaining the order form from the publications page of the ANC website **www.theanc.co.uk** . Please note all orders must be accompanied by payment.

Council rapped over failure to control airfield

A council in north Yorkshire has been found guilty of maladministration by the Local Government Ombudsman for its failure to exercise proper control over a noisy airfield.

Bagby Airfield. near Thirsk, had been operating in contravention of its planning permission for several years, but Hambleton Council missed opportunities to take action, said the Ombudsman, Anne Seex.

As a result the unauthorised use became immune from enforcement action. Ms Seex said that "losing planning control over the use of land as an airfield is an extreme and most serious failure of planning administration".

The council's maladministration had caused residents in the area the injustice of disturbance from flights and a sense of frustration and apprehension about the possibility of uncontrolled expansion.

At an enforcement notice appeal last year, noise consultant Alan Saunders, speaking on behalf of local residents, said they suffered from "serious noise impact", in particular from stunt aircraft and helicopters.

Ms Seex said planning permission was granted to the airfield in 1980, limited to a named person and to 40 take-offs and 40 landings a week.

"The named person left the airfield in 1997 but flights continued," she said.

"The airfield had operated in contravention of that permission. The council never monitored the number of take-offs and landings, although Government guidance says that planning conditions should be enforceable."

Planning control is particularly important because the Civil Aviation Authority cannot regulate the airfield and there is no power to enforce against noise created in the air.

In finding maladministration causing injustice, she recommended the council should:

- consider taking action to try to stop the current use, and
- provide funding of up to £5,000 for each village of Bagby and Thirkleby for projects of community benefit agreed with the respective parish councils.

Green light given for Olympic out-of-hours deliveries

Transport for London (TfL), London councils and London's business community have confirmed that they will be sympathetic to companies that need to make or receive out-of-hours deliveries in London during the London 2012 Olympic and Paralympic Games.

The approach was endorsed by London Councils' Transport and Environment Committee when they approved a statement to help local authorities explain the position on night-time deliveries during the Games. The statement makes it clear that councils will be supportive and sympathetic to the needs of businesses needing out-of-hours deliveries during the 2012 Games, when deliveries to businesses on the Olympic Route Network, in central London and around venues will be affected by Games-related restrictions on key parts of the capital's road network.

London boroughs reserve the right to continue to enforce against businesses that are inconsiderate or disturb local communities, especially if complaints are received about excessive noise being made when making or receiving deliveries. Good steps to minimise the chance of any enforcement action include following the Code of Practice and in particularly sensitive areas businesses are advised to discuss this issue with local borough councils in advance.

In order to support the needs of London's residents and those of the freight industry and businesses affected by Games-time restrictions, Transport for London (TfL) has published the final Code of Practice for out-of-hours deliveries. The code, which was developed with the Noise Abatement Society and the Freight Transport Association, provides businesses and delivery companies with simple, practical guidance on how to minimise noise from night-time deliveries and is available now.

London's Transport Commissioner, Peter Hendy, said: "The challenges surrounding deliveries during the Games are considerable. However, the success of the quieter out-of-hours delivery trials we've commissioned in recent months clearly demonstrate that out-of-hours deliveries can, and I believe will, play a vital role in ensuring London and the rest of the UK keeps on moving this summer.

"I urge businesses that make or receive deliveries in London to use the Code of Practice for all out-of-hours deliveries. It is up to the freight and business community to prove to London's borough councils that they are aware of, and care about, the impact they have on the communities they deliver to. If the industry gets it right this summer, this is also a real opportunity for reducing congestion and improving air quality and road safety in London in the future."

Lisa Lavia, Managing Director of the Noise Abatement Society, said; "London council's decision to support the principle of quiet, out-of-hours deliveries during Games time ensures that the rights of local residents are protected while taking a pragmatic approach to the challenge businesses making and receiving deliveries face this summer.

"TfL's out-of-hours delivery trials, which have been conducted using the Code of Practice we helped them draft, have proved the viability of quiet deliveries in the capital and the conditions under which they may be feasible. Introducing quiet delivery practices during Games-time, under strict guidelines and independent monitoring, ensures that the public can be protected throughout."

One person's sound is another person's noise! – a lawyer's view

Report by Mervyn Rundle, of Solicitors Title, Exeter, an Affiliate member of the IOA

Most practitioners will be very familiar with the relevant regulation or area of law which affects their daily practice. The law of nuisance and statutory nuisance does not generally impinge on these technical aspects but, instead, for the ordinary citizen, sets the baseline in Great Britain[1] as to what he or she will expect to bear in the course of ordinary life.

Nuisance cases are relatively unusual (unless you are an environmental health officer) but nuisance law highlights many of the problems which all practitioners face when dealing with noise generally. In particular, time and time again, the courts have to try to reconcile the science of acoustics with the nature and susceptibilities of the human person.

English law provides two basic mechanisms for dealing with noise nuisance. The first is a private legal action brought by an individual aggrieved person whilst the other is public nuisance (now known as a statutory nuisance). The former is played out in the civil courts. The latter is almost invariably driven by a local authority responding to complaints followed by it issuing a noise abatement notice. This can then be appealed to the magistrates' court. Although the two regimes use different court procedures the basic law of nuisance is much the same.

The generally accepted meaning of a legal nuisance is "an activity which unduly interferes with the use or enjoyment of land or the unreasonable use by one person of his land to the detriment of his neighbour". Historically most cases have been brought by adjoining landowners, hence the reference to the ownership of land, however in the context of statutory nuisance there can be no doubt now that there is no requirement to own land in order to suffer from statutory nuisance. All that is necessary is that there is a material and substantial effect on one's ability to enjoy a reasonable lifestyle. This "definition" is not what most people would expect in the 21st century but the lack of scientific/technical precision cuts both ways (there is no acoustic level or measurement which means a nuisance). It means that the law can be flexible in individual cases. It also recognises that science alone cannot accurately describe or define this problem.

One leading judge, as long ago as 1940, said: "It is impossible to give any precise or universal formula but it may be broadly said that a useful test is perhaps what is reasonable according to the ordinary usages of mankind living in society." In another case it was said that a nuisance must be "an inconvenience materially interfering with the ordinary comfort physically of human existence not merely according to the elegant or dating modes or habits of living but according to the plain sober and simple notions amongst English people".

Notwithstanding the lack of concise definition, there have been some very clear principles which have emerged over the years.

The first principle is that the test for nuisance is objective and not subjective. "Objective" in law does not have the same meaning as in the scientific sense. In law the test to be applied is what the court thinks the "reasonable" person would decide to be a nuisance in the particular circumstances. This is often referred to as the "man on the Clapham omnibus test". Either way the court will not simply accept the evidence of the aggrieved person that because it is a nuisance to him or her then so it must be at law. One can appreciate the reasoning for this since with such a contentious and sensitive topic modern life could be brought to a standstill if every person were allowed to define his or her own level of nuisance. In addition there is also the need to balance individual rights – we all have a right to a reasonably quiet lifestyle but on the other hand some quite rightly have to, or even want to, make noise as part of our employment or leisure time. Each is equally permissible in a free society and so there has to be a balance.

As people who have brought nuisance claims will attest, proving nuisance to the required standard is not as easy as one might think. To succeed, an allegation of nuisance must be supported by evidence which will be subject to the usual rules of scrutiny. It is in this context that the acoustic practitioner is likely to have a vital role to play. Having stated that there is no technical acoustic level at which a nuisance occurs, courts do expect to hear some form of expert evidence and look for documentary guidance. Courts regard expert evidence as impartial and therefore as one of the most important factors in many cases. An experienced judge will know that many witnesses of fact are likely to exaggerate or underplay the impact of noise and that in many cases a witness is just reflecting his own subjective emotions about a noise. A court is not bound by expert evidence but it is usually persuasive because it is seen as being without bias and providing the court with technical guidance upon which it can rely.

However, in the case of acoustic evidence there is immediately

Motorsport noise tolerance levels differ markedly

Martin Preston / Shutterstock.com

a problem in that most courts have little or no understanding of the complexities of noise measurement and there is thus a need to explain to the court the different acoustic measuring systems and how they are interpreted. In the lower courts where statutory nuisance is played out this can come as something of a very taxing revelation especially when the court clerk has listed the case for half an hour's hearing time!

All this said, and given the definition of "nuisance", acoustic readings of their own accord add only a limited amount to the argument as to whether a nuisance exists or not. This is perhaps because the issue to be assessed by the court is the impact and effect of the noise on lifestyle rather than the actual level of the noise itself. Reference to the various research papers and accepted acoustic standards are helpful here but often act as little more than a generic level. The WHO guidelines suggest noise levels which cause annoyance or severe annoyance but annoyance in law is not the same as nuisance. Annoyance is perhaps the subjective emotion which is felt when a person is subjected to noise rather than the actual effect on lifestyle. Similarly complaints may be evidence that someone is unhappy with a noise or noise level; however, complaints of their own do not equate to a legal nuisance.

In trying to assess nuisance objectively the courts have evolved a series of tests which must be passed if a nuisance is to exist. These are (briefly):

- Location – crowing cockerels in the countryside are different to those in town even though the noise will be the same
- Time – night-time noise levels are different to daytime noise levels
- Duration – how long does the noise go on?
- Frequency (time as opposed to acoustic) – this is how often but is also associated with concepts of dosage and respite. This consideration may be especially important in motorsport type cases where the noise may be loud but intermittent
- Convention – what is the norm for the area. This is perhaps linked to the character of the area
- Social benefit – is there a benefit to the community or person complaining of the nuisance?
- Difficulty in avoiding effects – this allows for an examination of how practical it is to control the noise and whether the noise-maker is being a good neighbour and doing his best to do so.

(In statutory nuisance cases there is also the factor of best practical means but this is only available to the business user).

Ultimately however there will always be an element of judgment and as another judge put it "in nuisance cases there is always an element of judgement in a continuum between mildly irritating activity to something which is intolerable and positively criminal…"

In truth, it appears there is always going to be considerable debate and argument as to what constitutes a nuisance. Indeed it has to be said that even the various acoustic standards and guidance when read carefully are grey as to what may or may not cause nuisance in a given circumstance for an individual. What is also clear is that at the levels of noise which usually form nuisance actions (i.e. not levels which have direct physical health implications) it is the issue of attitude and character which is a key factor. The reality is that as individuals all of us have different levels of tolerance to different types of noise. Nowhere more clearly is this illustrated as with cases involving motorsport. On the one hand complaints about motorsport are usually from local residents who find the engine and tyre noise at best irritating at worst intolerable. By contrast those who love motorsport either never notice the noise or actually embrace it as part of their daily lives. It is true to say that in many motorsport cases the population who were born and brought up near to a racetrack complain far less than those who may have moved into the area. A person whose purpose in moving to the countryside is to benefit from tranquillity is much more likely to be disturbed than someone for whom tranquillity has no great attraction.

Unfortunately this article does not allow space for an in-depth discussion of the relevant legal cases and thread of law which underpins nuisance at a very detailed level. There has, however, been a very useful (February 2012) Court of Appeal case which discussed and reviewed the major issues involved in nuisance law and which is a useful illustration of the kind of arguments which are often placed before the court in such cases. This case (RDC Promotions v Shields) examined several key areas relevant to noise. First, the court considered how important the location and character of an area might be in deciding what level of noise was acceptable. In dealing with this aspect it then looked at, and how much weight should be given to, an implemented planning permission for noisy activity. The other point before the court was whether a complainant who moves to an area where there was historic noise has the same rights of complaint as someone on whom a new noise is imposed. At first instance the Court found in favour of Mr. and Mrs Shields (the noise victims) and the matter went to appeal.

The Court of Appeal examined the law in detail and unanimously decided that an implemented planning permission meant that motorsport noise had become integrated into the character of the area. Accordingly, the noise generated by the motorsport was legitimate at the levels created and so no nuisance had occurred. The court also concluded that since the noise was well established and legitimate by the time that Mr and Mrs Shields purchased the property they took subject to it. Lord Justice Lewison also passed comment on the question of whether an easement of noise could exist (in other words, a right to transmit a certain level of noise over another person's land). He stated that although this would be unusual, an easement of noise was not something which was impossible to create.

Clearly in view of this judgment the law of nuisance leaves a lot of questions unanswered and the debate is likely to be ongoing for many years to come.

In the September/October issue Mervyn Rundle will examine in greater detail the issue of statutory noise nuisance.

References

1. the law relating to England and Wales is different to that in Scotland and Northern Ireland although there are major similarities. Detailed advice should be sought on any noise nuisance matter but particularly if the case is in one of these jurisdictions.

Teenage party girl attacks noise complaint officer

A teenage girl who assaulted a female environmental health officer responding to a noise complaint about a party has been given a 12-month conditional discharge.

The girl punched and kicked the officer after she approached partygoers at a council house in east London at 2am in response to calls from neighbours about the din.

She suffered a serious knee injury that required several operations and has yet to fully return to her job at Newham Council.

Following a hearing at Stratford Youth Court, the girl, who cannot be named, was found guilty of assault. She received a 12-month conditional discharge and was ordered to pay £60 costs.

Howard Price, Chartered Institute of Environmental Health principal policy officer, said: "Incidents like this are, fortunately, rare but when they do occur, officers are entitled to expect the full support of their employers and the courts."

Newham Council said it was applying to the County Court to evict the tenants in the council house where the party was held and the nearby council house where the girl lives.

The Sound of Sport: what is "real"?

Report by Peregrine Andrews

In 2011, I made a radio documentary for the BBC called *The Sound of Sport*. Although this was a radio piece, most of what it concerned itself with was television sports sound.

We tend to think of the dominant sound of sports broadcasts as the commentator, but this programme was mainly about all the *other* sounds, the sounds of the event itself, and how they get onto your TV. I work in the audio business, so I already had an idea of the challenge of this task and the enormous skill of sports outside broadcast engineers, but I thought it would be interesting to try to explain this art, so often taken for granted, to a wider audience. I also wanted to consider our feelings about sport sound in general.

The programme's presenter, and significant contributor, was Dennis Baxter, the only full-time sound-designer for the Olympics, a job he's had since 1992. I'm going to quote him often, as well as a number of other people whom I interviewed.

While making the programme, I came across something that really interested me. This was the idea of "reality" in live broadcasting. If we're actually at an event, what we hear will almost certainly be very different from what the audience at home hears. We might hear little more than the crowds around us, whereas the TV audience will be delivered a manufactured soundtrack created from many elements, just as it would be for a drama or a film. As Dennis Baxter says, "It's about creating exciting entertainment, whatever that takes." And "whatever that takes" is the key phrase here, for me. Just how far are we prepared to go, to depart from "reality" to make something entertaining?

In 2010, the football World Cup in South Africa had, for many, an unwelcome sonic intruder. the vuvuzela! This plastic horn, so popular with South African fans, was to become the signature sound of the games. So many were brought to, and blown at, the matches that the "normal" sounds of the game were largely masked. For the first time in my experience, ordinary people, i.e. ones who don't work in audio, began talking about the *sound* of the event, saying it sounded "wrong". So what did they mean? They meant that it didn't sound the way a football match was supposed to, how they expected it to. And as we'll see, meeting expectations is something sports sound designers have to do quite a lot.

The last London Olympics was in 1948. If you listen to archive recordings, there's not much more than commentary, just some very distant crowd noise. If any other microphones other than the commentators' were rigged, they didn't capture much detail. In contrast, the 2012 Olympics in only a few weeks will employ the use of around 4,000 microphones across all the events.

Dennis Baxter began his audio career recording music and, for a time, owned a studio. But it was a hard way to make a living. So when ESPN, the American TV sports network, started in the 80s, he became a sound supervisor for TV sport. He tried to apply the same standards, and some of the same methods, that he was used to in the recording studio, to the task of capturing sounds from the football pitch or basketball arena. And when he took on the Olympics job in 1992, he brought in the use of a lot more close-micing, a technique borrowed from music recording, where many microphones are used, each placed close to a sound source. In archery, for example, this means putting a microphone right next to the archer for the launch sound and another right near the target for the hit. The whole picture is built by mixing these signals together in appropriate amounts. It allows for far greater definition and control than, say, a single distant microphone high above the action. But more microphones means more circuits to get the signals back, and more inputs on the mixer. But since the introduction of digital pathways around events and digital mixing consoles, this isn't the headache it was in the analogue past.

A good example of a sport which has benefited from close-micing is the parallel bars in gymnastics. Microphones right beside the athlete pick up detail that a spectator at the event could never hear – breathing, grunts of effort, hands grasping the bar. The soundtrack of the TV broadcast would, most likely, be built from a combination of close microphones with more distant ones to capture ambience and crowd reactions etc. So the sound heard at home is a best of both worlds – the ambience of the event, but with lots of added detail and intimacy. It's not "real" in that it's not truly representative of "being there", but it is engaging and entertaining, bringing us closer to the athlete and their challenge. "Hyper-real" might be a good term.

A step further than putting a microphone very near the action is to attach one to the sports apparatus itself. In the Olympic gymnastics balance beam events, contact microphones are bonded directly to the beam. These capture what's happening *inside* the beam, the creaks as it stresses under the gymnast's weight, responding to each tiny shift of their feet. Even if you stood right next to the beam, you'd never hear this. It's a hidden world, only exposed by a special technique. This could be described as less "real", in that the naked ear could never hear it, but it is derived directly and only from the athlete's interaction with the bar.

When Dennis looked, or rather listened, to the archery coverage from previous Olympics, he noticed something missing. "Probably goes back to the movie *Robin Hood*," he says. "I have a memory of the sound and I have an expectation." The launch sound and target hit were there, but what was missing was the swish of the arrow in flight. Most of us would probably agree that this swish is part of our expectation of how an arrow "should" sound. And so, to provide this key extra element, Dennis used a small boundary microphone, laid flat on the ground, underneath the arrow's path. Now the sequence of release, swish and impact was complete. This is an example of the sound designer having to meet a well-formed public expectation of what is "right".

So now we've had microphones attached to objects. How about microphones on the players themselves? In UK rugby matches now, it's common to include a radio microphone fixed on the referee as part of the broadcast mix. Senior sound supervisor Bill Whiston says: "It's a wonderful addition to the commentary." So it adds information and we're able to understand much more of what the players are going through. It's almost as if we ourselves are in the game rather than just watching it.

And microphones on players have even made sports that were, maybe, considered a bit dull on TV, a lot more broadcastable. An example is curling, which entered the Winter Olympics in 1988. "How were we going to make curling exciting?" says Dennis Baxter. The answer was to put wireless microphones on the players. Curling is actually quite a vocal sport, and being able to hear what the players are saying to each other injects a whole new energy.

Microphones attached to athletes are sure to become more standard. As Dennis says, "It puts you right in the game. You can be the player". So here we have an interesting thing – a suggested shift in perspective for the home audience from spectator to player. It's as if the real event, when experienced on TV, could become a kind of video game.

I spoke to Gordon Durity, a sound designer at the video game company, Electronic Arts. In their EA Sports range there are many emulations of real sports...football, baseball, tennis, boxing etc. And sound plays a big part. Gordon says: "Sound puts you in the actual environment and creates an emotional response. We make it as authentic as possible, but then we try to go beyond. As a player, you expect to hear details you wouldn't as a TV viewer – the kicks, the scuffs etc." If you listen to the sounds in the EA Sports soccer games, there's a level of detail you could never get in a live broadcast. But it is, potentially, pushing up our P32

Nascar racing

Walter G Arce / Shutterstock.com

P30 expectations of how broadcast sport could sound.

Gordon talked about creating an emotional response with sound. For one of their boxing titles, they went into a studio to record joints of beef being punched and sticks of celery snapping, as well as actors grunting, sniffing and groaning. These are the same techniques used by sound-designers working on feature films. I talked to Rob Nokes, a sound effects specialist working in Hollywood. He travels the world recording sound effects for movies and he's worked on a lot of sport-related films, including *Seabiscuit* (horse-racing), *Miracle* (ice hockey), *Game of Their Lives* (soccer) and *Coach Carter* (basketball). He tries to pin down exactly what sounds might express the real essence of the sport and how it feels to be a player and a spectator. Then he goes out to try and capture those sounds, sometimes at real sports events, and sometimes in special recording sessions. Those sounds then go to the film's sound editors to help build the soundtrack.

In the basketball film *Coach Carter*, there was a very specific noise he was asked to try to capture – the "ping" as the ball flies into the air after bouncing. Rob experimented for quite a while with different microphone positions and ways of bouncing the ball until he got it. With a lot of experimentation he eventually managed to capture this sonic essence for the film.

Rob says: "I try to find the next level up, to go heightened reality. Sometimes you have to cheat a sound even bigger to make it cut through. Hollywood sound is definitely more theatrical than real. Just think *Fast and Furious* or *Die Hard*." Film sound-designers talk of "sweetening" a real sound with an additional artificial one to make it more dramatic. An example would be adding a swoosh sound to a bat hitting a ball, and then an additional impact sound mixed over the actual crack of the bat. That additional impact sound might be made electronically, or come from a totally different source. This is clearly not "real", but is used dramatically.

Rob has the luxury to analyse and capture sounds in a controlled environment in a way that a live sports sound designer never could. (For one film he, rather riskily, recorded an Arabian horse by putting a radio microphone on each of its hooves) But his approach and some of his techniques may well cross over into the broadcast sport world. And there's no doubt that the level of detail and drama that he brings to the cinema soundtrack raises our expectations of how live sport could sound.

Since 1829, the universities of Oxford and Cambridge have competed in rowing races on the River Thames in London. In March last year, I visited the team from Sis, the company providing the outside broadcast facilities to the BBC, in their truck on the river bank as they prepared for the race. Sound supervisor Andy James explained how they covered it. See diagram (right).

The race is around four miles. There are microphones at the start, finish, at various points along the river bank and on the chase boats. There are also microphones in the competing boats themselves, picking up the sound of the oars, and also a headset microphone on each cox. The coxes are a significant part of the team and their voices are really compelling. So Andy James had dozens of sources from which to create a mix, favouring different elements through the course of the race. Andy said: "Whenever I look at a shot, I want to try and better it with the sound. I want to hear every bit of effort put into that stroke." So his mix is largely picture-driven . But the director Paul Davies, who was responsible for selecting the camera shots, pointed out that the opposite can happen. Interesting sound can dictate the shot. For example, some lively instructions from one of the coxes might mean they go to a shot of that boat etc

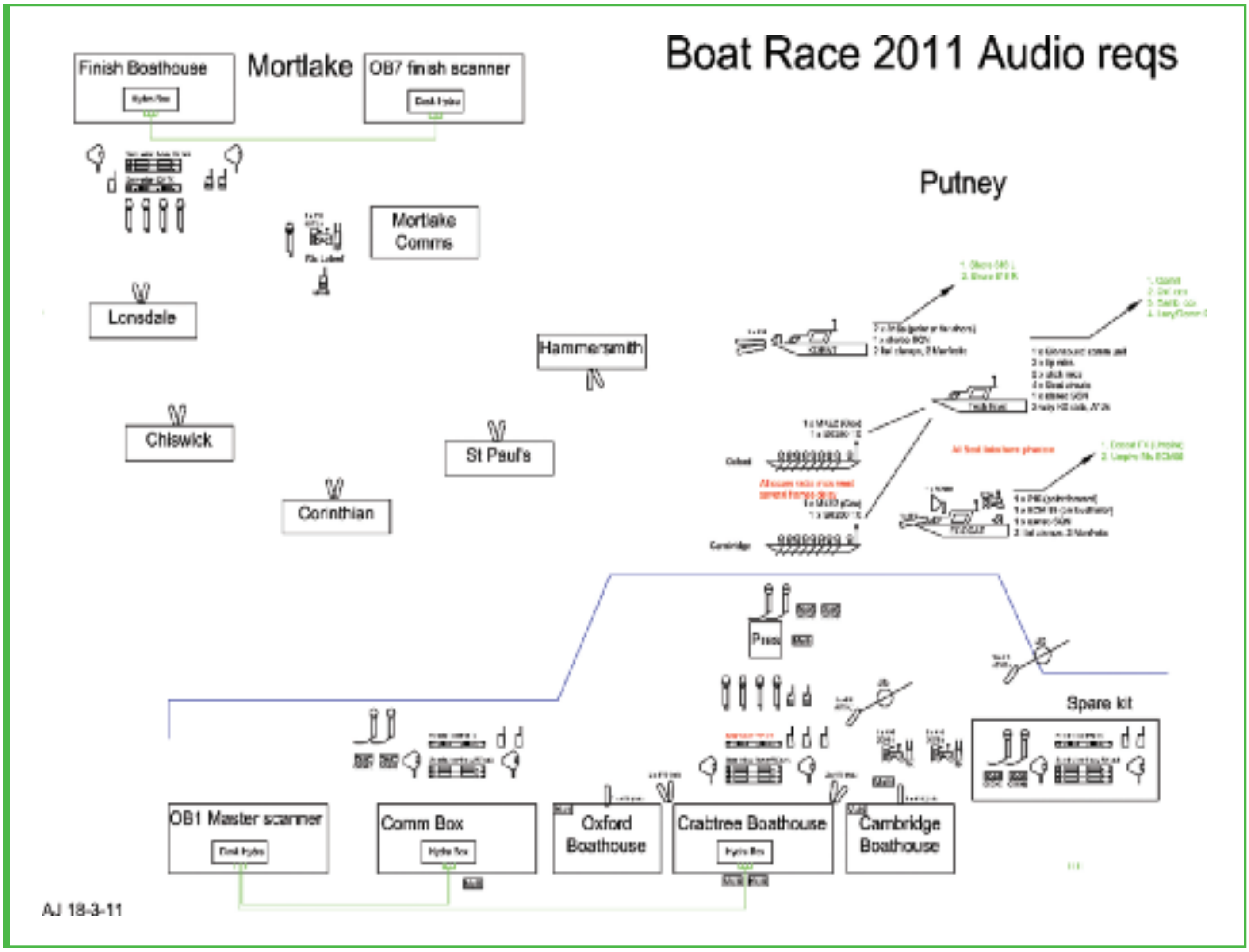
The sound mix for an event like the boat race combines a large number of elements, some connected closely with the action itself, and some more as background layers. This is exactly the same way that a soundtrack for a film or drama is constructed. A spectator on the banks of the Thames would get one perspective, and probably only hear the crowds screaming around them. They would certainly not get the detailed sounds of oars and the colourful language of the coxes. Andy James says: "What we can do is convey an atmosphere throughout the whole race for the viewer, so you actually get a much richer and more detailed experience." So is this real? Not exactly. Exciting? Definitely.

TV now provides the “swish” of arrows in flight

Dennis Baxter was working on Nascar, American car-racing, when he encountered a problem. In an event inside a stadium, the noise from the engines bounced around and masked pretty much every other sound. So, at the end of the event it was impossible to hear the crowd applauding. His producer complained: "I can't hear the crowd!" So, what could he do? He went back to his sound library and found a suitable recording of a crowd swell. The next time he had to mix a race, when it came to the end, he played in this pre-recorded crowd, mixing it to sound just right against everything else. The producer was finally happy and praised him for a great job. But when this same producer found out that he'd used a pre-recorded sound, i.e. a sample, he accused Dennis of cheating. But Dennis says: "Whom am I cheating? Am I cheating the audience? No. The audience sees a crowd. The audience has certain expectations. You see a crowd, you hear a crowd." This is another example of thinking about expectations and then working out how to meet them.

Olympic rowing is another problem sport. Helicopters and chase boats, which provide the visual coverage, completely wash out the sound of the boats. If you heard nothing but the chase boats and helicopters, which you actually don't see on your TV, you would think that was wrong. So Dennis went out before the event and recorded clean oar sounds which he played in from a sampler over the shots of the competition. Real, no. Expected? Yes.

In cross-country skiing, the size of the course is such that coverage by microphones is near impossible. The cameras have zoom lenses that can see a kilometre away, easily covering the course. But how do you match that with sound? As Dennis points



out, you'd need 20-30 mics between each camera position to cover the course. And that isn't practical. Dennis is not a purist. "Whatever the tool takes to deliver a high-quality, entertaining soundscape, it's all fair game." So, in events like these, he uses samplers, playing in pre-recorded ski sounds in perfect sync, from a keyboard.

Senior UK sports sound supervisor Bill Whiston explained that in UK horse-racing TV coverage, it is standard practice to run a galloping horses loop (actually a slowed-down buffalo charge) over the shots rather than mic up the whole course. "That's pretty much a standard thing, and I think it's probably the same recording they've used for years."

Films and video games depict sports in an enhanced and dramatic way, a hyper-real way. But there's evidence that their techniques feed back into the live sports world. Gordon Durity of Electronic Arts says: "The broadcasters have been listening to what we've been doing and then using our techniques back in the actual broadcasts...when you listen to a baseball game now versus 10 years ago, you hear these big bat whooshes and arm throws and big fat catcher-mits, because they have mics located very close to capture these sounds." And sports sound supervisor Andy James agrees: "Many years ago, the audio that people would have been used to expecting from a football match would have been the crowd noise, and that was all. Whereas now they expect to hear every kick, every grunt, every whistle of the referee, because that's what they get used to hearing on video games, on films...so we're always trying to match that sort of sound."

Senior sound supervisor Bill Whiston said: "We try and enhance the experience. We tread the middle road between what's real and what's unreal."

Television is, by its very nature, not real. Broadcasting is man-made magic, and even a big HD picture and surround sound get no way close to the level of sensory stimulation of actually being at an event. That's why broadcasters have to try harder, they have to compensate for the crudeness of a TV screen and a set of loud-speakers. But if by using theatrical enhancement, even a bit of trickery, they get closer to expressing how it feels to be a player or a spectator at that game then, surely, that is getting closer to some kind of "reality".

Acoustics of indoor sports halls and gymnasia

Report by Robert Conetta, Bridget Shield, Trevor Cox, Charlie Mydlarz, Julie Dockrell and Daniel Connolly

Introduction

This paper summarises noise and acoustic data measured in nine indoor sport halls and gymnasia in secondary schools. The data was collected as part of a project to investigate the acoustic environment in UK secondary schools. The project includes acoustic and noise surveys of a wide range of teaching spaces in secondary schools in both unoccupied and occupied conditions; questionnaire surveys of students and teachers; and testing of student performance in different noise conditions.

Indoor sports halls and gymnasia differ substantially from other secondary school classrooms in that they are very much larger spaces intended in general for teaching groups of active, rather than sedentary, students. As a result they have a dramatically different acoustic environment. In the questionnaire survey of nearly 3,000 secondary school students sports halls were rated as the most difficult learning space to hear in.

Although design criteria for the acoustics of indoor sports halls and gymnasia are part of current building regulations, in practice it has been difficult for designers to achieve these standards. A survey conducted by the National Deaf Children's Society[1,2] revealed that the acoustic designs for sports halls in new schools built as part of the 'Building Schools for the Future' initiative were frequently subject to an application for a Building Bulletin 93 'Alternative Performance Standard' for increased reverberation time.

It is also known that sports teachers are exposed to high noise levels[3] and experience significantly more voice problems than teachers of other subjects[4].

Figure 1: A typical secondary school gymnasium

Current acoustic design standards

Since 2003 the acoustic standards required of new school buildings under the Building Regulations have been specified in Building Bulletin 93: 'Acoustic design of schools' (BB 93)[5]. Prior to 2003 acoustic design guidelines for schools were provided in Building Bulletin 87: 'Guidelines for environmental design in schools'[6] and its predecessors[7].

The performance standards specified in BB 93 aim to facilitate good speech intelligibility and speaking conditions in teaching spaces, and to prevent interference by noise with study activities. Section 1 of BB 93 includes criteria for noise level and reverberation time for indoor sports halls and gymnasia as listed in Table 1.

Table 1: BB 93 noise and reverberation time specifications for sports halls and gymnasia

Type of room	Indoor ambient noise level (dB)*	Tmf** (seconds)
Indoor sports hall	≤ 40	< 1.5
Gymnasium	≤ 40	< 1.5

* The highest 30 minute equivalent noise level (dB LAeq,30min) occurring during normal school hours in unoccupied and unfurnished spaces, arising from external sources and building services
** Mid-frequency reverberation time (average of RTs at 500,1000 and 2000 Hz)

Room descriptions

Nine indoor sports halls and gymnasia were measured in eight secondary schools around England. (Note that the term 'room' is used in the text to refer to both indoor sports halls and gymnasia.) Most of the schools were located in towns in south-east England, on sites where the school buildings were surrounded by open areas thus having relatively low levels of external noise. School 7 by contrast is an inner city school located in an inner London borough.

Table 2 provides information regarding the type and physical characteristics of each room measured, plus average ambient external noise levels ($L_{Aeq,5min}$) measured during the school day. It also indicates whether or not the schools were built before or after the introduction of BB93. It can be seen that external levels for six of the schools were very similar, ranging from 49.1 to 52.5 dB $L_{Aeq,5min}$; while the inner London school (school 7) has a higher external level of 58.8 dB. A typical sports hall and gymnasium are shown in Figure 1. Photographs and fuller descriptions of the rooms are provided on the project website **www.lsbu.ac.uk/isess**

Three of the sports halls were situated on the ground floor of separate PE blocks, while two were at the rear of the school building away from classrooms. One room had acoustically absorbent panels on the upper parts of the walls; none of the other sports halls appeared to have any acoustic treatment. All had exposed corrugated ceilings and breeze block walls. Eight of the rooms had solid veneered wood floors; room 3 had toughened rubber flooring.

All gymnasia were on the ground floors of the main school buildings with veneered wooden floors, brick walls, single glazing and various ceiling types. All except one (room 7) had gym bars on the walls and were empty (apart from a small amount of gym equipment in room 9) at the time of measurement. Room 7 was set up for examinations with tables and chairs occupying most of the floor area.

Methodology

Noise levels and room acoustic parameters were measured with the rooms unoccupied. Lesson noise levels were also measured during ten lessons in four of the rooms (two sports halls and two gymnasia).

Unoccupied measurements

Unoccupied noise levels

Noise levels (L_{Aeq}, L_{Amax}, L_{A90}, L_{A10}) plus the unoccupied ambient noise level (UANL) were measured in each room, using a Norsonics N140 sound analyser with the microphone at a standing head height (1.55 m). The UANL was used to give an estimate of the indoor ambient noise level (IANL) as defined in BB

Table 2: Type and geometry of rooms measured							
Room	Type of room	BB 93	Estimated volume (m³)	Floor area (m²)	% Glazing	Acoustic treatment	External noise level (dB $L_{Aeq,5min}$)
1	Indoor sports hall	Pre	6691	558	0	None	51.6
2	Indoor sports hall	Post	6587	540	0.4	None	52.5
3	Indoor sports hall	Post	8508	937	0	None	-
4	Indoor sports hall	Pre	8951	968	0	None	49.1
5	Indoor sports hall	Post	6587	540	0	Wall (part)	50.5
6	Gymnasium	Pre	1427	260	3	None	52.5
7	Gymnasium	Pre	1290	224	6	Ceiling	58.8
8	Gymnasium	Pre	1413	292	11	Ceiling	51.1
9	Gymnasium	Pre	1690	262	7	Ceiling	-

Table 3: Unoccupied noise levels of each room.						
Room	Type of room	UANL (dB L_{Aeq})	dB L_{Amax}	dB L_{AMin}	dB L_{A10}	dB L_{A90}
1	Indoor sports hall	42.7	49.0	39.6	44.0	41.3
2	Indoor sports hall	36.8	42.7	27.5	39.9	28.9
3	Indoor sports hall	29.9	43.1	19.4	33.0	22.6
4	Indoor sports hall	31.1	41.5	36.9	32.4	28.6
5	Indoor sports hall	27.1	37.4	23.1	29.4	24.5
6	Gymnasium	43.5	51.5	41.6	44.3	42.4
7	Gymnasium	40.4	49.3	33.0	44.2	35.4
8	Gymnasium	35.6	42.2	34.6	36.1	35.2
9	Gymnasium	34.6	51.0	30.8	36.0	32.2

93, which applies to unoccupied and unfurnished spaces. Although the rooms surveyed were unoccupied at the time of measurement they were furnished and the measurements were made during the school day when other areas of the school were occupied. To measure the UANL the equivalent continuous noise level was measured for a period of between one and five minutes. Although the BB 93 performance specifications for IANL are in terms of $L_{Aeq,30min}$, as the noise was constant it was judged that the shorter measurement periods were sufficient to give an indication of the $L_{Aeq,30min}$.

Room acoustic measurements

The room acoustic parameters were measured using two methods: 1) impulse responses generated by balloon bursts were captured using a Norsonics N140 sound analyser and subsequently analysed using WinMLS 2004 acoustic measurement software; 2) impulse responses were generated by a swept-sine signal (20 s duration), using a dodecahedron omni-directional loudspeaker as a sound source and a ¼ inch omni-directional microphone (Earthworks Type M30BX) as a receiver, and analysed directly using WinMLS 2004 acoustic measurement software. In six rooms measurements were made at six source/receiver combinations, in accordance with BS EN ISO 3382-1[8] engineering procedure. In the other three rooms (rooms 4, 7 and 8) three source/receiver combinations were used. In all cases source and receiver positions were at a standing head height of 1.55 m. The calculated values were averaged arithmetically to provide a single figure for each parameter in each room.

The mid-frequency reverberation time (T_{mf}) and reverberation time (T_{20}) across the frequency spectrum, plus Speech Transmission Index (STI), were obtained for all rooms and are presented here. For rooms 1 to 8, Early Decay Time (EDT), Clarity (C50 and C80) and Definition (D50) were also calculated and are available at the project website **www.lsbu.ac.uk/isess**

Occupied measurements

Noise levels were measured during 10 PE lessons in two sports halls (rooms 2 and 5) and two gymnasia (rooms 6 and 9), and observations of the activities throughout each lesson were made.

It was noted that each lesson consisted of three distinct components: PE activity (e.g. team games, skills practice); teacher instruction (the teacher talking to the whole class); and other activities not related to the particular lesson (e.g. setting up, entering/leaving room, disruption during the lesson).

The noise was monitored continually throughout each lesson using a Norsonics N140 sound analyser with the microphone at a standing head height (1.55 m). The microphone location in each room was chosen so as to minimise disruption to the lesson activities.

The times spent in the three components of each lesson were noted and the L_{Aeq} levels corresponding to each were calculated. The 'lesson noise level' for each lesson was calculated by combining the L_{Aeq} levels for teaching activities (PE and instruction) and ignoring the periods of 'other activities' (disruption etc). The lesson and activity noise levels were averaged arithmetically to provide a single figure for each room, room type and activity.

Results and discussion

Unoccupied measurements

This section presents the unoccupied noise levels and reverberation times (T_{mf} and T_{20}).

Unoccupied noise levels

The unoccupied noise levels for each room are shown in Table 3. The measured UANL ranged from 27.1 to 43.5 dB L_{Aeq}. Figure 2 illustrates that seven of the nine rooms met BB 93 requirements for IANL with rooms 1 and 6 exceeding the performance specification. On average the UANLs measured in the gymnasia (38.5 ± 3.6 dBA) were higher than in the indoor sports halls (33.5 ± 5.6 dBA). Although the difference between the two groups is not statistically significant this probably reflects the fact that, as explained above, most of the indoor sports halls measured were sited away from the main school building, whereas the gymnasia were sited within the main building and were therefore subject to intrusive noise from occupant P36

Table 4: Lesson L_{Aeq} levels						
Room	Type of room	Lesson	School Year	Number of students	Gender of students	Lesson noise L_{Aeq}, dB
2	Indoor sports hall	1	8	32	Mixed	72.5
		2	7	30	Mixed	76.4
5	Indoor sports hall	1	11	19	F	68.2
		2	9	27	F	74.8
		3	10	17	F	68.3
6	Gymnasium	1	8	24	Mixed	87.8
		2	7	24	Mixed	82.3
9	Gymnasium	1	10	35	F	77.2
		2	10	27	M	81.6
		3	7/8	18	Mixed	74.4

Table 5: Activity noise levels and %time spent in each activity				
Activity		Indoor sports halls	Gymnasia	Overall L_{Aeq}
All teaching activity (lesson noise level)	% Time	88%	76%	76.9
	L_{Aeq}, dB	72.5	81.4	
PE activity	% Time	59%	57%	78.4
	L_{Aeq}, dB	74.4	82.5	
Teacher instruction	% Time	30%	19%	64.2
	L_{Aeq}, dB	62.4	66.5	
Unrelated activities	% Time	12%	24%	73.0
	L_{Aeq}, dB	69.4	76.6	
Average number of students		25	25.6	
Student density (number/m²)		0.05	0.1	

◂P35 circulation and nearby classrooms. It can be seen that levels below 30 dBA were measured in two of the sports halls.The higher levels are likely to be due to building services noise. In three schools there was a difference of over 9 dBA between the L_{A10} and L_{A90} levels; this was due to intermittent noise of construction equipment outside the building at the time of the measurement or, in the case of school 7, to external road traffic noise.

Mid-frequency reverberation time

Figure 3 shows the mid-frequency reverberation times (T_{mf}) measured in each room, which ranged from 1.4 to 6.5 seconds. The average T_{mf} for gymnasia (1.8 ± 0.4 s) was statistically significantly smaller than that for sports halls (4.3 ± 1.2 s). (Student t-test, $p<0.01$). As illustrated in Figure 3 only rooms 8 and 9, both of which are gymnasia, met the BB 93 requirement for T_{mf}. Their shorter reverberation times can be attributed to their smaller volume (the smallest indoor sports hall is more than 4 times larger than the largest gymnasium), more absorbent room surfaces, and the presence of PE equipment including bars, mats, benches and gym horses, which help to diffuse and absorb sound energy. It is also important to note that the three rooms with the shortest mid-frequency reverberation times (rooms 7, 8 and 9) have acoustically absorbent ceilings.

Comparison of T_{mf} and UANL

Considering the two groups of rooms separately, strong positive correlations were found between T_{mf} and UANL: for sports halls $r = 0.94$ ($p<0.05$) and for gymnasia $r = 0.96$ ($p<0.05$). Rather than reflecting a causal relationship this probably indicates that some schools had more stringent acoustic design leading to greater control of both reverberation time and noise levels.

Reverberation time (T_{20})

Figure 4 shows the mean T_{20} values for each octave band from 63 Hz to 16 kHz averaged across sports halls and gymnasia, plus 95% confidence intervals. It can be seen that, in general, in both room types the reverberation time increases towards the lower frequencies, while in sports halls it exceeds 2 seconds at all frequencies ▸

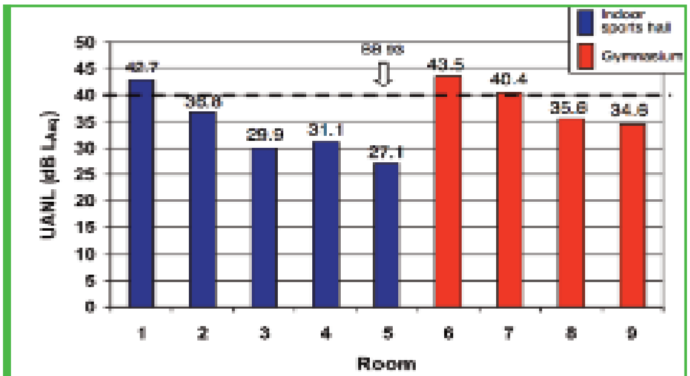


Figure 2: UANL for each room, compared with BB 93 specification

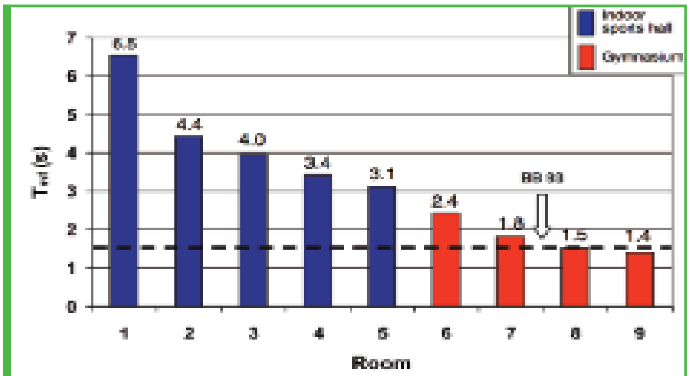


Figure 3: Mid frequency reverberation time, Tmf, for each room

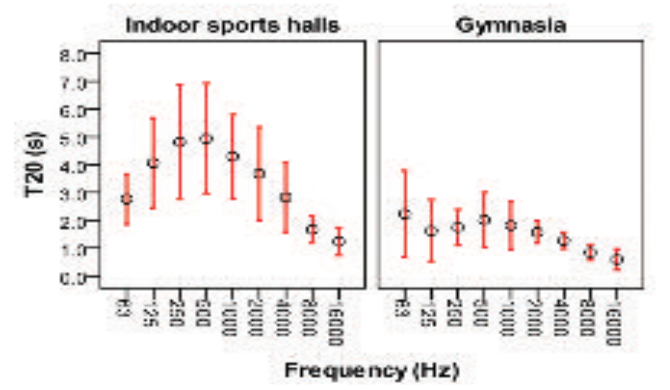


Figure 4: Mean T20 in each octave band with 95% confidence intervals

below 4000 Hz.

The long reverberation times across the speech frequencies will make hearing and understanding speech very difficult, particularly for hearing impaired students. The recommendation by BATOD (the British Association of Teachers of the Deaf) is that the reverberation time should not exceed 0.4 seconds across the frequency range 125 Hz to 4000 Hz[9]. The excessive reverberation in these spaces also creates a risk of voice damage to the teacher due to vocal fatigue[4].

Speech transmission index (STI)

Figure 5 shows the STI calculated while each room was unoccupied. All the rooms measured had ratings between 'Poor' and 'Fair' except room 8 which achieved STI of 0.6 ('good intelligibility'). In general higher values of STI were measured in the gymnasia than in the sports halls reflecting the longer reverberation times in the sports halls.

It is important to note that the STI was calculated while the rooms were unoccupied; during lessons the STI would be lower as noise levels in the rooms would be higher, while, given the large volumes and lack of acoustic absorption, the reduction in reverberation time due to the absorption provided by occupants would be negligible.

Occupied measurements

This section describes the results of the occupied measurements made in two sports halls (rooms 2 and 5) and two gymnasia (rooms 6 and 9). The number, age group and gender of students in each lesson are given in Table 4, together with the lesson noise L_{Aeq}, that is the overall L_{Aeq} due to teaching activities but excluding noise from other activities, as explained in section 4.2.

Average lesson and activity noise levels

The average noise levels associated with the identified individual lesson activities plus all teaching activity (PE and teacher instruction combined) in the two room types, together with the P38

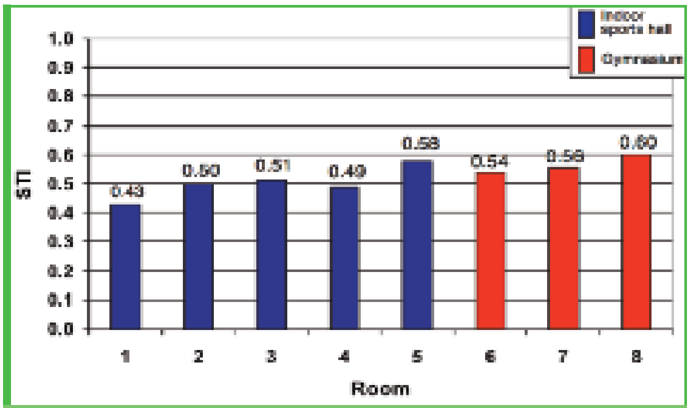


Figure 5: Speech Transmission Index for each room.

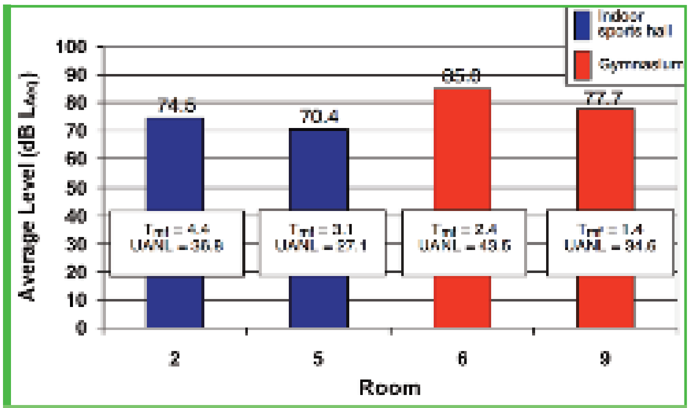


Figure 6: Averaged lesson noise level for each room

◂P37 percentages of time spent in each activity have been determined and are shown in Table 5. The average numbers and densities of students are also shown.

The overall noise during sports lessons is dominated by the noise generated during PE activities, while the noise levels when the teacher is speaking are not excessive. The lesson noise levels shown in Tables 4 and 5 were statistically significantly higher in the gymnasia than in the sports halls. This is probably due to the higher density of pupils in gymnasia which was twice that in sports halls owing to the larger volumes and floor areas in the latter; number of pupils was not a significant variable ($p>0.05$).

Figure 6 shows the averaged lesson noise levels in each room, according to room type, with the T_{mf} and UANL of each room also indicated.

It can be seen that within each room type the higher lesson noise levels occur in the rooms with the longer reverberation times. Data from more rooms is required to determine whether a statistically significant relationship exists between reverberation time and noise levels in sports halls and gymnasia.

Discussion

The results show that, while most rooms comply with Building Bulletin 93 requirements in terms of indoor ambient noise level, mid-frequency reverberation times in all except two rooms exceed the BB93 specification of 1.5 seconds, with five rooms having RTs of over 3 seconds. In one case the T_{mf} is over 6 seconds. These long RTs are due to the very large volumes of the spaces, particularly the sports halls, plus the lack of acoustic absorbent materials.

Of the five sports halls measured both the unoccupied noise level and T_{mf} were lowest in the one hall that had some acoustic treatment. Similarly, of the four gymnasia the UANL and T_{mf} were greatest in the one room without an acoustically treated ceiling.

The long RTs result in relatively low values of STI. With students in the spaces and corresponding increased noise levels the STI will be even lower indicating poor speech intelligibility during lessons. (Because of the large volumes of these spaces the additional absorption provided by occupants will be relatively small.)

Investigation of the reverberation time, T_{20}, across the frequency spectrum showed a large variation between high and low frequencies, particularly in sports halls. The average T_{20} in sports halls exceeded 3 s at all frequencies below 2000 Hz, and was greater than 4 s at frequencies between 125 and 1000 Hz. This would make listening and hearing very difficult, particularly for hearing impaired students. In gymnasia the mean T_{20} was highest (at around 2 s) at 63 and 500 Hz which would also lead to hearing and listening problems.

The high reverberation times measured would also cause difficulties in speaking for teachers in these rooms and are a contributory factor to the reported voice problems of sports teachers[4].

Measurements made during lessons in two indoor sports halls and two gymnasia suggest that the long reverberation times in these spaces, particularly sports halls, may contribute to high noise levels during lessons. Further data are required to determine whether there is in fact a statistically significant relationship between reverberation time and noise levels.

Conclusions

Unoccupied and occupied noise and acoustic surveys in typical indoor sports halls and gymnasia have confirmed that the majority of these spaces have very long reverberation times, high occupied noise levels and poor speech intelligibility. These are likely to be contributory factors towards the incidence of voice problems among sports teachers and reported difficulties of students hearing in such spaces. The long reverberation times in sports halls could be reduced by the introduction of acoustically absorbent material which would improve listening, hearing, understanding and speaking conditions in these spaces.

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Authors

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Wind shear and its effect on wind turbine noise assessment

Report by David McLaughlin MIOA, of Sgurr Energy

Motivation

Wind shear is widely misunderstood in the context of noise assessments. *Bowdler et al*[1] and Bowdler's more recent article[2], discussed the issue of wind shear and how it pertains to wind turbine noise assessment, but the purpose of this article is to provide a more comprehensive discussion. To that end, it will discuss:

- What is wind shear? It can be defined as the variation of wind speed with height above ground level (AGL).
- How does it affect wind turbine noise? Noise increases with increasing wind speed *at hub height*. Variation across the disk is not considered here.
- What is the problem that *Bowdler et al* seek to address? Turbine sound power levels are specified as a function of wind speed at 10 m AGL, but the conversion from measured hub height wind speed to 10 m wind speed is done in an artificial way that does not reflect wind shear at the wind farm site.

Logarithmic wind shear

In the wind energy industry, wind shear is generally defined to be the variation of wind speed with height above ground level (AGL). More generally it can be considered to be the variation in the wind velocity vector and therefore to include wind veer, or change in direction with height, which is conventionally treated separately in wind power studies. The simpler definition, excluding directional effects, will be assumed here.

This depends on a number of factors including thermal effects (*Burton et al*)[3]. If the ground is hot, this can cause rapid expansion of air near the surface, which then rises rapidly, resulting in turbulent mixing and little variation of wind speed with height. This is known as unstable stratification. When the surface is cooler than higher air, as can happen on cold nights, there is little turbulent mixing and significant wind shear can occur. This is known as stable stratification. When adiabatic cooling allows rising air to remain in thermal equilibrium with its surroundings, as is often the case at higher wind speeds, the stratification is described as neutral.

Subject to a number of assumptions, the distribution of wind speed U with height z above a sufficiently flat (as defined in, for example, IEC 61400-1[4] or IEC 61400-12-1[5]) ground surface is of the form

$$U(z) \propto \ln\left(\frac{z}{z_0}\right) + \Psi,$$

where Z_0 is the surface roughness length, a quantity that expresses how the atmospheric boundary layer interacts with the surface, and Ψ is a function depending on stability (see, for example, *Burton et al*). For neutral atmospheric conditions, Ψ is small and the expression simplifies to give

$$U(z) \propto \ln\left(\frac{z}{z_0}\right). \quad (1)$$

Surface roughness length varies from about 0.01 m in very flat and open terrain to about 0.7 m in cities and forests. For a given wind speed at a hub height of 80 m, the variation of wind speed with height in these two extreme cases is as shown in Figure 1.

Power law approximation

The logarithmic form of the wind shear, while based on sound physics, presents some practical difficulties. As will be discussed below, it is often convenient to measure the wind speed at two heights and derive an expression for the wind as a function of height from those two measurements. Although this can be done with a logarithmic function, the calculation is cumbersome.

A power law curve is a reasonable approximation, characterised by an exponent, and has the advantage that it is much more straightforward to find an analytical solution for an exponent.

Using the notation of IEC 61400-11[6], the power law takes the form

$$V(z) \propto \left(\frac{z}{z_{ref}}\right)^a,$$

for some value of the exponent a, where Z_{ref} (not to be confused with z_0) is an arbitrary reference height. IEC 61400-11 recommends expressing all wind speeds relative to that at 10 m above ground level (AGL), but in fact the above expression holds true for any pair of heights. This makes it easy to find an analytic solution for the exponent, a.

Writing this as

$$U = k\left(\frac{H}{H_{ref}}\right)^m \quad (2)$$

where $m = a$, $H_{ref} = z_{ref}$, $H = z$ and $U = V(z)$, and calculating the ratio of wind speeds at two different heights, U_1/U_2, leads to the expression in *Bowdler et al*, P40

$$m = \frac{\ln\left(U_1/U_2\right)}{\ln\left(H_1/H_2\right)} \qquad (3)$$

◀ P39 Given wind speeds of U_1 and U_2, measured at heights H and H_2, respectively, (3) can be used to calculate the exponent m (or a in the terminology of IEC 61400-11). Substituting the hub height for H, and H_1 or H_2 for H_{ref} in (2), we can calculate the hub height wind speed from the measured wind speeds at the reference height. Returning to the logarithmic expression (1), we can then correct from the hub height z to the reference height Z_{ref} (10 metres), assuming a surface roughness of $z_{0ref} = 0.05m$, by

$$V_s = V_H \left[\frac{\ln\left(\frac{z_{ref}}{z_{0ref}}\right)}{\ln\left(\frac{z}{z_{0ref}}\right)}\right]$$

where the terms are as defined in IEC 61400-11. This procedure is illustrated in Figure 2 for an 80 m hub height. The more complex expression,

$$V_s = V_z \left[\frac{\ln\left(\frac{z_{ref}}{z_{0ref}}\right)\ln\left(\frac{H}{z_0}\right)}{\ln\left(\frac{H}{z_{0ref}}\right)\ln\left(\frac{z}{z_0}\right)}\right]$$

in IEC 61400-11 corrects wind speed V_z from an anemometer height z to wind speed V_H at hub height H with an assumed surface roughness length in the field of Z_0, and from there back to wind speed V_s at reference height Z_{ref} assuming a roughness length $z_{0ref} = 0.05m$. If the wind speed is calculated from the power output using the power curve, rather than using an anemometer, the right-hand terms in numerator and denominator in H, z_0 and z should be omitted and the hub height wind speed derived from the power curve, V_H, substituted for V_z.

Turbine sound power level

The sound power level (SWL) of a wind turbine depends on wind speed. One consequence of wind shear is that the wind speed varies across the disc of the turbine rotor. This clearly can result in variations in the angle of attack as each blade rotates, which can complicate the generation of aerodynamic noise. Such complications apart, it is reasonable to assume that the SWL is a function of hub height wind speed.

Wind speed and IEC 61400-11

The measurement of the SWL of a wind turbine by the manufacturer, or by an independent test centre, is carried out in accordance with IEC 61400-11.

At an early stage in the design of a wind farm, it is often useful to compare the performances (including noise performances) of a number of candidate turbines. These candidate turbines may have different hub heights. If the SWL is expressed as a function of hub height wind speed, comparing two turbines of different hub heights becomes difficult. Hence there is a case for expressing turbine SWLs as a function of a wind speed expressed at some standard height AGL.

When the 1st Edition of IEC 61400-11[7] was being drafted, turbines were much smaller than many of today's models. It was also common to measure wind speeds at 10 metres AGL as 10 metre masts were (as they remain) readily available, cheap and easily transportable. Hence it was sensible to reference all wind speeds to 10 metres AGL. IEC 61400-11[6] still mandates 10 metres as the reference height for wind speeds, though that is expected to change in the next edition.

IEC 61400-11 also mandates that the wind speed be converted from hub height to 10 m using a logarithmic wind shear with a surface roughness of 0.05 m. This is likely to be a reasonable value for a well-chosen turbine test site, but many wind farm sites are significantly less than ideal.

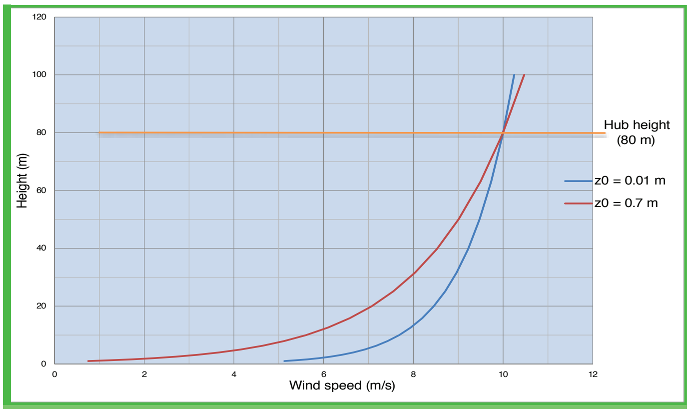

Figure 1 Logarithmic wind shear for two different surface roughnesses (m)

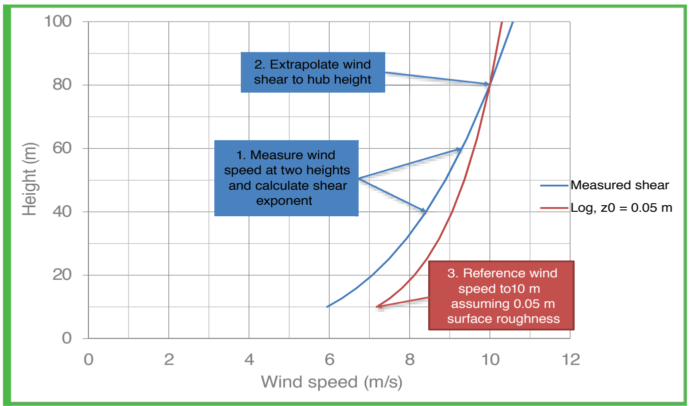

Figure 2 Measured and hypothetical wind shear meeting at 80 m hub height

Comparing prediction with background

In windy rural areas where wind farms are often sited, it is not only the wind farm noise that depends on wind speed; a significant contribution to the background noise is also due to the wind. ETSU-R-97[8] recognises that the noise impact of a wind farm depends on wind speed, and mandates that the criterion for assessing the wind farm noise should depend, in part, on that background noise.

Because the wind turbine SWL is expressed as a function of wind speed at 10 m AGL, it is tempting to compare the noise prediction at sensitive receptors based on that SWL with the background noise as a function of wind speed measured at 10 m AGL on the proposed wind farm site. That would be a mistake, because:

- the SWL of the turbine has been artificially referenced from hub height to 10 m using an arbitrary 0.05 m surface roughness;
- the wind shear between 10 m and hub height at the wind farm site may be much greater.

This can be seen much more clearly in the example presented in Figure 2. The blue curve shows the wind shear on site from 10 m AGL up to hub height (assuming a power law) based on measured site data, while the red curve shows how the SWL is referred to 10 m in accordance with IEC 61400-11 (assuming a logarithmic variation with 0.05 m surface roughness).

Obtaining wind speed at hub height

The most direct way of obtaining the wind speed at hub height is to measure it using a remote sensor such as LiDAR or SoDAR. The data acquired this way should be presented using 10-minute averaging intervals, synchronised with the background noise measurement. The effective operation of LiDARs and other remote sensors for these purposes should be conducted in accordance with best practice as discussed in Clive[9]. Examples of LiDAR measurements can be found in Clive[10].

If a remote sensing device is not available, it may be P42 ▶

◂P40 necessary to measure wind speed with a mast that does not reach to hub height. In that case, *Bowdler et al*[1] recommend measuring wind speed at two heights, one not less than 60% of hub height and the other between 40% and 50%. These can then be inserted into Equation (3) to calculate the wind shear exponent, which can be inserted in (2) to extrapolate the wind speed to hub height. This procedure should be done for every 10-minute interval.

It occasionally happens that the measured wind shear is negative, that is, the wind speed at the higher of the two measurement heights is lower than at the lower height. In that situation, *Bowdler et al*[1] recommend that the wind speed at hub height be taken to be the same as at the higher of the two measurement heights.

Even if a remote sensing device is available, it is not unknown for the hub height of the candidate turbine to change after the background noise measurements have been carried out, so it is always prudent to measure wind shear.

Compare at "reference" 10 metres

Planning conditions for wind farms normally specify noise limits as a function of wind speed at 10 m AGL. *Bowdler et al*[1] recommend that planning conditions continue to be referenced to 10 m, but stress that it is important to remember, and that the planning conditions should clearly specify, that the wind speed should not be measured at 10 m. Instead, the *hub height* wind speed should be *referenced* to 10 m in accordance with IEC 61400-11 as described above.

If background noise is determined as a function of hub height wind speed, then referenced to 10 m in the same way as turbine sound power levels, we can be confident of comparing like with like. An example of background noise against 10 m wind speed is shown in Figure 3.

If the wind speed at the time of the background noise measurements has not been measured at hub height, each 10-minute sample, represented by a marker in Figure 3, will have its own wind shear correction, based on the wind shear derived from the measurements acquired during that interval.

The predicted wind farm noise as a function of 10 m wind speed can be overlaid on Figure 3 to compare with a criterion based on the background noise.

Recall that one of the perceived advantages of using 10 m wind speeds is that it is easy to compare the noise emissions of turbines with different hub heights. Unfortunately, this advantage does not carry across to comparing wind turbine noise received at sensitive receptors relative to background noise. That is because the process of referencing the background noise to 10 m depends on the hub height.

Compare at hub height

Instead of comparing predicted turbine noise with background noise at a reference 10 m AGL, it is also possible to do the comparison as a function of hub height wind speed. The wind speed for each background noise measurement should not be referenced to 10 m, but should be left at hub height. The turbine sound power level should be referenced to hub height wind speed, using a logarithmic wind shear with 0.05 m surface roughness. This is the reverse of what has been done by the test centre under the current IEC 61400-11.

It is likely that the forthcoming version of IEC 61400-11 will specify that turbine sound power level be specified as a function of hub height wind speed.

Comparison at "site" 10 metres is flawed

Instead of changing the wind speed corresponding to each background noise measurement to hub height, and then referencing it to 10 m, it may be tempting to convert the turbine SWL to hub height and back down to 10 m using the power law with the site shear exponent. For best results (and equivalence with the other two methods above), this should use a different shear exponent for every 10-minute measurement.

Instead of a smooth curve of turbine noise against wind speed,

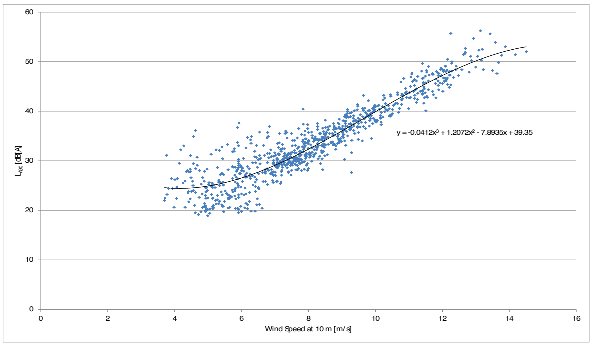

Figure 3 Background noise against wind speed at 10 m

the result would be a "scatter" plot of discrete points for each 10-minute sample. It is better to embed this scatter in the background noise, which already includes scatter due to other influences.

Summary

- In ideal conditions, wind shear is logarithmic.
- Surface roughness lengths observed on site can vary from about 0.01 m to about 0.7 m.
- A power law curve is a reasonable approximation of observed wind shear profiles.
- Turbine sound power level is to a significant extent a function of hub height wind speed.
- IEC 61400-11 references wind speed to 10 m, with 0.05 m surface roughness length.
- To compare predicted turbine noise with measured background noise, it is necessary to determine hub height wind speed for each 10 minute interval.
- If hub height wind speeds cannot be measured directly, they can be adequately approximated from wind speeds measured at two heights.
- Wind speed can be referenced to 10 m, using a logarithmic wind shear as per IEC 61400-11.
- Alternatively, turbine sound power level could be specified as a function of hub height wind speed, but not wind speed at 10 m on site, because that would give a different relationship between sound power level and wind speed for every 10-minute sample.

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New faces at Renson and Ramboll Acoustics


Mike Reeves

Mike Reeves has been appointed UK Director of Renson, with responsibilities for sales and operations, including the management of the UK manufacturing activities.

He has joined from Colt International, having many years of experience in both sales and project management in the fields of weather louvres, sun shading, architectural solutions, ventilation and smoke control.

Graduates Thomas Jones and David Harbon have joined Ramboll Acoustics as assistant consultants.

Thomas, who is based in Cambridge, is a graduate in Acoustics and Music from the University of Southampton and David, who works in the Birmingham office, is a graduate in Music Technology from Staffordshire University.

David, who has also completed the IOA Diploma in Acoustics and Noise Control, is currently writing his thesis on the Lombard effect for a master's degree from the University of Salford.


David Harbon (left) and Thomas Jones

Industry Update

Aircraft vibration tester 'has already paid for itself'

Carlisle Interconnect Technologies has enhanced its aircraft rack and tray systems testing capabilities at its facility in Wisconsin, USA, through the installation of a vibration test system, supplied by Brüel & Kjær VTS.

The system mainly tests designs during research and development, especially for complete lifecycle simulation, generally based on industry-standard test profiles. As with anything related to aerospace, exacting detail and specified tests according to customer and industry standards are performed, including shock testing to simulate events such as an aircraft's undercarriage experiencing a tyre blowout on the runway.

The engineering team uses test connectors, wiring harnesses, metal modules and fittings. Thanks to the time savings that the new system has provided– and the testing services work for third-party aerospace customers – Carlisle says it "has already paid for itself".

During testing of the aluminium trays shown in the picture, the size and mass of the load that they will endure in actual use are simulated. With the choice of using the slip table or the head of the V875 shaker itself, they can accommodate many different products and a variety of test types.

For more details go to **http://bksv.com/doc/bn1112.pdf**


The vibration test system

'Hola' as Cirrus opens first Spanish office

Cirrus Research has opened its first office in Spain. Based in Barcelona, Cirrus Research S.L. will provide sales, marketing and support activities, and its opening means that the company's entire range of measurement instruments is now available in the country for the first time.

Silvia Angeura, who has been appointed as Sales Support Administrator, will be the first point of contact for customers. "I have worked in customer services since 2003, in particular international offices, which has helped me develop my linguistic skills. I will be taking a key role in all administrative tasks and offer a high level of customer service to both pre and post sales in the Spanish market," she said.

Rick Heap, Cirrus Research Sales Director, said: "We are delighted to welcome Silvia and look forward to the opportunities that the new Spanish office will create. Having local representation in Spain is a logical progression for Cirrus Research and we look forward to supporting our customers in Spain for many years."

For more information go to **www.cirrusresearch.es** or email **info@cirrusresearch.es**

SRS 'scores top marks' at Oxford University

Poor room acoustics in the lobby at Oxford University's Oriental Institute have been improved by SRS.

Following an assessment of noise problems by Technical Director Richard Sherwood, Sonata Vario absorbers were fitted to the walls. A Sonata Memo board – a fully functional noticeboard that also acts as a high performance absorber – was also supplied.

Phil Rust, of Oxford University Estates Directorate, said: "Reverberation has been reduced to an acceptable level and it is now possible to utilise the circular entrance hall as a reception area."

SRS also solved similar reverberation problems at Aldwyn School, Audenshaw, Manchester, by the installation Sonata Vario absorbers on the walls and suspension from the ceiling and by supplying a Memo board.

Caroline Charnock, Associate Headteacher, said: "The noise quality is much improved. In assemblies, PE lessons and at lunchtime the room is quieter. We're very happy with the improved learning environment."

For more details ring **01204 380074**, email **info@soundreduction.co.uk** or visit **www.soundreduction.co.uk**

Sound sense: the new lobby at Oxford University's Oriental Institute

'Ten out of ten' for acoustics at new academy

A variety of ceiling types from Armstrong Atelier have been used throughout a new showcase academy.

Bespoke metal tiles and mineral tiles including antimicrobial ones were specified by Jestico + Whiles architects for the Passmores Academy, Harlow, Essex to meet acoustic, aesthetic and hygienic criteria.

Armstrong's Metal microperforated planks in standard sizes and specially commissioned trapezoidal tiles were used throughout the new secondary school's circulation areas, the latter where the corridors were curved.

These were complemented by three types of mineral tiles featuring sound absorption performances of up to Class A – Dune Max in classroom and office areas, Parafon Hygiene in toilet and changing room areas and the antimicrobial Bioguard in kitchen and food areas.

The £22million academy, which was procured outside of the BSF framework and built over 18 months by main contractor Willmott Dixon on an eight-hectare brownfield site in Harlow, features a large oval roof light as the heart of the two-storey, concrete-framed building.

Armstrong Ceilings have also been fitted to a new police motorway HQ in the Midlands

Some 260m² of Armstrong's RH 215 metal micro-perforated planks with a factory-applied acoustic fleece were used on the first floor to follow the curve of the shallow barrel vault roof, while a total of more than 600m² of Ultima dB and OP mineral tiles with a variety of edge details and acoustic properties were used on the ground floor.

The Central Motorway Police Group provides a fully-regionalised policing service for the motorways of the West Midlands, West Mercia and Staffordshire force areas. It is responsible for patrolling the Midlands motorway network, stretching south from Cheshire on the M6 to the Welsh borders on the M50.

For more details go to **www.armstrong.co.uk**

Passmores Academy, Harlow

The new police control centre

New calibration lab for Campbell Associates

Campbell Associates have opened a new calibration laboratory at their offices in Dunmow, Essex

The new facility has enabled them to increase capacity by 200 per cent, enabling three pieces of kit to be calibrated simultaneously.

Owners Ian and John Campbell (father and son) were delighted to welcome Sir Alan Haselhurst, MP for Saffron Waldron, and town mayor Ron Clover to the official opening,

Sir Alan said it was a pleasure to learn about a thriving small company which had steadily expanded throughout challenging economic times since its conception 12 years ago.

The business began life as a fledgling company operating out of one room in Ian's house. It soon moved to slightly bigger accommodation where it stayed for the next few years before relocating in 2005 to its present purpose-built offices.

It now employs 19 staff working in sales, hire, calibration, support and training for acoustic and vibration noise monitoring equipment.

Sir Alan Haselhurst formally opens the new facility watched by (far left) Mayor Ron Clover and Ian and John Campbell

The answer to the electric car noise puzzle

Frank Fahy asks (March/April 2012 issue) why we only have up to 5dB noise difference above 30mph at speed when there can be 20dB difference when stationary between normal and electric cars.

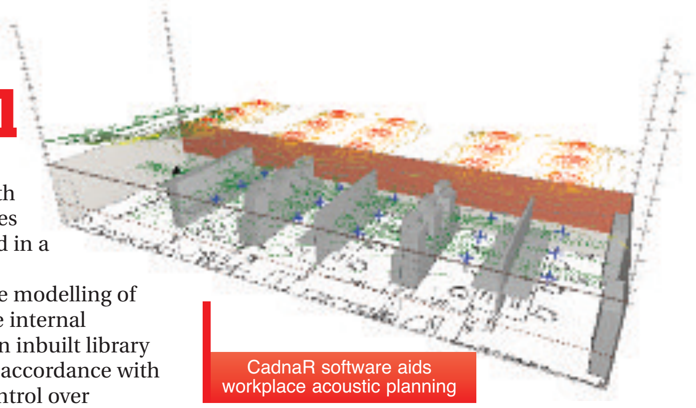
Well surely it's just the way uncorrelated multi noise sources tot up.

Very simply, if we take, say, four internal sources at rest for the electric car of, say, 30dB this will give a total of 36dB. Similarly for a normal car for four sources at 50dB (say) we get 56dB, hence the 20dB difference at stationary condition. Now if we introduce a new dominant source road noise at elevated speed and assume same road/tyres conditions, we can add, say, an extra 55dB to both, we now get a total noise difference even less than five we get 3.5dB: 55 to the electric and 58.5dB to the normal car.

So really electric car road noise is not lower, it is just that we start with lower other noise sources, and road noise starts to take over and dominate. You can play with the numbers.

Colin Troth, NVH Specialist, Ricardo UK

New acoustics planning software tool



CadnaR software aids workplace acoustic planning

Campbell Associates have introduced CadnaR room acoustics software which is designed to help with acoustic planning and noise mitigation in the workplace. It comes from Datakustik, the designers of the CadnaA software.

The software is arranged to enable users to build models and make calculations while benefitting from sophisticated input possibilities as the analysis becomes more complicated.

The package has a 3D view to enable advanced visualisation of the acoustics in a room within a second.

CadnaR uses scientific and highly efficient calculation methods, and with various calculation techniques sound levels can be displayed in a 3D grid quickly.

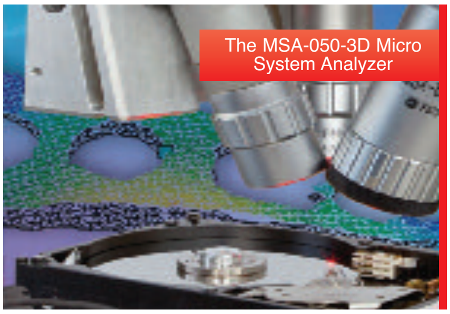
The package allows for the modelling of complex geometry to include internal screening objects. There is an inbuilt library of more than 700 surfaces in accordance with ISO 354 which gives great control over the calculation.

Advanced directivity is possible of sources to give precise predictions for directional sources including loudspeakers.

As with CadnaA, there are numerous import and export possibilities to help create models quickly and accurately.

A presentation video is available at www.datakustik.com For more details contact Campbell Associates on **01371 871030** or at **hotline@campbell-associates.co.uk**

New 3-D vibration measurement of even the smallest structures



The MSA-050-3D Micro System Analyzer

Polytec has expanded its range of solutions for vibrational analysis of the smallest components and microsystems.

The MSA-050-3D Micro System Analyzer, like its other laser Doppler vibrometers, measures vibration velocities and displacements with high precision and in real time.

The MSA-050-3D produces true spatial vibration data for each measurement point through the innovative combination of three vibrometers, providing complete movement information in three dimensions.

Full-surface measurements of components are achieved by using a high-precision XY scanning stage. Polytec's PSV scanning software package is used for efficient data analysis and a clear visualisation of the vibration shapes.

A measurement point area of only 35 µm in diameter provides high spatial resolution vibration data.

The MSA-050-3D can provide critical 3-D vibration data for the optimisation of fine mechanical components and microstructures for efficient R&D processes and rapid troubleshooting.

For more information go to **www.polytec.com/microsystems**

Soundtect range now available across Europe

A new range of acoustic panels launched by Soundtect in the UK now has distributors across continental Europe.

The panels, initially available in 11 different designs, are manufactured from recycled textiles and are themselves recyclable. Class 1 fire-rated, they aim to improve sound quality while reducing background noise and reverberation with a noise reduction coefficient of up to 0.95.

They have been designed for the hospitality, retail, commercial, education and residential sectors where noise pollution can be a problem, such as in meeting rooms, music rooms, restaurants, school halls, sports halls and shops.

All patterns feature a deeply embossed surface, giving them a sculptured and tactile feel while aiming to have an aesthetically appealing look, whether they are used as individual modules for localised sound dampening or installed across a whole wall to create an attractive and sound-absorbing feature.

The 11 initial designs range from simple geometry to floral themes and curved lines and from optical illusions to fluid shapes, raised spheres and undulations. More designs are planned, such as fun "splat" modules designed for school classrooms.

Most panels can be specified in a range of different colours including shades of black, white, grey, red, green and blue; they can also be painted to match any interior scheme.

For more information, ring **0845 548 0518** or visit **www.soundtect.com**

Tiles are available in 11 different designs


Tiles have a noise reduction coefficient of up to 0.95

New spray-applied acoustics plastering systems from CMS Danskin

CMS Danskin have launched "the next generation of spray-applied acoustic plastering systems". Fellert Even Better, has a noise reduction coefficient typically around 0,8-0,95, moving it from a Class C to a Class A absorber, and making it the most acoustically absorbent product of its kind currently available.

Fellert Even Better was tested in accordance with the room reverberation method described in SS-EN ISO 354:2003, with various Fellert finishes and alternating between 25mm and 39mm glass fibre boards and Type A and Type E-400 configurations (see table below).

Ian Bull, Business Development Manager at CMS Danskin, said: "Fellert Even Better bridges the gap between form and function, with no compromise required in terms of aesthetics or performance."

Plaster	Board thickness (mm)	Mounting	αw(-)	Absorption class
Even Better Secern/Sahara	25	A	0,80	B
Even Better Secern/Sahara	39	A	0,95	A
Even Better Secern/Sahara	25	E-400	0,70(MH)	C
Even Better Secern/Sahara	39	E-400	0,90	A
Even Better Silk	25	A	0,80	B
Even Better Silk	39	A	0,90	A
Even Better Silk	25	E-400	0,70(MH)	C
Even Better Silk	39	E-400	0,90	A


Fellert Even Better in action

Pioneering optical fibre can sense sound

An optical fibre that can sense sound has been developed by Silixa, a provider of sensing solutions for the energy, security and industrial sectors.

iDAS (Intelligent Distributed Acoustic Sensor) enables high quality digital recording of acoustic waves at every point along many kilometres of optical fibre cable up to frequency >100kHz with a wide dynamic range (>90dB).

It measures the true acoustic field every metre over up to 50km of sensing fibre. It does this by sending an optical signal into the fibre and looking at the naturally occurring reflections that are scattered back all along the glass.

By analysing these reflections, and measuring the time between the laser pulse being launched and the signal being received, iDAS can measure the acoustic signal at all points along the fibre.

iDAS measures from one end of a standard single, standard telecoms fibre; there are no special components, such as fibre gratings, in the optical path. It can even be used on existing cables, although custom cables will give a better response.

The distributed sensing system is used in a great variety of well surveillance applications including distributed flow metering, distributed seismic imaging, fracture mapping and well integrity monitoring.

iDAS technology can be combined with Silixa's distributed temperature sensor, UltimaTM DTS, to provide a continuum of benefits throughout the life of a well from exploration to drilling and completion, production and reservoir management.

Applications include: seismic appraisal at the borehole, cement evaluation, monitoring fracturing and fracture analysis, flow profiling, monitoring casing leaks, gas lift and electric submersible pump optimisation. Silixa has developed a range of advanced embedded data handling and visualisation tools to process the high volume of data generated by iDAS.

The fibre can be deployed in linear, directional or multi-dimensional array configurations. Acoustic array processing techniques allow the speed of sound in the material surrounding the fibre to be accurately determined. In multiphase flow measurement, the speed of sound can be used to profile the fluid composition such as the presence of gas in oil at different zones along the wellbore. In addition, the fluid velocity can be mapped by measuring the difference in speeds of sound due to Doppler shift introduced in the moving fluid.

In seismic application the optical fibre sensor can be installed in the well-bore, on the surface or on the seabed. Seismic data can be acquired on-demand without shutting down the production in a very cost-effective and safe way.

Mahmoud Farhadiroushan, Chief Executive Officer and co-founder of Silixa, said: "iDAS is a new tool for advancing the frontiers of dynamic acoustic sensing and imaging. The distributed fibre optic technology provides instant benefits throughout every stage of the life of a well in new ways that were not possible before."

For more information go to **www.silixa.com**

The Silixa iDAS sensor

'Hot' new range of accelerometers

A new range of piezo-electric voltage accelerometers that works at 185°C has been launched – and testing is now under way to introduce instruments that can withstand 225°C.


DJB's new acceleroremeter

The introduction by DJB Instruments is aimed at engineers working in such sectors as oil and gas, energy, aviation, aerospace, automotive and communications.

Paul Hunter, Managing Director, said: "We're confident this device will make a big difference to engineers where they are faced with the challenges of collecting data from high temperature environments. This is a step change in what is now possible."

Up until now, conventional voltage accelerometer electronics have operated within a traditional limit of 125°C which places severe limitations when working within challenging environments.

Consultant Ken Brown, who has worked with vibration transducers throughout his career, said: "This advance represents a significant cost and convenience saving over the previous alternates of charge output accelerometers with associated cabling and instrumentation or non-contact instrumentation such as lasers."

Working to a DJB Instruments design, the migration of the traditional low temperature control electronics to a high temperature SOI-based ASIC device has been carried out by GE Aviation Systems.

For more details go to **www.djbinstruments.com**

New ranges from Armstrong Ceilings

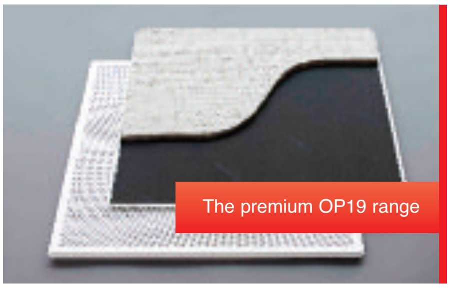
Armstrong Ceilings has extended its portfolio of metal systems with the launch of mesh metal and metal premium OP19 ranges.

The premium OP19 range comprises specially-developed 19mm acoustic mineral infills that have been factory-bonded into standard Armstrong metal ceiling tiles and panels for supply as a complete acoustic unit. This process reduces the pattern staining that can be associated with incorrectly-fitted mineral wool type acoustic pads.

Manufactured from up to 30% recycled content, the tiles are available in three perforation configurations and with a range of edge details to give light reflectance of up to 80%, relative humidity resistance of up to 95% and a sound absorption performance of up to 1.00 alpha w.

The new mesh metal range, in a range of four standard patterns and four colours to give a minimum of 16 design options, has been designed with hook-on and lay-in options for simple and economical installation on standard exposed and concealed grid systems.

Giving a contemporary design aesthetic, the different module sizes are designed to



The premium OP19 range

suit various room scales and building modules, particularly in industrial, airport and shopping centre applications, while fully-engineered and customised mesh metal ceilings are available for bespoke projects.

For more details go to **www.armstrong.co.uk**

The mesh metal range

Castle launches Vexo hand arm vibration meter

Castle Group has launched its latest hand arm vibration meter, the Vexo, which it says is the smallest and lowest cost option in its class.

The Vexo has a large colour screen, rechargeable battery pack, a big measuring range, data-logging and the simplest of user interfaces, with a switch-on and-go approach to taking measurements.

Simon Bull, Castle Managing Director, said: "The Vexo gives us the ability to offer real choice to customers when it comes to assessing human vibration."

The Vexo measures in three axes simultaneously and reports results for the individual axes as well as the overall sum and gives these as averages (Aeq), maximum levels (Amax) and peak values.

The meter has VibdataLITE software for downloading and viewing data stored on the meter.

For more details contact Dianne Hamblin on **01723 584250** or **dianne@castlegroup.co.uk**

The Vexo

New post-processing software for B&K sound meters

Measurement Partner Suite is a new post-processing software for Brüel & Kjær's sound level meters and hand-hand analysers.

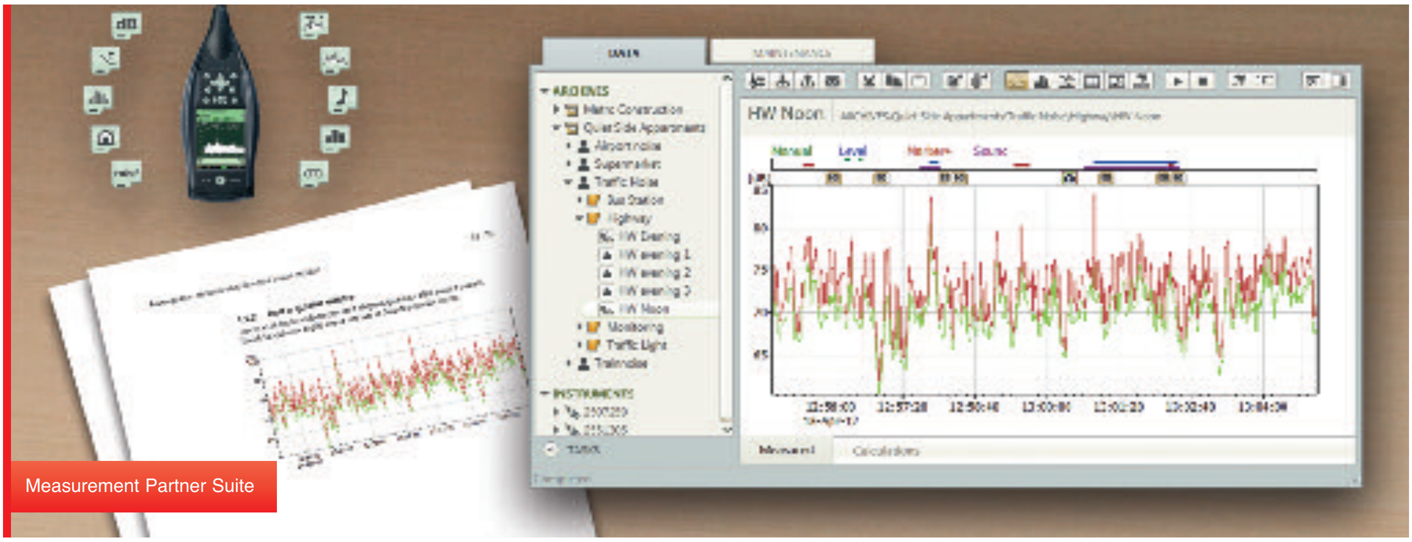
Users connect their sound level meter via USB, LAN or modem, upload their measurement data, then process and analyse their data in Measurement Partner Suite.

The most common post-processing tasks are automated, removing the need to export data to spreadsheets for analysis. In addition, the risk of errors when using and sharing spreadsheets is reduced.

Measurement data can be emailed to other users in seconds with a "pack-and-go" feature that zips and emails entire measurement archives with one click. The archive then reappears in the recipient's display automatically.

The intuitive user-interface is based on the same format as its predecessor, Utility Software for Hand-held Analysers, but with additional modules, designed on a smart-phone-like "application" principle that allows them to be activated as they are needed, on a time-limited subscription basis.

For more information, go to **www.bksv.com/measurementpartner**



Measurement Partner Suite

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Committee meetings 2012

DAY	DATE	TIME	MEETING
Thursday	12 July	11.00	Council
Thursday	26 July	11.30	Meetings
Tuesday	7 August	10.30	Diploma Moderators Meeting
Wednesday	12 September	10.30	Membership
Thursday	13 September	11.00	Executive
Thursday	27 September	11.00	Council
Monday	1 October	11.00	Research Co-ordination
Thursday	4 October	10.30	Diploma Tutors and Examiners
Thursday	4 October	1.30	Education
Thursday	11 October	10.30	Engineering Division
Thursday	18 October	11.00	Publications
Thursday	23 October	10.30	Membership
Tuesday	6 November	10.30	ASBA Examiners
Tuesday	6 November	1.30	ASBA Committee
Thursday	8 November	11.30	Meetings
Thursday	15 November	11.00	Executive
Wednesday	21 November	10.30	CCENM Examiners
Wednesday	21 November	1.30	CCENM Committee
Tuesday	4 December	10.30	CCWPNRA Examiners
Tuesday	4 December	1.30	CCWPNRA Committee
Thursday	6 December	11.00	Council

Refreshments will be served after or before all meetings. In order to facilitate the catering arrangements it would be appreciated if those members unable to attend meetings would send apologies at least 24 hours before the meeting.

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