Vol 41 No 3 May/June 2016

ACOUSTICS BULLETIN

in this issue... **The assessment of dog barking noise from boarding kennels**

plus... **42nd Annual Report of the Council**

Machine learning applied to the sonic classification of musical instrument loudspeakers

Sustainable design and practice in reproduced sound

Institute of Acoustics

ACOUSTICS BULLETIN

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The absence of a specific dog barking document is "a glaring omission" in the noise guidance library

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Conference programme 2016

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Acoustics on large infrastructure projects
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5 July
Organised by the
Musical Acoustics Group
Current developments in musical acoustics
London

5-6 September
Organised by the IOA
Acoustics 2016
Kenilworth

15-17 November
Organised by the
Electroacoustics Group
Reproduced Sound 2016
Southampton

12-13 December
Organised by the
Underwater Acoustics Group
Acoustic and environmental variability, fluctuations and coherence
Cambridge

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

Dear Members

I hope you are all had a pleasant Easter break. The Institute has had a busy and successful start to the year, as well as completing the finalisation of the annual accounts.

The audited accounts show a surplus for 2015 of £136,000. It should be noted that the profit and loss account does not include capitalisation, depreciation nor deferred income from education that is carried into 2016. A total of £21,000 of expenditure has been capitalised in 2015, depreciation was £20,000, whilst the deferred income carried from education into 2016 was £20,000.

The larger surplus is due to far higher than predicted surpluses from education, conferences and publications (advertising revenue) and the slower than expected progress on the history book, but more on that later.

Furthering our links with other institutions, the Institute and the Chartered Society for Worker Health Protection (BOHS) have been discussing for some time the recognition of each other's qualifications in certain areas. I am pleased to say the hard work and diligence by the Education Committee has now reached a conclusion with an agreement now in place. Full details appear on page 21.

Additionally we have regularly sent a representative to the Parliamentary and Scientific Committee meetings and we have joined the Campaign for Science and Engineering (CaSE).

In order to ensure we forge better links with you, our members, we have launched a new scheme enabling members to email Council. There is a need for members to be able to raise issues directly with Council in the same way constituents have the ability to contact their MP, so a new email address has been created (council@ioa.org.uk) This email is constantly monitored by the St Albans office and forwarded to the "on duty" Council member or appropriate Council member for action. It will be the responsibility of the duty members to brief Council on any issues raised during the period between Council meetings, even if they have since been resolved, so that we can ensure we are aware of items concerning you.

It is a matter of great pride that the Institute's 40th anniversary occurred during my Presidency and to mark this significant milestone we have produced the history book for you. To both members of the Institute and the wider public, I heartily commend this book. For the former, it provides a wonderfully detailed history of how our Institute has grown from small beginnings to the modern, professional, thriving and well-regarded members' body that it is today, while for the latter it provides a fascinating insight into the world of acousticians, the many diverse areas in which they specialise and why their work has and will continue to make a difference. My gratitude goes to all those involved in bringing it to print.

Lastly I wish to thank Peter Wheeler who has retired as Engineering Division Manager after 20 years, during which he oversaw the registration of scores of members with the Engineering Council. His support and patience has been a significant benefit to the IOA in developing its engineering credentials, and to many individuals with their careers. See page 21 for more details.

William Egan, President

Progress on many fronts in 2015 as membership rises again

42nd Annual Report of the Council

The Institute has continued to serve the interests of its members through its established programmes in the areas of education, professional development, meetings and publications, and by providing representation in areas such as the Engineering Council, Standardisation and International affairs.

The Trustees confirm that in the exercise of their powers as charity trustees, they have had due regard to the published guidance from the Charities Commission on the operation of the public benefit requirements and the aims of the charity are carried out for the public benefit.

The strategic aims confirmed by Council remained as:

1. To advise public policy with regard to the impact and nature of acoustics
2. Increase public awareness of good acoustic design
3. Increase understanding of acoustics by other professionals
4. Developing tomorrow's professionals
5. Providing better support for members
6. Increasing members' professional understanding.

To achieve these aims Council agreed the following objectives against which progress in 2015 is listed.

Objective	Progress in 2015
Advise policy makers on acoustics	The Institute has regularly sent a representative to the Parliamentary and Scientific Committee meetings and has joined the Campaign for Science and Engineering (CaSE).
Increase public awareness of good acoustic design	The Peter Lord Award for outstanding acoustic design was awarded in 2015. The Institute sponsored the *In Pursuit of Silence* film which had world premiere in 2015. The UK premiere is planned for 2016.
Create opportunities for other professionals to gain a better understanding of acoustic and its interaction with their specialist field	Joint activities have taken place with young members of other professional institutes. The Institute has contributed to debates on Engineering for the Future and the Nature of 21st Century Engineering Professional Institutions. ProPG guidance document on noise sensitive development jointly commissioned with the ANC; out for consultation in January 2016. Supplementary guidance notes have been out for consultation related to amplitude modulation of wind turbine noise.
To develop links with undergraduate students	The student e-zine was produced twice and student membership increased from 80 at the end of 2014 to 377.
To support the teaching of acoustics at AS/A2 level	Under review awaiting results of Government Consultation on Physics AS/A2 syllabus.
To improve the operational efficiency of the Institute	Further improvements have been made to the website: library catalogue online, members' annual register snapshot available to members.
To develop mechanisms for supporting members professional development	10% monitoring of members CPD continued. Series of conferences and events held during the year, including online events attended by groups across the UK. Major market research study undertaken to identify needs of members and sector over next 5 -10 years; currently being analysed.

Standing Committees

The operation of the Institute is guided by Council through standing committees concerned with Education, Engineering, Medals and Awards, Meetings, Membership, Publications and Research Co-ordination. The reports of the various committees follow.

Education Committee

The Diploma and Certificate courses have continued to provide education and training for both members and non-members of the IOA. The education programmes and courses introduce many working in acoustics and associated professions to the Institute and support the recruitment of new members.

The Diploma in Acoustics and Noise Control is now in its eighth year since revision in 2008. As a result of grades obtained in 2014/15, the Diploma was awarded to 75 students from four universities (Derby, Leeds Beckett, London South Bank and Southampton Solent) and four distance learning (DL) centres (Bristol, Dublin, Edinburgh and St Albans). Sadly the Diploma will not be offered at Salford or NESCOT for the foreseeable future and Colchester and Ulster have not recruited sufficient candidates to run the course at their centres. Sarah Wakely (DL St Albans) won the prize for best overall performance and Aoife Kelly (DL Dublin) for the best performance by an Irish student. Nine students received special commendation letters for achieving five merits. The committee continued to monitor the effects of the changes in higher education funding on students and centres, and is developing options for electronic delivery of learning materials. Newly acquired video tutorial facilities at St Albans are in operation for overseas candidates and DL candidates at St Albans.

In 2015, the numbers taking and passing the Certificate Courses were as follows: Hand-Arm Vibration, 18 students, 12 passes; Environmental Noise, 170 students, 154 passes; Building Acoustics Measurement, 41 students, 37passes (including presentations made for the first time in Ireland and Scotland); Workplace Noise Risk Assessment, 37 students, 32 passes. The Certificate of Proficiency in Anti-Social Behaviour (Noise) continues to be run in Scotland by Bel Noise Courses (now delivered by Alistair Somerville and Lilianne Lauder following the retirement of Cameron Procter) and by Strathclyde University, 33 students, 31 passes.

Since 2011, Diploma members have been able, for CPD or other reasons, to register for additional specialist modules. Nobody has taken advantage of this opportunity in 2015. However, in view of recent changes in Planning and Assessment regulations and guidance, there is the possibility of increasing numbers on the Regulation and Assessment of Noise Module by promoting it as "standalone" updating. The committee is also keen to work with groups and branches to support "formal" CPD, where there is a defined syllabus and assessment of learning outcomes. This may include on-line learning and topics for consideration include "sustainable acoustics", new acoustic guidance (e.g. BS 4142:2014, BB 93:2014, BS 8233:2014) and devolved guidance (e.g. Eire, Scottish, Welsh and Northern Ireland Building Regulations).

In 2012 Council approved the purchase of sets of demonstration equipment to support the "You're Banned" acoustic workshop for presentation to schools. Five "You're Banned" presentations were given during 2015. Also, through Acoustics Ambassadors on the committee, opportunities for promotion of acoustics to school children continue to be monitored and pursued (for example the Big Bang Fair).

Simon Kahn (chairman) represented the Institute at a meeting of the Parliamentary and Scientific Committee at the Houses of Parliament for discussion on the Science Legacy for the next parliament.

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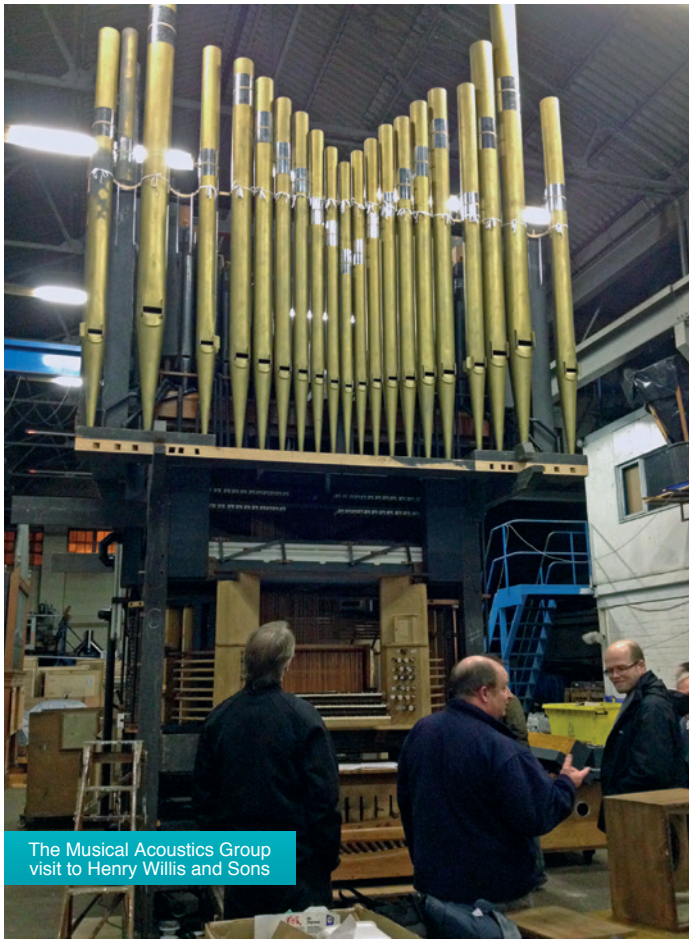

The Musical Acoustics Group visit to Henry Willis and Sons

Richard Perkins with Rita (left) and Joan McCullagh at the Gerry McCullagh Lecture

Pam Lowery at Noise impact assessment and development constraints

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The committee continues to be indebted to the support of its members, course tutors and examiners, the work of the Education Manager Keith Attenborough, supported by Education Administrator Hansa Parmar and other members of office staff.

Engineering Division Committee

The committee met three times during the year, confirming approval of registration for candidates. The number of inquiries for registration from Institute members remained strong, but many potential candidates still deferred or failed to complete their applications, despite the personal support provided. A relaunch of the Engineering Division mentoring policy has seen more, and better prepared candidates through to interview.

The number of formal applications for Chartered Engineer and Incorporated Engineer registration was a record. Eleven candidates presented themselves for Professional Review Interview, of whom six were "Standard Route" candidates, holding accredited degrees, and five were "Non-standard Route" candidates with diverse backgrounds, including physics degrees. Ten candidates were successful and one will return for a second interview.

Medals and Awards Committee

The majority of the 2015 awards were made at the Autumn Conference in October.

The Raleigh Medal was awarded to Professor Sir Harold Marshall and the R W B Stephens Medal to Professor Barry Gibbs. The A B Wood Medal 2014 was awarded to Dr Alexander (Sander) von Benda-Beckmann and the 2015 to Dr Ying-Tsong Lin. The Peter Lord Award was awarded jointly, to Arup Acoustics and to the Res Team and Villapennisinmusica.

An Honorary Fellowship was awarded to Martin Lester for his exceptional service to acoustics and the Institute. Kevin Howell also received this award.

Siegfried Linkwitz was awarded the Peter Barnett Memorial Award and Daniel Elford and Andrew Elliott shared the Young Person's Award for Innovation in Acoustical Engineering. Jen Taylor was presented with an award for the best performance in the IOA's 2014 Diploma and Manal Alfakhri and Arthur Vermuelen shared the Professor D W Robinson Prize awarded at their graduation ceremony at ISVR in July.

Meetings Committee

The committee met four times in 2015.

The membership of the committee has remained fairly constant since last year's report. The chairman remains Hilary Notley and Chris Turner remains as secretary and young member. Jeremy Newton (deputy chairman), Chris Skinner and Robin Woodward continue to be valued members of the team. They were joined by Martin Lester towards the end of the year and his contribution is already apparent. Peter Rogers has kindly agreed to continue being co-opted to allow the meetings programme to be designed with the aims of the Sustainable Design Task Force in mind at all times. The format of the meetings has recently been restructured with each member having his/her own responsibilities to report on throughout the year.

The committee presided over the organisation of 13 events covering a wide variety of topics. There were nine one-day meetings/workshops and three two-day events: an underwater acoustics conference, Reproduced Sound and Auditorium Acoustics held in France. Last, but by no means least, there was also the annual flagship event – Acoustics 2015. The feedback from the events' questionnaires in general continues to be very favourable and many of the proposals for future meeting topics are passed to the relevant specialist group.

Acoustics 2015 was held in Harrogate and, following feedback, this year took place over one day only. The event was judged to have been a success and sold out in advance. One hundred and eight-five attendees took the opportunity to attend a choice of excellent papers from five parallel sessions throughout the day. Delegates also enjoyed the poster display and exhibition. Feedback was good and those that attended generally found it worthwhile. However, a number of people commented that they would like to see a P10

London Branch members visit the Whitechapel Bell Foundry

Ying-Tsong Lin receives the AB Wood Medal from IOA President William Egan

Senior Members' Group visit to Farnborough Air Sciences Trust

Young members at an inter-institutional event in London

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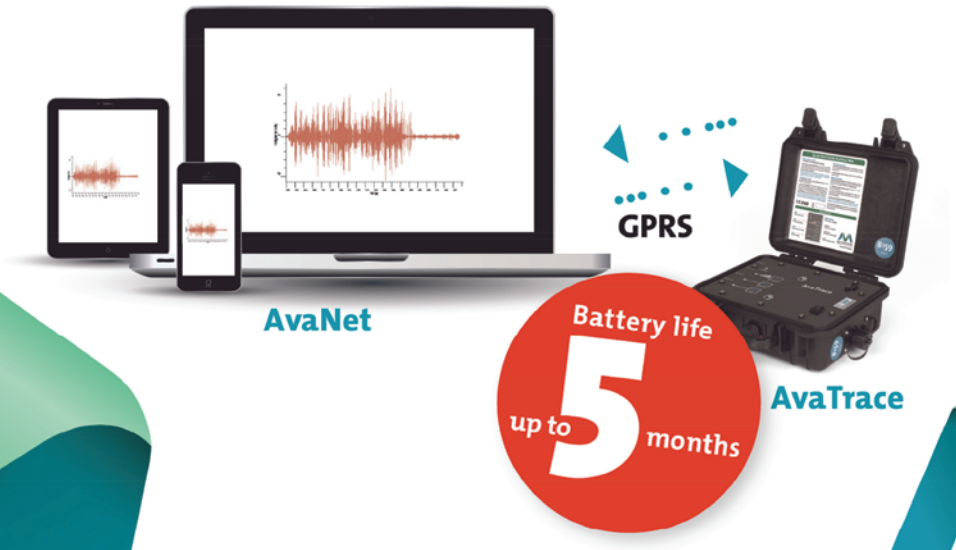

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return to the two-day format and so this is the challenge that the committee will be working on in the coming months.

The financial performance of meetings has continued to be closely monitored and we continue to review performances and learn from our experiences so that deficits may be minimised in the future and events continue to generate a moderate surplus. This year the committee saw a surplus of around £40,000, about four times the target.

Membership Committee

The committee met four times during 2015, during which Council confirmed Paul Freeborn as chairman for three more years. Chris Stopford resigned from the committee due to pressure of work, but Steve Dance was welcomed as a representative of members from academia and Rebecca Salmon joined as a representative of local authority members.

The Continuing Professional Development (CPD) subcommittee continued its work of reviewing CPD records of five per cent of members and offering advice where appropriate including providing examples of records on the website.

Nine Code of Conduct complaints were received during the year of which six were not proved. One was held in abeyance due to active planning issues and two are still actively being considered.

In order to speed up the approval of new and upgraded members, Council now vote by email on the committee's recommendations rather than waiting for the next Council meeting.

The committee's recommendation to Council that AcSoft should be invited to become a key sponsor of the Institute was approved by Council and AcSoft accepted the invitation.

Following some confusion over the interpretation of rule A1.2 of our Code of Conduct the rule was revised to provide greater clarity.

During the year 328 membership applications were assessed by the committee; a very similar number to the previous year. Of these 318 were elected to membership of various grades, representing a small increase on the previous year's figures.

2015	FIOA	MIOA	AMIOA	Tech	Affil	Sponsor	Total
Applicants	9	117	158	36	5	3	328
Elected	9	111	143	41	11	3	318
New Members	0	44	139	32	5	3	223
Resigned	2	26	12	2	2	3	47
Deceased	1	5	0	0	0	0	6

Publications Committee

Acoustics Bulletin and *Acoustics Update* continue to provide a high standard of technical content, reporting news and details of the Institute's meetings and affairs.

During 2015 the main changes resulting from publications activities are the library catalogue coming on-line, allowing members to search the website and find out what is in the library at St Albans, and the blog on the website managed by the Young Members' Group. Behind the scenes there have also been improvements in the running and organisation of the committee.

After the uptake of the electronic Bulletin the committee investigated having a specific electronic version. However, following some mock-up work and reviewing the costs and benefits the decision was taken to retain the primary focus on the paper version, retaining the look and format of the current Bulletin for now. As a result the current PDF will remain the electronic version for the near future.

Developments for 2016 include further work on abstracts and proceedings, and the greater use of social media.

During the year the committee has been joined by Matthew Cassidy and Jordan Mayes, with Rebecca Hutt leaving. Thanks are due to all committee members for volunteering their time and enthusiasm throughout the year: Daniel Goodhand,

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Barry Gibbs delivers the RWB Stephens Medal lecture at Acoustics 2015

Martin Lester (left) receives an Honorary Fellowship from IOA President William Egan

Mark Dowie (centre) discusses a point at Acoustics 2015

Nicky Shiers at Acoustics 2015

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James Hill, Mike Lotinga, Allen Mornington-West, Seth Roberts and Bob Walker. Thanks are also due to IOA office, Charles Ellis, Allan Chesney and Dennis Baylis. Lastly, thanks are due to everyone who contributes to the Bulletin and website with meeting reports, technical contributions, letters, book reviews, blog posts and everything else.

Research Co-ordination Committee

During 2015 the committee met in May and November at the Defra offices in London. The committee welcomed one new Tier 1 member, Jon Richards of KBR, a global technology, engineering, procurement and construction company serving the hydrocarbons and government services industries. This appointment made the committee more balanced in terms of the engineering noise control and technology expertise. The committee proposed an amendment to the Terms of Reference (ToR) document which reflects the new more democratic mechanism for the election of new members and membership rotation within the RCC. This document was discussed and approved by the committee at the November meeting.

The committee continued to review the current level of research funding related to acoustics and maintained close contacts with the EPSRC. In May 2015 the total value of grants related to acoustics, ultrasonics, audio engineering, noise and vibration funded by the RCUK was estimated at £140.9 million (140 active grants). The committee noted that the government comprehensive spending review (CSR) resulted in approximately 30% funding cuts for Defra and some other government departments. These cuts are likely to affect the UK's capability to carry out noise-related research. No cuts to the RCUK budget were proposed as a result of the CSR. The committee noted that it makes sense for Defra and Public Health England to work more closely with the RCUK and the Horizon 2020 Programme to ensure that the noise-related research in the UK is adequately supported.

In order to promote acoustics as a research discipline the committee is organising the *Acoustics research challenges in the 21st century* workshop which will be held at the Royal Society in London on15 April 2016. This workshop will bring together both academic and industry researchers working in acoustics. It will enable IOA members and other professional bodies to discuss the challenges that acoustics research faces in the UK in the 21st century and, most importantly, to explore actions which could help mitigate the impact of the funding cuts on this important science discipline. The workshop will be also attended by a representative of the EPSRC (Neil Viner) and KTN-UK (Fiona Kilkelly). Dame Professor Ann Dowling will give a keynote address.

These and other actions are detailed in the meetings notes which were submitted to the Institute in a timely fashion following meetings.

Specialist Groups

Building Acoustics Group

The annual conference in Harrogate was sold out and well received. BAG organised a full day of papers as well as contributing to the physical acoustics session which had sessions on cross-laminated timber structures and the acoustic issues associated with them. The multi-room concept worked well but the dinner was missed and we are looking forward to the 2016 autumn conference which will be over two days with fewer parallel sessions – and a dinner in between.

We were excited to see the success of the *Acoustic design of sustainable buildings* meeting, which was the first event with a multi-venue link up. We are hoping to learn from this experience for future events to make them more affordable and accessible to a much wider audience.

A special thank you goes to Mike Barron for organising the Auditorium Acoustics conference in Paris on behalf of BAG. This was hugely successful and attracted the best talent from around the globe.

Our members have also been busy with writing and consulting on several acoustic documents including the *Acoustics of Schools – a design guide*, CIBSE guide B4, good practice guide on the control of noise from places of entertainment and many more.

I would like to personally thank all of my committee members and everyone else who provides their valuable time for free – it is essential for the success of our profession in the years to come.

The acoustics industry in UK buildings is extremely buoyant and we are looking forward to the new opportunities that this brings. We wish you all success for 2016.

Electroacoustics Group

As in previous years, the group's main activity during 2015 was the organisation of the annual Reproduced Sound conference. The organisational tasks were once again spread amongst the committee members, each of whom had a defined role, so making this very much a team effort. The conference took place in November at the Fire Service College in the Cotswolds. This is the first time that this venue has been used for an IOA conference and, although delegate numbers were lower than we would have liked, the atmosphere and "buzz" which are hallmarks of RS conferences were very much in evidence. The Peter Barnett Memorial Award was presented at the event to Siegfried Linkwitz, who gave a fascinating talk on the magic in two-channel sound reproduction. At the EAG AGM, held at the conference, Sam Wise retired from the committee after many years of service, including as chairman, and the committee welcomed back another past chairman, Robin Cross, who re-joined. The group committee met on three other occasions during 2015. On 6 January we met at the Fire Service College to decide the call for papers for the conference, the abstracts were reviewed and the programme was mapped out on 1 June and the details of the conference were finalised on 21 September. The conference is moving venue again for 2016 to Southampton. It will be held on 15-17 November.

Environmental Noise Group

Through 2015 the Professional Practice Guidance on Planning and Noise (ProPG Planning and Noise) committee met regularly drafting national guidance to fill the gap left by the repealing of Planning Policy Guidance 24. The committee has eight IOA members working with representatives from the Chartered Institute of Environmental Health and the Association of Noise Consultants, and has been sponsored by all three organisations. In January 2016 the working group published the consultation draft: *Professional Practice Guidance on Planning and Noise: New Residential Development*. Consultation events in London and Manchester in March will begin the next stage of work to develop the draft into formal guidance.

2015 was a quieter year for public consultations, with the committee considering various consultations but responding to only one, the House of Lords Call for Evidence on the Built Environment, on which we worked with the Buildings Acoustics Group in September.

The group made a substantial contribution to the IOA's annual conference, Acoustics 2015, in Harrogate in October with a full day session comprising seven papers.

Measurement and Instrumentation Group

During 2015, the group has organised two one-day meetings and a webinar.

Following a trial webinar amongst the group committee members, the chairman, Richard Tyler, produced a presentation entitled *Are you sure you're calibrating your sound level meter correctly? Are you really sure?* which took place on 20 March. The topic proved very popular as 214 registered for the event, which was broadcast live. Unfortunately, the IOA system at present allows for 100 participants only, so many people were disappointed, which was very unfortunate. This aspect of webinars needs to be properly sorted before more on this scale are worth undertaking. However, the group remains committed to supporting this type of approach.

The other group events were a BS 4142 workshop, held on 19 May at the Royal Society and organised by Mark Dowie and Tony Higgins, and *Sound sensing in smart cities*, held on 26 November at the Old Fire Station, Salford and organised by Ben Piper.

Over the past year, the group committee members have continued contributing to the regular Instrumentation Corner article in *Acoustics Bulletin*. There have been 38 to date, producing some interesting articles and discussions, and they are scheduled to continue in 2016.

For 2016 the very successful BS 4142 workshop will be re-run at Austin Court, Birmingham on10 March.

My thanks go to all members of the committee for the active roles they take in all aspects of the group's activities.

Richard Tyler, founder chairman, stood down on 27 August, and Martin Armstrong stood down as secretary after 14 years on 8 December. John Shelton was elected chairman on 27 August and Susan Dowson elected secretary on 8 December. My thanks go to Richard for his skill in guiding the group and to Martin for his secretarial skills on behalf of the group, and I am pleased to say they will continue as active members.

Musical Acoustics Group

The group had another fulfilling year in 2015. First up was a visit at the Liverpool workshops of the renowned organ builders Henry Willis & Sons Ltd in February which around 20 members attended. This old-established firm was founded in the 19th century by Henry – "Father" – Willis who rose to fame by his organ built for the 1851 Exhibition at the Crystal Palace. This included a tour of the workshops where members were introduced to the traditional crafts of pipe-making.

Kingston University was the venue for the first ever joint one-day meeting by the Musical Acoustics and the Speech and Hearing Groups held in July. The focus was to address a longstanding need to explore better ways to improve the musical experience for listeners and performers with hearing loss, including those with tinnitus and hyperacusis. However, whilst being successful, it soon became clear that improvements were needed in transmitting the sound from the presenters to some members of the audience and the need for hearing loops at all IOA meetings was very clear. During this meeting, the group held its AGM and Stephen Dance from London South Bank University and Jemma Jones, the Young Person's Representative, were welcomed to the committee.

In September a crammed day of presentations were given in association with Galpin Society, the Royal Musical Association and the University of Cambridge in the glorious surroundings of the university's Faculty of Music. The conference ran over three days and the 29th September was devoted to the acoustics of musical instruments, opening with a keynote paper entitled *Why do light gauge strings sound brighter?* by Professor Jim Woodhouse of the University of Cambridge. This was followed by 11 more papers, poster sessions and a tour of Rubio Harpsichords of Cambridge. In the evening, delegates attended a splendid feast in the refectory at Selwyn College.

Acoustics 2015 at Harrogate saw the Musical Acoustics and Speech and Hearing Groups again joining forces. It attracted four papers on quite a diverse range of topics which included Patrick Gaydecki (University of Manchester) giving a fascinating talk on the "V Sound" system – a DSP package designed to enable an inexpensive electric violin. This was followed by Andrew Morgan giving a paper on the voice as a tool for healing – the role of the voice in holistic approaches to therapy and David Carugo (Oxford Brookes University) describing his development of a three-dimensional microphone array system for making acoustic measurements of musical instruments whilst played "under performance conditions".

The management committee held five meetings during the year and progress for further meetings in 2016 is under way.

Noise and Vibration Engineering Group

Two full committee meetings were held during the year, by teleconference in both cases, supplemented by a number of sub-group meetings to focus on planning for particular events. Unfortunately, the work commitments of individuals on the committee prevented any stand-alone meetings from being

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organised, although a contribution was made to organisation of the autumn conference.

Over the past 12 months we have been rejuvenated to some extent by Ashley Gillibrand from Jaguar Land Rover and Nathan Thomas from Dyson joining the committee, both of whom have a useful agenda of trying to attract membership from a wider range of industries into the Institute. As a result we are actively planning a meeting on NVH (Noise Vibration and Harshness) in 2016, to complement plans for a session on numerical modelling in acoustics at the autumn conference and tentative plans for a meeting on underwater noise from ships.

Physical Acoustics Group

In 2015 we re-established this specialist group by forming a small interim committee to organise a session of papers at Acoustics 2015 in Harrogate. A small start, but hopefully something we can continue in years to come. It is our intention in 2016 to form an established elected committee and support Acoustics 2016 in a similar way to last year, and eventually our goal is to hold our own regular meetings.

Physical acoustics is the fundamental science that underpins all we do as acousticians. We seek to find out how sound is generated, how it propagates and how our measurements are influenced by physical acoustics-based phenomena. Such examples like fluid mechanics, transfer coefficients, electro-statics, and meta-materials, are not well understood outside specialist circles. Therefore, it is the PAG's responsibility to disseminate useful theory, news of emerging technologies and to raise awareness of what physics acoustics is about, and how relevant it is. The list of potential topics for discussion seems almost endless.

We will continue to coordinate activities with the Institute of Physics who currently play a major part in the UK's contribution to general physical acoustics activities. However, we should strive to have our own programme of events that can link the theoretical science to commercially exploitable technology for our own membership.

We believe that the IOA's position as a professional institute is stronger with active specialist groups and branches that can represent and satisfy the diverse needs of the membership. So we as an institute can provide a sustained service, we would like to hear from the general membership about, ideas for meetings, your papers in the pipeline and offers of help from those who would like to spend a few hours a year to support our activities. We need to show that physical acoustics is relevant to the membership and our objective is to have physical acoustics-based topics more accessible.

Senior Members' Group

All communications have been by email, particularly with the committee, and this seems to have worked well. We also use *Acoustics Update* from time to time.

The AGM was held in conjunction with a meeting entitled *The ear and hearing – a tutorial for acousticians* on 29 January at the Keyworth Centre, London South Bank University.

A one-day meeting, open to all IOA members, was held on 1 October, when the group organised a successful visit to the Farnborough Air Sciences Trust. The trust is a charity dedicated to save most of the historically important buildings and artefacts from the former Royal Aircraft Establishment (RAE) and to make them available to the public. The trust museum, housed in one of the original HQ buildings, was opened in 2003. This successful meeting was fully reported in the Bulletin.

The SMG continued to support the work of the CPD Committee throughout the year.

The revised terms of reference for the group were finally approved by Council.

Chairman Ralph Weston has one more year after which he will stand down. He wishes to thank the committee for its support and contributions to the group, especially the secretary, Mike Forrest. Our AGM and half-day meeting will be on 21 April at IOA headquarters.

Thomas and Anne Budd at Acoustics 2015

Elena Shabalina at Reproduced Sound 2015

Alistair Somerville raises a question at Reproduced Sound 2015

Sam Wise at Reproduced Sound 2015

Speech and Hearing Group

The group co-hosted one event, jointly with the Musical Acoustics Group, during 2015. This was a one-day meeting entitled *Hearing impairment and the enjoyment and performance of music*, held at Kingston University in July. This attracted a good range of talks and a few poster presentations relating to different aspects of the theme, and was attended by delegates from the musical, clinical and educational sectors who participated in lively discussion on the presentations.

The group continues to liaise with other professional bodies (such as the British Standards Institute, the Royal College of Speech & Language Therapists and the British Society of Audiology) and also other specialist groups (including the Building Acoustics and Musical Acoustics Groups) and local branches of the Institute regarding topics of mutual interest. Joint meetings in collaboration with some of these are being planned for the future.

The group committee met twice (in February and December) during 2015. During the course of the year, long standing co-opted member Roz Commins stood down, and was replaced by Pippa Wilson, a speech and language therapist working on voice care. Dr Bradford Backus, an ordinary member of the committee and specialist in cochlear implants, asked to stand down from the committee. Dr Cleopatra Pike, a speech perception specialist, was appointed a co-opted member in December. Dr Emma Greenland, who had been on the committee since the group had been re-formed in 2007 and a former chairman, returned from maternity leave, but subsequently asked to stand down late in the year. Replacements for Dr Backus and Dr Greenland as ordinary members of are being sought.

Underwater Acoustics Group

The group's main endeavour continued to be the dissemination of knowledge via its conferences and other activities. Members of the committee helped with the organisation of *Oceanoise 15*. Steve Robinson held a session on piling noise and Paul Lepper held a session on marine renewables. Two sessions were organised at UAC 2015 on Crete in June: a hydrophone calibration session run by Steve Robinson and one on fluctuations in underwater acoustics organised by Peter Dobbins. Both attracted several contributions. The 2014 AB Wood Medal was awarded to Alexander von Bender-Beckman at this conference.

A meeting on *Seabed and sediment acoustics* at the University of Bath was highly successful with 90 attendees and 54 papers. The IOA President, William Egan, presented the 2015 AB Wood Medal to Ying-Tsong Lin at this conference.

Several members of the committee are currently in ISO working groups developing new International Standards for under-water acoustics. The group is now dedicating its efforts to future meetings, including a conference on *Acoustic and environmental variability, fluctuations and coherence*, which will be held at the Möller Centre, Cambridge University on 12-13 December 2016, and one on synthetic aperture sonar in Lerici, Italy, to be held in 2017. Beyond that, a bioacoustics conference is planned for 2017 at Loughborough University.

Young Members' Group

The group committee meets quarterly with three meetings by telecom and one meeting in person. In 2015 our face-to-face meeting was held in December in London, which was then followed by a social gathering of the committee.

We held a good number of educational events in 2015 including a successful mock planning appeal event in Birmingham and a CPD event at the V&A Museum, where YMs were given a pres-entation and tour of the Exhibition Road Project, on the protection of highly sensitive spaces within the museum from the adjacent demolition and construction works.

Our biggest achievement of the year was our inaugural Inter-Professional Networking Event held in August. It brought together young members from five different professional institutions – the IOA, Landscape Institute, IMechE, CIBSE and Institution of Fire

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Engineers – for an evening of informal networking. It was very well received and we are hoping to repeat the event in 2016 with more institutes involved.

To promote the IOA to students we gave presentations at the University of Salford and the University of Southampton about the benefits of IOA membership and chartership. To promote the IOA further afield we took part in an inter-professional football tournament in London.

We have new young member reps for the Yorkshire and North East, Southern and Scottish Branches, who are enthusiastic and interested in being active members of the committee.

For the year ahead we aim to present to students at more universities (e.g. Anglia Ruskin University, Southampton Solent University, University of Derby, University of Liverpool, Edinburgh Napier University, and University of Edinburgh). We are hoping to organise a joint event with the Research Committee, to provide a day of talks to PhD students on acoustics in the real world. We are also hoping to provide more events outside of London and repeat our successful events by holding a mock planning appeal in Basingstoke and the Inter-Professional Networking Event in London. We've kicked off the year with a monthly blog which is posted on the IOA website and promoted through the IOA social media platforms.

A full copy of the report, which includes regional branch reports, can be found in the publications section of the website.

Grade	2014	2015
Hon Fellow	38	38
Fellow	174	175
Member	1761	1789
Associate Member	758	772
Affiliate	58	57
Technician Member	100	125
Student	80	377
Totals	2969	3333
Founding Key Sponsor	0	2
Key Sponsor	2	1
Sponsor	49	46

Table 1. Membership

Group	2014	2015
Building Acoustics	1357	1475
Electroacoustics	387	434
Environmental Noise	1723	1804
Measurement & Instrumentation	641	711
Musical Acoustics	377	433
Noise and Vibration Engineering	1123	1215
Physical Acoustics	246	285
Senior Members	116	122
Speech & Hearing	214	243
Underwater Acoustics	236	264
Young Members	266	324

Table 2. Group membership

Branch	2014	2015
Central	222	244
Eastern	276	291
Irish	126	134
London	843	881
Midlands	397	446
North West	387	404
Overseas	331	341
Scottish	171	193
South West	270	297
Southern	490	517
Welsh	74	80
Yorks and North East	220	243

Table 3. Branch membership

Employment Category	2014	2015
Architectural Practice	183	324
Consultancy	1654	1914
Education	419	602
Industry/Commerce	380	634
Public Authority	401	437
Research & Development	428	623
Retired	135	141
Other	142	185

Table 4. Details of employment

Topics, Date & Venue	Attendance
The Ear and Hearing – a tutorial for acousticians *29 January - London*	57
The Art of Being a Consultant *15 April - Southampton*	41
Noise Impact Assessment & Development Constraints *13 May - Birmingham*	80
BS 4142:2014 *19 May - London*	90
Amplitude Modulation in Wind Turbine Noise *11 June - Newcastle*	36
Hearing Impairment and the Enjoyment of Music *9 July - London*	29
Seabed and Sediment Acoustics *7-9 September - Bath*	77
Acoustic Design for Sustainable Buildings *17 September - London*	71
Acoustics 2015 *15 October - Harrogate*	185
Auditorium Acoustics *29-31 October - Paris, France*	175
Reproduced Sound 2015 *10-12 November - Moreton-in-Marsh*	66
Sound Sensing in Smart Cities *26 November - Salford*	66
What the Numbers really Mean *7 December - Watford*	68

Table 5. Meetings and attendance in 2015

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Sound Masking

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Open plan offices benefit from Sound Masking

Cellular offices achieve better speech privacy with Sound Masking

Sound Masking is a cost effective solution to the problem of improving speech privacy in today's modern office environment. Best installed during office fit out but often installed as retrofit, Sound Masking from AET has improved the office environment for many international companies throughout Europe over the last 20 years.

In today's office speech privacy becomes a key aim and open plan offices can suffer from two speech problems:

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- Confidential conversations can be almost impossible to conduct

Similar problems also exist in cellular offices. Apart from noise breakthrough via partitions, flanking over, under and around them, other problem areas include light fixtures, air conditioning systems and services trunking. Sound masking compensates for these problems.

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- BP

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Sound Masking is also known as sound conditioning or white noise systems

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Officers		Ordinary Members
President	Mr W Egan MIOA	Dr K Holland MIOA
President Elect	Miss J Webb FIOA	Mr R Mackenzie FIOA
Immediate Past President	Prof B M Shield HonFIOA	Ms H Notley MIOA
Honorary Secretary	Mr J R Richardson MIOA	Mr P J Rogers FIOA
Honorary Treasurer	Mr D Wallis MIOA	Mr A W M Somerville MIOA
Vice Presidents		Mr D L Watts FIOA
Engineering	Mr R A Perkins FIOA	Dr P Lepper MIOA
Groups & Branches	Mr G Kerry HonFIOA	Mrs Claire Parsons MIOA
International	Dr W J Davies MIOA	Miss Emma Shanks MIOA
Committees & Sub Committees	**Chair**	
Education	Mr S W Kahn MIOA	
Diploma in Acoustics and Noise Control, Board of Examiners	Mr S J C Dyne FIOA	
Certificate of Competence in Environmental Noise Measurement	Dr M E Fillery FIOA	
Certificate of Competence in Workplace Noise Assessment	Mr D Lewis MIOA	
Certificate of Proficiency in Anti-Social Behaviour (Scotland) Act 2004 (IOA/REHIS)	Mr S Williamson MIOA	
Certificate in the Management of Occupational Exposure to Hand Arm Vibration	Mr T M South MIOA	
Certificate of Competence in Building Acoustics Measurement	Mr J Battaner-Moro MIOA	
Engineering Division	Mr R A Perkins FIOA	
Medals & Awards	Mr W Egan MIOA	
Meetings	Mrs H Notley MIOA	
Membership	Mr P T Freeborn FIOA	
Publications	Mr A Lawrence FIOA	
Research Co-ordination	Prof K Horoshenkov FIOA	
Specialist Groups	**Chair**	**Secretary**
Building Acoustics	Mr R O Kelly MIOA	Mr J Healey MIOA
Electro-Acoustics	Mr K Holland MIOA	Ms H M Goddard FIOA
Environmental Noise	Mr S C Mitchell MIOA	
Measurement & Instrumentation	Mr J Shelton MIOA	Mrs S Dowson MIOA
Musical Acoustics	Mr M Wright MIOA	Mr D Sharp MIOA
Noise and Vibration Engineering	Dr M G Smith MIOA	Mr S Stephenson MIOA
Physical Acoustics	Mr M Swanwick FIOA	
Senior Members' Group	Mr R J Weston MIOA	Mr M R Forrest MIOA
Speech & Hearing	Dr G J Hunter MIOA	Mr D Nash MIOA
Underwater Acoustics	Dr P F Dobbins FIOA	Mr A P Holden MIOA
Young Members' Group	Ms A Lamacraft MIOA	Ms E Keon MIOA
Regional Branches	**Chair**	**Secretary**
Central	Mr R A Collman MIOA	Mr M Breslin MIOA
Eastern	Mr M Jones MIOA	Mr H Cass MIOA
Irish	Dr M R Lester FIOA	Mr S Bell MIOA
London	Mr J E T Griffiths FIOA	Ms N Stedman-Jones MIOA
Midlands	Mr P J Shields MIOA	Ms F Rogerson MIOA
North West	Mr M Hewett MIOA	Mr P Hargreaves MIOA
Scottish	Mr A W M Somerville MIOA	Mr M Butterfield MIOA
Southern	Mr P Rogers FIOA	Mr D Saunders MIOA
South West	Mr D C Pope MIOA	Mr D O'Neil MIOA
Welsh	Mr G O Mapp MIOA	
Yorkshire & North East	Prof K Horoshenkov FIOA	Mr O Downey MIOA
Chief Executive: Mr A Chesney		

Table 6. Council

BS 4142:2014 workshop

By Tony Higgins, Enviroconsult

Austin Court, Birmingham saw an update of the BS 4142:2014 presentation run by the IOA Measurement and Instrumentation (M&I) Group last year.

The workshop was intended to address how the standard has been used by practitioners, specifically dealing with the practicalities of measurement to the new standard. In particular, it sought to identify problem areas and provide practical advice on reporting. As previously, this update drew a mixed group of attendees from both consultancy and local authorities.

John Shelton (AcSoft) as Chairman of the M&I Group opened the meeting and introduced the first speaker.

Stephen Turner (STAcoustics) went on to provide an overview of the standard. He reviewed the historic development of the standard showing how it had evolved over time, remarking that some of the principles we work with today had been identified in the Wilson Report in1963. Stephen highlighted the main differences between the 1997 version of the standard and the current 2014 version. These included the use of the word "sound", the different assessment outcome (size of impact rather than likelihood of complaint), and the different method for determining the rating level. He observed that the assessment outcome lined up reasonably well with the language of the English National Planning Policy Framework and the Noise Policy Statement for England.

Stephen said that care was needed in the interpretation of the word "context" within the standard, which arguably had different meanings depending on the issue. Stephen finished by suggesting that, given the way the rating level can be defined, more care was needed in using a desired rating level in a planning condition. He also thought that there was now no justification for using solely the external difference between the rating level and background level to judge the impact of industrial and commercial sound at night. Internal levels should also be considered.

Tony Higgins (Enviroconsult) provided a practical review of the standard and specific policies for a particular case study. Tony provided a practical example using the standard linking to other standards and observations in order to provide context. Tony also emphasised the need for any report to be directed to the needs of the regulator, echoing Stephen's comments in respect of the use of BS 4142 as "one of the elements" in use for helping determine impact. Tony reminded the delegates that noise readings should not replace observations where we seek to identify impacts. Tony provided some practical examples of how this could be achieved within the case study. The key message was that acoustic consultants liaising with their regulators to agree methodologies and reporting styles would help reduce potential tension, particularly where acoustic correction factors needed to be applied or representative background or residual levels identified.

Jon Tofts (Environment Agency) dealt with questions on correction factors and carrying out the assessments, having spoken about the practicalities of measurement. Jon expanded on his previous presentation by providing additional material on the practical use of acoustic correction factors and provided some context for their use. In particular Jon provided practical advice for identifying impulsive and tonal sounds. Jon's view was that it was best to use a risk-based approach when deciding which method to use, and that the objective and reference methods were best suited to the more contentious cases. For impulses, Jon recommended analysis of sound within 30 minute blocks, and evaluation of only the most notable impulses during that period. Jon issued a note of caution from his experience, where short duration clicks could generate huge impulse corrections comparative to large crashes producing far lower correction results. Jon emphasised the need to apply context to the assessments. Where readings were unattended it was necessary to distinguish the cause of impulsive events using audio recordings. Additionally analysing a greater number of events could go some way towards reducing the uncertainty of the assessment.

A session gets under way

Richard Collman (Acoustical Control Engineers and Consultants) provided a practical approach to dealing with uncertainty as envisaged by the BS 4142 drafting committee as well as some real life examples of uncertainty in practice. Richard's view was that uncertainty needed to be understood from basic acoustic principles in order that it could be minimised throughout the process of measurement and evaluation. Some uncertainty was unavoidable and would therefore need to be evaluated (either quantified or qualified) though calculation, estimation or guess! But most could be minimised by considering the practicalities of taking the measurements on site. The key issue was that uncertainty needed to be placed in context so that the effects on the data or the end result of the assessment could be better understood. Richard reminded delegates of some of the obvious (and not so obvious) uncertainties – weather, temperature inversions, locations for monitoring, reflections, standing waves, interference patterns, the interaction between specific and ambient sounds in the environment. Uncertainties in relation to weather were the subject of some discussion, and it was noted a further full day workshop on this issue is planned for 6 October. Richard also raised the issue of the use of models to predict sound levels, and this was highlighted further by John McCullough later in the day.

Ian Matthews (Redtwin) provided a case study of complaint-based use of the BS 4142 standard, with particular concerns relating to source identification on acoustically complex sites, and low frequency sound sources. Ian also dealt with the issue of how to obtain residual levels where the ambient always had the source operational. Ian's BS 4142 calculation identified where uncertainty started to influence the results obtained, particularly with residual and background level uncertainty, measurement durations (limited time available to the consultant) and the effects of weather. Ian's example relied heavily on the acoustic feature corrections to allow appropriate characterisation. Ian stressed the need to justify the corrections, but especially where they heavily influence the outcome.

Mark Dowie (Brüel & Kjær) picked up on the themes from the previous presentations, and provided a case study, complete with recordings of the sounds under investigation. Mark presented a set of acoustic measurements for a small engineering workshop and provided a planning based scenario. The delegates were asked to work in groups to evaluate the proposal and make recommendations. The case study was well received, and highlighted a number of key areas of concern around determination of background levels, calculating specific levels from ambient, and application of correction factors. Reassuringly the majority reached similar conclusions to the presenters.

John McCullough (Mid Kent combined service) concluded the day, providing a local authority regulator's view on what should be provided to the regulator in acoustic surveys. John provided a lively discussion with a number of actual (anonymised) examples of reporting both good and bad. John's view that liaison and discussion with the regulator actually saved time and prevented a need to revisit reports later received broad agreement within the room. John also clarified what regulators will need to see in reports emphasising that simple clear and concise reports were often more appropriate than more complex ones. John raised caution about the use of noise models, and provided an example of where a model had actually

confused rather than clarified the situation, which ultimately lead to a loss of confidence in the report. Above all John referred to the need to place the measurements taken into context, and explain the results in simple terms. In conclusion John noted that BS 4142 section 12 provided a detailed list of what was expected for a report and consultants should ensure they cover everything.

Once again, many thanks are owed to Linda Canty and the team at IOA HQ for all their hard work behind the scenes to facilitate such an enjoyable and stimulating professional meeting.

Peter Wheeler steps down as Engineering Division Manager

Peter (centre) with members of the St Albans office team

The IOA has bid a fond farewell to Peter Wheeler who has stepped down as Engineering Division Manager after more than 20 years.

During this time he oversaw the process of registration with the Engineering Council of scores of members, either as CEng or IEng.

Although he has officially left the role, Peter will continue to perform some duties until a successor is appointed.

As a mark of thanks he was presented with a watch at a ceremony at the IOA office in St Albans by Chief Executive Allan Chesney who praised his "outstanding service".

Peter also served as Education Manager from 1994 until 2008, helping to oversee the running of the Diploma and the short Certificate courses, and from 1992-1994 he served as President.

During his career which mixed the worlds of business and academia, he worked for the ISVR consultancy group and Racal Acoustics before joining the University of Salford where he was appointed Pro Vice-chancellor in 1995.

As well as serving on both the Membership and Engineering Division Committees, he was also secretary of the Southern Branch during the 1970s.

His many contributions to the Institute were officially recognised with the award of an Honorary Fellowship in 1997.

IOA in joint agreement with BOHS on qualifications recognition

The IOA and the Chartered Society for Worker Health Protection (BOHS) have agreed to recognise each other's professional qualifications.

The main terms are:

- Holders of certain IOA qualifications, including the Certificate of Competence in Workplace Noise Risk Assessment and the Diploma in Acoustics and Noise Control, will be able to use these in the BOHS qualification pathway to the Certificate of Operational Competence in Occupational Hygiene, the qualification for Licentiate membership of the Faculty of Occupational Hygiene and use of the post nominal letters LFOH.
- Holders of other IOA Certificates of Competence will be eligible for BOHS Specialist Licentiate grades. This specialist route is for those whose expertise lies in a specific area of occupational hygiene. Specialist Licentiate members of the Faculty of Occupational Hygiene are entitled to use the post nominal letters LFOH(S).
- Holders of the IOA Diploma will be eligible for the BOHS grade of Specialist Member of the Faculty of Occupational Hygiene which entitles the use of the post nominal letters MFOH(S).
- Hygienists who hold the BOHS occupational hygiene module entitled W503: *Noise – Measurement and its Effects* will be eligible to apply for Technician membership of the IOA.
- Holders of the BOHS Diploma of Professional Competence in Occupational Hygiene will be able to use this qualification to gain admission to courses for the IOA Diploma,
- Trainers with suitable experience who hold relevant BOHS professional qualifications will be eligible to teach IOA-accredited Certificate of Competence courses.

Allan Chesney, IOA Chief Executive, said, "This mutually beneficial agreement is an indication of the high regard between our bodies and holds great promise for important professional collaboration. I am confident that the new arrangements will foster the development of strong links between our professional organisations, both at the local and national levels."

Steve Perkins, BOHS Chief Executive, said: "We look forward to encouraging members of the IOA to expand their careers into occupational hygiene, and enabling BOHS members to gain further professional recognition in the specialised areas of acoustics and noise control."

More than 100 membership applications approved by Council

One hundred and five membership applications were approved by Council at its March meeting following the recommendations of the Membership Committee. Of the total, 82 were new and re-instatement, the remainder were upgrades.

FIOA

Adam Lawrence

MIOA

Emma Bigg
Georgios Chatzigiannidis
Nicholas Chotiros
Andrew Dean
Kevin Doyle
Sam East
Gerasimos Efthymiatos
Daniela Filipe
Sue Fitton
Helder Goncalves
Martin Hamer
Christina Higgins
Alan Hunter
Lodewyk Jansen
Brian Jarvis
Warren King
Laura Lopez
Chris Pickering
Konrad Ratowski
Richard Reeve
Andrew Rickard
Peter Roberts
Greg Smith
Fiona Smyth
Gary Wickens

AMIOA

Christopher Adair
Donald Angir
Gavyn Bache
Fauwaz Baig
Edward Barnett
Andrew Beamish
James Burchell
Eric Bustamante
Taylor Cooper
Muhammad Craddy
Timothy Crowe
Andrew Crowther
John Crowther
Benjamin Dawson
David Dodd
Jago Edwards
Steven Edwards
Paul Forster
Mateusz Garbala
Sarah Gilston
Jana Guijarro
Aaron Gutteridge
Lee Hadden
Stuart Hill
Tracy Hilton
Matt Howell
Luke Hurren
Elizabeth James
Simon Jefferson
Nicholas Jenkins
Robert Jenkins
Fabio Lassandro
Matthew Light
Angela Lorenzo
James Mackenzie
Sam Martin
Thomas Mays
John McBride
Derek McCreanor
Matthew McKee
Harry Moraitis
Rhys Morgan
Daniel Newbery
Alberto Nieto
Alexander Nix
Gizem Okten
Jacob Perry
Rosie Pitt
Florent Poiraud
Kieron Ripley
Joshua Rodell
James Seddon
Adam Sharpe
Mohamed Shazly
Sohrab Sidhu
Joshua Smith
Mark Smith
Nastassia Somikava
Mark Speed
Dawn Stewart
Shane Sugrue
Amit Tayal
Daniel Taylor
Aidan Tolkien
Emma Tynan
Sarah Wakely
Sam Welch
Samuel Williams
Alex Young

TechIOA

Nathan Gascoigne
Ben Harper
Tony James
Suneel Jhamatt
Jim McClymont
Sarah O'Mahony
James Shaw
Gavino Tabuzo

Sponsor

Embelton UK

Instrumentation Corner

Updated field sound insulation testing Standards

By Steve Cawser

The Standards used for the measurement within building acoustics are currently undergoing a revision. Over the last two years, some important revisions to the Standards that cover the field measurement of sound insulation have been published with the new BS EN ISO 16283 *Field measurement of sound insulation in buildings and of building elements*. This article covers some of the changes that are included within these Standards and the potential considerations for consultants who carry out these measurements.

February 2014 saw the publication of BS EN ISO 16283-1:2014, which supersedes ISO 140-4:1998 and covers the procedures for the field measurement of airborne sound insulation. December 2015 saw the publication of BS EN 16283-2:2015, which supersedes ISO 140-7:1998 and covers the procedures for the field measurements of impact sound insulation.

The primary purpose of these revisions is to cover procedures for when the sound field within the room does not approximate a diffuse field, and includes procedures for when operators are using a hand held sound level meter. The previous Standards only permitted fixed or mechanically swept microphones. Many of the changes are common to both Standards since the same sound level measurement procedures are used in both Standards.

The requirements for instrumentation have been updated from the ISO 140 requirements for sound level meters conforming to IEC 60651 to the current sound level meter Standard of IEC 61672. This means that anyone using a meter which does not conform to IEC 61672 will have to invest in new instrumentation; however, 61672 has been around for so long now that it is doubtful whether anyone carrying out this kind of testing is still using a meter that does not conform. The new Standard gives tighter requirements on the allowable level of field calibration drift. If the calibration level changes by more than 0.5 dB, then the measurements are required to be discarded, although it is likely that many consultants will already follow a similar procedure.

One change that potentially affects many consultants comes with a change to the requirements for the type of loudspeaker used for the sound source. The previous requirements of ISO 140-4 were not well defined and gave recommendations for using a dodecahedron style loudspeaker, but only went as far as stating that the loudspeaker used should be producing a diffuse field in the source room. The way this is achieved in the source room was left to the discretion of the operator. The new 16283-1 specifically requires a uniform and omni-directional source loudspeaker. The new Standard keeps the qualification method for measuring the source directivity from ISO 140-4, but includes a new requirement to have this directivity checked every two years. The new Standard recommends the use of a polyhedral type loudspeaker and specifically mentions the use of dodecahedrons and hemi-dodecahedrons as the most suitable for achieving the directivity requirements.

This is likely to be a change for many consultants who use different types of loudspeakers as the sound source, some of which will not be suitable for use with the new Standard. From experience, many consultants prefer the use of powered PA type loudspeakers due to them being much easier to handle when on site. This type of loudspeaker is unlikely to meet the requirements of the new Standard and will require testing to demonstrate its compliance. There is also now the requirement for periodic testing of the loudspeakers used in the testing, which potentially gives an increased burden on calibration requirements.

The new Standard has relaxed the requirements slightly for sound levels in the source room. The previous ISO 140-4 required there to be no more than 6 dB difference between adjacent one-third octave bands. This has now been slightly relaxed to 8 dB and recommends the use of a graphic equaliser where the 8 dB cannot be achieved by moving the source loudspeaker position.

One change that will assist many with on-site testing is the inclusion of using held-held microphone positions rather than purely fixed microphone positions. The new Standard includes different manual scanning paths along with diagrams to assist in visualising the requirements. This could assist many consultants by speeding up time it takes to carry out the testing on site.

The new Standard includes a beneficial change to the method of averaging the measured data. There has always been some conjecture about the exact requirements of ISO 140-4 on this subject. Approved Document E of the Building Regulations gives its own specific method to make this element of the calculation clear. The new ISO 16283-1 gives specific methods for carrying out this averaging depending on whether fixed or moving microphones have been used for the survey.

Another addition that many consultants should be aware of and give some thought to is the issue of uncertainty. This is a relatively new topic to many acousticians and is becoming a topic which we all should understand in more depth. The requirements for handling uncertainty within the new ISO 16283 series are referenced to BS EN ISO 12999-1:2014 *Determination and application of measurement uncertainties in building acoustics. Sound insulation*, which provides guidance for handling the measurement uncertainty. The requirements of the ISO 16283 series is simply that the uncertainty should be determined in accordance with ISO 12999-1, but does not specify how much detail should be reported.

These changes to the Standard will not become relevant to many consultants since Approved Document E of the Building Regulations does not currently reference the new Standard.

The new BS EN ISO 16283-2:2015 gives the requirement for impact sound insulation testing in the field. The instrumentation requirement for tapping machines remain largely unchanged. The general requirements for the hammers of the tapping machine are unchanged. The only change is the introduction of a new overall weight limit for the tapping machine of 25 kg. This is to ensure that the any lightweight floors are not loaded. Since any object greater than 25 kg would have manual handling restrictions, this is not likely to be a big issue for consultants or equipment manufacturers.

The biggest change is the introduction of a new source for the testing of impact sound insulation, namely the rubber ball. This is stated as being used for assessing heavy, soft impacts, such as people walking in bare feet or children jumping. The requirements for the ball are given in terms of dimensions and material properties, along with the test procedure. However, the test procedure requires the measurement of the L_{max} sound level in octave bands. However, there is no procedure for deriving a single number quantity from the rubber ball tests. The requirements also specify that the force output of the rubber ball only needs to be checked once after manufacture and as such there is no requirement for periodic verification of the performance of this source, which seems at odds with all other forms of standardised testing.

Since this is a new form of impact sound insulation testing, it is unlikely that many consultants will need to start carrying out this form of testing in the immediate future. Only time will tell if the use of the rubber ball becomes a common test process.

Most of this style of testing carried out by consultants will be for conformance with the Building Regulations. Approved Document E currently references the ISO 140 series Standards, BB93 was updated in February 2015 to reference ISO 16283-1 for airborne sound insulation but still references ISO 140-7 for impact sound insulation, so it may be some time before these changed procedures come into regular use for many consultants. However, it is certainly worth being aware of the requirements for when they come into regular use.

Steve Cawser *is a Principal Acoustics Consultant with AECOM and represents the Association of Noise Consultants on the I0A Measurement and Instrumentation Committee.*

Breakthrough in dynamically variable negative stiffness structures

Researchers in HRL Laboratories' sensors and materials laboratory in California have developed an active variable stiffness vibration isolator capable of 100x stiffness changes and millisecond actuation times, independent of the static load.

According to Principal Investigator Christopher Churchill: "This performance surpasses existing mechanisms by at least 20 times in either speed or useful stiffness change."

Mr Churchill says that the human body is home to a range of variable stiffness structures that enable efficient load-bearing and nimble activity. "The most ubiquitous tunable stiffness structures are our own joints, which use antagonistic muscle contractions to vary joint stiffness continuously," he said. "For example, limbs will stiffen to lift a bowling ball, but soften to paint with the tip of a brush."

Yet these features in the human body are rarely replicated in engineered systems due to the complexity, power, and cost of doing so. Mr Churchill says that the traditional approach-building a soft system and then adding damping and force is s expensive and low-bandwidth. "We developed a new paradigm, and instead built a stiff system and then softened it," he said. The result is a low-cost and high-bandwidth solution to long-standing challenges.

This breakthrough has broad applications for makers of automobiles, aircraft, watercraft, rotorcraft, and robotics. "Advanced lightweight materials are increasingly finding their way into transportation platforms to achieve low mass and high stiffness," Mr Churchill said. "Utilising adaptive negative stiffness to soften stiff systems on demand has the potential to solve shock and vibration problems that only get more difficult with these next-generation platforms."

The HRL research team's findings, *Dynamically Variable Negative Stiffness Structures*, were published in February 2016 issue of *Science Advances*.

Researchers to study effect of aircraft noise on children's sleep

Researchers at the German Aerospace Centre (DLR) are to conduct a study into the sleep patterns of 50 children living in the vicinity of Cologne/Bonn Airport.

The study is expected to provide insight into how nocturnal aircraft noise affects the sleep, cognitive ability, and psychological well-being of children.

Research into the effects of noise on the human body has been carried out in Germany for 40 years. The influence of nocturnal traffic noise on sleep has also been investigated in numerous studies.

Nevertheless, many questions remain unanswered. For example, the "vulnerable" group that includes children has not yet been studied. But researchers suspect that, in this group in particular, noise has negative effects on sleep – and hence on the ability to recover from its effects.

Researchers at the DLR's Institute of Aerospace Medicine will investigate how children's sleep is affected by aircraft noise; how long it takes children to fall asleep in the evening because of aircraft noise; how often they wake up in the night because of this; and how often and when a shift from a deeper to a lighter sleep state takes place.

To record their sleep data, the children, aged 8-10, will be studied polysomnographically at home for four consecutive nights. "This means that a variety of electro-physiological bodily functions are recorded throughout the night," said Julia Quehl from the Institute's Department of Flight Physiology.

To do this, the children will wear child-appropriate electrodes on their heads and upper bodies every night. These will provide the researchers with data that will help them measure levels of brain activity, to determine the various sleep states and waking reactions. In addition, all noise reaching the sleeping children's ears will be recorded in their rooms throughout the night. In this way, the researchers will be able to combine measurements of sleep patterns (for example, changes in the state of sleep or waking reactions) with individual noise events such as a take-off or landing at night.

In addition to this objective data, the researchers will use child-appropriate questionnaires conducted each morning to provide subjective data on how the children have personally experienced their sleep and aircraft noise during the night. This, in turn, will reveal the extent to which the children have been disturbed by the noise—from their own perspective. In addition, their cognitive abilities will be measured each morning in a psychological reaction time test on a laptop. "We will carry out the test with the children prior to the study," said Ms Quehl. "It will allow us to know their individual performance level in the test. Using the test scores during the study, we will be able to determine whether any noise-related impact on performance is detectable."

Acoustic test measurements will be carried out on site to ensure that individual aircraft noise events are not being masked by background noise. This would make a huge difference in the comparison of the acoustic data with the sleep data. The test subjects will be selected using questionnaires completed by the children and their parents, as well as by the results of a hearing test.

Using the collected acoustic data, the electro-physiological data on sleep patterns and the subjective data on sensitivity to disturbance, the researchers will generate exposure-response curves. These will indicate how the probability of a specific noise reaction (for example, a change of sleep state) changes as a function of noise.

Children's sleep patterns will be studied

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New research reveals sound of deep-water animal migration

New research finds there is a distinct sound coming from a massive community of fish, shrimp, jellies, and squid as they travel up and down from the depths of the ocean to the water's surface to feed.

This sound could be serving as a "dinner bell" for these deep-water organisms that play a key role in ocean food webs and the global carbon cycle, and could help scientists better understand this mysterious ecosystem, according to new research.

A vast number of animals, including fish, shrimp, and squid, live in the ocean's mesopelagic zone – the waters 200 to 1,000 meters (660 to 3,300 feet) below the surface. Taken together, these organisms weigh approximately 10 billion tons and are a major link in the food chain between microscopic plankton and top predators like tuna, birds, and marine mammals, according to Simone Baumann-Pickering, an assistant research biologist at Scripps Institution of Oceanography at UC San Diego. Because of their combined mass, these animals also play a major role in the global cycling of carbon from the atmosphere to the seafloor, she added.

The ocean's mesopelagic zone is a dark world: very little light filters down to these depths and without sunlight, food is less abundant. At dusk, many of these deep-water animals migrate up to the nutrient-abundant surface waters to feed, relying on the darkness to protect them from predators. At dawn, they sink back down to the dark mesopelagic zone for protection.

Now, Ms Baumann-Pickering and her colleagues have found that there is a distinct sound associated with these daily journeys upwards and downwards. The team used sensitive acoustic instruments to record the low-frequency hum the animals emit as they move up to the surface to feed at dusk, and back down to deeper waters at dawn. The researchers aren't yet certain which animals in the mesopelagic zone are creating the sound, but small bony fish that are abundant in the zone are the most likely suspects, Ms Baumann-Pickering said.

The communal sound is three to six decibels louder than the background noise of the ocean, making it difficult for the human ear to distinguish, but it could provide scientists with a new way to study these organisms and give new insights into this ecosystem, she said.

The sound could be a signal for the mesopelagic zone organisms to start migrating up to the surface or back down to the darker depths of the ocean, Ms Baumann-Pickering said. If mesopelagic animals convey information through sound, learning more about who is communicating and what they are communicating about could change scientists' understanding of how the ecosystem fits together. Using acoustics to monitor these organisms could also help scientists study how these animals could be affected by climate change, and the consequences of potential commercial fishing projects, she said.

Fish noise could act as a "dinner bell"

An acoustician's journey into hearing aids

By John O'Keefe, P.Eng FIOA

Author's note: *This article was published in The Globe and Mail, Canada's national newspaper. It was intended for a less technical audience than our IOA community. I still hope you enjoy it and take to heart how important hearing is to young children.*

There is a perception that an acoustician must have "golden ears". That is, they are uniquely set with such superior auditory processing that the application of scientific measurements and analyses are rendered superfluous. This perception persists in spite of the fact that it is at least two generations out of date. Creativity married to cold hard science is the answer these days. Still, it is an absolute anathema for an acoustician to wear hearing aids. It doesn't look good. But that's exactly what I've done. I've just been fitted with hearing aids. I'm not supposed to be talking about this but I will. And I'm glad I have my hearing aids.

I've spent a lifetime listening to sound in a rather analytical way. I get paid for it, after all. So my journey into hearing aids is perhaps different than others. And I don't mind saying; it's been a bit scary.

I was warned that hearing aids would give me too much noise and that it would take a while to get used to it. It's true; I now hear my middle age bones crackle too much. The floorboards in our 100-year-old house make more noise than they used to. My newspaper makes noise when I turn the page. When I play my guitar – a 45-year-old passion – I hear upper harmonics that I honestly don't remember. The sound of the wind in the trees that surround our house enthrals me. Sorry, perhaps I'm waxing on a bit too long. But none of this is noise. Here's the thing, I design the sound in buildings, theatres and concert halls because I love sound. And if I can hear sound better in the most important building in my life – our home – that's a good thing!

I was convinced that I needed hearing aids by a medical professional that I respect above all others. And I must admit I have what might be interpreted as a slightly non-professional romantic relationship with her. For 32 years now. She's my wife. We met at ISVR in Southampton when we were doing our respective Masters' degrees. Over the dinner table a couple of years ago she told me, judging by my increasing difficulties understanding conversation and the kind of mistakes I was making, that I probably had a hearing loss of 35 dB at 2000 Hz.

Recently, when Jacqueline finally measured my hearing it turns out she was spot on: 35 dB down at 2000 Hz.

Well, what does that mean? 35 dB means you're trying to hear something on the other side of a heavy and very well sealed door. 2000 Hz is the range of consonant frequencies that are critical for good speech discrimination; the speech sounds (called phonemes) p, t and k are all clustered around this frequency. And so many words in English are defined by one differing phoneme – such as tin, pin and kin, for example. Three words easily confused if you can't hear the phonemes. The high frequencies are the sounds that

give words in Western languages their clarity. Think of stage actors, opera singers and, for that matter, the great Louis Armstrong. They all over-emphasise their consonants so they can be understood at the back of the room. And as a scientist I don't mind telling you that actors and singers figured that one out long before we scientists did. Problem was, I couldn't hear those consonants anymore. I was behind a heavy, well-sealed door.

I can hear those consonants now but my speech discrimination is only slowly improving. My brain hasn't had to figure those sounds out for a while now. It's something called neuro-plasticity. The brain is a bit like a muscle. If there are parts of it you're not exercising, they fade away. But with new found exercise (i.e. my hearing aids) those parts of my brain will start to figure things out again. Right now my feeble brain can't figure out all those k's and t's that I haven't really heard for a long time. It should take about six months for neuro-plasticity to kick in. At least that's what my favourite medical professional tells me.

I'm a middle-aged man in a profession where I really shouldn't be seen wearing hearing aids – or writing about it for that matter. Big deal.

There's something much more important than that. There is a stigma that still persists about wearing hearing aids and it extends to children. Research has shown that a hard of hearing child needs to hear a word three times more frequently than a normally hearing child in order to understand that word and to incorporate it into her or his lexicon. Some parents with a hard of hearing child don't want to admit it. That's a mistake. And the child will pay for it, for want of a good education. During elementary school they're effectively behind that heavy wooden door, standing outside in the corridor. It's pretty hard to hear the teacher that way. And in the early years – the most plastic of neuro-plasticity – they are still forming language. If they can't do that during the critical early learning period, they're going to have trouble with learning throughout their education, which, indeed, they may shorten to their own detriment.

What's interesting is there seems to be a bit of a generation gap when it comes to hearing aids for children. Recently, Jacqueline prescribed hearing aids for a little boy. His mother wanted skin toned hearing aids, perhaps so no one would notice. He wanted the purple dinosaur hearing aids because they were cool. As, indeed, they are. At least for a little boy.

I decided against the purple dinosaur hearing aids!

I'll finish with a positive story.

A few years ago I was teaching a course on acoustics at the University of Toronto. A young woman came up to me at the beginning of the lectures and asked if I would wear a transmitter for her. This is something that you wear around your neck and it transmits your voice directly to her hearing aid. Her hearing loss was much more profound than mine. My guess is that she's had it all her life. You could tell by the way she talked. I might also guess that, when she was a little girl, her parents were smart enough and open minded enough to get her the proper treatment. I was proud to wear that transmitter for her.

Imagine. A young woman who overcame all of the educational challenges imposed on her by a profound hearing loss throughout her entire life and was about to complete a Master's of Architecture degree. Good for you girl!

So, if you think you need help with your hearing go out and get it. But much, much more importantly, if you think your child needs help with their hearing, go out and get it as fast as you possibly can.

John O'Keefe

John O'Keefe *and Jacqueline Hayden have, respectively, been practising acoustics and audiology for 30 years. Both care very deeply about this subject.*

New wave discovery may help in detection of tsunamis

Researchers in the US have identified a new and more reliable source of acoustic-gravity waves that may help scientists detect an upcoming tsunami early.

Acoustic-gravity waves are very long sound waves that cut through the deep ocean at the speed of sound. These lightning-quick currents are typically triggered by violent events in the ocean, including underwater earthquakes, explosions, landslides and even meteorites.

The researchers from Massachusetts Institute of Technology (MIT) have now identified a less dramatic though far more pervasive source of acoustic-gravity waves: surface ocean waves such as those that can be seen from a beach or the deck of a boat.

These waves, known as surface-gravity waves, do not travel nearly as fast, far or deep as acoustic-gravity waves but under the right conditions, they can generate the powerful, fast moving, and low-frequency sound waves.

"Severe sea states such as tsunamis, rogue waves, storms, landslides and even meteorite fall, can all generate acoustic-gravity waves," said Usama Kadri, visiting assistant professor and a research affiliate in MIT's department of mathematics.

"We hope we can use these waves to set an early alarm for severe sea states in general and tsunamis in particular, and potentially save lives," he added.

The researchers have developed a general theory that connects gravity waves and acoustic waves.

They found that when two surface-gravity waves, heading toward each other, are oscillating at a similar but not identical frequency, their interaction can release up to 95 percent of their initial energy in the form of an acoustic wave, which, in turn, carries this energy and travels much faster and deeper.

This interaction may occur anywhere in the ocean, in particular in regions where surface-gravity waves interact as they reflect from continental shelf breaks, where the deep-sea suddenly faces a much shallower shoreline.

Proessor Kadri derived a wave equation that includes compressibility and gravity as well as higher-order nonlinear terms.

The newly derived wave equation allowed Professor Kadri to study the behaviour of both acoustic and gravity waves.

Kadri and his colleague Triantaphyllos Akylas, Professor of mechanical engineering at MIT, have published their results in the *Journal of Fluid Mechanics*.

Swiss researchers predict road noise through auralisation

Swiss researchers have succeeded in simulating road noise by means of auralisation.

The aim is to predict noise along roads still in the planning stage – and thus include countermeasures at the same time.

In Empa's TAURA project funded by the Swiss National Science Foundation (SNF), a research team is working on a model, which simulates the noise of a car accelerating past an observer.

But developing such an auralisation model is easier said than done, it says. The noise caused by a car speeding past originates from different sources, which have to be entered into the "emission module" in the computer model.

First, there is the engine that roars in the ears, particularly at high speeds. Although speed, vehicle type and driving style also influence the engine-related driving noise. Then the tyres also generate noise as they roll along the road. This is largely dependent on the type of road surface and make of tyre.

Research team leader Reto Pieren and his colleagues would like in future to add further sources of noise into their auralisation model, such as the effect of different road surfaces and wind noises.

The researchers firstly had to identify the extent of all these influences. To this end, they recorded the driving noise of various makes of vehicle, for instance of a VW Touran, a Ford Focus 1.8i and a Skoda Fabia.

These measurements were taken from several microphone positions and at different speeds. The researchers also varied the tyre models, engine load and revolutions per minute. They then extracted the sound characteristics from these recordings and transcribed these as parameters in their auralisation model. They ended up with a total of several thousand such parameters, which cause a completely different driving noise depending on interaction.

Although even this was not sufficient: next they had to account for propagation phenomena such as the Doppler effect, sound absorption in air and reduction in noise due to the distance between the source of the noise and the observer.

Said Reto Pieren: "An observer will perceive noise differently depending on his or her position in relation to the source of the noise and how each moves relative to the other. We all know the Doppler effect from our daily lives: the siren on an emergency vehicle has a high pitch whenever the vehicle is approaching and a comparably lower pitch when it is driving away again."

The modelled signals finally have to be transformed into sound via headphones or a pair of speakers. Noise first arises in our consciousness, however, so is perceived differently from listener to listener and is not easily registered in physical measurement units. That is why test subjects were asked to listen to the simulated driving noises and make statements about their irksomeness, the level of noise induced impairment. Objective relationships can be established whenever several test subjects have assessed different noises according to their irksomeness, although noise is a subjective factor.

Noise has a different effect on human beings depending on the time of day, health condition and age. Accordingly the consequences for health extend from intermittent sleep deprivation through to an increased risk of cardiovascular disease. Noise reduction measures must therefore be taken into account when planning residential and industrial zones and traffic routes in order to prevent such impairment. This is where town planners, political decision makers and the public need indications of the anticipated noise emissions. Standard measures can be calculated nowadays – but auralisation can help with evaluating new ideas for noise optimisation. This is how Empa researchers contribute to noise reduction using their auralisation model.

Empa scientists recorded both tyre and engine-related car noises

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CONSULTANT / SENIOR CONSULTANT

The role involves providing advice on acoustics and vibration to a wide range of clients in many different industries. There will be opportunities to work on a diverse array of projects, both technically and geographically, and at various stages in the project lifecycle. Therefore a flexibility of approach will be an essential attribute. The work will be highly varied and include:

- Assessing the effects of noise and vibration on people and wildlife
- Undertaking detailed acoustics modelling and survey work
- Preparation of environmental impact assessments and technical reports
- Problem solving and providing clients with practical advice
- Developing our technical capabilities and growing our business.

The ideal candidate will:

- Have a good degree in a technical science or engineering subject (e.g. Sound and Vibration Engineering or Physics) and be AMIOA or MIOA
- Have experience in an acoustics consultancy business
- Possess excellent written and verbal communication skills
- Be entrepreneurial, self-motivated and an effective communicator
- Have a broad understanding of all acoustics work streams
- Preferably be experienced in building or environmental acoustics
- Have a good understanding of fundamental acoustics legislation, policy, guidance and relevant British Standards
- Be flexible in their approach to undertaking site work; travel to other sites/offices and at times possibly overseas is an essential part of this role and you will therefore need to hold a full UK/EU Driving License
- Be familiar with Noise Modelling Software (SoundPLAN, CadnaA)
- Be proficient with AutoCAD
- Be able to produce technical reports to a high standard.

SENIOR / PRINCIPAL CONSULTANT OR ASSOCIATE

The principal technical activity involves preparing fee proposals for, and carrying out, acoustics, noise and vibration assessments, sound management programmes and design specifications, which includes liaising with clients, acquisition and collation of data, computer modelling, noise and vibration monitoring, noise and vibration measurements, calculations and processing of results, interpretation of data, and production of reports, drawings, figures and tables.

The ideal candidate will:

- Be qualified to degree level standard and hold full corporate membership of the Institute of Acoustics
- Ideally, have a minimum of 5 years' experience in an acoustics consultancy business
- Have excellent written and verbal communication skills
- Be well rounded and have an in depth understanding of environmental and building acoustics work streams
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3D audio maps will help design noise-absorbing streets

Urban planners may soon use 3D audio maps to design streets that absorb noise.

By mapping and identifying different types of sounds in urban environments, researchers hope to help planners come up with ideas to reduce noise.

"What is important is sound absorption because noise can then be taken away," said Professor Maarten Hornikx of Eindhoven University of Technology in the Netherlands where he is using EU funding to develop a 3D sound simulation method that assesses noise distribution within the urban environment.

"There are already noise mapping software tools that work for a lot of areas in cities, but for cases (such) as narrow city canyons, side streets and inner yards where traffic noise sources are not visible, they don't give the correct results."

The openPSTD software (open-source software development of the Pseudo-Spectral Time-Domain method) computes sound propagation from sources of noise in the "urban soundscape" as well as how wind affects this propagation.

It then presents the information in 3D to provide precise readings that planners can use to implement targeted solutions to deal with noise pollution.

"We have a method that is far more accurate than most standardised prediction methods," said Professor Hornikx. "Since it is so detailed you can think of small-scale effects on a street level and how that can improve the noise situation."

This could include things such as using sound-absorbing materials for road surfaces and buildings, or introducing acoustic panels or green walls – vertical gardens made of plants or trees – at specific noisy places.

For many years such walls have been used along busy roads as barriers against noise, and if introduced at a street's weak spots or on the facades of buildings they can improve the soundscape of a neighbourhood.

"Installing a green wall can be worthwhile for noise reduction and for other effects it might bring," said Professor Hornikx.

He hopes that openPSTD will provide the information necessary for urban solutions to be introduced to neighbourhoods to achieve what he calls a "positive sound environment".

In another EU-funded project known as EVERYSOUND, software is being developed that can automatically classify sounds in everyday environments.

Tuomas Virtanen, principal investigator, said: "In the future we are going to have systems that map out noise and characterise why the environment is pleasant or disturbing."

For this, however, sophisticated technology that can differentiate between the types of sounds, such as birdsong, traffic noise or voices, is needed.

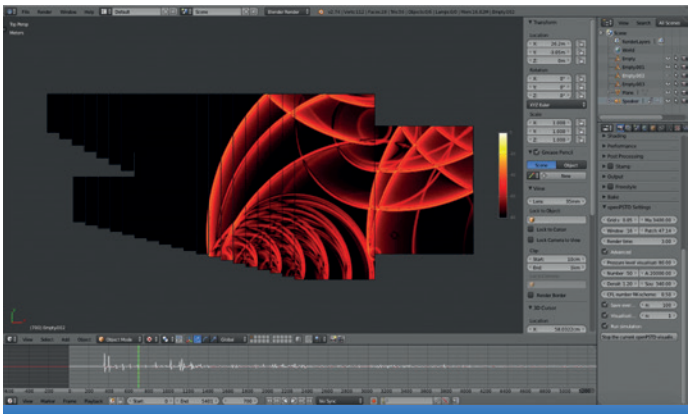
"Humans are amazingly good at detecting multiple sources of sound, but it is challenging for computers," said Professor Virtanen, Associate Professor at the Department of Signal Processing, Tampere University of Technology, Finland. "We have audio recordings and then have experts listen to them, annotating what sounds are present. We feed both the audio recordings and the annotations into our algorithms and the system learns the sounds."

These algorithms will allow the EVERYSOUND system to analyse recordings taken in everyday situations such as a street, park, home or building and provide high-level descriptions of the sounds contained within.

"We could monitor audio in an office environment and get statistics about the noises there," he said. "We could see if there are noise disturbances and if this affects people's work."

Eventually, the system could be automated further to monitor noise and detect the source of problematic sounds.

"You can develop phones, cars or robots that can recognise sounds in their environment," said Professor Virtanen. "They could monitor areas to see what people are doing or what kind of machines are there or other types of vehicles."



The openPSTD software produces a 3D model of how sound waves travel through the air in a particular environment. Image courtesy of openPSTD

More precise models of how sound waves travel as they bounce off buildings in cities could help urban planners come up with more targeted solutions. Image courtesy of openPSTD.

Concert hall acoustics influence the emotional impact of music

Researchers at Aalto University in Finland have found that the emotional impact experienced by music listeners depends on the concert hall's acoustics.

Earlier research has shown that the strongest emotional experiences by music listening may elicit shivers or goose bumps in the listener. Much weaker reactions can be detected from the variations in the electrical skin conductance.

Based on this knowledge, the researchers presented the test subjects an excerpt of Beethoven's symphony with the acoustics measured in different concert halls.

During listening, the skin conductance was measured with sensors attached in the listeners' fingers in order to record the magnitude of the emotional reactions to different acoustic conditions.

The results revealed that an identical performance of classical orchestra music evoked stronger emotional impact when presented in the acoustics of shoebox-type concert halls, such as Vienna Musikverein or Berlin Konzerthaus.

The study included identically selected two positions from six European concert halls: Vienna Musikverein, Amsterdam Concertgebouw, Berlin Konzerhaus and Philharmonie, Cologne Philharmonie, and Helsinki Music Centre.

"Some interpretations of a same music piece can evoke stronger emotions than others. Similarly, our study has succeeded in demonstrating that the hall's acoustics plays an important part in the overall emotional impact. After all, emotional experiences are a key factor in music to many listeners," said Dr Jukka Pätynen.

For decades, researchers on concert hall acoustics have aspired to explain the acoustical success of certain halls with room-acoustic parameters. The study by Finnish researchers is the first to assess the acoustics of existing concert halls as the emotional impact.

Dr Pätynen works as an Academy of Finland post-doctoral researcher in Professor Tapio Lokki's Virtual Acoustics research group. The group aims to understand how room acoustics affect sound signals, and how people perceive room acoustic properties. Research focuses on improved prediction and understanding of concert halls and other acoustically demanding spaces.

Acoustics affect emotional impact

Critically ill patients disturbed every six minutes at night in noisy hospital wards

Noisy hospital wards are preventing recovery with the very sickest patients disturbed every six minutes by sounds as a loud as a pneumatic drill, Oxford University has warned.

While television dramas represent intensive care units as places with dimmed lights, hushed voices and softly beeping machines, the reality is that noise levels are more like a busy restaurant.

But researchers found average sound levels at the John Radcliffe Hospital in the city always exceeded a perceived loudness of 45 dBA.

They wrote: "On average, there were approximately 25 minutes of every hour during the day when peak levels above 85 dBA occurred.

"Peak levels above 85 dBA occurred less frequently overnight but a patient can still expect to be disturbed at least once every 7 to 16 minutes of every hour between 10pm and 7am."

The researchers warned that some of the sickest patients are forced to wear ear-plugs and eye masks to get any sleep at all.

Measures to reduce the din have included replacing noisy metal bins with quieter plastic ones, and introducing new guidelines to ensure the volume settings on equipment are appropriate and that staff try to keep a more normal day and night routine.

Professor Duncan Young from Oxford's Kadoorie Centre for Critical Care Research and Education, said: "High levels of noise make it harder to sleep, sleep deprivation leads to confusion, and confusion is thought to complicate the healing process and slow recovery.

"Yet our research found that during the day, noise levels in an ICU are equivalent to those of a busy restaurant.

"While things are quieter at night, we still found that sounds louder than 85 decibels – around the level of a road drill – were happening up to 16 times an hour.

"Patients may get earplugs and eye masks to help them sleep, but that doesn't deal with the underlying issue. We talked to patients, visitors and staff to find out if particular noises cause more disturbance.

"We also spent time in an intensive care unit watching and listening to identify the main sources of noise and how patients and staff reacted to them."

Professor Young said: "The experience helps staff understand things from the patient's point of view, and most of those who have been through the training have said that they will change the way they work.

"The next stage is to develop a noise display, so staff can see and better manage the noise level in the unit. Taken together, we hope all these activities will make intensive care a better environment for patients."

Australia funds $3.3 million study of wind turbine syndrome

Australia's leading medical funding body has awarded two grants totalling $3.3 million to study the effects of wind farms on human health.

Research at the Flinders University of South Australia will explore relationships between noise from wind farms and effects such as annoyances and reduced sleep and quality of life.

Studies at the University of New South Wales will investigate the broader social and environmental circumstances that may influence the health of people living near wind farms.

The outcomes of the research will assist in developing policy and public health recommendations regarding wind turbine development and operations in Australia.

Professor Anne Kelso, CEO of the National Health and Medical Research Council (NHMRC), which has awarded the grants, said that further research was needed to explore the relationships between wind farms and human health.

"Existing research in this area is of poor quality and targeted funding is warranted to support high quality, independent research on this issue," she said.

New studies will investigate the health effects of wind farms

Cutting edge technology uses acoustics to clean water

A US company has developed a new technology that uses acoustic waves to clean contaminated water produced as the result of oil and gas exploration.

Such water contains naturally occurring hydrocarbons, salt, bacteria, radioactive material and other compounds, as well as any chemical additives used to ease extraction.

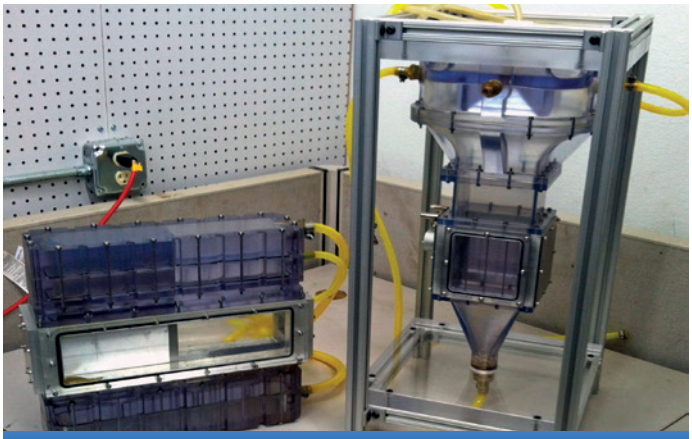
To treat this water before disposal or reuse, the industry depends on filtration and separation techniques which are energy-intensive and may require the addition of chemicals to work. They have also proven inefficient at removing the tiniest oil droplets and contaminants.

At the heart of FloDesign Sonics' system is a method called acoustophoresis, in which droplets or particles within a liquid can be manipulated with a special acoustic wave pattern. The new system uses a pattern of ultrasonic waves in the megahertz range.

The wave pattern exerts acoustic forces that bind substances dispersed in the liquid into clusters. Depending on their relative density compared to the liquid, these larger clusters either settle to the bottom or rise to the surface, where they can be separated easily.

"Acoustophoresis has been used primarily in microfluidics and other micro-scale systems," explained Jason Dionne, co-founder and senior engineer of FloDesign Sonics. "When the U.S. Army was looking for a technology for rapid detection of anthrax spores in large bodies of water, we got the idea to develop an acoustic separation technology that works at the macroscale."

The system, known as Acoustic Wave Separation (AWS), reduces energy and chemical usage by up to 75 per cent compared with current treatment methods.



The Acoustic Wave Separation system being tested. Credit: FloDesign Sonics

While it was designed to treat water from fracking operations, FloDesign Sonics believes it has potential for separations in many sectors beyond oil and gas.

One sector showing special promise is life science. Not only is the technique gentle on living cells, which can be damaged when separated by traditional methods, it also is able to separate particles of any size, overcoming a limitation of current filtration techniques.

The company can picture the technology being used one day for cleaning and transfusing a patient's own blood during surgery.

Machine learning applied to the sonic classification of musical instrument loudspeakers

By Andrew Harper

Introduction

Machine learning is the field of study that gives computers the ability to learn, without being explicitly programmed. The more experience a program has, the better it gets at its task.

The task here is separating musical instrument loudspeakers into groups based on how positively a listener will perceive them to sound. The more measurements the developed program receives during training, the better it gets at separating previously-unseen measurements into their correct groups. The boundary which separates these groups is found automatically, and updates to improve performance as more grouped measurements are presented. The final program is capable of accurately predicting a listener's subjective judgement based on a handful of typical measurements.

The measurement and processing techniques commonly used each indicate how a loudspeaker performs in one regard. Many of these relate well to subjective impression of one performance aspect, but interpreting how they combine to give an overall impression becomes more difficult. Loudspeaker engineers learn to relate a range of measured information to the sound of loudspeakers over many years of experience, often knowing largely how a loudspeaker will sound before listening. The methodology investigated here replicates the learning element, allowing a program to find the optimal separation between groups of loudspeakers when fed with a range of the most meaningful measurements. New drive units can then be grouped as good or bad for example, in a meaningful way, based on the single quantified output. These groupings or classifications correlate highly with subjective judgements.

This article briefly outlines the relevant concepts of machine learning for loudspeaker classification, and gives a brief overview of the methods used before outlining the reasons for the chosen solution.

These techniques give an interesting insight into the relative importance of each measurement as an indicator of subjective judgement, and final results show a greatly improved separation of groupings compared to alternative techniques or any one measurement alone.

An efficient listening test methodology is described which is uniquely suitable for this purpose, providing the maximum audible difference between groups, while being repeatable, controlled and time efficient. Drive units which were judged consistently were selected, and their measurements used to train, tune and test the models.

It should be stressed that musical instrument speakers are intended to produce sound, rather than reproduce sound[1], and that inaccuracy of reproduction is the design intention. An illuminating demonstration of these two loudspeaker types can be given by playing a distorted electric guitar through a hi-fi speaker, then a familiar studio recording through a guitar speaker.

In this context *good* refers to the ideal sonic character of that speaker for the typical applications where it is used. Results are not directly transferable to speakers intended to reproduce sound.

Background

For musical instrument loudspeakers the desired tonal response is a fine balance of different characteristics. Like a recipe, the desired quantities of each tonal ingredient depend on one another. The interdependence of each characteristic requires a multidimensional approach, for which many machine learning methods are ideally suited.

While several measurement types or processing techniques, features, relate well to subjective opinion of sonic quality, none are able to encapsulate everything. When any of the selected features are plotted individually, two distinct groups can be seen, having approximately normal distributions about differing means. However, as can be seen in *Figure 1,* the groups are not linearly separable; results overlap considerably. The probability density function of one of the highest performing features, brightness, is plotted above in *Figure 1*.

Whichever value of brightness is selected as the good/bad boundary, a significant proportion of units from each group will be incorrectly classified. The aim of combining many features into one overall decision with a machine learning classifier is to improve this separation. Using these methods to simultaneously consider all features it is possible to make a much more confident decision on the classification for each loudspeaker.

Similar techniques have been applied to a variety of classification problems in audio and acoustics such as music genre and artists labelling, soundscape and domestic sound classification, musical similarity, the separation of drum sounds, and voice recognition. However, publications focussing on sound quality have mainly been concerned with the prediction of performance ratings rather than classification, and have therefore tended to use a different subset of statistical methods to predict a continuous value rather than a discrete grouping.

The aim of this classification problem was therefore to find a method that best separates groups of data, usually through first finding the boundary that separates them, as opposed to finding a method that best predicts the trend in one group of data.

Many methods exist solely for this type of problem, some of which provide a dichotomous result, only giving the predicted grouping, whereas others also provide values relating to the certainty of these predictions. The simpler linear methods can provide very useful information on the relative importance of each input, telling us which measurements best relate to sonic performance. The most advanced methods are ultimately better at classifying loudspeakers, but give less meaningful or harder to interpret information on the relationships between measurements. P36

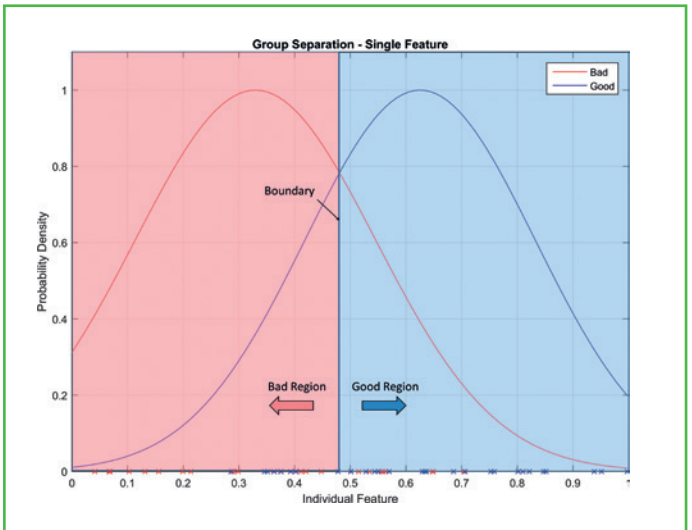


Figure 1. Probability density function for a single high-performing feature

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Which model is best will depend on the structure and amount of the data, along with the desired result, whether discrimination ability or model interpretation is the main goal.[2a]

The phrase "essentially, all models are wrong, but some are useful" by George E.P. Box is highly relevant. The main outcomes of being able to quantify how important each measurement type is for our purposes, and having a method to instantly relate measurements to the perceived sonics of the loudspeakers, are both incredibly useful results to us. However, there is no false illusion that any true psychoacoustic theory is being defined here.

The question most commonly asked during our day-to-day listening tests is; "given a known golden reference, does this test unit meet our standards?" It is rare that an overall grading is requested or that quantified subjective results are required for any performance criteria. Given this, along with the known issues of scale-bias and repeatability with continuous grading, it was decided that a binary output would be of most use.

Whilst several studies have successfully linked combinations of quantitative measurements to subjective sound quality, to the author's knowledge this is the first such research into loudspeakers intended for music production, and is unusual in taking a logistic approach. A brief literature review can be found the accompanying IOA paper presented at Reproduced Sound 2015.[3a]

Listening test method

Before any algorithm development could take place, there was a need to gather many drive units of each grouping. These units would be used to train, tune, and test the machine learning models. As each of these stages required a distinct batch of drive units, the number of units being assessed was large. There was a need to develop a repeatable and efficient test method.

Developing the listening test method

We are fortunate at Celestion to have a state of the art bespoke listening room, as pictured in *Figure 2*.

This was designed by Philip Newell to have the following key attributes which are vital for reliable listening test results:

- Minimal placement bias – such as differences in reflections / room interaction between left / right / centre.
- No significant room modes – so that differences at the listener locations are largely loudspeaker-related.
- Diffusive front wall, to help blend the off-axis sound at the listening position.
- Consistent reverberation time of around 150 ms from bass to high-midrange (120-4000 Hz).
- Floor coupling for a typical response.

This provided an excellent environment to judge drive units for preliminary investigations, and to amass a selection of suitable units for the main listening tests, described below.

Confidence was required that each unit used to train the model belonged to its assigned group, and therefore required reliable listening test results. To obtain a statistically significant judgement, with an alpha value of 0.05 for a two tailed test, a speaker must be given the same judgement in at least nine out of ten listening tests. Around a hundred grouped units were required; this meant that around twice this number were to be judged in total, each ten times for statistical significance. The sheer number of required listening tests necessitated a listening method with no physical changeover of speakers between tests. It was therefore decided to take controlled recordings of each speaker, allowing simple switching between recorded samples of each test unit.

An automated test method was designed with a simple graphical user interface (GUI) that would randomise playback and automatically save results for statistical analysis, shown in Figure 3.

After listening, units with statistically significant judgements were selected, and their measurements used to train, tune, and test the models.

Program material was selected to give maximum audible difference between units, revealing flaws in bad units whilst still making good units sound musical. Playback was controlled through re-amping; one source file, a direct input (DI) recording of an electric guitar, was played back through a valve test amplified into each speaker. Studio quality recordings of each speaker were then taken using instrument microphones, with techniques widely used for their ability to best capture the sound of the electric guitar.

Notable psychoacoustic effects were observed throughout this process. Differences between units were found to be far more audible at very low playback SPLs, to the extent that barely audible differences with moderate SPLs under headphones became obvious in the headphone spill. This was attributed to the widening of masking bands as SPL increases and because of this, headphone level was drastically reduced and controlled to good effect[4]. This technique allowed for high recording levels, where the amp and speaker are performing as intended, but controlled playback levels, where listening ability is maximised.

Inputs – sonic features

Machine learning models require numeric inputs based on meaningful measurements and post-processing techniques. These quantifiable inputs will be referred to from here on in as features. It was of key importance that well-performing features were selected, and that these had a high probability of relating to the subjective judgements. Engineering knowledge was applied to ensure causation as well as correlation. Where applicable, mid-ear filtering and perceptual scaling were applied (conversion to sone scale of perceived loudness, and Bark scale of critical frequency bands) before relevant features were computed.

Feature selection

While the number of features is not limited, it is good practice to only use those which provide a statistically significant separation individually. A full explanation of the features investigated and the reasons for the final choice is beyond the scope of this article; however some of the highest performing and interesting features will be discussed.

T-tests were used to assess whether the groupings for each feature were sufficiently different from each other, to give an indication of whether that feature was significant to the grouping. P38

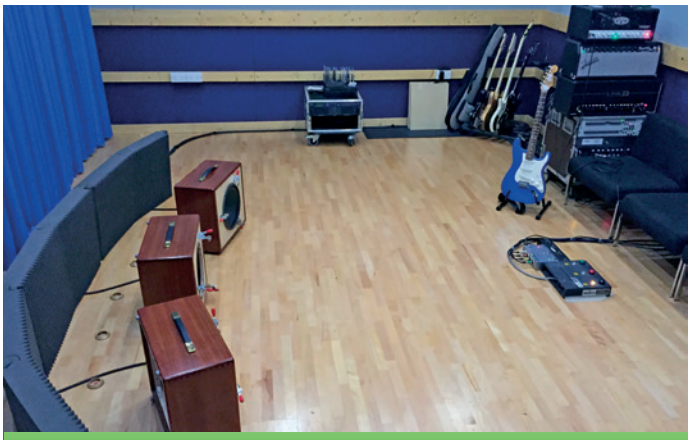

Figure 2. Celestion listening room

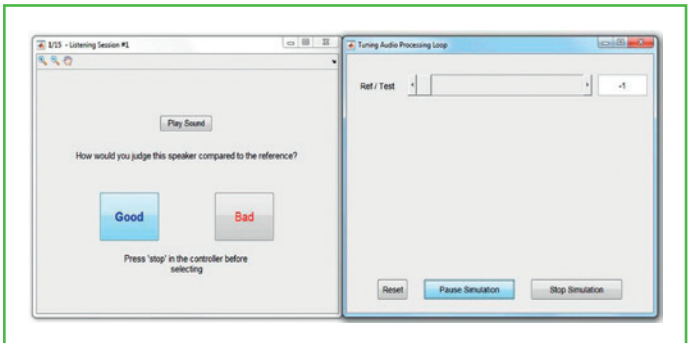

Figure 3. Listening test GUI

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Sometimes the most cost effective and straightforward method to prevent ground-borne vibration entering a building is to isolate the entire structure.

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Isolation bearings being installed. Bolts for construction purposes only and are to be removed upon completion.

Bearing Manufacture

Bearing Testing at Mason Industries HQ

The Conservatoire bearings had a loaded natural frequency of 6.0Hz, to isolate against rail vibration.

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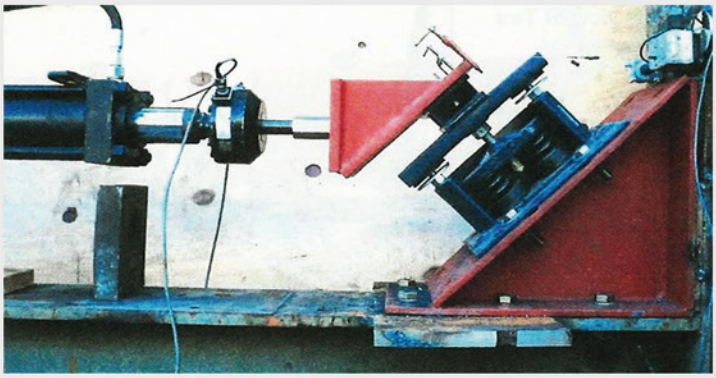
Mason UK regularly test our elastomers and other products in independent laboratories. As part of the Mason Industries group, we also have access to extensive testing facilities. As well as taking responsibility for our own design and engineering, we often have to fabricate bespoke solutions, some of which require very specific testing and certification.

Whether a standard solution or a problem never tackled before, Mason UK can help.



Spring Mount testing

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The value for alpha of 0.05 was adopted as the standard. Features which return a p value of ($p<0.05$) were taken to be statistically significant, and were therefore included as features.

While the p value gives the probability that the separation seen in values for each feature occurred by chance, it gives no comparative information between features. In order to assess relative feature performance, a logistic regression classifier was trained on each individual feature. Once the optimal boundary was obtained, in this case just a value, the quantity of correctly and incorrectly classified units from each original group could be be quantified.

It is common to visualise the possible outcomes in a confusion matrix, as shown in *Table 1*.

		Predicted Classification	
		Good	Bad
Subjective Judgement	Good	True Positive	False Positive
	Bad	False Negative	True Negative

Table 1. Confusion matrix

The relative proportions of each outcome in the confusion matrix allow various performance measures to be calculated, including:

- Precision; the proportion good units that are correctly classified.
- Recall; of the units classified as good, this proportion was classified correctly.
- F1-Score; the harmonic mean of precision and recall.
- Mathew's Correlation Coefficient; a balanced measure of correlation for binary data.

These all relate in different ways to the relative proportions of outcomes in the confusion matrix shown, and all quantify the performance in very different respects. The relative importance of each performance measure therefore very much depends on the application.

In total 27 features performed well and were selected. These can loosely be divided into five categories:

- Psychoacoustic metrics[4], e.g. sharpness
- Electroacoustic parameters
- Energy features[11], e.g. energy centre
- Those relating to cone behaviour
- Spectral features, e.g. HF roll-off, brightness

Where applicable, mid-ear filtering and perceptual scaling were applied before relevant features were computed. Engineering knowledge was applied at this stage, to ensure there was causation as well as correlation. It was also of key importance that features were not linearly related.

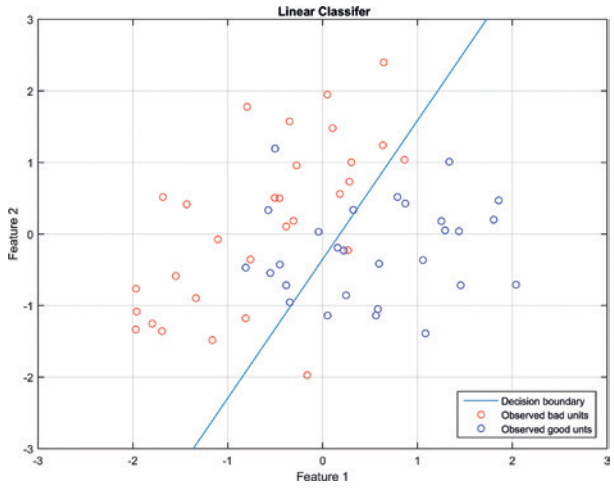

Figure 4. Relationship between two features and the linear decision boundary

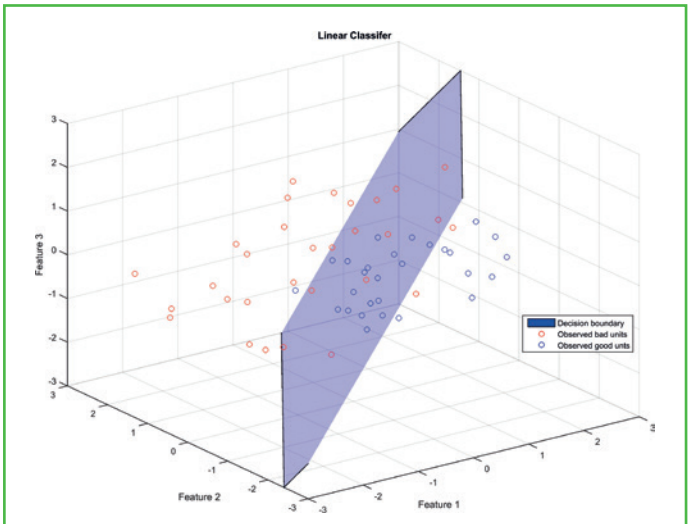

Figure 5. Comparison between three features and the linear decision boundary

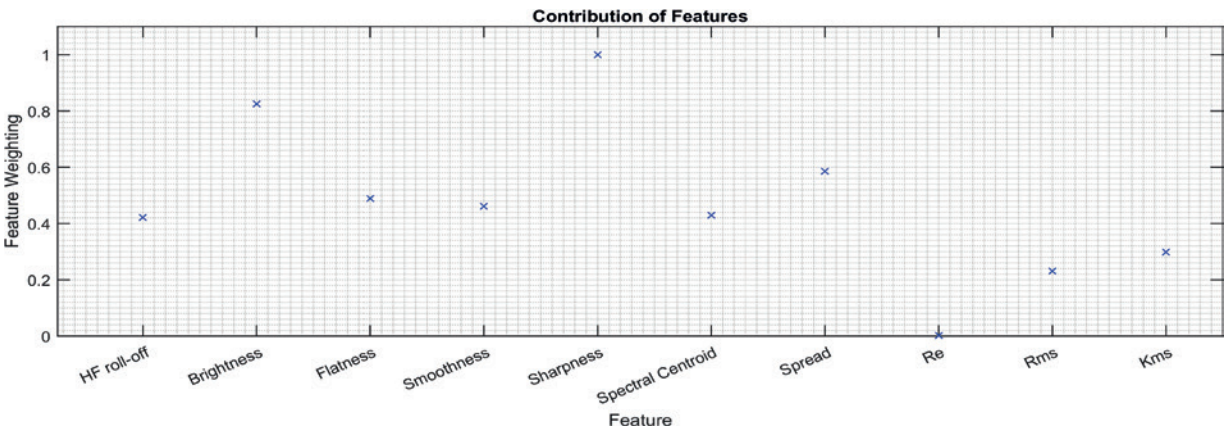

Figure 6. Calculated weighting for a selection of features

These features then act as the inputs to the machine learning algorithms, with each drive unit having a single value for each feature.

Before the next stage each feature was normalised to its mean, and scaled to unit variance. This process helped ensure the optimisation algorithms progress towards the minimum at a rate that is equally biased for all features, preventing any overshooting and reducing processing time. A brief overview of the machine learning techniques explored for this project will now be given.

Machine learning

Linear logistic regression

Linear logistic regression is used to find the optimal linear separation between groups of measurements, the decision boundary, by minimising the cost function for the hypothesised boundary. The probability of each outcome for a new measurement can then be obtained by feeding the parameters of the decision boundary into the hypothesis function, along with the quantified features.[12]

The properties of this linear boundary are relative to the number of features input, or the number of dimensions within which it is calculated. When looking at only one feature there is only one dimension, so the boundary is just a value along that dimension. When investigating the relationship between two features, plotted in two dimensions as illustrated in *Figure 4*, the boundary becomes a line; a one dimensional boundary in two-dimensional space.

In general, the decision boundary is a sub-space, with dimension order one less than the space being evaluated. For three dimensions, where three features are being evaluated together, this boundary becomes a plane, a two-dimensional plane in three-dimensional space, as illustrated in *Figure 5*.

When nonlinear relationships exist between features, or higher-order boundaries are preferred in general, it is simple to create new features as products of existing features or higher order products of a single feature. These interaction terms and variable transformations just become additional columns of the feature matrix and the standard methods are still applicable. This method was applied with reasonable success, improving performance relative to a linear boundary.

When defined higher-order relationships exist between features this technique is ideal. However, more advanced techniques exist for when the boundary is to be explored, or when discrimination ability is to be maximised at the cost of simplicity and interpretation ability. These are outlines briefly below and in the Appendix.

Feature ranking

As mentioned in above, linear methods can provide useful information on the relative importance of each feature. This includes linear logistic regression and linear Support Vector Machines (SVM), the former will be the focus here.

For linear logistic regression the optimised parameter vector θ was used to analyse the relative contribution of each feature to the good/bad decision making process. This relative weighting for each feature, as shown in *Figure 6,* provided the relative importance of each measurement and post-processing technique.

The parameter vector θ can be likened to the relative weightings of each feature. Higher θ values mean that a change in this feature is more likely to cause a crossing of the decision boundary.

As can be seen from *Figure 6,* sharpness is weighted as the most important feature to the separation for this model, with brightness a close second. Re was found to be unimportant to the classification process, and was weighted to have near zero contribution. Rms and Kms were shown to be useful, but less so than the remaining spectral features. In general, psychoacoustic and spectral features such as sharpness and brightness are weighted far more strongly than linear parameters. This technique also gives an indication of the direction of each feature contribution, whether a higher value for that feature is likely sway the result towards good or bad.

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Support Vector Machines

Support Vector Machines (SVM) optimise the boundary to be as far away as possible from both groups of data points, and in their most basic linear form are comparable to linear logistic regression but are more efficient. When used with suitable kernels, such as the radial basis function (RBF) kernel, they can be used to find non-linear boundaries with no predefined order. These can be likened to splines in two-dimensional drawing.

Kernels are algorithms which map the feature space to higher dimensions, allowing complex non-linear and non-parametric boundaries to be calculated. They do this in an efficient way by calculating the necessary inner products for combinations of higher order features, without ever calculating the exact coordinates in that space[13]. These are a relatively recent development in the last ten years or so.

Figure 7 illustrates the same data as *Figure 5*, but using SVM with the RBF kernel the boundary now becomes a hyperplane around the good units. Units outside this region are deemed bad but only the good region is shown for clarity.

Figure 7 was formed by inputting a linearly-spaced dummy feature matrix into a trained SVM with RBF kernel. The data used to train the SVM is also shown. Note how the shape of the good region is not defined by any pre-existing ideas, but purely by the data. Exact plotting of the boundary itself would require knowledge of the hyperplane coefficients. While this may be possible for linear SVM it becomes virtually incalculable for such non-linear boundaries, leaving the point-cloud method as the only realistic option.

It should be noted that while SVM are dichotomous, in that only two classes are permissible, for problems with multiple discrete outcomes it is possible to combine multiple SVM into one multi-class classifier. As the problem considered here was binary this technique was not required.

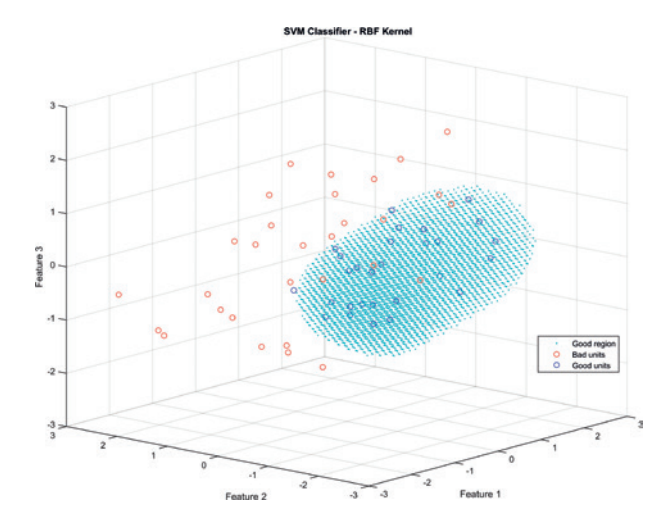

Figure 7. SVM decision boundary with RBF kernel for three features

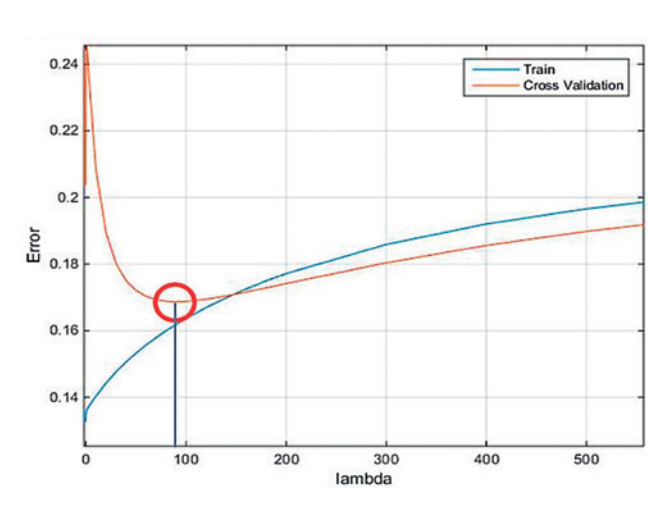

Figure 8. Error against regularisation parameter

Neural networks

Neural networks provide another mechanism by which classification problems can be solved. These are very much in vogue at the moment, with London-based AlphaGo's DeepMind system just beating the world champion human player of GO – an ancient same of strategy with more possible positions that there are atoms in the universe. Crucially, after training itself on 30 million moves played by humans, it trained itself by playing thousands of games against older versions. As of last year this huge leap forward for artificial intelligence was widely not expected to happen for another decade.[16]

While neural networks can perform brilliantly on huge datasets, it is generally believed that SVM perform better when dataset size is limited, relative to neural networks.[17]

These techniques were applied to this data with appreciable success, however with SVM and ensemble methods already working well, and the expert advice suggesting that SVM should perform better for our data structure; a thorough comparison was not conducted.

Ensemble methods

Ensemble methods were used to combine many reasonably-performing classifiers into one high-performing classifier, using the random forest technique which combines many decision trees. Some trained listeners use similar techniques, listening for several aspects of performance, each of which could be broken down into sub-criteria. For example, the dynamic performance might be based on tightness and punchiness while the spectral character might be based, amongst other things, on extension and spectral balance. Each of these general performance areas are then combined and weighted to make the overall judgement.

While ensemble methods further improve the performance of the model, one drawback is that it becomes difficult to dissect the information and relate it back to what makes a good speaker. In this respect the simpler algorithms give more information on ideal performance and the importance of each measurement or processing technique, despite ultimately performing sub-optimally.

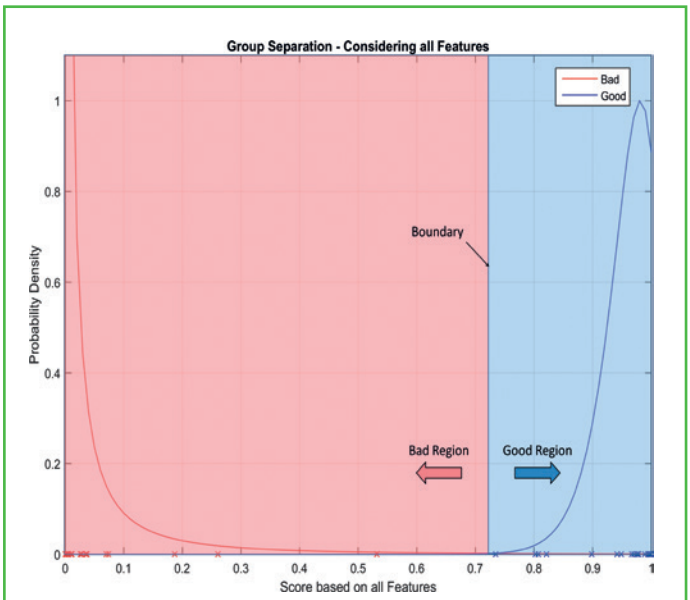

Figure 9. Probability density function of final algorithm

Improving the model – tuning and regularisation

Regularisation is a technique used to ensure the boundary is not oversimplified or over-complex. This was applied to ensure the model separation was representative of the true data trend, and that it was transferable, ensuring the model isn't tailored to fit one dataset precisely but becomes less applicable when transferred to other similar datasets.

Regularisation

Regularisation is a process that ensures the boundary is not oversimplified, or overly complex, allowing the underlying pattern to be extracted from the data. The key concept of is how well the boundary will translate to other datasets, as the goal is to classify previously unseen measurements. For this process a separate cross-validation dataset was used, to ensure the model is based on the global trend rather than local noise in the training set.

Figure 8. shows a typical plot used to select the regularisation parameter lambda.

The ideal classifier has minimal error based in the cross-validation set, circled in red. This increases the error for the training set, relative to no regularisation (lambda = 0). Below this optimum value, where less regularisation is applied, the error for the training set reduces as the model tailors itself to the training data, as it becomes less transferable to other datasets the error increases for the cross validation set. Above this, where excess regularisation is applied, the error in both datasets begins to increase, as the model is now too simple to provide a good fit with either set.

Regularisation was employed on every model, from linear logistic regression, through SVM, to ensemble methods outlined below. To ensure reliable regularisation, the number of training units was kept far higher than the number of features. Otherwise points become perfectly separable by even linear classifiers, and some of the matrix transformations required for efficient optimisation do not work.

Dimensionality reduction

Any features that are directly related to others will be redundant, and won't add any value. These will also cause the covariance matrix to be non-invertible, which rules out the most efficient optimisation methods. In this instance dimensionality reduction techniques such as PCA (principal component analysis) can be applied to project related features into a lower dimensional sub-space, reducing training time and storage space, and ensuring orthogonality of features. This technique has been applied in previous studies to allow many features to be projected onto a small number of key perceptual dimensions, in order to discover how many independent variables are involved. However, this wasn't applied here as model simplification was not the aim, purely discrimination ability. The relatively small number of features did not make processing speed or storage a concern and any dimensionality reduction would reduce performance.

Cascade architecture

Cascade architecture was used as a final improvement to the model. After the initial training classification, incorrectly assigned data points were removed, and the boundary recalculated. This improved performance by further reducing the noise and focussing the model on the global data trend.

This technique was originally proposed to speed up real time facial recognition; with a series of classifiers of increasing complexity only using all available features when necessary[14]. As the number of features employed here was comparatively few at only 27, computing power was not a concern. The full featured and regularised classifier was used in each stage, with cascade architecture employed more as an anomaly detection technique.

Final performance

The performance measures outlined in the features section above were also used to compare and tune the different machine learning models, allowing the most suitable model for the specific task to

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be selected. For some applications recall can be maximised. This helps ensure that when a speaker is classified as bad by the model, there is a high probability of it being a bad sounding speaker, and that very few good sounding speakers would be judged incorrectly. Other applications require maximum precision, where we want to ensure only the best sounding units are selected. The flexibility of the final solution allows us to tailor the model used to the question being asked.

This final method of cascaded ensemble classifiers is capable of separating the loudspeakers into two distinct groups, as illustrated by *Figure 9*, and outperforms both linear and non-linear logistic regression as well as SVM with a range of kernels.

An improved separation can clearly be seen in results using the final algorithm, shown in *Figure 9*, compared to that for any single high-performing feature, an example of which is shown in *Figure 3*. The proportion of units from each group that could be misclassified has been drastically reduced, as seen by the significantly reduced overlap between probability density functions.

Conclusion

Based on a handful of basic measurements, it has been shown possible to confidently predict the subjective judgement of these loudspeakers. New input features have been developed and combined with existing sound metrics and raw measurements to provide the inputs. The program utilises cascaded ensemble methods, and is simplified to ensure a level of complexity appropriate to the data. Automatic anomaly detection removes potentially misleading data before recalculating the most suitable decision boundary, based on those loudspeakers most important to the groupings. The final performance based on separate test data shows a marked improvement relative to suitable alternative methods, and a drastic improvement compared to analysis of any one measurement alone. The output is a classification which correlates highly to subjective judgements.

Appendix

Method comparison

Neural networks typically have a significantly improved discriminatory power relative to logistic regression, with around a 5:2 ratio in the number of instances of higher success.[2] It is now generally believed that neural networks outperform SVM for larger datasets, whereas the reverse is true for smaller datasets, although this is heavily dependent on the structure of the data, such as number of features. In this context, large would be tens of thousands or more; the preliminary data used in this study was sixty units, with an additional hundred for the final models.

SVM have the advantage that they are firmly rooted in statistical learning theory, whilst performance comparisons can often be marginal; SVM can in some instances gives higher precision and lower error rates.[17]

SVM are often superior to neural networks because they avoid two major weaknesses:

1. Neural Networks can often converge to local minima, missing the wood for the trees.
2. They can also tend to overfit if care isn't taken in cross validation, meaning they start to consider the noise as part of the pattern.

SVMs don't suffer from either of these two problems.

As mentioned earlier, there is a trade-off between model interpretation and discrimination ability. Logistic regression, linear SVM and some methods not discussed such as k-nearest neighbours and decision trees all allow for interpretation of parameters. However, these so called white-box models often perform poorly compared to black-box models like artificial neural networks and SVM with non-linear kernels, which are likely to perform better at predicting the classification.[2]

It should be noted that the techniques used to give the relative importance of each feature discussed above, one of the key results of this research, are not possible with SVM, neural networks or ensemble methods. This is only realistically achievable using linear logistic regression or linear SVM where the hyperplane coefficients are more easily obtainable.

It is often mentioned that whoever has the most data wins; basic models with more data regularly outperform more sophisticated models trained on less data. The trick is in knowing which method is most applicable to a given data structure and size.

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The assessment of dog barking noise from boarding kennels

By Damian Brosnan MIOA and Dr John Pritchard MIOA

Introduction

The number of dog boarding kennels in the UK and Ireland is currently estimated at more than 4,500, with at least an additional 1,000 animal welfare establishments. One of the key issues affecting such establishments is dog vocalisations, chiefly barking, but which may also include whining, howling and yelping (DEFRA, 2005). Barking may be audible over extended distances, giving rise to nuisance at up to 500 m (EPA Victoria, 2008). On occasions, a number of dogs may contribute to an extended barking frenzy, giving rise to potentially severe noise nuisance at neighbouring dwellings (An Bord Pleanála, 2001; Manley v New Forest DC, 2007).

In the 1999-2000 national UK noise attitude survey conducted by the BRE, 65 % of more than 5,000 respondents listed barking dogs as a noise source which "bothered the respondent to some degree", constituting the fourth most common source of noise nuisance (Grimwood et al, 2002). While the respondents did not distinguish between barking noise originating from a neighbour's dog, and noise from boarding kennels, it is likely that some of the respondents were affected by the latter. Kamst & Eddington (1988) noted that barking ranks in the top three sources of noise annoyance in Australia, with complaints registered at separation distances as far as 800 m. A more recent Australian document indicates that complaints of dog barking received by several local authorities exceeded all other complaints approximately ten-fold between 2004 and 2008 (EPA New South Wales, 2013).

Given the community response to barking noise, it is somewhat surprising that, to date, no comprehensive noise guidance documents have been issued with respect to boarding kennels in the UK nor in Ireland. In the absence of such guidance, approaches adopted by local authorities and noise consultants in the assessment of kennel noise vary widely. This article is a brief review of current assessment practices in the UK and Ireland.

Current dog boarding kennel legislation and guidance

In the UK, boarding kennels are regulated through the Animal Boarding Establishments Act 1963 which requires each kennel operator to obtain a licence from the Local Authority. The Breeding Of Dogs Act 1973 (as amended), almost identical in wording to the 1963 act, sets out similar provisions applicable to operators of dog breeding kennels. Licences are generally renewed annually. Both acts provide for local authorities, to attach to a licence, conditions relating chiefly to animal welfare and disease control. No reference is made in the acts to impacts on amenity or the environment, and dog vocalisations are not mentioned. In Ireland, the Dog Breeding Establishments Act 2010 sets out a similar registration procedure, again without any reference to impacts on amenity or the environment.

In an attempt to raise dog kennelling standards, and to introduce an element of consistency between local authorities in their licensing of boarding kennels, the Chartered Institute of Environmental Health (CIEH) issued *Model licence conditions and guidance for dog boarding establishments* (CIEH, 1995). As with the 1963 act, the CIEH conditions relate almost entirely to kennel

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standards and animal welfare. Little or no reference is made to barking noise or impacts on amenity, and indeed the CIEH document indicates at the outset that its focus is almost solely on animal welfare. While the document refers to the extreme importance of preventing noise nuisance, no further guidance is offered in relation to kennel noise measurement or control.

Although several UK local authorities have issued guidance documents in relation to the kennel licensing procedure, all such documents reviewed include conditions drawn from the CIEH model conditions document, and thus focus almost entirely on kennel structure and dog welfare. The Environment Agency document *Scoping the environmental impacts of kennels, catteries and stables* (2002) offers little or no advice with respect to noise impacts. Guidance issued by the Irish Department of the Environment, Community and Local Government (2011) offers a single paragraph of noise guidance. In a guidance note targeting dog owners encountering difficulty in controlling their barking dog(s), Defra (2005) makes a single reference to boarding kennels, ironically as a temporary mitigation measure to provide the owner's neighbours with some relief from barking noise!

The only kennel-specific noise guidance document issued in these islands to date is *Supplementary planning guidance: Location of premises for the boarding and breeding of dogs and other animals – Noise issues* (South Holland District Council, 1999). Prepared by the in-house EHOs, the document sets out a method to assess noise impacts arising from proposed boarding or breeding kennels, or those seeking to expand their kennelling provision. Guidance with respect to barking noise attributable to existing kennels is not offered in the document.

The widespread application of BS 4142:1997 to the assessment of dog barking noise is evident. The revised version, introduced in 2014, has been entirely reworked to reflect the standard's widespread application to situations for which it was not originally intended, including barking dogs. The fundamental methodology, whereby specific source levels are compared to background levels to assess the degree of impact, remains unaltered. However, one of several changes relates to the standard's scope: the 2014 version for the first time clearly precludes itself from several categories. Included in these is "domestic animals". It therefore appears that BS 4142 is now precluded from application to boarding kennels. While it is possible that the authors of the standard had only domestic situations in mind, such as dog barking at a neighbouring dwelling, the standard does not include any clarification in this regard.

At the time of writing, it is too early to tell if BS 4142 will see continued use with respect to the assessment of boarding kennel noise. Given the absence of any other standards relating to either kennels or the assessment of noise complaints, it is possible that noise consultants will see no alternative but to apply the standard, particularly given that:

- The standard notes that it is applicable to the assessment of sound from "sources of an industrial and/or commercial nature" (p.1). Boarding kennels are indeed commercial premises.
- Section 1.3 of the standard lists eight exceptions to which the standard should not be applied, including domestic animals. It is noted that other noise standards exist for most of the exceptions, and indeed the last exception listed is "other sources falling within the scope of other standards or guidance" (p.1). As no official standards or guidance exist for boarding kennels, it is possible that innovative noise consultants will view this as justification for continued use of BS 4142 on commercial kennel projects.

Planning authorities and kennel noise

UK local authorities do not benefit from any national guidance on how boarding kennel noise should be assessed. Ultimately, kennel noise issues appear to be managed through planning controls, or, failing this, through statutory nuisance legislation. A 2015 search of planning files/applications available online indicates a wide range of approaches adopted by local authorities in assessing planning applications for boarding kennels. The approaches adopted include:

- A minimum separation distance equal to 10 times the number of dogs proposed (Boston Borough Council, pers. comm).
- A 400 m separation distance, adopted from the authority's guidance on intensive animal units (Hertfordshire County Council, 2009).
- A night-time $L_{Aeq\ 5\ min}$ limit of 30 dB applicable internally at surrounding receptors, with no daytime limit (Angus Council, 2002).
- A relative limit (background +5 dB) at receptors, with an additional night-time absolute $L_{Aeq\ 5\ min}$ limit of 40 dB, inexplicably applicable only to properties within 1 km of the kennel (Dumfries & Galloway Council, 2013).
- No noise limit; as an example, six other kennel planning consents issued by Dumfries & Galloway Council during the period 2010-2013 did not include any noise limits, or indeed any reference to noise.
- A general noise condition without any reference to limits, e.g. 'the kennel shall not give rise to nuisance' (Durham County Council, 2013).
- No reference to criteria or nuisance, instead specifying certain kennel works and management practices (North Lincolnshire County Council, 2008; Durham County Council, 2011). In at least one case (Teignbridge District Council, 2011), the planning officer recommended inclusion of several conditions relating to such works due to his apparent reservation that noise criteria are insufficient at protecting amenity from barking noise. In another case, (Taunton Deane Borough Council, 2013), the EHO conditioned the erection of a hay bale wall of height 7 m, to be maintained for the lifetime of the proposed kennel adjacent to an acoustic barrier conditioned separately

In contrast to UK local authorities, a clear preference for the inclusion of noise limits, particularly absolute limits, is evident in conditions attached to kennel planning consents granted by Irish Planning Authorities. In 25 An Bord Pleanála (ABP, the Irish planning appeals board) consents granted between 2001 and 2014, daytime 55 dB and night-time 45 dB criteria appear in the majority of those which included a noise condition, applied either to the kennel site boundaries or to offsite receptors. Nonetheless, inconsistencies abound; for example, night-time hours variously applied are 2000-0800 and 2200-0800. A night-time limit of 40 dB has been applied in three of the reviewed cases (ABP, 2006; 2010a; 2013). A 45 dB limit has been specified on a 24 hour basis in one case (ABP, 2003) while a much more lenient 55 dB limit has been conditioned over 24 hours in three cases (ABP, 2005a; 2005b; 2009). A relative limit (background +5 dB) has been specified on one occasion (ABP, 2010b). Measurement intervals specified typically vary from 15 minutes to 30 minutes. Additional criteria include various limits on the maximum number of dogs allowed, and the overnight confinement of dogs internally during specified hours, typically 1800-0800. While a small number make reference to rated values to account for impulses, most do not make any reference to tonal or impulsive characteristics. Although it is possible that some of the variation noted in noise conditions may be a result of differing local noise environments, it is unlikely to account for the entire variation, particularly as many of the reviewed files relate to locations with relatively similar noise environments.

Noise consultant reports on public files

A sample of 14 noise consultant reports (Table 1) available through online planning files relating to UK and Irish boarding kennel applications were reviewed to provide a flavour of the assessment methods applied. Up to 50 % of the assessments applied the BS 4142:1997 methodology, in some cases at the specific request of the planning authority. WHO (1999) criteria were referenced in five cases, some of which used the WHO criterion for L_{AFmax} levels and BS 4142:1997 criteria for L_{Aeq} levels. BS 8233:1999 was applied in three cases, and one consultant also applied CIEH guidance with respect to clay target shooting (CIEH, 2003). Just three (21 %) applied the SHDC guidance, suggesting that the document has not circulated outside a limited area.

Most consultants who applied BS 4142:1997 included a statement in their reports that the standard is not specifically

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Year	Authority	Methodology
2007	Lichfield District Council	Barking noise level measured using single large dog, and on-time corrected for 10 s each hour. Levels at receptors predicted for both normal dog height (0.6 m) and standing on rear legs (2 m). Impacts assessed using BS 4142:1997.
2008	Clare County Council (accessed through An Bord Pleanála, 2008)	Measured L_{Aeq} and L_{AFmax} while dogs provoked, then used these data to predict levels at receptors. L_{Aeq} prediction assumed dogs barking 10 % of time. Compared levels to WHO 50 dB daytime and 45 dB night-time L_{Aeq} criteria, and 55 dB day/night L_{AFmax} façade level based on WHO internal 45 dB night-time criterion +10 dB. Also concluded that data suggested barking not impulsive.
2008	St. Helens Metropolitan Borough Council	Measured L_{Aeq} levels at similar kennels, then used data to predict levels at receptors. These compared to measured ambient levels in loose approximation of BS 4142:1997.
2009	Ribble Valley Borough Council	Compared likely barking L_{AFmax} levels to residual $L_{AF90\ 5\ min}$ levels using BS 4142:1997, although acknowledging that background levels were below 30 dB, thus precluding use of BS 4142:1997.
2011	Allerdale Borough Council	SHDC guidance used to predict $L_{Aeq\ 5\ min}$ levels at receptors, and these assessed using BS 4142:1997 (with 'expected' rather than actual background data applied). Measured L_{AFmax} levels also predicted, and loosely assessed by reference to CIEH shooting noise guidance. As SHDC applies only to daytime external barking, consultant also assessed internal night-time barking impacts by assuming $L_{Aeq\ 5\ min}$ barking noise level of 100 dB, and L_{AFmax} 105 dB, based on experience.
2012	Herefordshire Council	SHDC methodology applied at request of local authority.
2012	Limerick County Council	BS 4142:1997 assessment requested by local authority. Typical barking noise levels obtained from literature, and used to predict levels at receptors. Daytime barking noise corrected for on-time (15 min in any 45 min window). WHO criteria also applied.
2012	Ribble Valley Borough Council	Measured L_{AE} from one dog (in octave bands), and used this to predict $L_{Aeq\ 15\ min}$ at proposed residential development, based on barking at intervals of 2.2 s as observed at existing kennel. Predicted $L_{Aeq\ 15\ min}$ compared to 55 dB criterion taken from WHO daytime recommendation.
2012	Rossendale Borough Council	L_{Aeq} and 95th percentile L_{AFmax} levels determined from existing dogs based on 10 s intervals, and these used to predict offsite levels associated with proposed extension. Internal criteria applied at receptors, from BS 8233:1999.
2012	West Lindsey District Council	Measured barking L_{Aeq} levels at nearby kennels and used these to predict L_{Aeq} levels at receptors, assuming up to 2 min barking in any hour by day, and 1 min in any 5 min by night. Assessed using BS 4142:1997 by reference to measured background levels. 5 dB impulse penalty applied. SHDC methodology also applied, and found to give similar results.
2013	East Riding Of Yorkshire Council	Measured barking L_{Aeq} levels at nearby kennels and used these to predict L_{Aeq} levels at receptors. Assessed using BS 4142:1997. Measured background levels found to be low, so BS 8233:1999 also applied with respect to internal receptor impacts.
2013	Midlothian Council	50 dB daytime & 45 dB night-time L_{Aeq} criteria applied, based on ambient data, without reference to BS 4142:1997. Also 65 dB daytime L_{AFmax} criterion applied, based on WHO night-time 60 dB recommendation. Prediction based on data measured at another site, scaled accordingly. EHO unimpressed by application of WHO guidance to barking, and refusal recommended.
2013	Taunton Deane Borough Council	Barking noise measured at other kennels used to predict levels at receptors, and impacts assessed using BS 4142:1997 & BS 8233:1999. Use of BS 4142:1997 criticised by another consultant, although no alternative offered.
2014	Cork County Council (accessed through An Bord Pleanála, 2014)	Measured barking noise levels used to predict levels at receptors. 55 dB L_{AFmax} criterion applied to daytime & night-time, based on night-time WHO 60 dB L_{AFmax} recommendation, minus 5 dB to account for impulsive nature of barking.

Table 1: Sample of 14 noise consultant reports reviewed through online publically available planning reports

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applicable to barking noise, adding that its use was necessitated by the absence of any other guidance, and that, regardless of relevance, its use provides an indication of impact. The consultant who applied CIEH shooting guidance included a similar statement. Several consultants appear to have been criticised for selecting their various methodologies, whether based on BS 4142:1997 or WHO criteria.

Consultants not using SHDC guidance variously obtained typical barking noise levels by direct measurement or by reference to literature. Barking noise descriptors used consisted of the L_{Aeq}, L_{AFmax}, 95th percentile L_{AFmax}, and, in one case, the L_{AE}. Barking noise L_{Aeq} levels applied ranged from 84 dB at 5 m to 108 dB at 1 m. Where possible, most Consultants measured noise from large dogs such as a Doberman or a Pyrenean mountain dog in order to adopt a worst case scenario.

Approximately one half of the reviewed reports factored the character of barking into their assessments. One firm applied a 5 dB impulsive penalty in a 2014 assessment, despite concluding separately in a 2008 assessment, by direct measurement, that barking noise was not impulsive! In predicting noise levels at receptors, another report applied two source heights (0.6 m and 2 m) when calculating barrier screening, depending on whether dogs would be on all four legs, or standing upright on their hind legs, when barking.

The various approaches to barking noise adopted by noise consultants is also apparent in legal cases relating to barking noise nuisance and anti-social behaviour. By way of example, the outcome of a case relating to a kennel used to house 46 German shepherds in Scotland was significantly influenced by contrasting methodologies applied by noise experts appearing for the plaintiffs and the defendant (Moray Council v Andrew Deshwar Debedin, 2012). The decision by local authority EHOs, giving evidence on behalf of the plaintiffs, to apply BS 4142:1997 was found to be unsuitable for several reasons, whereas the judge found favour with the use of WHO absolute criteria, modified by the addition of a 5 dB penalty for impulsive character, as applied by the noise consultant retained by the defendant. The judge was also critical of the EHOs' use of a 99 dB barking noise level at 1 m, determined by averaging measured levels, and used to form the basis of a predictive assessment, preferring a 95 dB level applied by the consultant

Noise consultants interviewed

A snapshot of current kennel noise assessment practice was obtained by interviewing eight noise consultants across the UK and Ireland by telephone in 2015. All interviewees were practising members of the Institute of Acoustics, and have a minimum of five years' experience. All were employed at well-known consultancies, and all had been involved in kennel noise assessments previously.

WHO criteria have been applied by six of the eight consultants. BS 4142:1997 has been used by five of the consultants, with all five noting that they use the standard despite its apparent preclusion from kennel noise, basing their decision on the absence of any other criteria. The CIEH clay target shooting methodology is one of two non-routine methodologies applied by the interviewed consultants, the other being BS 8233:1999 (now replaced by BS 8233:2014). One of the consultants has a policy of agreeing the assessment methodology with the relevant EHO in advance, and as a result has been required to apply a different methodology on all four kennel projects to date.

$L_{Aeq\,T}$ criteria alone have been used by two consultants to quantify barking noise. Similarly, L_{AFmax} criteria alone have been used by two. The remaining four Consultants have applied both parameters. Where the $L_{Aeq\,T}$ has been used, the interval T has varied between 1, 5 and 15 minutes. Seven of the eight consultants have applied a penalty for barking character, considered to be impulsive by all seven. Of these, five have used a subjective assessment of impulsiveness, one has used an objective assessment, and one has used both. The penalty has been 5 dB in almost all cases.

Two of the three consultants who have relied solely on WHO criteria intend to continue avoiding use of BS 4142:1997, now

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replaced by BS 4142:2014 (Figure 1). The third proposes to apply the revised version in future kennel projects, due to the standard's reference to its suitability for commercial noise sources, as stated in its scope. Two consultants who have applied BS 4142:1997 in the past also intend to use the revised 2014 version. In contrast, one consultant who has relied on BS 4142:1997 to date, proposes to base future assessments on BS 8233:2014, which will increase the number of interviewed consultants who use this standard to two. The two final consultants who have used BS 4142:1997 to date remain undecided regarding implementation of the revised version, intending to make the decision when forced by a kennel project commission.

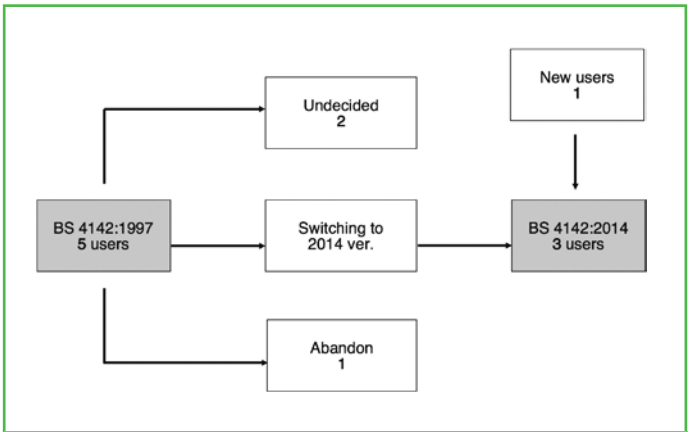

Figure 1: Number of eight interviewed consultants using BS 4142

The way forward

In light of the plethora of guidance documents available for a wide range of noise sources and activities, the absence of a document specific to dog barking is unfortunate, and a glaring omission in the noise guidance library. In the absence of any existing guidance documents, approaches adopted by noise consultants and local authority EHOs in the British Isles are highly variable, and no emerging trends are readily apparent apart, from widespread misapplication of BS 4142:1997 when assessing impacts. Although the 2014 version of the standard specifically precludes application to domestic animal noise, several interviewed consultants indicate that they intend to apply same due to the absence of any other guidance.

All consultants interviewed acknowledged the need for a kennel noise guidance document which will allow a consistent approach to be adopted by consultants and planning authorities alike. Such a document might include guidance on measurement methodology, predictive modelling, noise limits, and advice on kennel design and noise management, and would benefit planning departments, environmental health personnel, kennel operators and noise consultants. It is considered that the derivation of suitable noise limits would require some element of social annoyance studies relating to barking noise, in order to identify (a) a suitable noise descriptor and (b) thresholds of annoyance. A barking noise guidance document may benefit from inclusion of an assessment methodology based on a specified number of barks to be measured, similar to the method set out in the CIEH clay target shooting guidance document.

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More kennel noise guidance is needed

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Sustainable design and practice in reproduced sound

By Ben Mosley

Introduction

Large broadcasters are beginning to recognise the importance of environmental sustainability in their operations as part of their corporate responsibility. The albert+ standard developed by the BBC[1] and BAFTA[2] and Sky's *The Bigger Picture*[3] reports are evidence of this. There is evidence of pockets of development in environmental sustainability in the audio industries but the industry is yet to develop a coherent strategy in this area.

This article reviews some of the current literature and practice in environmental sustainability in the audio-visual (and related) industries and considers how this can be applied to some of the challenges of live and installed sound with regards to reducing carbon footprints and operating in a more environmentally friendly and sustainable way. The article focuses on the activity areas of the Institute of Acoustics' Electroacoustics Group but there are applications to the work of the wider acoustics community.

Background

Environmental challenges in the audio industry

The professional audio industry faces very specific challenges with regards to sustainability and carbon footprint, particularly in the area of reproduced sound. High sound pressure levels require high power amplifiers which often require large amounts of energy input. High sound pressure levels also require bulky loudspeaker systems which require transportation with associated emissions and carbon footprint. The materials used in the manufacture of audio systems are a complex mix of metals, wood, electronics and composites and need careful supply chain sourcing in order to ensure sustainability is maintained.

The industry is a very diverse one, with audio related activities taking place within the wider audio-visual creative industries, the acoustics industry and beyond. It is often the case that audio related activities have to take place under the environmental sustainability requirements of other industry areas and there is evidence of discussion and research into sustainable practice in the wider creative industries and engineering industries that include aspects of audio. At the time of writing there is very little discussion specifically in the audio industry with regards to environmental sustainability and green practice. However, there are now well established sustainability agendas within the major UK broadcasters which are clearly visible on the public webpages of these organisations[3,4,5,6,7]. There are many parallels between broadcast and the audio industries in terms of the types of activities that are carried out and, of course, audio is a fundamental part of the broadcast industry. It is clear that there is much that can be taken from the broadcast industry with regards to sustainable practice.

Sustainability guidance documents, research and policy

Julie's Bicycle

Early investigations into environmental sustainability in the music industry were carried out by the consultancy and think-tank organisation Julie's Bicycle. In 2007 they conducted a greenhouse gas emissions survey of the UK music industry. Their key findings with regards to emissions were:

- Live performance – In the order of 75 million tickets are sold annually, 90% are venue-based and 8% are music festivals. There are ~2,200 venues in the UK regularly playing live music and almost 500 festivals annually. A music venue with a capacity of 2,000 people is likely to produce over 400 t CO2e per year. A large music festival (more than 40,000 people) including audience transport will produce in the order of 2,000 t CO2e.
- Live music performance sectors together with audience travel account for three-quarters of the UK music industry's GHG emissions. Recorded music sectors account for a quarter of GHG emissions. [8]

The report recognised that "it is clear that there is widespread support for coordinated industry actions on climate" [9] and made several recommendations, including:

- In the short term, it is proposed that reducing the industry's own carbon footprint should be the clear priority.
- In the medium term, the industry should identify its "levers of influence" and use these to effect policy interventions and public education on climate
- The music industry is centrally influential in lifestyle choices and therefore has an opportunity to be an important leader in the transformation to a low carbon economy, as emissions are closely tied to decisions on lifestyle. As a service industry, it could and should be an exemplar in the UK and internationally for demonstrating how business works in partnership with its sub-contractors and customers to transform its products and services; to minimise the emissions generated; and to bring an amplified voice for changes in the energy infrastructure and for a drive towards a low carbon economy. The mobilisation of the industry's critical mass will be key to its becoming a climate leader. [8]

Since this report, Julie's Bicycle have widened their scope beyond just the music industry and have been active producing a wide variety of guidance documents related to environmental sustainability in the creative industries which are available on their webpages. Their latest piece of survey work, *Sustaining Creativity Survey: Actions and attitudes from the creative community: environmental sustainability 2014*, provides an interesting snapshot of current attitudes and development and could be seen as a natural follow up to the 2007 emissions survey. The research presents the following headline trends:

- High engagement across the sector, with strong affirmation of the importance of sustainability, and an emergent vision and desire to lead change. The strongest driver for engagement is the personal commitment of staff.
- Encouraging levels of action, with scope to further embed environmental sustainability into operations and communications of most organisations. Around half of organisations have also created work that concerns environmental sustainability, though very few consistently focus on this.
- For many, action leads to financial and/or reputational benefits, though environmental sustainability is yet to be perceived as a core business concern by executive and non-executive directors.
- Appetite to come together and take a lead through peer groupings, knowledge transfer and networking.
- Despite the high engagement level and the financial and reputational benefits of incorporating environmental sustainability, there remains a value-action gap (the gap between the values and attitudes of an individual/organisation, and the actions. This is true of the population as a whole.) Environmental sustainability is seen as a priority but actions do not match attitudes. [9]

From these findings it appears that whilst there have been some promising developments in practice and a clear appetite for change, there remains a lack of action and the recommendations from 2007 have not really been followed up on.

Albert

The Albert Consortium members include BAFTA, all3media, BBC, Channel 4, Endemol, IMG, ITV, Kudos, NBC, Universal International Television, Sky, Shed Media, Twofour and UKTV' [10]. Established in 2011 it is "the leading think-tank on sustainability for film and television, working to raise the profile of sustainability in the industry, championing sustainable production techniques and freely providing the tools, guidance and direction needed to reduce the impact of moving-image media production on the environment" [10].

One of the key initiatives of the Albert consortium is the albert+ standard. Based on original research and development by the BBC, albert+ is a 'mark of sustainability which indicates that the programme has taken steps to manage and reduce its environmental impact during production' [2]. Although Albert focuses on the production process for TV programmes there are many parallels with live event production and considerations such as travel, energy use on location, waste disposal and equipment supply chain are all pertinent to live events.

Albert provides a checklist for production companies to work to covering "General" issues, "In the office", "On location", "Transport", "Sets, props and wardrobe", "In the studio" and "Post production and show launch". Many of the issues in this checklist can easily be applied to live and installed audio projects and a selection of these are shown below:

General

- Consider how to make the biggest cuts to the footprint Albert's predicted for your production
- Write a simple statement of intentions and goals
- Nominate a senior individual responsible for sustainability
- Tell all cast, crew and supply chain about the plan as soon as possible

Travel

- Use Albert to estimate your travel carbon footprint and commit to cutting to a minimum
- Devise a travel plan based around low-carbon vehicles, public transport usage and reduced mileage
- Request low-carbon vehicles from all suppliers
- Cut the number of vehicles needed by making sure each vehicle is full

On location

- Ensure your work will not impact on wildlife or vegetation
- Devise a sustainable transport plan for getting cast and crew to the site
- Choose local accommodation providers where possible
- Keep meter readings of energy consumption on site
- Research generator efficiency and go with the best
- Keep generator use to a minimum
- Provide clearly-signed recycling points for all main materials. [2]

The Albert standard provides a really strong base for audio events and installations. This could easily be developed and adapted into a checklist for audio system design, installation and operation. Albert is seeing strong adoption in the broadcast industry and is backed by a wide range of significant organisations which should see it gain a strong base in the broadcast and creative industries in the coming years.

The broadcasters

Being publically funded, corporate responsibility is high on the agenda at the BBC and the corporation has a strong sustainability policy called The Difference that is highly visible on their webpages. The BBC is also one of the key early partners in the Albert project. The Difference focuses on five areas:

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- Get the basics right – reducing the impacts of the infrastructure we provide and operate, for example by investing in energy efficiency for our buildings and technology;
- Improve how we work – addressing our own behaviour, for example by reducing travel by increasing video conference use and using bespoke tools such as albert the carbon calculator for TV production to encourage good practice;
- Work with our suppliers – improving the sustainability of the products and services we procure;
- Lead the industry – embedding sustainability in the TV production process and working closely with partners in the broadcast industry;
- Engage our staff – encouraging and enabling sustainable behaviour by BBC staff across the organisation through training courses and awareness campaigns. [4]

Channel 4[5], ITV (itvresponsibility.com [6]) and Sky (The Bigger Picture [7]) all have very clear sustainability policies in place.

British Standards

BS ISO 20121:2012 *Event sustainability management systems – Requirements with guidance for use* provides a very generic framework for event sustainability with a strong emphasis on documentation and tracking with clear and strong management of the whole event process from planning and procurement through to evaluation. There is, however, some useful guidance for the audio side of events, with energy efficiency of equipment, choice of renewable energy sources, transport and logistics and noise levels all being identified as key issues for one off events [11].

BS EN ISO 14001:2015, *Environmental management systems – Requirements with guidance for use* [12], has recently been rewritten and "specifies the requirements for an environmental management system that an organization can use to enhance its environmental performance". This is a much more wide reaching document than BS ISO 20121:2012 and is intended to support the long term development of an organisation's environmental sustainability policies. It focuses on leadership, management, policy and monitoring. It provides a great deal of useful guidance on how to run an organisation in an environmentally sustainable way. It is a widely known international standard that has been in operation in various forms for 20 years. The British Standards Institution offer a certification route against BS EN ISO 14001:2015 for organisations.

Professional bodies

The Institute of Engineering and Technology (IET) have sustainability written into their rules of conduct for members which suggests that sustainability should be a part of all members daily professional practice.

- Members shall take all reasonable steps to avoid waste of natural resources, damage to the environment, and damage or destruction of man-made products [13].

The Institute of Acoustics has a sustainability task force in place which is running workshops and seminars to progress discussion in the area. The IOA code of conduct includes a statement with regards to the environment, stating that members should not "needlessly pollute the environment except when legally authorised to do so" [14].

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Environmental sustainability will continue to be an important part of the activities of audio companies and audio practitioners

Advertising Feature

Armstrong Ceilings prove a multi-acting medicine for CPI

A wide variety of ceiling systems from Armstrong have proved just the tonic for a ground-breaking new medical research centre

More than half a dozen different solutions, including wall-to-wall systems, rafts and linear baffles, were specified by architects NORR for the National Biologics Manufacturing Centre in Darlington, County Durham, which was opened by Jo Johnson, Minister of State for Universities and Science.

Developed with a £38 million investment by the Government as part of the Strategy for UK Life Sciences programme, it is used for conducting research on biologic products by promoting collaboration between academia, the NHS and industry.

The 5,000m2 facility features flexible laboratory and pilot plant areas, dedicated spaces for Good Manufacturing Practices (GMP) process, analytical and technological development, and clean rooms for research as well as offices, meeting rooms and spaces for training and conferencing.

Armstrong Ceilings systems were used widely in white for maximum light reflectance, including the manufacturer's metal systems - Tegular 2 microperforated tiles with acoustic fleece in the laboratories, B-H 300 microperforated planks (1800mm x 300mm) with acoustic fleece between plasterboard margins in corridors, and V-P 500 perforated metal baffles (1534mm x 150mm x 30mm) at 125mm centres in break-out areas and the double-height reception area. The D-H 700 floating raft ceiling, comprising 2140mm x 500mm x 30mm microperforated panels with acoustic fleece hung from a U-profile grid system, was also used in the reception area.

Mineral systems used were humidity-resistant Hydroboard 600mm x 600mm tiles with corrosion-resistant grid and perimeter trim in the changing rooms, Optima Vector tiles (600mm x 600mm) on a 24mm grid with shadow perimeter trim in meeting rooms, and Cradle to Cradle™ certified Ultima+ Vector tiles (600mm x 600mm) on a 24mm grid in offices, corridors and stairwells.

They were selected by regular Armstrong specifiers NORR, who handled Stage 4 onwards detailed design and full technical delivery to completion, for an equally wide variety of reasons, with particular challenges being the short timescales for a heavily serviced building (it was a 15-month build), aesthetics and services.

A NORR spokesman, who was taken by Armstrong's Architectural Specialties team to Paddington Station to see Armstrong V-P 500 baffles in service, said: "The Armstrong systems were specified for the look of the ceiling, the excellent pre-specification service, the fact they are a great product, and that they have been used on similar buildings of quality.

"They play multiple parts in the project, from adding interest to a 7m high ceiling, providing easy access and maintenance, acoustics and reducing air intake as the baffles are used to assist the M&E strategy."

They were installed in the steel-framed building for Darlington-based design and build contractor Interserve over three months by a team of 16 from specialist Armstrong Omega sub-contractor Interceil.

To view more images of this project, please go to the Armstrong project gallery **www.armstrong-ceilings.co.uk/projectgallery**

Armstrong V-P 500 Metal Baffles

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Sustainability in Production Alliance (SiPA)

SiPA is a relatively new group launched at PLASA 2015 which describes itself as a "community of allies working throughout the life-cycle and supply chain of live production igniting sustainable cultural change in our industry". It 'exists to co-create a culture of sustainability in our industry that is supported at all levels of the supply chain and at all stages of the production life-cycle' [15].

SiPA has a range of goals covering equality, well-being, cultural learning, zero loss, responsible resourcing, running on renewables, reporting, fair rewards and a value economy [15]. It is very much a holistic approach to sustainability with a wide remit and there is much to take from the way this group has developed. With a focus on the theatrical and live production industry many live sound engineers, system designers and acousticians may find themselves working within the goals of SiPA.

The key messages

Government policy and media discussion suggests that environmental sustainability will continue to be an important aspect for any business activity and will only grow in importance over the coming years. The summary research presented in this article indicates that many of the major broadcasters in the UK have recognised this and have clear policies in place to incorporate environmental sustainability into their everyday operations with clear and ambitious targets. There is much to learn from these approaches for audio based activities.

Despite clear progress in the wider creative and engineering industries, the reproduced sound industry more specifically has yet to develop any formal guidance and policy in this area. The Julie's Bicycle research suggests that there is an appetite for change here, mostly driven by the personal desires of the practitioners involved, yet the critical mass to create significant change is not yet in place. The reproduced sound industry is in a position where the equipment available to it is the most efficient and sophisticated it has ever been. The choices available to audio engineers in terms of renewable energy sources, equipment and transport give us a wealth of opportunities to choose more sustainable options for our activities. There should be no reason why the reproduced sound industry cannot make significant developments in environmental sustainability in the coming years.

There are several key features of all the policy and guidance presented in this article and these are summarised below:

- Minimise transportation and use low emission vehicles and transport choices
- Use low emission or renewable energy sources
- Reduce overall energy use
- Recycle and minimise waste
- Consider the supply chain and use suppliers with strong sustainability policies
- Document and record sustainability activities
- Place the responsibility for sustainability on a senior member of the team
- Communicate your sustainability agenda strongly both within and outside of your organisation.

In addition to this there are more specific issues for audio engineers to bear in mind when designing, commissioning, using and installing audio systems. These are:

- Choosing the most efficient and lightweight equipment for a given task
- Using sound systems in the most energy efficient way
- Careful choice of equipment supply chain to ensure renewable materials are used
- Engaging with supply chain manufacturers to encourage dialogue and development of sustainable policies.

Conclusions

It is clear that environmental sustainability as an agenda for audio companies and audio practitioners will continue to be an important part of their activities. There is a clear mandate to consider environmental sustainability written into the code of conduct for members of both the IOA and the IET. Whilst there has been some interesting research and discussion of environmental sustainability in audio this has yet to have a significant impact on policy and practice, although new developments such as SiPA have great potential to ignite change. Further work is required within special interest groups, and in general, to raise the profile of this important issue and to work towards policy and guidance for audio engineers and those engaged in audio related activities. Audio engineers have access to the most sophisticated, lightweight and efficient tools that have ever been available to them and the ability to make a real difference to practice within the industry.

Ben Mosley *(AMIOA) is a Senior Lecturer at Leeds Beckett University specialising in audio engineering and acoustics. He is Course Leader for the BSc (Hons) Audio Engineering course and teaches across a range of undergraduate and postgraduate audio and acoustics modules ios and music technology suites for a range of private sector and educational institutions across the UK. He also continues to work as a recording engineer and acoustician. He is an associate member of the Institute of Acoustics, a Member of the AES and a Senior Fellow of the Higher Education Academy. Ben is currently studying for a DEng with the Leeds Sustainability Institute in the area of recycled and renewable materials for acoustic absorption.*

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New base for AcSoft Group as business booms

AcSoft Group, which comprises AcSoft, Svantek and GRAS, has relocated to a new purpose-built office in Bedford to accommodate recent significant business growth.

As well as more space and meeting facilities, the new base comprises a noise and calibration laboratory.

John Shelton, Managing Director, said: "More space is critical to continue to support future expansion. Our aim is to ensure that AcSoft Group is a pleasurable and motivational place to work and the office move reflects that effort. The location is also set to enable a more efficient and effective interaction with our national sales force."

The new address is: Building 115, Bedford Technology Park, Bedford MK44 2YP. Tel: 01234 639550.

In another development, GRAS UK recently staged roadshows at Salford and Cambridge Universities. The events consisted of a two-hour interactive seminar and presentation by Per Rasmussen, Technical Director at GRAS in Denmark, and son of Gunnar Rasmussen, developer of the first reproducible one inch condenser microphone.

The new headquarters

Cirrus revamps environmental noise monitoring service

Cirrus Environmental has launched its latest Project Planning Service to meet growing demand in the UK construction sector.

The revamped service covers every aspect of environmental noise monitoring, from equipment and software to specific siting and ongoing support and service.

"The new project planning element has been launched to help the construction industry gets its noise monitoring right first time," said Craig Storey, Cirrus Environmental General Manager.

"We believe this is our most comprehensive service package to date and takes the pain out of the planning, processes and implementation surrounding environmental noise monitoring."

For more information go to **www.cirrus-environmental.com**, ring **01723 891722** or email **sales@cirrus-environmental.com**

Noise monitoring at a construction site

Farrat Isolevel scoops High Sheriff's award for enterprise

Farrat Isolevel, an IOA sponsor member, has won the High Sheriff of Cheshire's overall award for enterprise 2015/16.

The Altrincham-based company, which specialises in vibration control, thermal isolation and precision levelling solutions, was chosen for its "outstanding commercial success and sustainable growth".

The presentation was made by the High Sheriff, Bill Holroyd, at a ceremony at Chester Racecourse attended by 400 people.

Oliver Farrell, Chief Executive Officer said: "This award is a wonderful recognition for our achievements."

Staff members with the award

Building Acoustics

By Marc Asselineau

Review by Jordan Mayes, Senior Engineer, Acoustics with WSP Parsons Brinckerhoff

Building Acoustics can be a useful addition to the shelf of any well-read building acoustician. While it's unlikely to displace the traditional heavy hitters (*Fundamentals of Acoustics, Acoustics and Noise Control, Architectural Acoustics etc.*) as your go-to reference book, but, and at considerable risk of sounding like a football pundit, it's always good to have strength in depth.

The book provides a light touch on the maths and physics which dominates most acoustic reference books and instead focuses on helpful and precise text outlining the concepts and issues we encounter every day in the field. There are also numerous insightful anecdotes and references to real-life scenarios based on the authors own extensive experience. However, a number of the technical references point to European standards or papers which will likely impair the ability of those without some serious language skills from delving further into the technical side of things.

In general I found the book to be accessible and, in contrast to other acoustics text books, has clearly been written with designers and consultants in mind. For example the references to – and suggested compromises for resolving – the age old duel between function and form is something most building acousticians will relate to and find useful.

The depth of technical acoustic theory certainly doesn't match that available in other publications, but for a lot of readers that will come as a refreshing change and the strength of the well-crafted text sheds just enough light on the perceived "dark art" of acoustics to be useful without being overwhelming.

On balance I'd say there's a place for *Building Acoustics* on the bookshelf but it's likely to be of most benefit to architects and designers wanting to further their understanding, or an acoustician starting out in the field of building acoustics.

Publisher: CRC Press (23 Mar. 2015)
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Since 2004, MSA has provided a bespoke recruitment service to clients and candidates working in Acoustics, Noise and Vibration. We are the UK's niche recruiter within this sector, and as a result we have developed a comprehensive understanding of the industry. We pride ourselves on specialist market knowledge and an honest approach - we are focused on getting the job done and providing best advice to clients and candidates alike.

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For a confidential discussion call Jim on 0121 421 2975, or e-mail: j.mcnaughton@msacareers.co.uk

www.msacareers.co.uk/acoustics

Richard Earis wins RBA Acoustics best dissertation prize

Richard Earis has won this year's RBA Acoustics prize for the best dissertation on London South Bank University's MSc in Environmental and Architectural Acoustics course. His dissertation was entitled *An investigation into noise and annoyance from the London Overground Railway in South Hackney*.

The study compared the pre-construction noise impact predictions with measured post-construction noise levels of the new line in north London and looked into how well absolute noise level correlates with annoyance.

Richard was invited to give a presentation of his work to RBA Acoustics staff recently and was presented with his prize by Director Torben Andersen.

Richard Earis (right) receives his award from Torben Andersen

Debra Gill takes up new sales post at Svantek

Debra Gill has been appointed to the newly created position of Internal Sales Executive at noise and vibration monitoring equipment specialist Svantek.

She was previously Sales and Telemarketing Executive at Asphalt Reinforcement Services where she helped achieve a 44% increase in sales. She also spent four years as Marketing and Advertising Co-ordinator at Turpin Barker Armstrong.

In her new role she is responsible for business development and strategic account management while providing administrative and prospecting support to the UK field sales team.

Debra Gill

Phil Price is new President of ISCE

Phil Price, International Sales Manager at RCF, has been appointed President of the Institute of Sound and Communications Engineers (ISCE), taking over from Tony Smith. Helen Goddard, Managing Director of AMS Acoustics, has been appointed Vice-President.

Setting out his goals, Mr Price said he faced a challenging period ahead. "I want to spearhead much more awareness of the Institute from outside our membership," he said. "I also want to see the Institute become more prominent as a 'recognised' body for ensuring the correct standards are applied when projects and installations are completed."

Furthermore, he said he sought recognition from other allied associations "to show that choosing an ISCE member or supporting member organisation will ensure that the highest standards have been applied".

The appointments were made at ISCE's AGM at Coombe Abbey, Warwickshire, which preceded its annual trade exhibition and seminar day. One of the highlights was a presentation to Dr Peter Mapp who was awarded an Honorary Fellowship.

Phil Price

Helen Goddard

Noise insulation software will help meet ISO 16283-1:2014 measurement standard

Brüel & Kjær has developed new software to assist acousticians, architects and developers ensure that room acoustics meet the latest ISO 16283-1:2014 standard.

Qualifier Type 7830 software has been created for viewing, analysing, documenting and archiving sound insulation measurements made with the company's sound level meters – Types 2250, 2270 and 2260.

Qualifier automatically supports calculation and reporting according to a variety of national and international standards, making it ideal for testing airborne sound insulation, impact sound insulation and reverberation time.

Qualifier also displays reverberation measurements as 3D-multispectra, providing a complete overview of the frequency-dependent reverberation curves.

The reverberation times and reduction curves can be graphically modified in the corresponding displays. The software also makes it possible to manually adjust levels and reverberation times used in calculations, enabling developers to modify walls and rooms during the design stage.

More information can be found at **http://goo.gl/Dtc9Hm**

Qualifier Type 7830 will help with measurement analysis

Virtual reality brings a new vision to acoustics design

Cundall has launched a virtual acoustic reality system (Cundall VAR) which, it forecasts, will transform building and infrastructure design with a combination of audio-prediction modelling and gaming-quality graphics.

Eschewing the flat graphic interface of traditional acoustics computer modelling, Cundall has combined the Oculus Rift virtual reality headset with a gaming engine and audio to take clients and project design team members on an immersive audio and visual tour of a building – before it is built.

The ability to hear how sound actually changes as users move through different spaces will, it says, enable decisions to be made based on experiential factors rather than numbers on a page.

Andrew Parkin, Cundall's Acoustics Partner, said: "We've evolved from a very boring static numerical prediction through to something which is based on an audio visual experience, is now dynamic, immersive and can be taken around the world to clients."

The user sees a 3D representation of the inside of the building, including furniture, partitions, etc, simultaneously hearing whatever noise sources are input into the model.

This could be a teacher within a model of a classroom, assessing the clarity of sound reaching a student; a piano within a recital hall, to judge the level of clarity and listen to the effects of reverberation and echoes within the room; or various sound sources within a restaurant, allowing an operator to appreciate the benefits of providing specific acoustic treatments within the dining room.

Cundall VAR links a 3D graphics programme, Unity, with the CATT acoustic software. Users operate an X-Box controller to move forward, backward and side to side within the 3D model.

Andrew Parkin (second right) tests the new system

The Oculus Rift headset system changes the direction of the virtual "head", giving 360 degree vision and altering the 3D view displayed to match the user's orientation. A pre-programmed acoustic model calculates the conditions at many locations across a grid, and the 3D walkthrough enables the user to travel across that grid, hearing – in real time – how the sound changes.

Noise Logger provides round-the-clock measurements

Brüel & Kjær has unveiled its new Noise Logger that allows users to take unattended noise level measurements 24 hours a day. The Noise Logger enables organisations to:

- demonstrate noise level compliance
- resolve noise complaint investigations
- gain approval for a planned change or an operational licence.

Noise Logger customers can obtain accurate data and keep informed about what is happening while they are off site. The system allows users to view real-time noise data, transfer information to the cloud, check equipment and manage measurements during a survey. Customers can assess online data daily, and end their survey as soon as they have the measurements required. Data can be used for a variety of post-processing activities including reporting representative noise levels or regulatory compliance.

The logger sets up in minutes for efficient use out of the box. For an optimal user experience, its self-contained, single-unit system includes:

- solar panel for extended, continuous operation during good weather
- a weather-resistant outdoor microphone that's fit for purpose and long life
- a corrosion-proof, integrated microphone mount.

Noise Logger in action

Noise Logger comes with a Type 2250 sound level meter, software and accessories including full statistics, 1/3-octave band analysis, audio recording with event triggering and a memory card. Email alerts can notify when pre-set noise levels are exceeded or the internal battery runs low. Remote communication and stand-alone operation versions are available.

Full details can be found at **www.bksv.com/noise-logger**

Campbell launches new package for BS 4142:2014 calculations

Campbell Associates have developed a package that allows users to assess the impact of environmental noise according to BS 4142:2014.

It features Class 1 instrumentation measuring down to 25ms and software that aims to simplify the process of BS 4142 calculations. The NorReview software included in the bundle gives the user objective results on tonal penalties and impulsive calculation, making, says Campbell, BS 4142 calculations quick and easy.

The Norsonic 140 & 150 kits provide a portable, unattended and precision outdoor noise monitoring solution for BS4142 calculations. The software works by importing data straight from the sound level meter and then giving users the exact penalty for tonal (using ISO1996-2) and impulsive noise with just a few clicks in the NorReview software.

NorReview software will aid BS 4142:2014 assessments

Brüel & Kjær upgrade Measurement Partner Suite and Type 2250 SLMs

Brüel & Kjær's Measurement Partner Suite post-processing software and Type 2250 family of sound level meters have been updated.

Key enhancements include:

- Support of ISO 1996:2007 measurement uncertainty
- A turnkey solution for BS 4142:2014 users
- Improved vibration measurement capabilities

Measurement Partner Suite has been improved to support measurement uncertainty according to ISO 1996:2007. With the software's guidance, acousticians are helped through the task of estimating their measurement uncertainty due to instrumentation, operating conditions, ground and weather conditions – and residual sound.

The turnkey software has also been enhanced to support BS 4142:2014, the British standard governing the way environmental assessments are performed in the UK. It now simplifies calculating and reporting rating levels (including objective tone and impulse assessments) when assessing industrial and commercial noise, measuring sound levels at proposed new residential dwellings and investigating complaints.

In addition to these improvements, Type 2250 and Type 2270 portable sound level and vibration meters have been updated to measure peak particle velocity and vibration criteria.

For more details go to **http://www.bksv.com/measurementpartner**

Measurement Partner in action

New prepolarised low-noise microphone is industry first

PCB Piezotronics has launched a new ½in (12mm) microphone and preamplifier system, model 378A04 – the industry's first prepolarised low-noise device capable of measuring 6.5dBA (5.5dBA typical), matching the specification of existing externally polarised models.

This ICP sensor is designed for use with data acquisition systems (DAQs) that provide industry standard constant current power. Prior to the release of the 378A04, test engineers had to use high cost 7-pin cables and expensive 200V power supplies to measure below 15dBA. The new microphone from PCB uses standard coaxial cables with BNC connectors and can be shared with other ICP compliant products including accelerometers, force and pressure sensors. It can also be used with DAQs that provide 4mA minimum (or paired channels that combine for 4mA).

PCB says the 378A04's portability and interchangeability minimises test set-up time and reduces the cost-per-channel. Applications include computer hard disk drive testing (e.g. spin-up noise), cabin noise measurements, white goods tests (appliance noise reduction), sound power measurements, noise source location, environmental noise monitoring and electric vehicle sound quality.

Features include low 6.5dBA (5.5dBA typical) noise floor, 450mV/Pa sensitivity, wide frequency range (±2dB) from 10Hz to 16kHz, prepolarised sensor design for ease of use and low cost per channel, suitable for use with existing low cost standard coaxial cables and compatible with ICP sensor arrangements.

Additional specifications include 3% harmonic distortion limit >80dB (100dB below 5kHz), maximum sound pressure of 130dB and operating temperature range from -10 to +80°C.

For more details go to **www.pcbpiezotronics.co.uk** or email **ukinfo@pcb.com**

The 378A04 in action

New features added to ANV's noise, vibration, dust and weather monitoring website

New features have been added to ANV Measurement Systems' LivEnviro, which provides real-time noise, vibration dust and weather data on a single secure website using certified and site-proven sensors.

For instance, two new audio features have been added to Live Leq. Audio clips can be stored whenever noise limits are exceeded and you can select "Listen Now" to initiate live streaming of audio data from a monitor.

Live PPV measures peak particle velocity, dominant frequency *and displacement* which is necessary for a proper BS 5228:2/BS 7385:2 assessment. The limits from these standards and DIN 4150 are built into Live PPV, which also allows users to specify multiple broad-band and/or frequency-dependent limits.

On construction projects acoustic consultants are often asked whether they can install dust monitors in addition to noise and vibration kit. Live PM10 shares the same intuitive web platform as Live Leq and Live PPV so adding dust (and weather) to a LivEnviro monitoring system is easy, says ANV.

If you need to know when the wind is blowing in a certain direction or when it's raining, logic-based alerts have been added to Live Met, the live-to-web weather monitoring element of LivEnviro.

LiveEnviro

It is also possible for users to tie weather data in with noise (or dust) measurement data because the data is all stored on the LivEnviro server and available almost instantaneously across the Internet.

For more details ring **01908 642846** and email **info@noise-and-vibration.co.uk**

Virtually drive automotive CAE models

Brüel & Kjær's latest noise vibration harshness (NVH) simulator can directly incorporate large computer-aided engineering (CAE) models.

It means that complete CAE component design models can be driven by non-experts and experts alike in just seconds, inserted into the complete virtual vehicle simulation.

This allows the latest design iteration, or many design alternatives to be easily driven, in order to compare them with previous design iterations and benchmarked competitor vehicles – at any stage in the development process.

This new capability – called CAE Auditioner – automatically converts standard CAE response data from all common CAE codes into ready-to-run NVH simulator models. Careful testing has ensured that it recognises the file types and knows how to read them seamlessly.

Engineers can also blend CAE models with real-world test data at will, such as allowing them to mix predicted energy strengths from CAE files with real-world test data that quantifies the sensitivity of the path through the vehicle to the driver. This speeds up development by integrating the worlds of test and CAE, and also allows components measured on a test bench to the "driven" in the virtual vehicle.

The CAE Auditioner in action

More information can be found at **www.bksv.com**

BS 4142 objective and reference methods for tonal and impulsive noise

The BS 4142: 2014 objective method for assessing impulsive noise requires sampling of Fast A-weighted SPL at a rate of between 10 and 25 msec. Rion have added 10 msec sampling to all new NL-52s. Furthermore, if you already have a Rion NL-52 and wish to have it upgraded to 10 msec sampling, ANV Measurement Systems will do this free of charge. 10 msec sampling of wav files can also be carried out using Rion's AS-70 wav file analysis program.

With regard to tonal noise, Third Octaves and FFT have long been available for the Rion NL-52 and to this extent tonal analysis has always been covered. Although the Joint Nordic 2 Method looks rather daunting, do not overlook the simple advice in Annex D of the standard that if you are using a suitable FFT analyser "just audible tones appear as local maxima of at least 8 dB above the masking sound in the averaged spectra". So a suitable FFT analyser can be used in-situ to quickly establish the presence or absence of audible tones.

If you want to carry out a full Joint Nordic 2 assessment of tonal noise quickly and painlessly, Rion have added this to their wav file analysis program AS-70.

For more details ring **01908 642846** or email **info@noise-and-vibration.co.uk**

Rion NL-52 with FFT option

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Committee meetings 2016

DAY	DATE	TIME	MEETING
Tuesday	10 May	10.30	CCHAV Examiners
Tuesday	10 May	1.30	CCHAV Committee
Thursday	12 May	11.00	Publications
Tuesday	24 May	10.30	Executive
Tuesday	14 June	10.30	ASBA Examiners(Edinburgh)
Tuesday	14 June	1.30	ASBA Committee (Edinburgh)
Tuesday	**14 June**	**10.30**	**Council**
Tuesday	21 June	10.30	Distance Learning Tutors WG
Tuesday	21 June	1.30	Education
Wednesday	22 June	10.30	CCENM Examiners
Wednesday	22 June	1.30	CCENM Committee
Wednesday	22 June	10.30	CCBAM
Thursday	14 July	11.30	Meetings
Tuesday	9 August	10.30	Diploma Moderators Meeting
Thursday	11 August	10.30	Membership
Tuesday	6 September	10.30	Executive
Tuesday	**13 September**	**10.30**	**Council**
Thursday	22 September	10.30	Engineering Division
Monday	26 September	11.00	Research Co-ordination
Thursday	13 October	11.30	Meetings
Thursday	20 October	11.00	Publications
Thursday	27 October	10.30	Membership
Tuesday	1 November	10.3	Diploma Tutors and Examiners
Tuesday	1 November	1.3	Education
Wednesday	2 November	10.3	CCENM Examiners
Wednesday	2 November	1.3	CCENM Committee
Wednesday	2 November	10.3	CCBAM Examiners
Thursday	3 November	10.3	CCWPNA Examiners
Thursday	3 November	1.3	CCWPNA Committee
Tuesday	8 November	10.3	ASBA Examiners (Edinburgh)
Tuesday	8 November	1.3	ASBA Committee (Edinburgh)
Tuesday	15 November	10.3	Executive
Tuesday	**6 December**	**10.3**	**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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- BS 7385: 2 Frequency – Dependent PPV Limits and Displacement Limit < 4 Hz Limits
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