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ACOUSTICS BULLETIN

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plus... **Reproduced Sound 2015: 'enjoyable, friendly and worthwhile'**

First new class of sound wave in more than 50 years could lead to revolution in stem cell therapy

Planning conditions for noise

Institute of Acoustics

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Front cover photograph:
Musicians must be able to perform in safety

Contacts

Editor:
Charles Ellis

Contributions, letters and information on new products to:
Charles Ellis, Editor,
Institute of Acoustics,
3rd Floor St Peter's House,
45-49 Victoria Street, St Albans,
Hertfordshire, AL1 3WZ
tel: 01727 848195
e-mail: charles.ellis@ioa.org.uk

Advertising:
Enquiries to Dennis Baylis MIOA, Peypouquet, 32320 Montesquiou, France
tel: 00 33 (0)5 62 70 99 25
e-mail: dennis.baylis@ioa.org.uk

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

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

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Conference programme 2016

10 March
Organised by the Measurement and Instrumentation Group
BS 4142
Birmingham

21 April
Organised by the Scottish Branch
Acoustics of unconventional oil and gas
Glasgow

10 May
Organised by the London Branch
Acoustics on large infrastructure projects
London

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

2016 is now in full motion, with plenty to do.

I have recently presided over the medals and awards selection for 2016. It is pleasing to continually find that we have many worthy nominations. It is always difficult to select the winners and it is by no means a comment on those that did not win, as the standard is high and our deliberations are long.

One award for which we are still seeking nominations is the Peter Lord Award, which was initiated in 2014 to honour the memory of a former IOA President who died in 2012. Peter was a hugely influential figure in UK acoustics, being a driving force behind the setting up of the Institute, the founder of the Applied Acoustics department at the University of Salford and first editor-in-chief of *Applied Acoustics*. The award is given annually for a building, project or product that showcases outstanding acoustic design. It will be presented to the team or individual responsible for the acoustic design, and will consist of a plaque to be displayed on the winning construction or project (where possible), together with a trophy and certificate for the winning team or individual. Last year we were extremely fortunate to have two winners. The promotion of this award raises the profile of the Institute and those who receive it. I would therefore like to ask every member to identify possible opportunities that can be submitted. Submissions for this award do not have to be sponsored and can be submitted by the individuals or team themselves. Full details, including a nomination form, can be found on the IOA website under Medals and Awards which is in the About Us section, so please let the head office have your nomination as soon as possible.

We are indebted to our volunteers, who are the backbone of the Institute and I am pleased that we have identified a number of recipients to receive awards for promotion and services to the Institute. Additionally I am delighted that this year to have signed 39 certificates for those members who have achieved Silver status, completing 25 years as Corporate members of the Institute.

We continue to ensure that our strategic direction of the Institute is aligned and we have recently updated the strategic plan with progress from 2015 and targets for 2016. This enables us to develop as an institution and identify where we can utilise our monies effectively, such as the improved IT for members and students. Some of the key successes have been the development of student members now standing at 370, up from 80 in 2014, we have started a blog on the website to promote acoustics to sixth formers and our career pages have received 5,443 hits in 2015. This bodes well, ensuring we highlight acoustics as a career for new entrants.

The education review continues, but due to the depth of the report and the analysis required, we are unable as yet to give an update, but we will expect that this will be available shortly.

On the success of being awarded the ICSV 2017 event in London, we submitted a bid into the preliminary round for Inter-Noise 2019 with Glasgow as the venue. The Board of Directors of I-INCE accepted the recommendation of the Congress Selection Committee (CSC) to invite the Institute of Acoustics to present a formal proposal to the CSC next year to hold Inter-Noise 2019 in Glasgow. This means we are now down to the final two, so I hope for continued success and will inform you when the decision is made.

William Egan, President

Professional Practice Guidance on Planning and Noise – new residential development, consultation draft

By Colin Grimwood

Many members will already be aware that the IOA, the Association of Noise Consultants and the Chartered Institute of Environmental Health have undertaken to produce Professional Practice Guidance on Planning and Noise (ProPG). This initially focusses on new noise sensitive development, in particular new housing. A draft of the guidance is now available for consultation and feedback is welcomed via a short online questionnaire from anyone involved in the planning and noise process. A link is provided at the end of this article. The deadline for comments is 31 March 2016. Two consultation events were arranged during the consultation period, on 2 March in London and 7 March in Manchester, which will have taken place by the time you read this. The scope of the ProPG is restricted to England although some of the content may be of interest to practitioners in other countries.

The need for the ProPG has arisen as a response to ongoing developments in the planning and noise field such as the publication of the National Planning Policy Framework (NPPF), relevant Government Planning Practice Guidance and the Noise Policy Statement for England (NPSE). All three sponsoring bodies had received requests from practitioners for additional technical guidance on the management of noise within the planning system and agreed to work together to try to produce a guidance document that would satisfy the varying needs of their members.

The ProPG initiative is being overseen by a working group (WG) consisting of representatives of all three organisations. A full list of WG members is included in the consultation document, with the published consultation draft representing a consensus position that was reached at the end of 2015. The document will be subject to further review once the consultation process has closed. Depending on feedback, the WG may also seek to produce additional guidance on noise-generating development at some time in the future.

The overall intention of the ProPG is to broadly align with current government policy whilst clarifying some of the aspects that have proved challenging for practitioners to apply. To this extent it is seeking to encourage a more consistent application of current policy as contained in the NPPF (and NPSE), but not to change that underlying policy where it is already clear.

The ProPG recommends that there should be an initial noise risk assessment of proposed residential development sites. It is intended to encourage good acoustic design from the earliest possible stage. It advocates the proportionate consideration of internal noise levels, as well as a wider assessment of external noise conditions and other relevant issues. It is proposed that the process is supported by the use of Acoustic Design Statements. In response to a specific call from members, the ProPG also provides clarity on when a recommendation should be made to the decision maker to prevent new noise sensitive development *on noise grounds* alone and irrespective of other planning considerations.

ProPG recommends there should be an initial noise risk assessment of proposed residential development sites

Practitioners in England will be aware that the previous policy and technical advice on planning and noise matters which was contained in PPG 24 was cancelled with the publication of the NPPF in March 2012, some four years ago. Many LAs are still thought to be relying on planning and noise policies created under the old regime. Since then, clearer policy aims and new supporting concepts such as LOAEL (Lowest Observed Adverse Effect Level) and SOAEL (Significant Observed Adverse Effect Level) have been introduced to the assessment, management and control of noise via the planning system. However whilst new policy objectives have been introduced, supporting technical advice and guidance was felt by practitioners to be insufficient. The current government has already advised that it does not intend to provide additional detailed technical guidance. This is leading to uncertainty for developers, regulators and their advisers alike. In the absence of clear guidance there is an increased risk that development may be mistakenly refused, constrained or approved thus adding to the number of disputes and appeals that can slow down the operation of the planning system at a time when the provision of new housing is high on the political agenda.

The various members of the ProPG WG have worked hard to reach a common understanding of current government policy in the NPSE and NPPF and to develop technical guidance that broadly aligns with that understanding whilst also providing useful guidance that should encourage a more consistent application of policy. Along the way the WG have had a few lively debates and differences of opinion and we are expecting to make further changes once we have had an opportunity to assimilate the feedback received.

All three professional bodies firmly believe that the ProPG is a worthwhile initiative, and with your help and support the WG will do its best to produce a guidance document that works alongside the current planning system to ensure that noise is properly dealt with as an integral part of the process of delivering the high quality new housing that this country so badly needs.

The WG would like to ask all members of the ANC, IOA and CIEH, and indeed all practitioners in this field, to read the consultation document and to respond to the consultation so that the WG can seek to ensure that the final version has broad and cross-profession support.

If you haven't already done so, please download the consultation draft and respond to the consultation process via this link http://www.ioa.org.uk/news/new-guidance-noise-sensitive-development

Colin Grimwood *FIOA FRSPH CMCIEH is the main author of the ProPG, and currently works as an independent consultant operating at the interface of technical advice, research and policy analysis. He has 30 years of experience in the planning and noise field including contributing to national and local policy and guidance on the topic.*

Viscount Hanworth, speaking during a government debate on the Housing & Planning Bill on 26 January 2016, said: "Significant damage was inflicted (on our national planning system) in 2012 with the establishment of the new NPPF. A set of sophisticated and carefully crafted documents, which had provided policy guidance in many specific circumstances, and which had been developed and refined over the previous 25 years, was tossed into the rubbish bin, to be replaced by 50 pages of vacuous generalities".

Reproduced Sound 2015: 'enjoyable, friendly and worthwhile'

Full conference round-up

By Bob Walker

Reproduced Sound 2015, organised by the Electroacoustics Group (EAG), was held on 11-12 November, with informal events on the 10th to allow delegates to get together and a visit on the 13th. This year it was held in a new venue at the Fire Service College, Moreton-in-Marsh which had been chosen as a return to the usual residential format for RS.

The Institute's thanks and appreciation go to Keith Holland for chairing the organising committee, to all the committee members for their contributions over the preceding year in organising the event. Thanks also go to the college staff, who were always friendly, helpful and co-operative, greatly helping the smooth running of the conference.

The meeting room had also been equipped with an advanced audiovisual system. This had been organised and managed by John Taylor of d&b audiotechnik, assisted by other members of the company. The conference organising committee gratefully acknowledges the effort put in by many people in arranging, setting up and managing the technical support. Thanks also go to d&b audiotechnik for the use of their equipment, including the large screen and the projector.

The contributions of the exhibitors to the success of the conference are also gratefully acknowledged. Several exhibitors also included sponsorship as part of their exhibition package. Those were valuable and much-appreciated contributions to the conference budget.

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Keith Holland

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The technical presentations took place in the large meeting room of the college, with the adjoining part being used by the exhibitors, for the refreshment breaks, for the conference dinner and for the essential evening refreshments. The venue facilities fitted the conference requirements well, with the private bar and lounge providing space for informal evening breaks.

The conference theme continued from previous years with its focus on developments in spatial acoustics, electroacoustics, room acoustics and intelligibility. Because of the special location, the focus this year was intended to be voice alarm systems and public address, as suggested in the conference sub-title *Playing with fire*.

In addition to a workshop session (a new feature of RS) and the Peter Barnett Memorial Award paper, 19 technical papers were presented in eight sessions. This made for a very busy and intensive programme, fully occupying both days.

A "welcome and arrivals" session was held on evening of the 10th. That included a presentation on setting up for a live event, primarily focussing on pop concerts or other large-scale live music events. Following the conference, for the 13th, a visit had been arranged to the World of Mechanical Music Museum in Northleach, Gloucestershire.

The conference was well attended, with 66 registered delegates, of whom nine were registered as students, plus three exhibitors. The committee was again pleased to see a number of faces new to RS. Sadly, and in contrast to 2014, the contingent of students was rather small.

The delegates certainly appeared to have had an enjoyable and worthwhile conference. Overall, the EAG committee was very satisfied with the response to the programme and the smooth running and friendly atmosphere. The 2016 event will be held in Southampton on 15-17 November. Full details will be confirmed in due course. It is likely that visits will be arranged to ISVR at the University of Southampton and/or to Southampton Solent University.

The conference programme

The programme began on the10th with an evening workshop and discussion entitled *Reproduced Sound (virtual) Sound Check*. Mark Bailey of QSC, Robin Dibble of Martin Audio and Simon Durbridge of the University of Derby, along with quite a number of other volunteers, had set up a small-scale version of a playback and sound re-enforcement system to demonstrate different approaches to setting up "EQ", compression, sound gates and 'reverb' to "make things a lot better, at least if applied correctly!". There was a lively discussion amongst the 35 or so delegates present, with numerous different opinions expressed. Mark and his colleagues had put a great deal of effort into setting up the equipment and making the presentation. That was much appreciated by the delegates present.

The demonstration led naturally and almost seamlessly into the following "Sam's Jam" session. That had been arranged by Sam Wise of Venue Strategies as a more organised approach to the usual informal jam sessions of previous RS conferences. The intention was to invite people with known playing ability for an evening of mixed music, whether they were conference delegates or not. Delegates were invited to join in with any music and instruments they might have brought with them. The whole session was very successful, with many staying until well after the bar closed at midnight.

Sam Wise

Glenn Leembruggen

The effort put into both of these sessions by Mark and his colleagues and Sam and his colleagues was greatly appreciated and the RS committee thanks them for it.

The conference was formally opened on the 11th opened by the Electroacoustic Group Chairman, Keith Holland, who presented a brief history of RS and welcomed the delegates to the venue. He said that the conference had been well supported, with many papers submitted and good attendance numbers. He thanked the committee, the delegates, the Institute staff, the exhibitors and all the other people who had helped to make sure the conference happened.

The welcome address was followed by the presentation of the Peter Barnett Memorial Award to Siegfried Linkwitz (Linkwitz Lab) (see page 16). The citation was read by Glenn Leembruggen. That was followed by the remaining technical sessions of the day.

After the day's sessions, the EAG AGM was held, followed by a short break before a reception and the conference dinner was held at 7pm.

After the dinner, Keith Holland thanked every one involved in organising and attending the conference, especially the venue staff and Linda Canty. He said that Linda in particular had, as usual, put a great deal into the organisation of the conference, assisted by other members of the Institute staff.

John Watkinson then presented a talk and demonstration entitled *The importance of directivity in loudspeakers* in which he demonstrated his special, non-directional loudspeakers. In his usual engaging style, John spoke for about two hours altogether, including a lively and interactive Q&A interval. All present appeared to have enjoyed a thoroughly entertaining and informative event. John Watkinson and Siegfried Linkwitz in particular appeared to have enjoyed their substantial technical exchanges.

The second day of the conference started with further technical sessions. They continued until the last paper of the conference ended at 6pm.

On the 13th a visit to the World of Mechanical Music Museum had been organised by Glenn Leembruggen of Acoustic Consultants, Australia. About 12 delegates had stayed overnight to take part in this very interesting and informative visit. The collection of cylinder and disk music boxes (commonly incorrectly known as "polyphon" players), automatic pianos and historic phonographs was fascinating. Most of them were in working condition. One old acoustic phonograph was played to visitors so frequently that it wore out several 78 rpm shellac disks a year, despite being limited to playing only half of one side on each occasion. The collection included some impressive (and equally valuable) disk music boxes, including one coin-operated version that was a distinct pre-cursor to a juke box. It was said that the origin of the phrase "when the penny drops" came from such machines – the listener was supposed to guess the name of the tune before the penny coin was released by the mechanism into the collection box.

Technical Sessions, Wednesday 11 November

The day started with the Peter Barnett Memorial Award Lecture *The magic in 2-channel sound reproduction – Why is it so rarely heard?* by Siegfried Linkwitz (Linkwitz Labs). In the lecture, Siegfried spoke about hearing, perception and small room acoustics. He continued with a discussion of loudspeaker design principles and the effects of cabinets. That was followed by a section on stereophonic reproduction and the loudspeakers requirements. He then described two different approaches to loudspeaker design – a pure dipole and a hybrid dipole. He noted that loudspeaker design was still a challenge! The lecture was followed by a substantial number of questions from the delegates.

Session 1, Sound Reinforcement, Chairman – Paul Malpas

Session 1 began with *Consideration of complex loudspeaker setups, including phase effects in the frame of environmental noise predictions on the basis of the ISO 9613-2 and the Nord2000*. The

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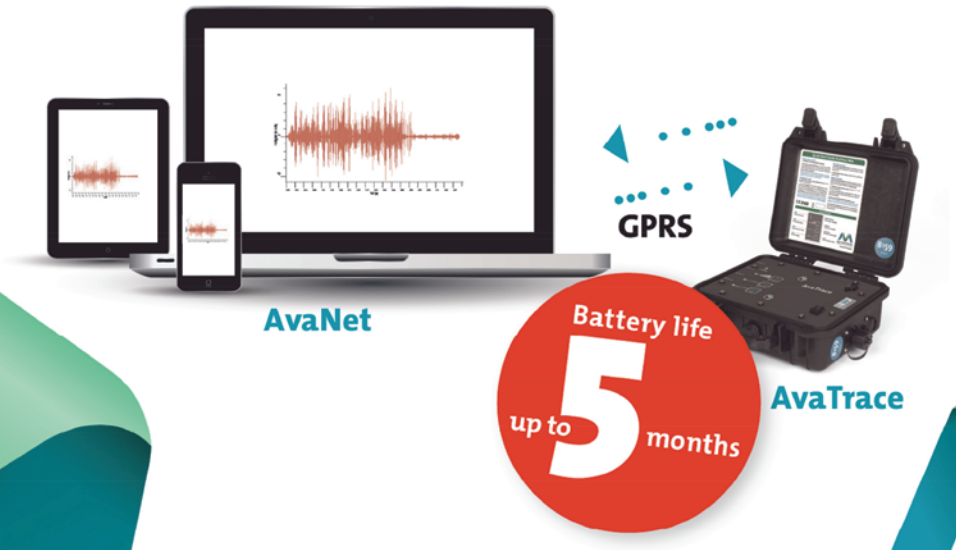

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paper was presented by Elena Shabalina (d&b audiotechnik GmbH). It described the use of the implementations of the ISO 9613-2 and the Nord2000 methods in the noise mapping software SoundPLAN® to consider some loudspeaker setups. As part of the validation process, the implementation for short distances had been checked against the planning software ArrayCalc®. The validation process for longer distances was still ongoing, using actual field measurements.

The session continued with *Designing PA systems for live outdoor events – the challenges of getting good sound in the audience arena and designing out noise problems off site*. The paper was co-presented by Jim Griffiths (Vanguardia Consulting) and Miles Hillyard (SSE Audio Group). It described the extension of near-field loudspeaker parameters to far-field performance and also referred to ISO 9613-2. Two case studies were described. The first considered the effects of terrain irregularities on the choice of the best position for the stage. The second looked at the problems of the London Olympics, with 12 main zones. Real-time presentation of averaged one-third octave band envelopes was used for live equalisation, to optimise the sound for the audience whilst minimising neighbourhood disturbance.

The final paper of the session was *Sound localization or speech intelligibility?* by Wolfgang Ahnert (ADA Acoustics & Media Consultants GmbH). Wolfgang presented a history of sound reinforcement systems from the invention of loudspeakers and microphones, at that time mainly used for the enhancement of loudness and localisation. He then described the developments of delay lines, initially in the form of magnetic loops, to permit coverage over larger areas or for distributed speaker arrays. He also described installations in the huge congress halls built in the 50s and 60s, predominantly in socialist countries. The paper then continued with descriptions of modern systems offering smooth coverage, wide frequency ranges, high sound levels and high intelligibility using complex arrangements of electronic delay.

The session was followed by lunch in the college dining hall, amongst a large collection of fire and rescue officers, police and ambulance crews, mostly in their outdoor working clothes. It was certainly a different atmosphere there.

Session 2, The Anti-workshop, Chairman – John Taylor

After the lunch break, the programme continued with something new for RS, though not for many other conferences. That was in the form of a workshop, chaired by John Taylor (d&b audiotechnik). The intention was to present some aspects of "how not to do it" in the context of live sound, on the basis that it could be more informative to learn about what not to do. The panel consisted of Simon Lewis (University of Derby), Glenn Leembruggen (Acoustic Consultants, Australia), Steve Jones (d&b audiotechnik) and Miles Hillyard (SSE Audio Group).

The workshop began with the panel members expressing their own "pet hates". Simon's was badly-installed induction loops, Glenn's was badly operated good systems where the operator was not engaged with the performance and not getting the result that the system was capable of, Steve's was operators who were not taught how to deal with problems and would immediately start dismantling a system at random without first thinking about the problem and Miles' was "acoustic scrim", or materials presumed to have "magic" acoustic properties based on hearsay and marketing. The workshop then went on to engage with these issues, and others, until the tea break.

Session 3, PA/VA system design, Chairman – Robin Dibble

The first paper of the session was *Design principles for distributed loudspeaker solutions in PA/VA* by Paul Malpas (Engineered Acoustic Designs). In his presentation, Paul described how it was advantageous to discuss a project's acoustic objectives and targets with the other team principles, such as architects and the clients, at an early stage. That was more likely to deliver a system that was integrated with other services, physical structures and architectural preferences with a minimum of compromise. The paper also presented a number of design solutions for loudspeaker distributions in spaces of different proportions and also the potential of small improvements in acoustic treatment.

The second paper of the session was *Design aspects of a re-entrant horn system for hazardous area use*. The paper was presented by Giuseppe Di Carlantonio (Electroacoustic Design) and discussed the special design requirements and specific performance constraints for that application. The paper highlighted the key design aspects of a re-entrant horn loudspeaker suitable for hazardous area use. It also showed how the acoustical response could be adjusted to fulfil the requirements of the voice

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Siegfried Linkwitz

Elena Shabalina

Jim Griffiths

Wolfgang Ahnert

A session gets under way

Exhbitor John Shelton of AcSoft

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alarm standards, for example BS EN54 -24. In particular, the presentation showed how the properties and position of the necessary "sinter" flame barrier inside the loudspeaker could be used to improve the acoustic performance. The effects had been first modelled in a nice example of FE/BM analysis and then verified by measurement. It also demonstrated how a cheap, basic alarm "sounder" could be successfully converted into a reasonable loudspeaker for voice signals.

The final paper in the session was *Is class 'D' the most efficient amplifier for real audio signals?* by Jamie Angus (University of Salford). Jamie began with an outline of the conventional approach to comparing efficiencies of different amplifier classes, as carried out for large amplitude sine waves. That was followed by an explanation of how real audio signals were not at all like large sinusoidal test signals and how a realistic measure of efficiency would alter the optimum choice of topology. The conclusion was that the best form of amplifier for typical signals was probably a Class 'G' type, with a lowest voltage supply of ± 5V, or even less. That would deliver most of the audio signal with high efficiency and low distortion, with the capacity occasionally to deliver higher powers using the higher voltage supplies.

The session was followed by the EAG AGM. That was followed by a reception and the conference dinner. The after-dinner speaker was John Watkinson and his presentation is described in the conference programme above.

Technical Sessions, Thursday 12 November

Session 4, Perception: live sound quality, Chairman – Mark Bailey

The day started promptly at 9am with *The effect of distortion on perceived loudness in live sound reinforcement* by Simon Durbridge (University of Derby). Simon explained that the aim of the study was to test the hypothesis that some forms of distortion affected perceived loudness. A number of subjective tests had been carried out comparing perceived levels of original and distorted samples. The conclusion was that clipping distortion did result in an increase in loudness. The test subjects also commented that they were listening mainly to the bass content.

The second paper of the session was *The non-auditory, physiological perception of low frequency* by John Taylor (d&b audiotechnik, GmbH). In his presentation John described how high levels of low-frequency music increased endorphin levels in listeners and how the effect was related to the physical activity of running. The paper explored the possibility of a link between a non-auditory stimulation of the vestibular system by low frequencies, particularly in the 2 to 3 Hz range, and the release of endorphins in the brain similar to that of a runner's 'high'.

Session 5, Case studies and design practice, Chairman – Glenn Leembruggen

The first paper of the session was *New sound systems for Gulbenkian Foundation Grande Auditorio, Lisbon, Portugal* presented by Sam Wise (Venue Strategies). In his presentation, Sam described the hall, which had originally been built in 1964. The hall was used for a wide range of events, from classical music to conferences and amplified music. It was also used for relaying live transmissions from New York Metropolitan Opera. To meet the wide range of requirements, the hall was equipped with a truly vast assembly of moveable staging, electronics and acoustic treatment. Sam then described a substantial refurbishment programme and the design of powerful and flexible audio system installations within an almost visually untouched interior. The entire project had been completed in less than 9 months.

The session then had a break for coffee. Afterwards, Ben Mosley (Leeds Beckett University, UK) presented *Sustainable design and practice in Reproduced Sound*. The paper began with the comment that the environmental impact of the audio industry was equivalent to the emissions of about 180,000 private cars. It then reviewed some of the current literature and practice relating to sustainability issues facing the audio industry, including the use of high-power and heavy loudspeakers and audio amplifiers and their associated transportation costs. It was suggested that current industry policies

Panel (L-R) Miles Hillyard, Steve Jones, Glenn Leembruggen and Simon Lewis

Jamie Angus

John Watkinson

Paul Malpas

Guiseppe Di Carlantonio

Networking during a break

and agreements were more statements of intent than actual actions. The paper concluded with some recommendations about future working practices and additional research required in this field.

Session 6, Measurement and Modelling 1, Chairman – Keith Holland

Demystifying the effects of loudspeaker cables presented by Nicolas Bertin (L-ACOUSTICS, France). The paper reviewed current practices in PA systems, especially the continuing shift to higher power levels and improved quality. Both of these were promoting a change from 70/110 V systems towards low-impedance ones. The power losses associated with large currents could become very significant indeed, even with substantial cables. Mathematical models were presented of distribution cables and associated amplifiers and loudspeaker loads. These showed significant losses of signal over large distances. Unfortunately, and it may have been a semantics issue, the presentation failed to distinguish between voltage loss due to resistance and inductance and real power loss due to resistance alone.

Machine learning applied to the classification of musical instrument loudspeakers presented by Andrew Harper (Celestion). In his paper, Andrew described an automated system for the assessment of loudspeaker quality in production. The purpose was the development of an objective assessment system that could produce a go/no-go result for acceptance of production loudspeakers. The system included feature extraction and learning/optimisation algorithms and was currently in R&D only. The presentation was followed by a great many questions and discussion and eventually by a slightly delayed lunch break.

Session 7, Measurement and Modelling 2, Chairman – Bob Walker

Implementation of dynamic panning reproduction with adaption for head rotation presented by Dylan Menzies (ISVR, Southampton University). The paper outlined the advantage of head tracking and panning algorithms in order to achieve convincingly stable spatial reproduction with two loudspeakers. It included much vector mathematics, as well as descriptions of available head tracking systems. The paper was an extension of earlier work on stabilising phantom images against lateral movement of the listener.

That was great, can you play it again?: Making 3D acoustic measurements of instruments under performance conditions presented by David Carugo (Oxford Brookes University). David began by noting that acoustic measurements of real musical instruments were usually carried out by testing in a laboratory, often without the musician even being present. Such measurements were useful for analysis and design but not very helpful to recording engineers trying to find good microphone positions. The paper went on to describe a system for making high-resolution 3-D measurements of radiation patterns. It included, potentially, a 120-sensor array though that had not yet been completed. The array geometry was intended to minimise errors in the interpolation of a virtual sensor array. The interpolation process had been compared against measured results and had been found to give a reasonable match.

High frequency room acoustic analysis using fast multipole BEM by Patrick Macey (PACSYS). Patrick presented an approach to speeding up the calculation of acoustic responses in large spaces using the Boundary Element Method. He noted that, in a direct approach, the matrix factorisation problem increased as the 6th power of the frequency. Iterative methods could reduce that to the 4th power x the number of iterations. The fast multi-pole approach provided faster matrix x vector multiplication. Results from FMBEM analyses were compared with the 2½-D approach for rooms of constant height, as presented at earlier conferences, with good agreement. It was also found that fewer iterations were needed as the damping increased.

Session 8, Perception: cinema and Surround Sound, Chairman – Sam Wise

Following the break, the first paper of the session was *Maximising*

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perceived diffuseness in loudspeaker systems with height using optimised relative loudspeaker levels presented by Michael Cousins (ISVR, Southampton University). Michael described how many systems with height components were now in use. However, these generally had very sparse layouts in the vertical direction. The results of two listening tests were presented. The test subjects were required to judge "diffusivity" for 10 different subsets of a 21-loudspeaker array by adjusting the level of the "vertical" components until maximum diffusivity was obtained. The results had been rather inconclusive. A further MUSHRA-style test had also been carried out comparing four loudspeaker layouts and three ISLD options. The optimised ISLD was found to be perceived as slightly more diffuse than maintaining equal sound levels from each loudspeaker and both of these were significantly more diffuse than maintaining equal level from each subset.

In the absence of the next scheduled paper, Sam Wise (Venue Strategies) gave an impromptu presentation on *Sustainability* in which he discussed issues relating to the economic and environmental impact of PA systems and live events.

That was followed by *Why does cinema sound quality mostly fail to realise its potential? Some interesting results from the SMPTE's 2014 report on cinema sound systems* presented by Glenn Leembruggen and Philip Newell. Glenn first described the findings of the recent comprehensive SMPTE survey of cinema sound systems. The presentation included detailed time and frequency response results from four commercial cinemas and two dubbing stages, as well as a commentary on the process and results. It clearly demonstrated why those previous types of measurements were inappropriate and were failing to satisfy the requirements for consistency in different venues. Possible alternatives, including "Clarity" and "Cumulative Energy" function, were discussed, suggesting that they might be more useful. However, it was made clear that the matter is by no means decided yet.

The final paper of the conference was *The relationship between subjective and objective response differences at different heights above cinema seating* presented by Philip Newell (Consultant, Spain). He described how the "X" curve is still causing all kinds of problems in cinema sound. The main part of the paper described a pilot study of the effects of microphone height over the seat backs. It was a small part of a much larger project on cinema measurement. The premise was that the current specification of having the measurement microphone only just over the top of the seat backs was causing anomalies. The presentation included results of measurements at seven different heights. It was found that there were few differences for heights over 60 cm but irregularities became very severe at 4 cm. In addition to the measurements, a panel of 20 people had been asked for their subjective impressions of the effects of head height. Some couldn't hear much difference and few expressed any preferences, even for seated versus standing height.

A break in proceedings

Alastair Meachin (seated) tests a product

Alistair Somerville raises a question

Making a point - Matthias Christner

The conference dinner

Loudspeaker expert Siegfried Linkwitz wins Peter Barnett Award

Siegfried Linkwitz (right) receives his award from Glenn Leembruggen

Siegfried Linkwitz has been awarded the 2015 Peter Barnet Memorial Award which recognises advancements and technical excellence in electroacoustics, speech intelligibility, and education in acoustics and electroacoustics.

It was presented to him at Reproduced Sound 2015 by Glen Leembruggen who told delegates: "Siegfried Linkwitz has provided the world of audio and reproduced sound with rigorous, innovative thinking and a significant number of new techniques for loudspeaker design and measurements. Siegfried's commitment to communicating his knowledge has greatly enriched the audio community."

Below is a summary of his citation.

Although Siegfried is best known to the wider community for the loudspeaker crossover system known as the Linkwitz Riley crossover, his contribution to our understanding of loudspeakers and the way that they interact with small-room acoustics has been both important and prolific.

Siegfried and his friend Russ Riley co-developed a particular class of loudspeaker crossover-filter which had the benefit of producing both a flat amplitude response and a symmetrical radiation pattern around the crossover frequency for loudspeaker systems with drivers that don't share a common axis. Publication of this crossover filter has subsequently spawned numerous papers on other types of filter classes that include the benefits of the Linkwitz Riley crossover.

Siegfried received his first engineering degree in electrical technology at Technical University in Darmstadt, Germany, and then worked at Telefunken and then Siemens in Germany. After emigrating to the USA, he obtained a second degree in electrical engineering from Stanford University. He then spent 37 years at Hewlett Packard, developing state-of-the-art electronic test equipment, such as microwave spectrum analysers, network analysers and EMI receivers.

During his last 18 years at Hewlett Packard, Siegfried participated in national and international standards committees for Electromagnetic Compatibility Test Instrumentation through ANSI and IEC/CISPR.

Although retired, he is active as a consultant and freelance writer and a developer of hi-fi loudspeaker systems. Since 1999, he has maintained the LINKWITZ LAB website to educate readers about loudspeaker design, sound reproduction and recording. In the early 1980s he wrote a series of articles on loudspeaker design in *Wireless World* magazine, which provided strong guidance for budding electro-acoustic engineers.

One of the hallmarks of his work has been his novel and innovative solutions to acoustic problems, with those solutions being well grounded in rigorous engineering and strong attention to numerical details. His approach has helped the industry to mature.

Siegfried may have been the first to use the Modulation Transfer Function (on which the Speech Transmission Index is built) to compare the temporal performances of monopolar and dipolar loudspeaker systems in small rooms. His work with dipolar loudspeaker systems has helped to open up a whole range of possibilities for sound reproduction in small rooms. Siegfried also developed an equalisation filter for closed-box loudspeakers to allow their response to become an integral part of a crossover system. This filter has become known as the Linkwitz Transform.

Order of Merit for Ann Dowling in New Year's Honours

Professor Dame Ann Dowling, President of the Royal Academy of Engineering and an Honorary Fellow of the IOA, was admitted to the Order of Merit in the Queen's 2016 New Year's Honours list.

The award, a personal gift of the sovereign, recognises exceptional service towards the advancement of the arts, learning, literature and science, and is limited to just 24 living recipients.

President of the Academy since 2014, Dame Ann is Professor of Mechanical Engineering at the University of Cambridge, where she served as Head of the Department of Engineering from 2009-14 and is currently a Deputy Vice-Chancellor. As a world authority on combustion and acoustics, she is admitted to the Order of Merit for her exceptional service in advancing the field of mechanical engineering, with almost 40 years of research on aeronautics and energy, most recently in developing low noise aircraft.

Outside of her own world-leading research, Dame Ann has an influential leadership role across the engineering and academic sectors. She serves as the first female President of the Royal Academy of Engineering, and is a Fellow of the Royal Society, the US National Academy of Engineering and the French Academy of Sciences. She also sits as a non-executive member of the board of Department for Business, Innovation and Skills and is a non-executive director of BP.


Dame Ann Dowling speaking at the IOA's 40th Anniversary Conference

In 2015, Dame Ann published *The Dowling Review of Business-University Research Collaborations*, which identified the complex mechanisms in place to encourage collaboration between academia and industry in the UK and called for a simplification of these systems in order to reap the full potential of the excellent research being done in UK universities. Dame Ann also chaired the widely respected 2004 report *Nanoscience and nanotechnologies: opportunities and uncertainties*, which highlighted the need for responsible regulation and research around the use of materials at an extremely small scale.

In 2014 Dame Ann was awarded the IOA's Engineering Medal for her pioneering work in acoustical engineering. It was presented to her by Institute President William Egan at the 40th Anniversary Conference in Birmingham, where she gave her medal lecture on the subject of jet noise.

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- Building acoustics
- Noise nuisance

Public Health Outcomes Framework

By Stephen Turner

The Public Health Outcomes Framework (PHOF) entitled *Healthy lives, healthy people: Improving outcomes and supporting transparency* is described as setting out *"a vision for public health, desired outcomes and the indicators that will help us understand how well public health is being improved and protected"*.

The framework was published in January 2012 at roughly the same time that public health responsibilities were being passed from the NHS to local government. The framework comprises two high-level outcomes to be achieved across the public health system, supported by four domains that cover the full spectrum of public health.

The PHOF has a vision: *To improve and protect the nation's health and wellbeing, and improve the health of the poorest fastest*

The two high-level outcomes are:

- Outcome 1: *Increased healthy life expectancy taking account of the health quality as well as the length of life*
- Outcome 2: *Reduced differences in life expectancy and healthy life expectancy between communities through greater improvements in more disadvantaged communities.*

The four domains are:

1. **Improving the wider determinants of health** with an objective: *Improvements against wider factors that affect health and wellbeing, and health inequalities*
2. **Health improvement** with an objective: *People are helped to live healthy lifestyles, make healthy choices and reduce health inequalities*
3. **Health protection** with an objective: *The population's health is protected from major incidents and other threats, while reducing health inequalities*; and
4. **Healthcare public health and preventing premature mortality** with an objective: *Reduced numbers of people living with preventable ill health and people dying prematurely, while reducing the gap between communities.*

The outcomes are designed to reflect a focus not only on how long people live, but also on how well they live at all stages of life.

The reason why this information is appearing in this journal is not simply the fact that the Vision and High-Level outcomes are structurally similar to the Noise Policy Statement for England, but because noise features in the "Improving the wider determinants of health" domain with Indicator 1.14.

This indicator is in three parts:

- 1.14i – The rate of complaints about noise;
- 1.14ii – The percentage of the population exposed to road, rail and air transport noise of 65 dB(A) or more, during the daytime
- 1.14iii – The percentage of the population exposed to road, rail and air transport noise of 55 dB(A) or more during the night-time.

The information is categorised by local authority and also aggregated by region and nationally. The authorities quoted in the data are based on the structure used for the Directors of Public Health. Consequently, the information is provided at county and unitary level, but not district.

Complaints (1.14i)

The data shown here is based on the results of the annual survey of local authorities about the number of complaints received; a survey which is carried out each year by the Chartered Institute of Environmental Health [1]. As not all local authorities respond to that survey (the response rate tends to be 40 – 50%), a methodology was derived by Defra to impute the missing values (based on factors such as the type of authority and any previous information supplied by that authority). Public Health England (PHE) carries out the necessary calculations to obtain the results for authorities that did not supply data. The values for this indicator are updated annually.

The results for four consecutive years can be found on the PHOF. The rate for England has declined from 7.8 to 7.4 complaints per thousand population between 2010/11 and 2013/2104. The population has, however, increased over that period so the overall total number of complaints has remained roughly the same in that time at around 400,000 per annum (including the imputed data).

Daytime exposure

This value is based on the $L_{Aeq,16h}$ *according to the results of the strategic noise mapping carried out as required by the Environmental Noise (England) Regulations 2006, as amended.*

The PHOF states that the data have been derived from the results of the separate mapping of the three sources. The number of people exposed to more than 65 dB(A), LAeq,16h from each source was summed to produce the overall result. This method does mean that an individual exposed to more than this value from more than one source will be included more than once in the overall total. At a national level, this is not expected to produce a large error. From the mapping carried out in 2011 (and based on the 2011 census), the total number of people in England exposed to 65 dB, $L_{Aeq,16h}$ or more was 2.74 million.

Night-time exposure

This value is based on the L_{night} ($L_{Aeq,8h}$), again *according to the results of the strategic noise mapping carried out as required by the Environmental Noise (England) Regulations 2006, as amended.*

The PHOF states that the data have been derived in the same way as for the daytime exposure, but with the values being based on the number of people exposed to more than 55 dB(A), L_{night} from each source. From the mapping carried out in 2011 (and based on the 2011 census), the total number of people in England exposed to 55 dB L_{night} or more was 4.25 million.

Two sets of results can be seen on the PHOF for the exposure indicators, reflecting the first two rounds of noise mapping. The percentage of the population in England exposed to 65 dB(A), $L_{Aeq,16h}$ or more has reduced from 5.4 to 5.2 %. For night-time exposure, the equivalent values are 12.8% and 8.0%. Care is needed when interpreting these results because they may have been influenced by changes in the mapping methodology between the first two rounds of mapping.

Department of Health consultation on PHOF [2]

When the PHOF was first published in 2012 there was a commitment not to make any changes for 3 years to allow it to become established during the transfer of public health responsibilities from the NHS to local authorities.

A consultation was held during September 2015 *to make sure it is still as relevant and useful as possible, with a view to updating the indicators from April 2016.*

This consultation sought views on whether existing indicators should be

- Removed
- Revised; or
- Replaced

Consultees were also invited to suggest adding new indicators *but only where there are important public health gaps.*

It will be noticed that there was no option to respond by saying that certain indicators should be retained. In fact, the consultation overtly stated that: *You do not need to provide any response for indicators you are either content with or about which have no comments.*

The Institute of Acoustics felt that without providing clear support for the retention of the noise indicators, it was possible that some other respondents may seek their removal and there would be no counter-balancing argument.

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Through its links with PHE's noise and health programme manager, the IOA did provide a response to this consultation supporting the retention of the noise indicators. The letter that was sent to PHE is reproduced right.

The Department of Health is currently considering the responses to the consultation, and intend to publish its response by the end of the year. This will set out the changes to the PHOF from April 2016.

The significance of noise indicators in the PHOF

As our letter noted, the detail of the indicators are not perfect. They were designed to provide a measure of the impact of neighbour and neighbourhood noise (1.14i) as well as environmental noise (1.14ii and 1.14iii). In keeping these indicators on the list, Directors of Public Health will continue to have a duty to consider noise alongside all the other factors that affect our health and well-being. They do, of course, have other health priorities but with the existence of the noise indicators, it gives those of us who care about the management of noise a way of keeping the issue of noise and health on their agenda. If the noise indicators were to be lost, the Directors of Public health would have no formal need to consider noise and its impact.

More information on the PHOF can be found here: http://www.phoutcomes.info/

Stephen Turner HonFIOA *is Director of Stephen Turner Acoustics Limited. Prior to that he was a technical adviser to the noise policy officials at Defra for 15 years, including four years as a civil servant finishing in January 2015.*

The author would like to thank Ben Fenech for his assistance in preparing this article.

References

1. http://www.cieh.org/policy/noise-statistics-research.html
2. Information on the consultation can still be found here https://consultations.dh.gov.uk/ph-outcomes-framework/phof-refresh-2015

Public Health Outcomes Framework
Submission to PHE from the Institute of Acoustics
Reviewing the Indicators in the Public Health Outcomes Framework
Open Consultation

This response has been prepared by the Institute of Acoustics (IOA), which is the professional body for those who work in the field of acoustics and noise control.

We welcome this opportunity to respond to this consultation. We believe that the Public Health Outcomes Framework (PHOF) is a very valuable tool for monitoring trends in public health and well being.

We note, however, that the scope of the consultation seeks comments on whether a particular indicator should be removed, replaced or revised. There is no option for expressing support for the unaltered retention of a particular indicator.

We have, however, been given to understand that you will accept correspondence which contains support for the retention of indicators.

The IOA wishes to express its support for the retention of the following indicators:

- 1.14(i) – The rate of complaints about noise;
- 1.14(ii) – The percentage of the population exposed to road, rail and air transport noise of 65 dB(A) or more, during the daytime; and
- 1.14 (iii) - The percentage of the population exposed to road, rail and air transport noise of 55 dB(A) or more, during the night-time.

Noise has been described as the Cinderella pollutant, but yet its impact can be felt by many people. The World Health Organisation is clear about the adverse effects of noise exposure and there is an increasing body of research demonstrating the link between noise exposure and health effects such as hypertension, cardio-vascular disease and acute myocardial infarction.

Current Government policy provides a good framework for the effective management of noise. The suite of indicators in 1.14 of the PHOF provides a simple but effective measure of the extent of the impact and effect of noise and how well that policy is being implemented across England.

We recognise that the indicators are not perfect, but they do provide a good platform for monitoring the overall trend in noise impact and effect, and provide data for Directors of Public Health regarding the situation in their area.

Only recently (11th September 2015) there was a television programme on ITV which showed the adverse impact of noise and included a brief demonstration of how noise can adversely affect sleep.

With the aim of the PHOF being to monitor the public's health and well-being, it is essential that indicators monitoring the impact of noise are retained in the framework.

Environment Certificate course updated and the Building Acoustics Certificate rolled out in Ireland and Scotland

By Keith Attenborough, Education Manager

In the autumn of 2015 there were 76 candidates (including three resits) at seven centres for the Certificate of Competence in Environmental Noise Measurement (CCENM) of whom 69 passed. To take account of the use of "sound" rather than 'noise' in the 2014 version of BS 4142, consideration has been given to replacing "noise" by "sound" in the title of the Certificate but in view of the fact that potential candidates and their employers are more likely to search for courses using "noise", it was agreed by those present at the management committee meeting on 28 October not to change the title. However other aspects of the revised standard are having some impact on the course. It was agreed to include an introduction to contexts and examples in which penalties for tonality, intermittency and impulsivity might be considered during assessment. Also more attention will be paid to matters of accuracy, repeatability and uncertainty.

There were 19 candidates at three centres for the Certificate of Competence in Workplace Noise Risk Assessment (CCWPNRA) in October 2015, of whom 17 passed. An agreement between the IOA and the British Occupational Hygiene Society (BOHS) in respect of mutual recognition of courses for membership purposes is close to being finalised. Andy Nicholls is succeeding Tim Ward as examiner but we still seek a successor for the current chairman of

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the management committee (Dave Lewis).

A trial run of an Irish version of the Building Acoustics measurement certificate course (CCIBAM) took place in September 2015 with seven candidates all of whom passed. Also as the result of an approach from South Lanarkshire Council the Certificate was presented to eight candidates in Scotland. 10 candidates took the "regular" certificate at Southampton Solent University. Out of these 18, 14 candidates passed. The possibility of a Scottish centre for delivery of CCBAM is to be investigated.

The Certificate of Proficiency in Antisocial Behaviour etc. (Scotland) Act 2004 Noise Measurements (ASBA) was delivered in October 2015 by Bel Noise courses. Alistair Somerville and Lilianne Lauder have taken over the course administration from Cameron Procter who has retired. 15 candidates (including a resit from Strathclyde) passed but one did not sit the examination.

Antisocial Behaviour Act 2004 Noise Measurements

Bel Noise Courses	
Brogan B	Kirk B
Campbell D	Low R F
Clark F J	Meehan M P
Conti S M	Scobie S M
Fik D	Thomson L
Garven D G	Von Doring C M
Gilmour A E	Wilson L A
Irving J A	
University of Strathclyde	
Carrigan N J	

Building Acoustics Measurements

Southampton Solent University	
Allen M	Joyes K
Anfishi A	Mahmood A
Ashworth M P	McGhee M
Bal H S	Neilson G L M
Duffy D	Robertson M A
Eacott L	Tabuzo G
Jenkins R	Toivonen P T
Southampton Solent University (Ireland)	
Blunnie D	Monaghan M
Howell J M	Reynolds J M
Kelly A	Williams L
Mac Phee I C	

Environmental Noise Assessment

University of the West of England	
Betts J	Hunt R J
Brown A	Roberts C
Edwards K J	Walton P
Hale M A	Wonnacott J P
University of Derby	
Colella K A	Moore S J
Fennell D	O'Brien C R
Gascoigne N D	Pierce T J
Gundel A	Robinson A P
Hirst J M	Talbot R L
Hocking S M	Wallis A
Liverpool University	
Anderson L J	Hill S
Clayden C I	Hunter K D
Clayton J S	McGing A
Clayton N	Mellor J D
Conroy C	Nieto A
Dunabin E L	Seiffert J
Hawi Z	Swindlehurst J D

London South Bank University	
Baggs K	Sahota S
FernandeZ Cachafeiro M	Stead J
Le Core L	Vernon-Hunt G W
Longworth S	Walton M
Payne K A	Wisniewska S
Quitian C	
Shorcontrol Safety	
Brennan F	Moloney K C
Daffy A	O'Flynn B
Elliott V	O'Sullivan A T
McKibbin G J	Speer R
Southampton Solent University	
Harty C	Jones C E
Holland M F C	Sartori I C
Jakubowski S J	
University of Strathclyde	
Beaugas J	McAuley C
Gibbs T G	Morrison C M
Gunning L J	Murphy M
Javed I	Qamar Z
Jones D M	Taylor A W
Laing K	

Workplace Noise Risk Assessment

EEF Sheffield	
Cardwell M	McCole K
Denholm C	Morgan L
Findon C	Storey E
Garrill C N	Taylor S J
Kemp A	Wan Foong L
Leigh-Howarth S J	

Leeds Beckett University	
Chapman P	Graham D
Conroy C	
Shorcontrol Safety	
Cryan B	Gamble D S

Successful students and projects in 2015 Institute Diploma

The following students at the University of Derby passed the Institute Diploma in Acoustics and Noise Control in 2015:

Barnett E L	Chauhan H	Denson L	Green T A	King T J L	Martin S	Oseland A K	Young A E
Basic M	Crowe T P	Edwards S R	Gutteridge A	Lassandro F	Maycock J	Tynan E J	Zorn T D
Burchell J	Cumming S F C	Gray M A	Hankins G	Latif Y	Moseley A N	Willcocks J F	

The following are the titles for projects submitted for the 2015 Diploma.

University of Derby

Hand arm vibration in motor vehicles	Reduction of rev times in performance spaces
Relationship between vehicle speed and noise levels	Acoustics of churches
Microphone directionality and environmental noise measurements	Acoustic assessment of schools for SEN children
Comparison on the 1997 and 2014 versions of BS 4142	Acoustic characteristics of churches
Noise emitted from high speed hand dryers	Permitted residential developments and noise
Assessing vibration in a cold atoms laboratory	Speech intelligibility in open plan offices
Reverberation time in a community hall	Effect of furniture on RTs in classrooms
Acoustics of concert halls	Noise impact of gymnasia
Investigation of a flutter echo	A comparison of BS 4142 (1997) and BS 4142 (2014)
Noise prediction and assessment of HVAC systems	Room acoustics of multimedia spaces
Effect of surface films on acoustic performance of ceiling tiles	

Leeds Beckett University

Isolation of vibration by footwear; a mass-spring model	Road traffic considerations for planning use determination
Whole body vibration in slate quarry vehicle drivers – risk and control management	Bell tower acoustics
Improvement in RT of a treated microphone capsule testing room	A shortened measurement procedure for airborne sound insulation testing
Acoustic considerations in the development of teaching and medical spaces	An investigation into dose levels of DJs, nightclub workers and clubbers
Investigation applying the methods of BS 4142:2014 and BS 4142:1997	An investigation into the reliability of very low traffic flow corrections in CRTN
A review of insertion losses following the installation of an acoustic enclosure	A practical assessment of NPAS helicopter crew hearing protection
The room acoustics of an open-plan office	Exploring methods of improving acoustics in a cellular office

London South Bank University

Acoustics for home cinema comparisons of modelling and measured results to achieve "ideal" home cinema acoustics	Control of noise from urban football pitches using impact absorption and a sustainable "green" barrier
Critical assessment of budget ear defenders	Comparison of measured and predicted construction noise. Good practice in modelling
Investigation into the acoustic suitability of two music rehearsal rooms	Investigation into the acoustics of a commercial cinema
A research of Speech Transmission Index Measurement in mosque acoustics	An investigation into using soundscapes to improve speech privacy and productivity
Case study of plant noise in the London Borough of Tower Hamlets (technical investigation from residential premises using new Standard for environmental noise monitoring BS 4142)	Investigation and assessment of the typical noise impact of licensed premises smoking areas with a view to providing practical advice to them in order to mitigate nuisance noise
The efficacy of sound insulation in council property for family with additional needs late submission	The acoustic/electroacoustic design and testing of quarter wave transmission-line

Southampton Solent University

The effects of reduced absorption coverage in a hemi-anechoic chamber	The noise impact of running events on an urban city
An investigation into reverberation time measurement techniques	The effects of fair weather riders on the local environment
An investigation into weekend noise levels within Woking town centre	

DL St Albans

Reverberation time as a characterizing criterion of halls	An investigation into the effect of new acoustic treatment on the RT60 of a small performance venue
Sound reduction through open windows	Experimental measurements on the noise impact of landing gear deployment on approach to Heathrow
Assessing speech privacy for a local authority criminal investigation room	Examining and comparing the accuracy of the different methods for calculating and measuring road traffic noise
Investigation of influence of distribution of absorbing materials among room surfaces on reverberation time and prediction of reverberation time in rectangular room using different methods.	The effectiveness of motorbike silencer systems for road going machines.
Evaluation and execution of the acoustics at Poncho Villas night-club, Bur Dubai (UAE)	Construction and in-situ acoustic evaluation of a domestic partition wall P24

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A study of speech intelligibility in meeting and conference rooms
Control of noise emissions from a trailer mounted power pack
Assessing and attenuating the noise emissions of a solar pond air pump
Assessing the variables within sound insulation testing
Noise control in an existing hotel's conference rooms from adjacent F1 track
Noise control treatment for a diesel generator
Testing and selection of ceiling and wall panels for a school auditorium
Prediction and measurement of railway noise and potential adverse health effects
Improving the sound absorption of porous materials at low/medium frequencies
Acoustic renovation of an 835-seat multi-purpose hall: a case study

DL Edinburgh

A methodology for minimising wind farm energy losses through optimised curtailment scheme
A study into the accuracy of predicted road traffic noise and barrier attenuation
Investigate the noise issues associated with multi use games areas (MUGAs) in educational establishments (schools)
Noise assessment of an operational wind farm including amplitude modulation
Post completion performance analysis of remedial works to an open plan teaching primary school with a record of historic acoustic difficulties
Analysis of noise exposure at live events in arena-sized venues
Investigation into the façade effect
Comparison of speaker position on sound insulation method for partition walls
A study of noise levels in an open plan office and the effectiveness of desk baffle boards

DL Bristol

Investigating the validity of the façade level correction
Evaluation of car park noise guidance and its validation and use within UK car parks.
Assessment of motor vehicle interior noise levels with and without air-conditioning ventilation
An investigation into the accuracy of measuring background levels over different time intervals
Investigation into the reliability of measurement intervals for background sound levels
Analysis into the laboratory and field measured rows for secondary glazing
Comparison of sound levels and glazing requirements in bedrooms overlooking main roads
Analysis of signal generator Android apps.
Impact sound measurement and the influence of airborne noise during measurements
An investigation into sound levels of an office atrium mezzanine and how the perceived acoustics are influenced by the building design and human interactions

DL Dublin

A comparison of BS 4142:1997 and its 2014 revision; an assessment of changes on applicants
The measurement of Speech Intelligibility Index from evacuation notices generated from public announcement (PA) systems in a public building
Acoustic analysis of control room acoustics using a binaural microphone measurement system.
An investigation of the suitability and feasibility of using environmentally friendly materials as acoustic absorbing panels in buildings

Next steps for UK aviation industry following the Airports Commission's Final Report

By Louisa Johns, Jack Naumann and Nicole Porter, Anderson Acoustics

The meeting was held at London South Bank University to discuss the lessons learnt from the Airports Commission's (AC) process and how the acoustics industry could apply these when approaching future projects. Around 50 delegates attended comprising acousticians, local authorities, Civil Aviation Authority (CAA) and community representatives. It was chaired by Nicole Porter, of Anderson Acoustics, who began by setting the scene. She summarised the terms of reference of the Airports Commission and presented the timeline of its work. She summarised a number of key topics included in its final recommendations comprising noise envelopes, metrics, (predictable) respite, monetisation, noise levies, extensive compensation/ insulation schemes, night noise curfew/ban, a UK independent aviation noise authority, community engagement board, and more collaborative relationship with local communities.

Attendees were reminded the day was not to be a discussion of the merits or issues of the proposed schemes, but rather provide a forum to debate the progress presented in this landmark report.

The AC's final report considered the need for predictable respite periods to be more reliably maintained. Nicole provided a summary of the work of the UK's Respite Working Group, and their identified research priorities in investigating what comprises an effective respite strategy. She introduced a new research project to better understand the key characteristics of an effective respite strategy for Heathrow Airport and its noise-affected communities, consistent with efficient operations.

This was followed by a presentation by Dr Darren Rhodes, Head of the Environmental Research and Consultancy Department (ERCD) of CAA, who highlighted the role the CAA played in the Final Report, which not only included noise but also safety, airspace design and economic regulation. He discussed the various scenarios the CAA was asked to model in order to assess the proposed airspace designs, which was used by the Airports Commission for interpretation and analysis. He concluded by emphasising the need for a few meaningful metrics since many are self-correlating, and demonstrated the sensitivity of the noise model to technological changes, such as population growth and the delivery of new aircraft types.

During the remainder of the first session, Bernard Berry, of BEL Acoustics, provided an overview of the current evidence relating health impacts of aviation noise and how these impacts have been monetised. The difficulty in providing a single figure due to the variability in disability weightings and separating the effects of road traffic and aviation noise were highlighted. Bernard discussed the forthcoming WHO Environmental Noise guidelines and the recent AEF review of health impacts from aviation noise. Both reports showed calculations of the monetary cost of health impacts due to aviation noise.

Following the coffee break, the session focused on metrics and policy. Andy Knowles, of Anderson Acoustics, presented a range of acoustic and non-acoustic metrics that can be used to describe the noise environment and the differing roles each play for various stakeholders. He demonstrated, using a recent case study, how standard metrics may not always be a reliable indicator of community response while, in this instance, increases in complaints were reflected by significant changes in N65. Metrics can only ever describe a noise environment; they cannot tell you how people will respond, and often dose-response relationships are adopted to predict response from a metric but there are many uncertainties introduced in this part of the process. Metrics (standard and supplementary) can be refined to include specific operations or time periods and derived at the community level.

P26

01dB

Advanced noise & vibration measurement

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This highlighted the need to choose appropriate metrics to suit the particular situation. Andy also stressed the importance of language in communicating noise exposure, warning against the use of average noise contours as boundaries to defining the onset of annoyance. His view was that the AC's process has brought supplementary metrics into the main stream, and care is needed to target the metrics such that they are fit for purpose.

Dani Fiumicelli, from Temple, summarised national policy in relation to aviation noise. Dani mentioned how, through policy documents, we can focus on limiting and reducing population exposed to aircraft noise, sharing the benefits of noise reduction technology with the communities. The discussion again covered the use of metrics and limitation in predicting annoyance onset. He further supported the use for the industry to increase its use of refined and supplementary metrics, particularly by mode. He also commented on the range of thresholds in relation to LOAELs and SOAELs for aviation that are still not definitive.

The afternoon session began with Steve Mitchell from ERM addressing mitigation and compensation conditions proposed by the Airports Commission. He described his view of the effectiveness, value and deliverability of the proposed conditions including providing clarity on differences between mitigation and compensation. He also discussed "winners and losers" and the concept of the provision of respite in the context of minimising number of people newly overflown, and when it is appropriate to aid relocation to less noisy areas. He concluded with remarks about the future with physical operational measures being considered as a given, the development of substantial noise insulation and considerable compensation schemes.

Steve went on to lead a workshop discussion on the relative merits and importance of mitigation and compensation, although it was noted that there would be difficulties in providing financial compensation for potential health effects. It was discussed that although mitigation reduces noise levels a community may overestimate the benefits that insulation will provide. However, there are non-acoustic benefits to consider from offering insulation that go beyond reduction of noise. The use of auralisation techniques was suggested, which could be used to manage the expectations of the public. Next it was questioned whether it is right to increase the number of newly affected overflown communities and whether this can rightfully be offset by those removed when considering comparing different scenarios. The extent of resident's habituation to noise over time was considered, and whether there is a difference in perception of noise from residents who have had flights "forced upon them" as opposed to those moving into a community already overflown. It was also suggested that it could be the duty of estate agents or local authorities to provide a true picture to residents thinking of moving to an overflown area.

The final presentation of the day was given by John Stewart, Chairman of community group HACAN, who described his experience in engaging with Heathrow and the Airports Commission. He discussed, despite the challenges, the benefits of engagement over consultation, and how establishing a meaningful relationship can lead to positive results for both parties. Engagement with the airport has brought about a commitment to use a suite of metrics, studies into meaningful respite and clearer communication of technical issues. Furthermore, he noted how engagement with the Airports Commission has led to a step forward in noise policy and a tough set of conditions for a third runway, if approved. He accepted that it was often easier for a community to completely oppose all new plans but was hopeful that engagement would help to work towards building trust in airports in the future. He concluded that there are benefits to all sides with open engagement but we are learning as we go.

The day served to highlight how important factors such as community engagement, mitigation and compensation are in sharing the benefits of aviation across all stakeholders. It also pointed to the need for Noise Policy and other documents to provide effective guidance in managing aviation noise. The need for evolving metrics that are fit for purpose is paramount. Assessment of aviation noise and its impacts is evolving and we must continue to learn from the process.

Thanks go to everyone who helped organise the event and to all who contributed to the presentations and discussions.

The Scottish Wind Farm Impacts Study

Southern and Scottish Branches joint meeting

By David Yates and Laurent Galbrun

On 4 February the Southern and Scottish Branches got together for a joint meeting in both Southampton Solent University and Heriot-Watt University in Edinburgh. The two meetings were joined by a video conference link, which was a first for the IOA and represented a number of technical challenges which were ably overcome by the teams at the two universities. As well as delegates in two different locations at opposite ends of Great Britain, additional attendees logged in online including a contingent from the Irish Branch.

The meetings were chaired by Andy McKenzie (Hayes McKenzie) in Southampton and Laurent Galbrun (Heriot-Watt University) in Edinburgh and presented the findings of the Scottish Wind Farm Study.

Ragne Low, who is a Programme Manager at ClimateXChange, gave the first presentation from Edinburgh and the delegates in Southampton and online saw the presentation as a webcast and heard the commentary from her. She gave an interesting overview of the project, which looked at visual impacts and shadow flicker as well as noise impacts. Ragne told the delegates how 10 existing wind turbine farms were chosen, of varying sizes, location, topography, age and with very different histories in terms of complaints. The aim of the project was to provide evidence for the Scottish Government to assist in the determination of future policy and best practice guidance. Once she had finished her presentation, Ragne took questions from both Edinburgh and Southampton, as well as via the Internet.

Andrew Bullmore from Hoare Lea then presented from Southampton about the noise assessment carried out, with delegates in Edinburgh and online seeing the presentation as a webcast. He identified the 10 sites in terms of rough locations, and it could be seen that they were located all over Scotland. Having explained the logistics involved in carrying out noise measurements for wind turbines at all of these locations, it was clear that it would be not be possible to carry out further measurements. The assessment was then carried out utilising the information available from the original applications and Environmental Impact Assessments (EIAs). The information contained within the EIAs was utilised to replicate the original predictions within Hoare Lea's noise modelling software and this information was compared to predictions carried out to the methodology of the IOA's Good Practice Guidance. Having carried out site visits for each wind farm location, they were also able to carry out predictions utilising the actual turbine locations and types of turbines (during the EIA stage, wind farms are generally assessed using "candidate" turbines and locations as the exact information would not be known). The results were also compared against post-installation noise measurements where these were available. The analysis showed that the original prediction methodologies produced variable results, however the IOA Good Practice Guide methodology produced repeatable results and never under

predicted the noise levels. Based on the results of the assessment, and the responses from a residents questionnaire, a number of recommendations were made, which included the production of additional guidance, good practice methods and increasing the level of communication to local residents. Andrew also answered questions from both Edinburgh and Southampton, as well as via the Internet.

Feedback from the Scottish Branch suggested that they generally thought it was a good event, and that the video link was a good way to get a wider range of speakers who otherwise would not be able to present to them. It was also felt that having questions from a broader audience enhanced the experience. It was noted that the quality of the visual and audio was generally very good, with just a couple of tweaks required, although it would have been good to have a video of the presenter as well.

Robin Woodward (Hayes McKenzie), who attended online, said: "I think the meeting went really well from a virtual participant's point of view. The feed quality was generally very high, with some variation depending on who was speaking where, but overall it was easy to follow and relatively immersive. There are clearly lots of positives to take out of this, as well as lots of ideas and lessons learned."

Graham Parry (ACCON UK), who attended in Southampton, said: "This was an excellent opportunity to learn about some interesting research in respect of Scottish wind farms. Whilst the research had three aspects, which included visual intrusion, shadow flicker and noise it was the noise aspect that I awaited eagerly to hear. As always, Andrew Bullmore did not disappoint with his presentation about the research findings. For me the big question is as to whether the research will be utilised to partially inform a review of the utility of the much derided ETSU-R-97 wind turbine noise assessment methodology and in that respect I suspect the jury is still out."

There were 35 people in attendance in Southampton, 45 in Edinburgh and four online.

The Southern Branch subsequently held its AGM during which the Chairman Peter Rogers (Sustainable Acoustics) and long standing committee member Andy McKenzie (Hayes McKenzie) stepped down and a number of new people elected. The new Chairman is Daniel Saunders (Clarke Saunders Associates), the new Secretary is Reena Mahtani (Sandy Brown) and the new Young Member's Representative is James Glen (Southdown Environmental Consultants).

The Scottish Branch also held its AGM after the end of the joint meeting. The IOA members present elected the new Young Member's Representative, César Bustos (Arup).

Andrew Bullmore addresses the meeting in Southampton

Ultrahaptics and ultrasonics

South West Branch report

By Dan Boote

In December the branch arranged talks from Professor Bruce Drinkwater (University of Bristol) and Tom Carter (Ultrahaptics). Bruce spoke to us about his research into using sound waves to move objects (see *Acoustics Bulletin Vol.41 No.1*). In the animated presentation, he gave a live demonstration of how sound can be used to suspend objects in mid-air, as well as answering that all important question: Can sound levitate a human?

Tom gave a fascinating presentation on why touch is important to us, and the work of Ultrahaptics in developing a technology allowing people to feel objects in mid-air that aren't really there

Professor Bruce Drinkwater giving his presentation

Tom Carter demonstrating the Ultrahaptics technology, with Mark Dowie trying it out

(see *Acoustics Bulletin Vol. 40, No.1*). The talk concluded with Tom inviting attendees to try out the technology in a live demonstration.

Feedback from IOA members in attendance was that the talks were both very good with the right amount of technical detail for the audience.

What the numbers really mean

By Richard Collman

In December BRE hosted the first one-day Central Branch conference, which attracted good attendance. The aim was to learn more about where some of the numbers that acousticians frequently use and rely upon originate from and to understand some of the data's limitations.

Stephen Turner started by providing his unique insights into Standards and Guidance, explaining how much we still rely on work originally undertaken for the 1963 Wilson Report. For example, the 75dBA limit for outdoor noise in BS 8233 was derived from the ability to hold a telephone conversation using 1960s telephones and 1960s glazing systems – but it still seems to work. One of the many important messages from his enlightening presentation was that whilst the origins of many of the numbers that underpin guidance may be surprising, the numbers do work pretty well on the whole (which is why they have stood the test of time).

Paul Goring then changed the focus onto *Field tests, uncertainty, reports & charlatans*, looking at the many different factors that can affect the outcome and validity of field tests in particular, such as airborne sound insulation and impact testing. In addition to challenges such as design, workmanship and supervision, the way materials have been stored can be significant, before even considering test methods and equipment. Whilst significant, uncertainty is only one factor that can cast doubt on reported values, with poor quality testing, analysis and reporting being another, with several examples of work that should not have seen the light of day, let alone been submitted to demonstrate the suitability of constructions.

John Harriman turned from field testing to the laboratory, talking about *Measurement uncertainty: the laboratory perspective*. This is potentially the most reliable part of the source of data, with carefully controlled conditions enabling precise measurement, testing and calibration with relatively little uncertainty, which can also be quantified. However, John explained that even this "precise" has significant limitations and should be properly understood.

Hans van Leeuwen provided a comprehensive review of acoustic modelling. Any acoustic model involves selection, abstraction and idealisation, all of which introduce uncertainty into what may appear to be a highly precise and accurate analysis. For example, noise mapping can be an ideal tool for large scale work such as new road schemes, but detailed calculations for specific points can be more appropriate for expert research. Road traffic source noise levels can vary by 0.1dB/˚C due to tyre noise alone i.e. 4dB in a country where the temperature can vary between -10˚C and +30˚C; similarly rail track roughness can change the sound level by 10dB. This is before considering other factors such as what assumptions are included in the relevant standards and how the inevitable ambiguities have been dealt with in any particular model; even without uncertainty in the data being used for the model and assuming there are no other errors such as incorrect data. Once a model has been produced, further uncertainty can then arise depending upon how it is interpreted.

After an excellent lunch provided by BRE, Gary Timmins and his colleagues organised a tour of BRE's laboratory facilities, including their impressive anechoic chamber and test suite. Gary explained how even something apparently as trivial as where a doorset is mounted in a test aperture can significantly affect the results of "precise" laboratory testing, with a 6dB difference in level when a door frame was moved from flush with one face to the middle of the depth of the test aperture. Gary then had to try to work out what could be causing this very significant variation.

Andrew Parkin moved us from laboratory testing to *Sound within buildings* reinforcing Gary's warning that test data is not representative for installation conditions that can vary significantly from the test conditions. In addition to reviewing a wide range of practical factors that can affect how sound propagates within buildings, Andrew also provided invaluable insights into other commercial considerations such as the potential implications of mistakes or simply careless wording such as "ensure". He also highlighted other "real world" considerations such as contractual clauses to be wary of and some problems that can arise if a report is used by unintended parties.

Mike Breslin brought matters to a close, extending John Harriman's previous talk to the problems with *Outdoor acoustic measurements*. Mike explained how reducing reported precision increases uncertainty, but increasing it can give a false sense of precision; together with the importance of type testing and periodic testing. Other factors that can affect measurements were also discussed such as the way in which the noise floor of even a Class 1 SLM can have an indeterminable effect on statistical parameters such as LA90,T even after it has been recognised that this parameter can vary between different instrument models/ manufacturers – depending solely upon how it has been implemented.

This fascinating and entertaining conference packed a wealth of information and experience into a relatively short time, showing how important it is to properly understand the data we work with and that simply applying even apparently robust data and authoritative guidance can be misleading without such understanding.

Our thanks to the fantastic panel of expert speakers and also to BRE for the great facilities.

Smart attack: some thoughts on Internet noise monitoring

By John Shelton

History

There's nothing like moving house or office to unearth some old project from the past, and while unloading all my shelves of documentation, I happened upon an old presentation I put together more than 20 years ago when I started AcSoft. Lovingly crafted on overhead transparencies using WordPerfect and Freelance Graphics, it extolled the virtues of PC-based instrumentation, which is what we peddled at the time, but also made some rash predictions for the next 20 years.

One prediction was that PC-based systems would become commonplace, based on emerging operating systems and hardware, and that dedicated instruments would not fade away, but become more "consumerised". This means that sound or vibration meters would be built for specific tasks, become cheaper, and much more widely available.

It's fair to say that PC-based systems are now industry-standard, and most noise and vibration acquisition systems now consist of a front-end combined with software running on a PC or similar device.

Similarly, dedicated sound level meters are now widespread, and much lower in cost. A Class 1 sound analyser that used to cost more than £10,000 is now available for little over £1,000, and specific applications, such as STIPA, can be built into low-cost devices.

Not a bad prediction then, except that the idea of using the Internet in noise and vibration applications completely passed me by. At least I was in good company – Microsoft famously made the same mistake, and it could be said that they have only caught up in recent years!

Generally speaking, though, we are using our modern kit for broadly the same purposes now, as we were 20 years ago. Noise enforcement, aircraft and road noise, product development, product quality, building acoustics, health and safety etc all have a set of procedural standards to which we adhere, with instrumentation standards ensuring the quality of our instrumentation. These have of course been tightened over the years, and now BS EN 61672:2013 lays down some tough criteria which must be met before an instrument system is labelled Class 1.

This is as it should be, but it also creates a "closed" market, with some innovations being stifled in favour of doing the same thing, but faster/cheaper. Rather than widening the appeal and application of acoustic measurements, the tendency has been to keep it amongst "the professionals".

Ultimately, a Class 1 sound level meter can only be made so cheap, a large part of that cost coming from the condenser microphone, which in many cases is still hand-built by angels on the south face of Happy Mountain.

The Internet of noisy things

The ubiquity of the Internet, along with new technologies, now challenges that, as well as making completely new possibilities in democratising noise measurement.

The first idea to come along is the "Internet of things" (IOT) where any device can now be connected via the internet to provide data and also control our environment. This is not just happening with noise – it applies also to your refrigerator (order some more milk on Supermarket.com when you're running low), your car (tells the dealer when you need a service and what parts might be needed), weather data (real-time online weather for the budding sailor) or air pollution (redirect traffic to avoid build-up of particulates). The list is endless, but one thing is clear – all the information is easily available to Joe Public, and perhaps no longer in the hands of the closed-shop professional. Noise is just another number (albeit a difficult to understand decibel), but it makes sense that noise, pollution, vibration, temperature, UV radiation, rain, etc. are just part of the information flow.

The idea of the 'Smart City' is now with us, where our environment can be managed to improve the quality of urban life, and also make large efficiency savings.

Smart cities

The Measurement and Instrumentation (M&I) Group in the IOA regularly runs one-day meetings covering aspects of noise and vibration measurement. One such meeting was organised by Ben Piper, a member of our committee, last year called *Sound sensing in smart cities*. It was a fascinating day, which covered exciting stuff on instrumentation and data management.

NPL has been working for some years on new microphone technologies such as MEMS to see if it's possible to make a low-cost microphone meeting accepted standards of accuracy. The idea of this is to make noise monitors so cheap that they can be widely deployed in a network, for urban and other applications. A MEMS-based microphone was developed and demonstrated to meet Class 1, albeit in a "traditional" package.

Similarly, the Dreamsys project showed how data from such a system could be collated and publicly presented as part of a noise management programme.

I had the opportunity to visit NPL recently and see the latest developments. Ben and his colleagues are now working with a little box based on a Raspberry Pi, with Class 1 MEMS microphone, measuring Leq and 1/3 octaves (!) and delivering the data to the Interweb. Very impressive considering the whole hardware cost is around an order of magnitude cheaper than a conventional system. Trial sites include a large railway development in Central London, and around a large airport in the London area.

Of course, they are not the only ones doing this kind of thing – Azimut Monitoring in France have networks which measure noise and other air pollutants; the *Sounds of New York* project have many noise monitors deployed and feeding data in real-time; and European projects such as DYNAMAP are working towards dynamic noise mapping.

Measurement Quality

As the M&I Group, we should of course ask questions about the quality of such noise data. Does it meet recognised standards like BS EN 61672? How do you calibrate it? Is the cost-saving in hardware irrelevant if the cost of deployment and maintenance dominates? Should it be Type-approved?

The measurement accuracy of any system is normally defined by the purpose for which the data will be used. If certifying the sound power of a machine, or settings limits to noise exposure, or certifying aircraft engines, or testing pass-by noise of cars, then clearly the instrumentation must meet very tight standards, and demonstrably so.

Is the same true of wide-area noise monitoring/mapping? Perhaps we are more interested in trends, rather than absolute accuracy. Is it noisier today

Figure 1: The NPL Raspberry Pi-based noise monitor with MEMS microphone

Figure 2: Azimut's Greenbee, with MEMS microphone hidden in the box, adds measurements of NO2, Ozone and PM10 too! Solar power makes it completely autonomous and very green.

than it was yesterday? What was that loud noise at two in the morning? Do we only need to measure over a limited range? Noise in London for example rarely falls outside the range 45-65 dBA, so why measure it with an instrument that can measure linearly from 20 up to 140 dBA?

Taking the example of the Raspberry Pi, some even have a MEMS microphone on the PCB, so why not use this and forget Class 1 completely?

Perhaps we can use a different quality-of-life indicator too, on a simple scale A-G instead of confusing decibels?

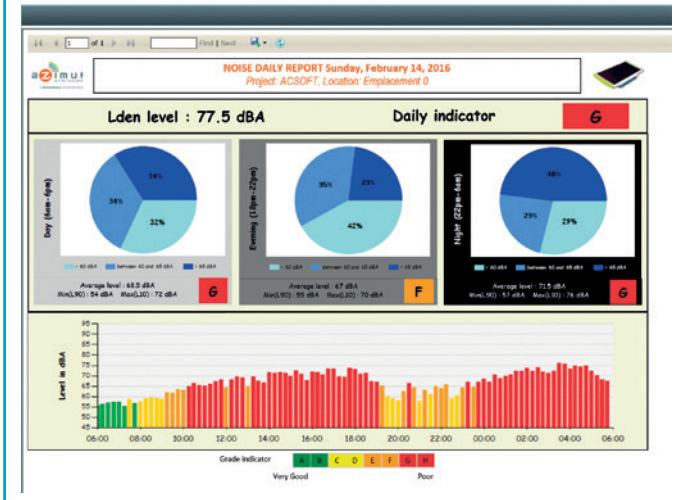


Figure 3: An example of different QOL indicators as well as Lden dBA

Calibration

We are all familiar with calibrating our sound measurement instrument, using a reference source to confirm we are measuring the right levels. For a remote noise monitoring system, this could also be done by such techniques as electrostatic actuation, or insert voltage.

Regular calibration of, say, 300 noise monitors could be a real chore and cost for the operator, negating the cost advantage of the hardware. Perhaps other techniques could be used.

Again, NPL are working on this – by looking at the statistics of the measured data, e.g. $L_{A,50}$, it's possible to spot slow trends, indicating system calibration drift, or system failure (obviously wrong data). As the network is so widespread, all you need to do is flag or ignore the data until the monitor has been visited and fixed, just like a faulty light bulb in a street lamp, on the next maintenance round. You could also put in a couple of regular expensive noise monitors to provide a sanity check to the data.

This is a great example of doing things differently, rather than just doing the same but more cheaply.

Summing up

The idea of this article was to be thought-provoking, as we move to an even more connected world. Of course, all the traditional players are watching with interest – is this the end of the sound level meter? How will we pay the mortgage in five years' time?

Of course, the "legal" metrology will continue, with the associated costs, standards and procedures and will undoubtedly feed future meetings of the M&I Group.

But noise (and other pollutant) monitoring over wide areas will become widespread, perhaps with completely different technologies and methodologies. Exciting times indeed!

John Shelton MIOA *is with AcSoft, GRAS UK and Svantek UK, and is the chairman of the IOA Measurement and Instrumentation Group.*

Are people suffering as a result of ultrasound in the air?

New research from the University of Southampton indicates that the public are being exposed, without their knowledge, to airborne ultrasound.

The study found increasing exposure to ultrasound in locations such as railway stations, museums, libraries, schools and sports stadiums, in which there have been complaints of nausea, dizziness, migraine, fatigue and tinnitus.

Ultrasound in public places can be generated from a number of sources including loudspeakers, door sensors and public address systems.

For a number of years, workers who have been regularly exposed to occupational ultrasound through industrial devices for cleaning and drilling have reported similar negative effects.

While there has been insufficient research to confirm or deny a link, the study author Professor Tim Leighton says that current guidelines and research knowledge for occupational safe levels are inadequate to cope with the current mass exposure of large numbers of people.

Professor Leighton, from the University's Institute of Sound and Vibration Research, said: "Existing guidelines are insufficient for such large public exposures as the vast majority refer to occupational exposure, where workers are aware of the exposure, can be monitored and can wear protection. Furthermore, the guidelines are based on the average response of small groups, often of adult males.

"The guidelines are also based on an insufficient evidence base, most of which was collected over 40 years ago by researchers who considered it insufficient to finalise guidelines, but which produced preliminary guidelines. This warning of inadequacy was lost as regulatory bodies and organisations issued 'new' guidelines based on these early guidelines, and through such repetition generated a false impression of consensus."

Using smart phones and tablets equipped with an app that produced a spectrogram of the microphone reading, Professor Leighton collected readings of very high frequency/ultrasonic fields (VHF/US) fields in a number of public buildings, at a time when they were occupied by hundreds of people. The findings were then calibrated with two or three independent microphone and audio data systems.

Professor Leighton found that members of the public were exposed to VHF/US levels over 20 kHz, which is the threshold of the current guidelines. He is now calling for further research and the production of a new set of guidelines based on this research.

"Individuals who are unlikely to be aware of such exposures are complaining, for themselves and their children, of a number of negative conditions. Recent data suggests that one in 20 people aged 40-49 years have hearing thresholds that are at least 20 decibels (dB) more sensitive at 20 kHZ than that of the average 30-39 year old. Moreover, five per cent of the five to 19 year age group is reported to have a 20 kHz threshold that is 60 dB more sensitive than the median for the 30-39 year age group," he said.

"The lack of research means that it is not possible to prove or disprove the public health risk or discomfort. However, it is important that sufferers are able to identify the true cause of their symptoms, whether they result from VHF/US exposure or not."

Guidelines suggested by Professor Leighton include:

- No new guidelines must be based primarily on selection of levels quoted in older guidelines.
- Guidelines for occupational exposure must not be applied to public or residential exposure, and recognition must be given to exposure of long-term 'guests' (in schools, hospitals, prisons, public transport for example).
- Studies and new guidelines must take account of the deviation from the average of individuals within a population, and within particular demographic subsets within the population.
- Research is required to ensure that guidelines properly account for the selection of those adverse effects that should be minimised or prevented.
- Research must be undertaken to assess whether current audiological practices, equipment and standards are suitable for the VHF and ultrasonic regimes, and identify measures to rectify any shortcomings.
- A current survey of modern devices and their source levels (using international standard procedures and calibrations traceable back to primary standards) should be undertaken.

A full list of the guidelines and research recommendations can be found in the study, which is published in the journal *Proceedings of the Royal Society A*.

Tim Leighton (right) collecting ultrasound data from a door sensor

First new class of sound wave in more than 50 years could lead to revolution in stem cell therapy

Acoustics experts have created a new class of sound wave – the first in more than half a century – in a breakthrough they hope could lead to a revolution in stem cell therapy.

The team at RMIT University in Melbourne, Australia, combined two different types of acoustic sound waves called bulk waves and surface waves to create a new hybrid: "surface reflected bulk waves".

The first new class of sound wave discovered in decades, the powerful waves are gentle enough to use in biomedical devices to manipulate highly fragile stem cells without causing damage or affecting their integrity, opening new possibilities in stem cell treatment.

Dr Amgad Rezk, from RMIT's Micro/Nano Research Laboratory, said the team was already using the discovery to dramatically improve the efficiency of an innovative new "nebuliser" that could deliver vaccines and other drugs directly to the lung.

"We have used the new sound waves to slash the time required for inhaling vaccines through the nebuliser device, from 30 minutes to as little as 30 seconds," said Dr Rezk.

"But our work also opens up the possibility of using stem cells more efficiently for treating lung disease, enabling us to nebulise stem cells straight into a specific site within the lung to repair damaged tissue.

"This is a real game changer for stem cell treatment in the lungs."

The researchers are using the "surface reflected bulk waves" in a breakthrough device, dubbed HYDRA, which converts electricity passing through a piezoelectric chip into mechanical vibration, or sound waves, which in turn break liquid into a spray.

"It's basically 'yelling' at the liquid so it vibrates, breaking it down into vapour," said Dr Rezk.

Bulk sound waves operate similar to a carpet being held at one end and shaken, resulting in the whole substrate vibrating as one entity.


Dr Amgad Rezk

Surface sound waves on the other hand operate more like ocean waves rolling above a swimmer's head.

"The combination of surface and bulk wave means they work in harmony and produce a much more powerful wave," said Rezk, who co-authored the study with PhD researcher James Tan.

"As a result, instead of administering or nebulising medicine at around 0.2ml per minute, we did up to 5ml per minute. That's a huge difference."

The breakthrough HYDRA device is improving the effectiveness of a revolutionary new type of nebuliser developed at RMIT called Respite. Cheap, lightweight and portable, the advanced Respite nebuliser can deliver everything from precise drug doses to patients with asthma and cystic fibrosis, to insulin for diabetes patients, and needle-free vaccinations to infants.

The HYDRA research has been published in the scientific journal *Advanced Materials*.

Mains hum helps forensic scientists authenticate digital recordings

By Philip Harrison

As audio recording technology has changed from analogue to digital, forensic scientists have had to adapt their analysis methods and develop new techniques for determining the authenticity of digital audio recordings. One technique which has proved to be of great value is known as Electric Network Frequency (ENF) analysis. The approach compares and matches small fluctuations in the frequency of low amplitude mains electricity interference – often referred to as 'mains hum' – in evidential recordings with historic reference databases of mains frequency variation. The technique is used to establish the time and date that recordings were made as well as helping to demonstrate whether they are continuous or have been edited.

The approach relies on two fundamental properties of mains electricity power grids. Firstly, the frequency of AC mains electricity is not fixed, but varies unpredictably by a small amount around a nominal frequency, which is 50 Hz in the majority of the world and 60 Hz in America. The frequency variation is a consequence of the continual change in demand on the grid, which must be managed by balancing it with the amount of power supplied by generators. As demand on the grid increases then the frequency reduces and as demand decreases so the frequency rises. The acceptable range of resulting variation is typically +- 0.2 Hz. Crucially, over a period greater than a few minutes, the pattern of frequency variation can be considered as unique to that period of time.

The second important property of grids is that the generators are synchronised, which results in the frequency of the electricity being the same across the entire grid. This means that a single continuous log of frequency variation is all this is required for the entire geographic area of a grid. Mainland Britain operates on a single grid which is separate from the Irish gird and the majority of continental Europe is part of the world's largest single grid, which covers over 20 countries.

To use the technique with an evidential audio recording, it must contain induced mains interference. Although not all recordings contain it, a significant proportion that are submitted for analysis do, and they include those made on police surveillance equipment, telephone call loggers, mobile phones and portable digital recorders. Using a recording device in the proximity of mains wiring and mains powered devices is often sufficient for the interference to be induced and recorded, often at a level which is inaudible.

The examination process involves spectral analysis of the evidential recording to ensure that interference is present. If it is, the frequency of the interference is usually measured at 1 second intervals over the duration of the recording. The measured frequency values are then automatically compared with a reference database in an attempt to find a match in the patterns. This method allows automated searches over long time periods and also provides a statistical basis on which a

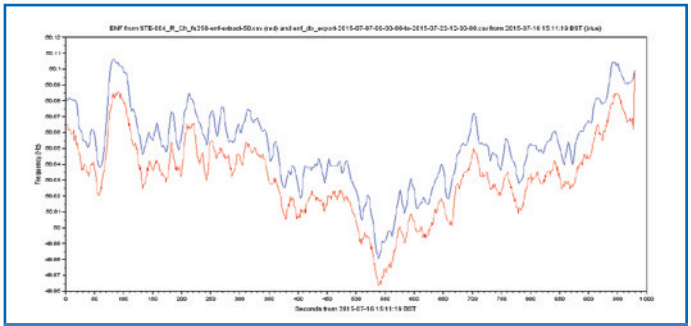
match can be confirmed.

Locating a match within the reference database provides the time and date that the evidential recording was made. If the pattern of variation matches over the entire duration of the recording then this provides a very strong indication that the recording is continuous, i.e. it has not been edited. If a recording has been edited, for example by removing or inserting material, then there will be sections of the recording where the ENF pattern does not match the reference database. It may also be possible to determine the time and date that any inserted material was recorded.

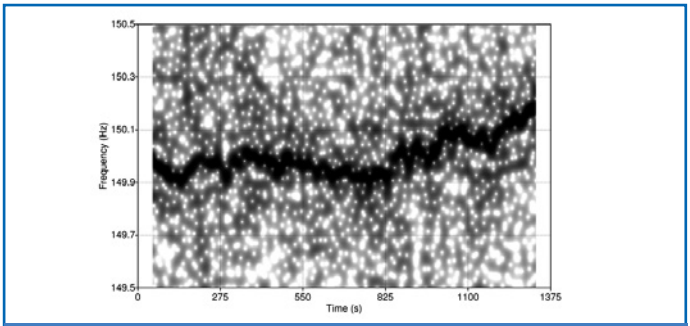
The technique of ENF analysis was first developed in the late 1990s by Catalin Grigoras, a Romanian forensic audio and video expert who now works in the USA. Since then its use has spread worldwide with the Metropolitan Police Audio Laboratory in London and J P French Associates in York applying the technique in the UK. Both have reference databases resulting from 24/7 logging of the ENF over many years. It has been used in many criminal cases to both demonstrate the integrity of recordings and determine the time and date that they were made. In one case, the internal clock on a police surveillance recorder had not been set correctly and the metadata of the recordings suggested that they had been made before the police had the legal authority to do so. However, ENF analysis showed that they had in fact been lawfully made at the time claimed by the police and the integrity of the recordings was not challenged.

Recent research has demonstrated that ENF information can also be extracted from video footage based on changes in the intensity of light caused by the flickering of fluorescent lights. Another interesting development is the potential to narrow down the geographic region within a grid that a recording was made. Changes in the frequency of the grid take a short amount of time to propagate and this is reflected in very small differences in geographically separated reference databases. Comparing extracted ENF data with a number of such reference databases can reveal which geographic region it is most similar to and therefore within which region of the grid the recording was most likely to have been made.

Dr Philip Harrison MIOA *is a forensic speech and audio expert at J P French Associates, where he undertakes enhancement, transcription, authentication and analysis of audio recordings. He is also involved in research within the field and is a Research Fellow at the University of York.*



R Ch Trace – A match between the ENF extracted from an evidential recording (red) and the reference database (blue).



ENF Spectro – A spectrogram showing the ENF interference in a recording at a harmonic of 50 Hz.

Health of more than one million UK people 'at risk from aircraft noise'


Aircraft noise puts people's health at risk

The Government's aircraft noise policies are risking the health of more one million people and an urgent policy rethink is needed ahead of upcoming decisions in 2016, says the Aviation Environment Federation.

In a new report, entitled *Aircraft Noise and Public Health: the evidence is loud and clear*, it states that aircraft noise can no longer be considered simply as an inconvenience to people's lives. Major studies have concluded that aircraft noise is negatively affecting people's health and quality of life.

Exposure to aircraft noise can lead to short-term responses such as sleep disturbance, annoyance, and impairment of learning in children, and long-term exposure is associated with increased risk of high blood pressure, heart disease, heart attack, stroke, dementia, and may contribute to long-term mental health issues.

In the UK, more than one million people are exposed to aircraft noise above levels recommended for the protection of health, estimated in the report to cost £540 million each year.

Around 460 schools are exposed to aircraft noise at levels around Heathrow that can impede memory and learning in children while around 600,000 people in the UK are exposed to average aircraft noise levels that risk regular sleep disturbance.

Aircraft noise policy has not, however, been updated in line with this mounting evidence base, with some noise policies based on studies dating back to the early 1980s.

The health burden is not just experienced close to airports. The current policy on flight path changes, for example, does not consider the evidence that sudden changes to aircraft noise exposure are likely to lead to much greater disruption for communities which has implications for health.

The report calls for the Government to act now and commit to developing targets to protect the public from the health impacts of aircraft noise and to review all policies in light of these targets. The report also calls for any future aviation policy decisions to assess the impact from aircraft noise on health.

Loud noise during pregnancy 'can damage children's hearing'


Pregnant women should avoid loud noises

A new study shows that exposure to noise during pregnancy can damage the child's hearing, with an 80 percent increase in risk in occupational environments with particularly high decibel levels.

The results of the research by the Institute of Environmental Medicine (IMM) at Karolinska Institutet in Sweden strongly indicate that pregnant women should not be exposed to loud noise.

Whereas it was previously assumed that foetuses were well insulated from external noise, several studies have shown that noise, especially low-frequency noise, is physically conducted to the foetus. A link between noise exposure during pregnancy and hearing impairment is also corroborated by animal experiments. All in all, the available evidence shows that women should not be exposed to high levels of noise during pregnancy.

"The Swedish Work Environment Authority recommendation is that pregnant women should avoid noise levels of over 80 dBA, but unfortunately this recommendation is not always followed," said Jenny Selander, researcher at the IMM. "Our study shows how imperative it is for employers to observe this recommendation. Even if pregnant women themselves use ear protectors in noisy environments, the babies they're carrying remain unprotected."

The study, published in the journal *Environmental Health Perspectives*, comprised more than 1.4 million children born in Sweden between 1986 and 2008, and sourced its data on the mothers, such as occupation, smoking habits and presence at work during pregnancy, from the National Board of Health and Welfare's medical birth register and national central registers kept by Statistics Sweden and Försäkringskassan (the Swedish Social Insurance Agency). Occupation data were used to code exposure to noise at work during pregnancy into three classes: low (< 75 dBA); medium (75-84 dBA) and high (≥85 dBA). Data on hearing dysfunction (sensorineural hearing loss or tinnitus) were taken from the National Board of Health and Welfare's patient registry, which is based on diagnoses made by specialists.

Some 290,000 mothers had worked in occupations with medium noise exposure while pregnant, and another 6,000 in occupations with high noise exposure. Hearing dysfunctions serious enough to warrant specialist examination was present in approximately 1 per cent of the children. For the women who had worked in high-level noise environments (over 85 dBA), the risk of hearing dysfunction in their children was 80 percent higher than for the women who had worked in low-exposure environments.

This increase was statistically significant and adjusted for differences in smoking habits, age, bodyweight, level of education, nationality, and the birth year, sex and birth order of the children. Amongst part-time workers in high-exposure environments, the researchers found a 25 per cent increase in risk that was not statistically significant. In the medium-exposure group, there was no statistically significant increase in the number of hearing-dysfunction diagnoses, but the possibility of a higher risk there as well cannot be ruled out. The results will be incorporated into the advice given to pregnant women and in the information we distribute to midwives at maternity clinics.

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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

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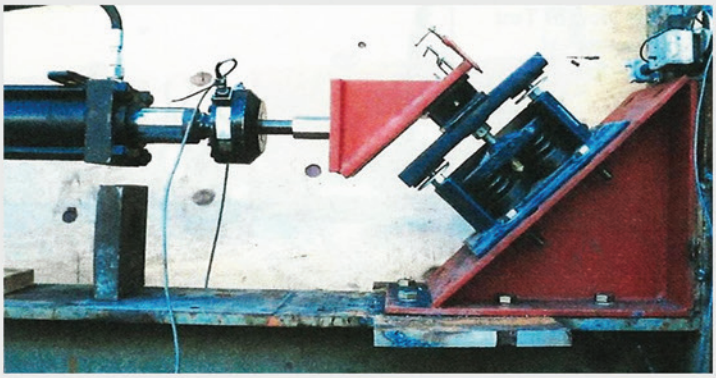

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Trapping microbubbles with lasers and sound

The National Physical Laboratory (NPL) has worked with University College London (UCL) and the University of Oxford to develop an innovative system that can trap microbubbles. This enables scientists to study the bubbles' properties and develop safer, more effective medical products.

Microbubbles are gas bubbles that are smaller than 1%#160;mm in size ¬– their radius is typically between 1 and 10 microns for medical applications. In the past 10 years, the use of microbubbles to enhance contrast in ultrasound images has become an everyday practice in hospitals in UK and across the world. Microbubbles now sit at the forefront of techniques used for the diagnosis of heart diseases and certain types of cancer.

New technological advances, and recent successes in treatment have shown that the addition of certain molecules to the shell of these bubbles could make them ideal vehicles for targeted medicine delivery and microsurgery.

As the potential applications increase, it becomes more important to characterise how microbubbles interact with sound and how different manufacturing techniques impact on their performance. Information about the microbubble properties can be used to engineer bubbles for specific medical uses, and in a more cost-effective way.

Scientists from NPL have worked with UCL and the University of Oxford to develop a controlled setting in which to study microbubbles. The unique device, which was designed and constructed at NPL, traps the microbubbles using optical tweezers in combination with acoustic tweezers, which control the movement of objects using sound waves.

While these two techniques are commonly used for solid particles, they both present challenges when used with bubbles. Optical tweezers, for instance, are often used to trap and study biological samples using highly-focused laser beams to hold and move items. However, objects with a low refractive index, such as microbubbles, are difficult to optically trap due to strong repulsive forces experienced in proximity to high intensity light.

Bubbles also present a peculiar response to acoustical tweezing, behaving in different ways depending on the selected manipulation frequency. If the acoustic field is higher than the bubbles natural frequency they will move to where the field is strongest in pressure, but if the field is lower than the natural frequency the bubbles will collect at the weakest point.

This method will allow researchers to perform characterization at the single bubble level and support the development of medical microbubbles. Fully characterised bubbles may even act as standalone sensors, for stratified medicine purposes.

New metamaterial manipulates sound to improve acoustic imaging

Researchers in the US have developed a metamaterial made of paper and aluminium that can manipulate acoustic waves to more than double the resolution of acoustic imaging, focus acoustic waves, and control the angles at which sound passes through the metamaterial.

"This metamaterial is something that we've known is theoretically possible, but no one had actually made it before," said Yun Jing, an Assistant Professor of mechanical and aerospace engineering at North Carolina State University and corresponding author of a paper describing the work.

Metamaterials are materials that have been engineered to exhibit properties that are not found in nature. In this case, the structural design of the metamaterial gives it qualities that make it a "hyperbolic" metamaterial. This means that it interacts with acoustic waves in two different ways. From one direction, the metamaterial exhibits a positive density and interacts with acoustic waves normally – just like air. But from a perpendicular direction, the metamaterial exhibits a negative density in terms of how it interacts with sound. This effectively makes acoustic waves bend at angles that are the exact opposite of what basic physics would tell you to expect.

Among the useful applications for metamaterials is the improvement of acoustic imaging. Traditionally, acoustic imaging could not achieve image resolution that was smaller than half of a sound's wavelength. For example, an acoustic wave of 100 kilohertz (kHz), travelling through air, has a wavelength of 3.4 millimetres (mm) – so it could not achieve image resolution smaller than 1.7 mm.

"But our metamaterial improves on that," said Chen Shen, a PhD student at NC State and lead author of the paper. "By placing the metamaterial between the imaging device and the object being imaged, we were able to more than double the resolution of the acoustic imaging – from one-half the sound's wavelength to greater than one-fifth."

The metamaterial can also focus acoustic waves, which makes it a flexible tool.

"Medical personnel and structural engineers sometimes need to focus sound for imaging or therapeutic purposes," said Professor Jing. "Our metamaterial can do that, or it can be used to improve resolution. There are few tools out there that can do both."

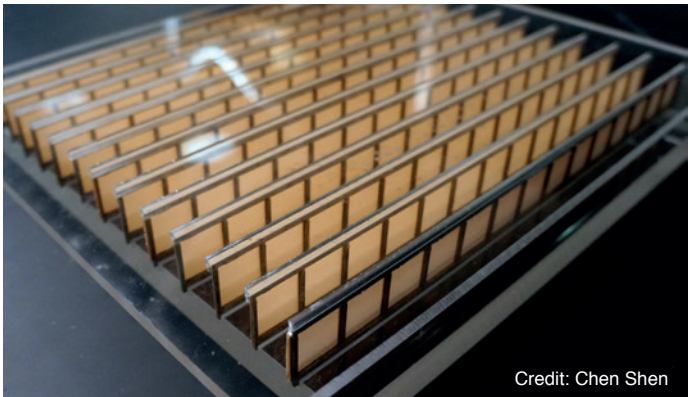
Lastly, the metamaterial gives researchers more control over the angle at which acoustic waves can pass through it.

"For example, the metamaterial could be designed to block sound from most angles, leaving only a small opening for sound to pass through, which might be useful for microphones," Mr Shen said. "Or you could leave it wide open – it's extremely flexible."

The prototype metamaterial is approximately 30 centimetres square, and is effective for sounds between 1 and 2.5 kHz.

"Our next steps are to make the structure much smaller, and to make it operate at higher frequencies," said Professor Jing .

The paper, *Broadband Acoustic Hyperbolic Metamaterial*, was published in *Physical Review Letters*. It was co-authored by Ni Sui of NC State and Yangbo Xie, Wenqi Wang and Steven Cummer of Duke University.



The metamaterial is made of paper and aluminium but its structure allows it to manipulate acoustic waves in several ways.

Software adapts speech to surrounding noise levels

German scientists have devised an audio system which promises to significantly improve the audibility and comprehension of spoken messages – for notifications in busy train stations, speakers in lectures, or even mobile phone conversations on a noisy road for example.

The Hearing, Speech and Audio Technology Group based at the Fraunhofer Institute for Digital Media Technology (IDMT) has developed the specialised software, ADAPT DRC, which is able to continuously analyse ambient noise levels via a microphone, and adjusts the speech in real-time.

"It is not enough to simply make the voice louder over the loud-speaker or mobile phone to drown out the noise," said team lead Dr Jan Rennies-Hochmuth. Such technologies were already used today in car radios, making the voice louder, but not necessarily more easily understood, because, at high volumes, the speakers reach their limits and start to rattle. "Speech is much more complex," he explained.

An announcement detailing the research described the importance of pitch and frequency to target the listener effectively. While vowels are generally spoken at lower pitches, and are "drawn out" and easy to understand, consonants are snappy with higher frequencies and are therefore harder to understand in a noisy environment.

To tackle the audibility challenges, the researchers designed algorithms which prioritise certain frequencies and place emphasis, at the right time, on parts of speech which would typically be problem areas for listeners in busy settings.

The software is also able to modify parts of a message which are spoken at different volumes. As speech contains both loud and softer sections – termed voice dynamics – the technology can subdue louder parts while amplifying quieter parts. The process is known as Dynamic Range Compression (DRC)

The DRC system has already been developed and tested, achieving application maturity and has been made available to industrial partners. The team has argued that as phones and other loud speaker equipment already possess in-built microphone technology, the system could be easily applied to many existing setups without additional installation costs.

Announcements at busy rail stations are often incomprehensible

Researchers achieve total acoustics absorption in low frequency ranges

Researchers at the French National Centre for Scientific Research (CNRS) and the University of Lorraine have recently developed a design for a coiled-up acoustic metasurface which can achieve total acoustic absorption in very low-frequency ranges.

"The main advantage is the deep-subwavelength thickness of our absorber, which means that we can deal with very low-frequencies – meaning very large wavelengths – with extremely reduced size structure," said Badreddine Assouar, a principal research scientist at CNRS in Nancy, France. The work is described in *Applied Physics Letters*.

Acoustic absorption systems work by absorbing sound energy at a resonant frequency and dissipating it into heat. Traditional acoustic absorbers consist of specially perforated plates placed in front of hard objects to form air cavities; however, in order to operate at low frequencies, these systems must also be relatively thick in length, which makes them physically impractical for most applications.

To remedy this, Mr Assouar's group, whose previous work consisted of developing coiled channel systems, designed an acoustic absorber in which sound waves enter an internal coiled air channel through a perforated centre hole. This forces the acoustic waves to travel through the channel, effectively increasing the total propagation length of the waves and leading to an effective low sound velocity and high acoustic refractive index. This allows them to make the absorber itself relatively thin, while still maintaining the absorptive properties of a much thicker chamber.

This is made possible because the coiled chamber's acoustic reactance – a property analogous to electrical reactance, a circuit's opposition to a change in voltage or current – compensates for the reactance of the perforated hole and allows for impedance matching to be achieved. This causes all of the acoustic energy to be transferred to the chamber, rather than reflected, and to be ultimately absorbed within the perforated hole.

Further applications of such metasurface may deal with the realization of tunable amplitude and phase profile for acoustic engineering, which would allow for the manipulation of an acoustic wave's propagation trajectory for special applications, such as manipulating particles with a vortex wavefront. Future work for Mr Assouar and his group will include developing the sample fabrication process with 3D printing and subsequent performance analyses.

Cutting the top speed of HS2 trains 'will significantly reduce noise nuisance'

Cutting the top speed of trains on the HS2 rail scheme by 60 kilometres an hour will substantially reduce the noise nuisance, say consultants Sharps Acoustics.

In a report presented to MPs, they state that reducing the speed from 360 to 300kph – the top speed of French TGVs and German and Japanese high speed trains – would cut noise levels at 25 metres from the line from 83 to 77 dB.

This would be "substantially beneficial". Even a 3 dB reduction, which would be achieved by trains travelling at 330 kph, would be "significant" and would have a "significant positive impact".

Sharps also concluded that further noise reductions could result from better screening where aerodynamic noise was less influential.

Their findings were part of a report prepared for the HS2 Action Alliance protest group which was presented to the House of Commons Hybrid Select Committee reviewing the project.

The report also included studies from other consultants on air quality and other environmental impacts.

Artificial 'trees' will convert wind-induced vibration into renewable power

New tools for harvesting wind energy may soon look less like giant windmills and more like tiny leafless trees.

A project at the Ohio State University in the US is testing whether high-tech objects that look a bit like artificial trees can generate renewable power when they are shaken by the wind—or by the sway of a tall building, traffic on a bridge or even seismic activity.

In a recent issue of the *Journal of Sound and Vibration*, researchers report that they've uncovered something new about the vibrations that pass through tree-shaped objects when they are shaken.

Specifically, they've demonstrated that tree-like structures made with electromechanical materials can convert random forces, such as winds or footfalls on a bridge, into strong structural vibrations that are ideal for generating electricity.

The idea may conjure images of fields full of mechanical trees swaying in the breeze. But the technology may prove most valuable when applied on a small scale, in situations where other renewable energy sources such as solar are not an option, said project leader Ryan Harne, assistant professor of mechanical and aerospace engineering at Ohio State, and director of the Laboratory of Sound and Vibration Research.

The "trees" themselves would be very simple structures: think of a trunk with a few branches – no leaves required.

Early applications would include powering the sensors that monitor the structural integrity and health of civil infrastructure, such as buildings and bridges. Professor Harne envisions tiny trees feeding voltages to a sensor on the underside of a bridge, or on a girder deep inside a high-rise building.

The project takes advantage of the plentiful vibrational energy that surrounds us every day, he said. Some sources are wind-induced structural motions, seismic activity and human activity.

"Buildings sway ever so slightly in the wind, bridges oscillate when we drive on them and car suspensions absorb bumps in the road," he said. "In fact, there's a massive amount of kinetic energy associated with those motions that is otherwise lost. We want to recover and recycle some of that energy."

Sensors monitor the soundness of a structure by detecting the vibrations that pass through it, he explained. The initial aim of the project is to turn those vibrations into electricity, so that structural monitoring systems could actually be powered by the same vibrations they are monitoring.

Today, the only way to power most structural sensors is to use batteries or plug the sensors directly into power lines, both of which are expensive and hard to manage for sensors planted in remote locations. If sensors could capture vibrational energy, they could acquire and wirelessly transmit their data in a truly self-sufficient way.

At first, the idea of using tree-like devices to capture wind or vibration energies may seem straightforward, because real trees obviously dissipate energy when they sway. And other research groups have tested the effectiveness of similar tree structures using idealized, that is, not random, vibrations.

But until now, researchers haven't made a concerted effort to capture realistic ambient vibrations with a tree-shaped electromechanical device, mainly because it was assumed that random forces of nature wouldn't be very suitable for generating the consistent oscillations that yield useful electrical energies.

First, through mathematical modelling, Professor Harne determined that it is possible for tree-like structures to maintain vibrations at a consistent frequency despite large, random inputs, so that the energy can be effectively captured and stored via power circuitry. The phenomenon is called internal resonance, and it is how certain mechanical systems dissipate internal energies.

In particular, he determined that he could exploit internal resonance to coax an electromechanical tree to vibrate with large amplitudes at a consistent low frequency, even when the tree was experiencing only high frequency forces. It even worked when these forces were significantly overwhelmed by extra random noise, as natural ambient vibrations would be in many environments.

He and his colleagues tested the mathematical model in an experiment, where they built a tree-like device out of two small steel beams – one a tree "trunk" and the other a "branch" – connected by a strip of an electromechanical material, polyvinylidene fluoride (PVDF), to convert the structural oscillations into electrical energy.

They installed the model tree on a device that shook it back and forth at high frequencies. At first, to the eye, the tree didn't seem to move because the device oscillated with only small amplitudes at a high frequency. Regardless, the PVDF produced a small voltage from the motion: about 0.8 volts.

Then they added noise to the system, as if the tree were being randomly nudged slightly more one way or the other. That's when the tree began displaying what Professor Harne called "saturation phenomena": It reached a tipping point where the high frequency energy was suddenly channelled into a low frequency oscillation. At this point, the tree swayed noticeably back and forth, with the trunk and branch vibrating in sync. This low frequency motion produced more than double the voltage—around 2 volts.

Those are low voltages, but the experiment was a proof-of-concept: Random energies can produce vibrations that are useful for generating electricity.

"In addition, we introduced massive amounts of noise, and found that the saturation phenomenon is very robust, and the voltage output reliable. That wasn't known before," Professor Harne said.

Acoustic tweezers manipulate cells with sound waves

Engineers at MIT, Penn State University, and Carnegie Mellon University in the US have devised a way to manipulate cells in three dimensions using sound waves. These "acoustic tweezers" could make possible 3-D printing of cell structures for tissue engineering and other applications, the researchers say.

Designing tissue implants that can be used to treat human disease requires precisely recreating the natural tissue architecture, but so far it has proven difficult to develop a single method that can achieve that while keeping cells viable and functional.

"The results presented in this paper provide a unique pathway to manipulate biological cells accurately and in three dimensions, without the need for any invasive contact, tagging, or biochemical labelling," said Subra Suresh, president of Carnegie Mellon and former dean of engineering at MIT. "This approach could lead to new possibilities for research and applications in such areas as regenerative medicine, neuroscience, tissue engineering, bio-manufacturing, and cancer metastasis."

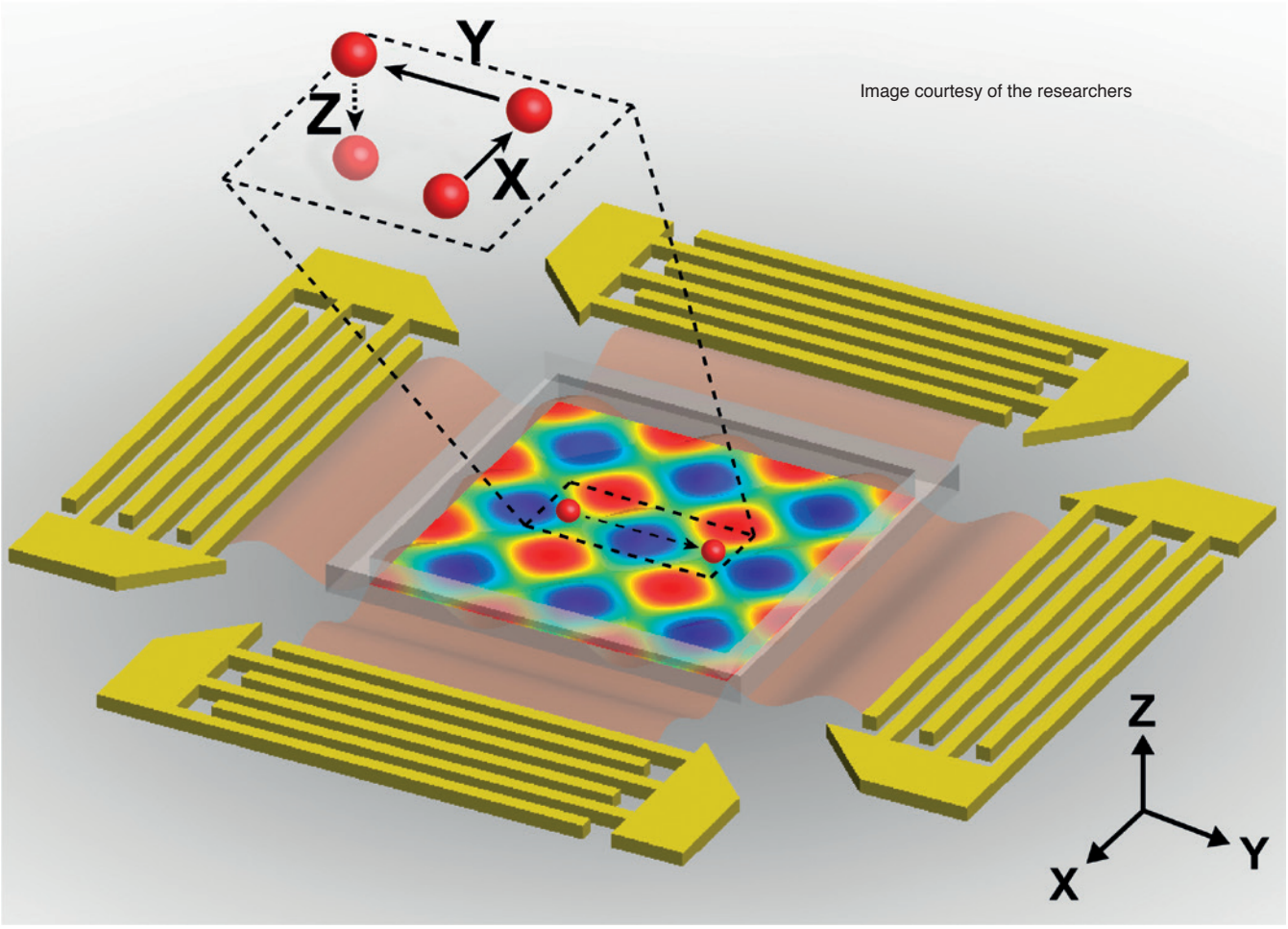
The new acoustic tweezers are based on a microfluidic device that the researchers previously developed to manipulate cells in two dimensions. This device produces two acoustic standing waves, which are waves with a constant height. Where the two waves meet, they create a "pressure node" that can trap single cells. By altering the wavelength and another wave property known as the phase, the researchers can move the node and the cell trapped within it.

The research team previously used a similar approach to separate cancer cells from healthy cells, which could be useful for detecting rare tumour cells in a patient's bloodstream and predicting whether the tumour will spread.

In the new study, the researchers added a third dimension of control: Once the cells are trapped in a horizontal plane, they can be moved up and down by altering the acoustic waves' power, that is, the rate at which sound energy is emitted. Boosting the power allows the researchers to lift the cells from the surface in a type of "acoustic levitation," then place them in a specific location, said Ming Dao, a principal research scientist in MIT's Department of Materials Science and Engineering.

The researchers also developed equations that allow them to accurately predict how changes in the wavelength, phase, and acoustic power will affect cells' positions.

"We now have a good idea of what to expect and how to control the 3-D positioning of the acoustic waves and the pressure nodes, enabling validation of the method as well as system optimization," Mr Dao said.



An illustration of the surface acoustic wave generators, with the generated 3-D trapping nodes.
The inset indicates a single particle within a 3-D trapping node, which can be manipulated independently along x, y or z axes

A comparison of the hearing acuity of classical musicians

By Dr Stephen Dance

Introduction

Performing artists must be able to practice, rehearse, and perform safely. With respect to hearing and the "noise" of performance however, the nature of their work and the dedication of performers themselves may mean that they are placed in a difficult position when complying with Control of Noise at Work Regulations 2005 (HSE, 2005) [1]. These regulations include a requirement for any employer to undertake hearing health surveillance for any employee at risk of high noise exposure. Being at the forefront of classical music education, the Royal Academy of Music decided to start the implementation of a health surveillance programme and to continuously collect data on the hearing acuity of their music students. This article presents the approach of the Royal Academy of Music on the issue of health surveillance for classical music students and discusses the findings of audiometric hearing tests conducted over eight years, 2007-2014, a total to date of 2,576 students. The collaboration between the Acoustics Group and the Royal Academy has a wider scope which includes education, dosimetry and the pursuit of innovative solutions and is reported elsewhere [2-4].

The approach

The Royal Academy of Music took an inclusive view whereby every new student had to compulsorily take an automated audiometric screening test during the first week of his or her studies at the Academy (Fresher's week). The testing closely followed the methodology outlined in the Control of Noise at Work Regulations. Students, prior to testing, attended a targeted one-hour hearing seminar, which amongst others, informed students on the purpose and procedure of the audiometric testing. To minimise the influence of any Temporary Threshold Shift (TTS), students were asked to avoid exposure to any loud noise a day before their testing and the use of smartphones while travelling to the test. One-to-one interviews with each student and an otoscopic examination were used to identify any factors, which may influence the health surveillance results.

The test was based on a pure-tone air conduction Bekesy test (frequencies 500 Hz to 8 kHz), using Amplivox automated screening audiometer with TDH49 audiocups. The test was conducted in the audiometric soundproof booths at the Acoustic Laboratory of London South Bank University (LSBU) in accordance to ISO 8253-1:2010 [5]. Once the test and questionnaire was completed, each audiogram was categorised according to the Health and Safety Executive (HSE) categorisation scheme (HSE, 2005), see Table 1. Students received a copy of their audiogram with the original being sent to the Academy for their records; the students improved on this system by taking a photograph of the audiogram. Results were discussed individually with each student and advice has been given on protection from noise exposure, including advice on most suitable hearing protection option based on lifestyle and instrument played. Each student is then given a pair of musician's earplugs, Happy Ears, www.happyears.se.

Results

As a result of the testing over the last eight years, a large audiometric database has been developed, holding more than 2,500 student audiograms. By categorising the audiometric according to HSE overall assessment criteria, a sum of 1, 2, 3, 4, 6 kHz hearing losses, 94% of the Academy students have what is considered to be good hearing, P44

Category	Calculation	HSE Criteria Male (dB)	HSE Criteria Female (dB)	Action
1 ACCEPTABLE HEARING ABILITY Hearing within normal limits	Sum of hearing levels at 1, 2, 3, 4 and 6 kHz.	<51	<46	None
2 MILD HEARING IMPAIRMENT Hearing within 20th percentile. May indicate developing NIHL.	Sum of hearing levels at 1, 2, 3, 4 and 6 kHz. Compare value with figures given for appropriate age band and sex.	>51	>46	Warning
3 POOR HEARING Hearing within 5th percentile. Suggests significant NIHL	Sum of hearing levels at 1, 2, 3, 4 and 6 kHz. Compare value with figures given for appropriate age band and sex.	>95	>78	Referral
4 RAPID HEARING LOSS Reduction in hearing level within 3yrs	Difference in the sum of hearing levels at 3,4, 6kHz.	>30	>30	Referral

Table 1: HSE categorisation scheme for 18-24 year olds.

P43

4.5% of students showed a mild hearing impairment (warning) and only 1.5% of students had poor hearing (referral level). Among the latter, most recorded referral cases were due to genetic hearing problems or accidents that occurred in the past and can't therefore be associated with noise induced hearing loss. For the general population, percentages for warning and referral levels are set at 20% and 5% respectively. This indicates that young musicians have excellent hearing, see figure 1. Please note that another reason behind the excellent hearing results recorded among music students may be the fact that with their well-trained ears and developed sensitivity to sound/changes in pitch, music students could simply be better at detecting pure tones than the general population of the same age. On the other hand, noise induced hearing loss has a dose-response relationship, and hence may take up to 20 years to become apparent. From the questionnaire data the students tend to have been playing for between 10 and 15 years depending on instrument.

Once all 2576 student summed hearing losses have been put in ranking order, rather than categorised, it can be seen that half of the students achieve a negative result, see figure 1, with the left ear slightly worse than the right ear result. For comparison the latest published research on the hearing acuity of young people [6] found significantly worse hearing acuity, see table 2. The populations were similar, 1432 young people in education, 11-35 years old. The difference was found to be approximately 25 dBHL at all population fractions, or 5 dB at each frequency.

Upon closer inspection of figure 1, figure 2 focuses on the students with the highest hearing acuity, approximately 10% of the population. It can be clearly seen that the left ear is less sensitive than the right ear. It can also be seen that a handful of students had hearing more sensitive than the audiometer could measure, -50 which equates to -10 dB per frequency and more importantly, from the audiogram (not shown), the students were not struggling to achieve this result.

Upon closer inspection of figure 1, figure 3 shows the students with the least hearing acuity, approximately 10% of the population. It can be clearly seen that that 40% (student 100) have a hearing acuity below the warning level, good hearing, and approximately 120 students have warning levels of hearing loss.

Figure 4 shows the hearing acuity of 1.4% of the population. It should be remembered that every student at the Academy has to pass a strenuous audition. A hearing acuity score of 450 would indicate a hearing loss of 90 dB per frequency, a level where cochlear implants would be recommended by the NHS. It can also been seen that the left ear tends to have a higher hearing acuity and music students tend to suffer from unilateral hearing loss, students 10 to 29. This could be a consequence of the asymmetry of musical instruments, see [7] for further results.

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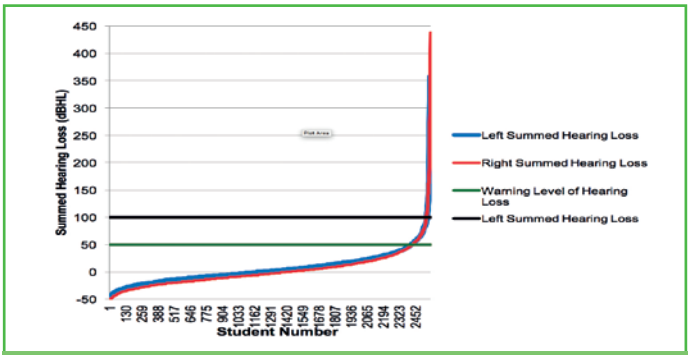

Figure 1. Summed hearing loss (dBHL) of 2576 music students in ranking order

Ranked Population fraction	Summed Hearing Loss for Young People in Education (dBHL)	Summed Hearing Loss for Classical Music Students (dBHL)
10%	0	-25
25%	10	-14
50%	25	-2
75%	50	15
90%	75	36

Table 2. Summed hearing loss of a fraction of the population for classical music students and young people, average of both ears.

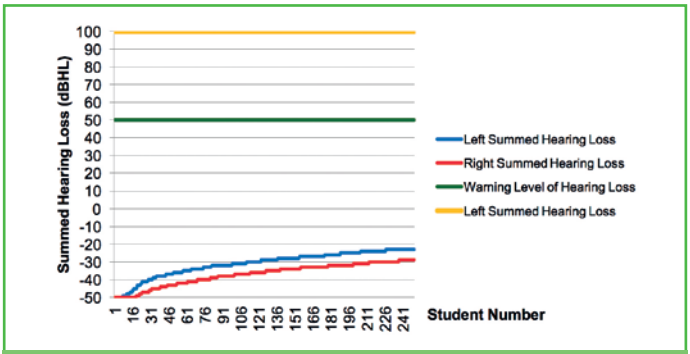

Figure 2 Summed hearing losses (dBHL) for the best 250 music students in ranking order

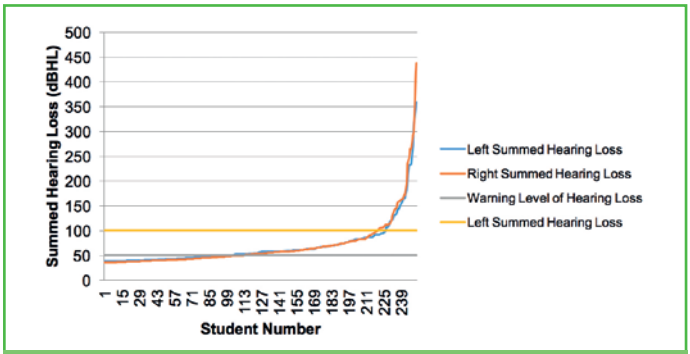

Figure 3 Summed hearing losses (dBHL) for the worst 250 music students in ranking order

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Results by instrument group

When analysing the averaged audiometric data for each type of instrument it became apparent that every result showed an increase in hearing loss (although at very low levels) at 6 kHz compared with the 4 kHz normally associated with noise induced heairng loss, see figure 5.

Figure 5 shows something interesting on the far left side of the graph, specifically for piano and piano accompanists (PA). By investigating the hearing of pianists and piano accompanists it is possible to study the effect of other music on musicians' hearing. The accompanists play for singers and hence are subjected to sound coming from their right hand side, where the vocalist always stands due to the design of the piano. The sound level produced by vocalists during practice is surprising high, typically $L_{Aeq,2}$ minutes of 85-110 dBA [8].

The effect of the high singing levels on the pianists can be clearly seen from figure 6. The left ear has very similar average hearing losses for 4 and 6 kHz and a 2 dB difference at 8 kHz, with the a 4 dB difference in the overall criteria. However, looking at the right ear there is now a 4 dB difference at 6 and 8 kHz and a 6 dB difference in the overall criteria. There was no difference at 4 kHz between the 302 pianists and the 70 piano accompanists. The difference can only be accounted for by the introduction of the vocalist. Hence, it appears that musicians can protect themselves from their own instrument, but not from another instrument.

Conclusions

Since 2007, the Royal Academy of Music has been following a management policy to assess the hearing acuity of the musicians at the start of their career. Results of more than 2,500 hearing tests revealed that music students have excellent hearing and less hearing problems than those of general population, despite their high sound exposure dose. Highest incidence of students with mild hearing impairment or poor hearing was found amongst composers. Finally, averaged hearing thresholds per frequency for each instrument group showed a significant threshold notch at 6 kHz for all instrument types. This clearly shows the effect of music is different from the effect of noise on hearing.

As a hypothesis: musicians have learnt to control their Stapedius Reflex, to protect themselves from their instrument's sound. The analysis of the hearing thresholds of pianists compared to piano accompanist indicated that there is evidence to suggest the validity of the hypothesis.

Acknowledgements

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Dr Stephen Dance *is a Reader in Acoustics in the Division of Civil and Building Services Engineering at London South Bank University. He obtained a BSc in Computer Science at the University of London, before studying for a PhD on non-diffuse fitted enclosed spaces. He was an EPSRC Research Fellow for six year before being appointed at senior lecturer in 2003, since when he has been active in teaching, research and consultancy in environmental and architectural acoustics. He is the course director for the MSc in Environmental and Architectural Acoustics and is responsible for the Institute of Acoustics Diploma.*

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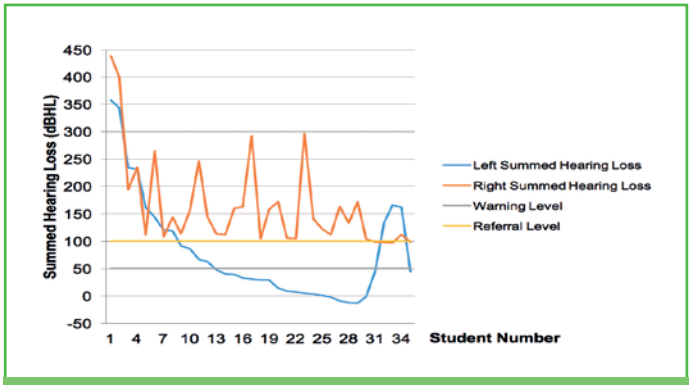

Figure 4 Summed hearing losses (dBHL) of individual music students in ranking order

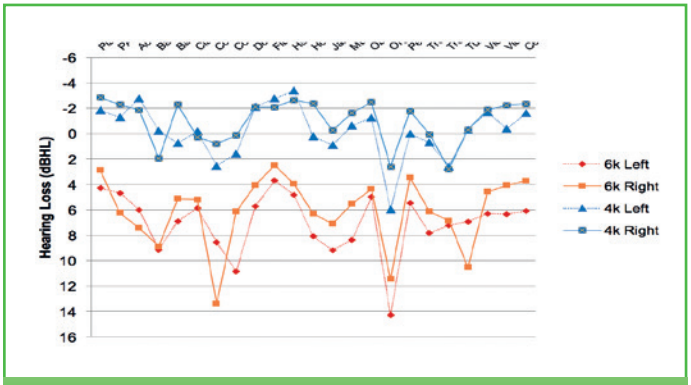

Figure 5 Left and right ear average hearing thresholds for 4 and 6 kHz for 2006 musicians

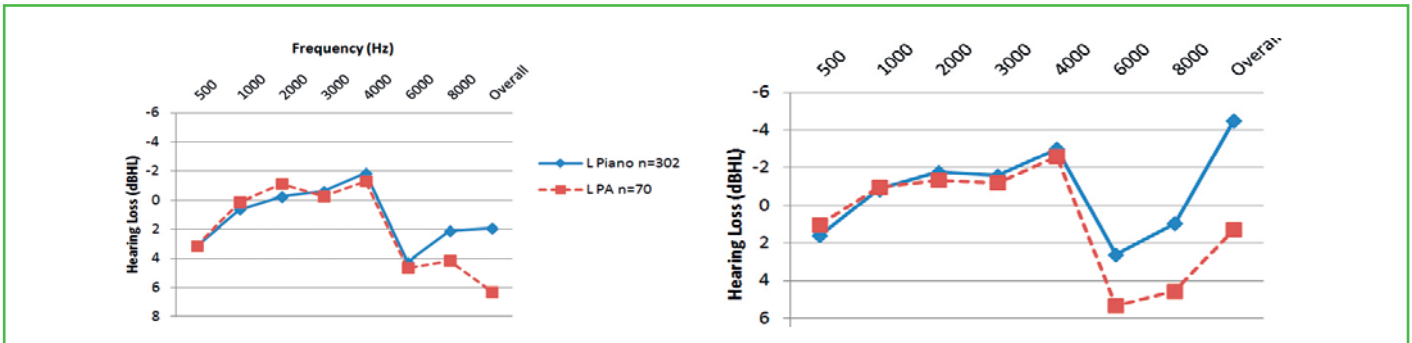

Figure 6: Left and right ear averaged hearing thresholds for pianist and piano accompanists

Planning conditions for noise

By Toby Lewis Associate, WSP Parsons Brinckerhoff

Introduction

This paper explores the recent changes to the national planning system, its relationship with local policies, and the implications of both on the lawfulness of planning conditions relating to environmental noise.

Planning policy

The national planning system has undergone radical changes since 2012, commencing with the introduction of the National Planning Policy Framework[1] (NPPF) in March 2012. The NPPF was produced by the coalition Government, as part of the effort to reduce red tape and facilitate development, and replaced a plethora of Planning Policy Guidance Notes and Statements with a single fifty nine page document containing a single paragraph on noise.

Although the NPPF explicitly references the explanatory note contained in the Noise Policy Statement for England 2010[2] (NPSE), produced by the previous Government, its policy aims include a significant difference. The aims to avoid and mitigate 'significant adverse' and 'other adverse' noise impacts respectively are identical, but whilst the NPSE includes the aim of "*where possible, contribute to the improvement of health and quality of life*"[3], this aim is not reiterated in the NPPF. Two new aims are introduced, however, the first of which is to "*recognise that business will often create some noise and existing businesses wanting to develop in continuance of their business should not have unreasonable restrictions put on them because of changes in nearby land uses since they were established*"[4].

Whilst the NPSE remains Government policy, this change of emphasis does represent a policy shift and signals a Government expectation of greater tolerance to existing or proposed commercial noise sources generally as well as a more cautious approach to permitting noise sensitive development close to existing commercial premises.

The first two aims common to both policy documents, of avoiding "significant adverse" and minimising "other adverse" impacts, initially provoked some bewilderment amongst practitioners as to how such vague concepts could be applied in practice. There was unquestionably a paucity of guidance at that time, resulting in frequently argued interpretations from an industry accustomed to the relative simplicity of noise exposure categories[5] and the long established British Standards BS 8233:1999[6] and B S4142:1997[7].

The online suite of forty seven Planning Practice Guidance (PPG) documents which followed (leading many to question the original stated intention of Government replace "*over a thousand pages of policy with around fifty*"[8]) fleshed out many of the concepts in the NPPF, and the guidance on noise included an entirely subjective matrix[9] of example outcomes illustrating how 'significant adverse' and 'other adverse' noise impacts might be interpreted. The subjective nature of the matrix does not translate conveniently into any sort of objective scale and clearly needs to be considered on a case by case basis.

LPAs quite rightly determine planning applications in accordance with their development plans. An unfortunate feature of Local Plans, however, is their tendency to be out of date even before they are adopted, which results from the painfully slow plan development, consultation and approval process. This is of paramount importance when interpreting local policies for a number of reasons specified in the NPPF and PPG.

The NPPF includes a "*presumption in favour of sustainable*

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development that is the basis for every plan, and every decision"[10]. This is a very clear direction which may conflict with the application of existing local policies in development control decisions and will influence the eventual replacement of those policies.

To clarify this point, the PPG says "*Where the development plan is absent, silent or the relevant policies are out of date [the NPPF] requires the application to be determined in accordance with the presumption in favour of sustainable development unless otherwise specified*"[11].

Also, "*The NPPF represents up-to-date Government policy and must be taken into account where it is relevant to a planning application or appeal. If decision takers choose not to follow the NPPF, clear and convincing reasons for doing so are needed*"[12].

So LPAs are obliged to follow the NPPF unless they have up-to-date local policies that would justify a departure and, even then, the NPPF has 'material consideration' status. Where local policies conflict with one another, considerations shall be "*guided by the NPPF*"[13]. Where local noise policies are dated, absent or in conflict, as is often the case, it appears that national noise policy must take precedence.

Some local politicians may resent what they perceive as heavy handed interference with their local policies and priorities by central government, leading to reticence or resistance in prioritising national policies over their own.

This dynamic between national and local policy in decision making is an important backdrop to any consideration of planning conditions because legitimate policy objectives form an essential justification for lawful planning conditions.

Planning conditions

The Town and Country Planning Act 1990 (the Act) empowers LPAs to "*grant planning permission, either unconditionally or subject to such conditions as they think fit*"[14]. This power is not unqualified, however, and PPG states that it "*must be interpreted in light of material factors such as the NPPF, this supporting guidance… and relevant case law*"[15].

The NPPF requires LPAs to consider if '*otherwise unacceptable development could be made acceptable through the use of planning conditions*'[16] but should only be imposed where they are "*necessary, relevant to planning and to the development to be permitted, enforceable, precise and reasonable in all other respects*"[17]. These pre-requisites are known as the "six tests" and are often the subject of debate at planning appeals and Public Inquiries. They should, of course, be fully considered by LPAs in the development of planning conditions too.

The "six tests" are not new to the NPPF having been carried forward from the predecessor guidance, Circular 11/95[18], with relatively few changes. The PPG reiterates the need for compliance with the tests stating that the "*six tests must be satisfied each time a decision to grant planning permission subject to conditions is made*"[19], and provides guidance on interpretation of the tests.

The first test is that a planning condition is **necessary**. The PPG advises that, for a condition to be necessary, it would have to be appropriate to refuse the permission without that condition. There must be a clear planning reason for it to be necessary and the condition must not be wider in scope than it needs to be to achieve the desired objective.

It is on this question of necessity that the current planning policy backdrop becomes so important. Whilst the guidance on necessity has not radically altered from Circular 11/95[20] to the NPPF, the underpinning reasons for a potential refusal have changed quite significantly. In short, the inferred amenity objectives have become more subjective, less conservative, less standardised and (arguably) more permissive.

To weigh whether or not a condition is necessary, therefore, an LPA would first need to establish if noise from a development is likely to exceed the lowest observed adverse effect level (LOAEL) or significant observed adverse effect level (SOAEL). The example outcome provided in the PPG describing noise below the LOAEL threshold states that "*noise can be heard…can slightly affect the acoustic character of the area*"[21] and the corresponding planning action is "*no specific measures required*" so the inclusion of a planning condition would certainly not supported in this scenario. Some LPAs still seek inaudibility via condition for certain types of development but in view of the above, such conditions would not pass the test of necessity.

When noise from a development, or likely to affect a development, is predicted to be categorised between the LOAEL and the SOAEL then the corresponding planning situation is less clear. The "action" advocated by the PPG in these cases is to "*mitigate and reduce to a minimum*" which does not imply that noise would constitute a reason for refusal and thus justify a planning condition. The language in the PPG example outcome, however, appears to describe a tangible noise impact where a "*perceived change in the quality of life*" results in "*material changes in behaviour*". Many practitioners would, understandably, question the wisdom of a policy position which would not support the inclusion of noise conditions in these circumstances.

The above scenario is arguably the most controversial aspect of the PPG for noise. One may infer that, if noise impacts predicted to fall between the LOAEL and SOAEL cannot be conditioned, then the "*reduction and mitigation*" proposed by the PPG must take place during the design evolution prior to the planning application being decided. This is outside the control of the LPA, however, and commercially focused developers may decline to include such measures if the LPA is perceived to have no formal mechanism for requiring them. Whilst the majority of developers consider noise impacts responsibly, and respond positively to mitigation suggestions from the LPA, it is a concern that formal noise policy now appears to be so permissive.

There is often uncertainty as to exactly what noise outcomes would result from a development. Where it is possible, but perhaps unlikely, that the LOAEL or SOAEL may be exceeded by noise from a development the LPA may understandably wish to adopt a precautionary approach and to include a noise condition. There are High Court precedents which have supported a precautionary approach but these currently relate to air quality[22] and water quality[23] and have not been universally accepted by Inspectors considering noise conditions. An example of this is the historically low incidence of excess amplitude modulation (EAM) conditions imposed by Inspectors in wind farm appeals. Their exclusion has often been justified due to a lack of firm evidence that EAM will occur and that a condition is therefore unnecessary.

An obvious difficulty with applying the "precautionary principle" to planning conditions is the wide range of possible interpretations of the principle. An extreme interpretation would suggest that conditions are necessary to cover even the most unlikely consequences of a development. A well evidenced and balanced risk assessment should therefore underpin any proposed precautionary condition to support its necessity in the event of challenge.

Issuing standard conditions for particular types of development is still relatively common place in LPAs (fixed plant noise limits or schemes to be agreed for insulation, for example) and may be an attractive option to LPA's whose planning or environmental health resources have been reduced. Indiscriminate use will inevitably result in the issue of conditions which are unlawful on the basis of necessity. Furthermore, whilst Circular 11/95 recognised the benefit of standard conditions[24] (albeit with cautious application) the PPG is quite clear stating that "*it is important to ensure that conditions are tailored to tackle specific problems, rather than standardised or used to impose broad unnecessary controls*"[25]. That is not to say that some model conditions could not be used as a starting point and, indeed, the Planning Inspectorate retain a suite of model conditions. Importantly, those which they retain for noise are skeletal, relatively simple and do not drift into the interpretation of the thresholds of LOAELs and SOAELs.

In the event that a condition is accepted as necessary, the scope to achieve the target outcome would need to be carefully quantified and set out, as to require more than is strictly necessary would fail the test. This stage alone can, therefore, necessitate the derivation of objective criteria such as noise levels and durations, to correlate with the subjective criteria provided in the PPG.

The second of the tests is that a condition is **relevant to planning**. The examples provided by the PPG relate to the objectives being within the scope of the permission and avoidance of repetition of control imposed by separate statutory regimes.

This explicit requirement to be 'relevant to planning' reinforces the need for the policy requirements and other material considerations to be the sole determinants of the test of necessity. Various non-material arguments raised during the consideration of an application may appear relevant and compelling to LPAs but, if they are non-material, they should have no bearing on the decision making process.

The need to avoid duplication of controls with other statutory

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regimes does have relevance for noise conditions and warrants careful consideration. It may seem superficially that the Licensing[26] and Environmental Permitting regimes[27] would preclude noise conditions being necessary for certain types of development. This can be a dangerous assumption for two reasons. Firstly those regimes have very different noise objectives[28,29] to the planning regime, so resulting conditions may vary. Secondly, if the consented developments later fall outside of those regulatory regimes they may be left without any noise controls whatsoever. Potential duplication certainly deserves consideration but it is probable that conflicts will be relatively rare and only occur in very specific circumstances.

The third test is for a condition to be **relevant to the development to be permitted** and asks "*does the condition fairly and reasonably relate to the development to be permitted?*" Clearly, where an application site has existing noise issues, a condition cannot directly address those issues unless they form part of the application. Attempts to restrict whole site operating times or boundary limits, for example, when granting permission for a discrete element of an established operation would clearly be unlawful.

The fourth test that a condition is **enforceable** is arguably one of the more complex tests to apply. The PPG asks the question "*Would it be practically possible to enforce the condition?*" In the author's experience, these practical considerations can be neglected, particularly where the most vocal parties at a committee or inquiry are legal professionals who tend to equate "enforceable" with "precision" which is, of course, a separate test.

An experienced acoustician will consider the practical aspects of condition enforcement such as; cost, detection of exceedances, safe and accessible monitoring locations, measurement protocols, handling interferences and the potential for error. Ideally, any draft noise condition will be reviewed with these practical issues in mind. Careful consideration of condition wording and practicable implementation still do not guarantee an enforceable condition, though, without a wider consideration of the nature of the planning enforcement regime.

Planning enforcement is carried out at the discretion of the LPA[30] when they regard it as "*expedient to do so having regard to the development plan and other material considerations*"[31]. The meaning of 'expedient' is not defined in the Act but the Oxford dictionary suggests it is "*convenient and practical although possibly improper or immoral*". In considering the use of enforcement action the LPA should act in a proportionate way and "*have regard to the potential impact on health, housing needs and welfare of those affected by the proposed action, and those who are affected by the breach of planning control*"[31].

The planning enforcement system is perceived as "*complex, cumbersome, and difficult and expensive for LPAs*"[32]. It was perceived to have a "lack of staff resources and trained staff"[33] even before the 2008 financial crisis. Enforcement is a discretionary power rather than a duty and the LPA is obliged to consider 'expedience' and many other interests before determining whether or not to enforce, although it is expected to enforce where "*serious harm to local public amenity is being caused*"[34]. Any investigation must have regard to the European Convention on Human Rights[35], associated UK legislation[36,37,38,39] and any relevant enforcement concordats. This combination of factors can make enforcement action a risky and unattractive option to LPAs.

In practice, most investigations into non-compliance are complaint led and it is likely that the LPA (unless a county council) is simultaneously considering the noise issue as a potential statutory nuisance[40]. As there is a positive obligation (rather than a discretionary power) to investigate complaints of statutory nuisance and to take action where they are found to exist, this procedure will often take precedence over planning enforcement. A conclusion that statutory nuisance does not exist may also be used to support an LPA's decision that planning enforcement is neither expedient nor necessary on the basis that serious harm is not occurring. Conversely, where statutory nuisance action is initiated, this too may satisfy the LPA that planning enforcement is not expedient as the issue is already being addressed via an alternative regime. This dynamic between the two regimes is understandable, given the extant pressures on LPAs, but it does ultimately result in a failure to pursue planning objectives and to maintain public confidence in the system.

The fifth test is that a condition should be **precise** so that it is clear and unambiguous to the applicant what needs to be done to comply with it. A lack of precision in condition wording can also undermine a condition's compliance with other tests, such as those of necessity and enforceability. It seems that poor precision results from rushed or poorly reviewed conditions just as frequently as from a lack of understanding.

The sixth and final test is something of a catch all; that the condition is **reasonable in all other respects**. Unjustifiable and disproportionate burdens will fail the test of reasonableness. This is a clear indication that the scale of the development will have a bearing on just how onerous compliance should be for the applicant, be that in a fiscal or managerial sense.

The introduction of "proportionate" as integral to reasonableness increases the risk associated with the indiscriminate use of standardised conditions. Whereas a relatively onerous standard or model condition might be reasonable for a development of significant size and value, it may be disproportionate for a smaller development. Wind farms, again, provide a good example for the consideration of the proportionate burden of a condition. The approach adopted in the Institute of Acoustics (IOA) example condition which is appended to their good practice guide (GPG) [41] has been widely applied to commercial wind farms both before and since its publication. It is particularly onerous, however, so has often been acknowledged as too burdensome for operators of small scale developments. Simplified or less onerous conditions have quite rightly been applied to many smaller development although unfortunately, due the piecemeal development of these, many fail several of the tests and are thus unlawful.

Conclusions

There is no doubt that the fundamental changes to national noise policy since 2012 have had a profound effect on what constitutes unacceptable amenity impacts, and therefore when noise conditions might be **necessary**. These same changes have also influenced what conditions might be **relevant to planning, enforceable** and **reasonable**. Unfortunately, these changes have come at a time when LPAs are facing unprecedented pressures on resources resulting in reduced staff, training and continuity, making adaptation particularly challenging.

The recent changes to key standards, such as BS 8233[42] and BS 4142[43], have been sympathetic to the national policy changes and to some extent dovetail with new policy directions. BS 4142:2014 in particular aligns its wording and approach with the current planning policy objectives for noise. If applied in an appropriate manner, with due regard to national and local policy requirements, these standards provide useful methodologies and criteria to underpin noise assessments used for planning. They do not negate the much higher degree of subjectivity now involved in the quantification of noise impacts but they do at least offer some standardization of approach to practitioners.

There is unquestionably a high level of understanding of relevant national and international guidance amongst acoustics professionals in the UK. Many practitioners also have a detailed knowledge of the planning system as it applies to noise. Far fewer have a rounded and in depth knowledge of current planning policy, development control and planning enforcement matters. Unfortunately this breadth and depth of knowledge is necessary to permit a proper consideration of the noise impacts of development proposals and the drafting of suitable noise conditions when necessary.

A seamless interface between planning and acoustics professionals respectively could provide this balanced perspective but, given the development pressures, policy and guidance changes and reduced resources, such an interface is currently unlikely to exist within many LPAs. At the risk of oversimplifying the situation it seems the heart of the problem could be summarised thus: Planners don't understand acoustics and Acousticians don't understand planning. The result is a very high incidence of unlawful noise conditions.

This conclusion is admittedly largely based on anecdotal evidence and opinion. However, personal experience has long suggested that a significant proportion of noise conditions are unlawful and unenforceable. A recent straw poll of noise consultants involved in planning provoked an outpouring of examples of LPAs adhering to unjustifiable

and unlawful conditions and noise objectives. Whilst flawed plant noise conditions were the most numerous, other examples included wind turbine noise, industrial operations, entertainment noise, construction noise and residential schemes.

If noise conditions are relied upon by decision makers to make otherwise unacceptable development proposals acceptable, then those conditions may be needed to confer essential amenity protection for existing or proposed residents, or protection for business operators. Whilst applicants and some interested parties have options to challenge or vary conditions, the LPA itself has no mechanism to retract conditions or correct errors retrospectively. When permissions are granted with flawed noise conditions, the implications can therefore be both long term and severe for residents, business operators and LPAs.

A majority of development control decision makers are laypersons or generalists (Councillors and Inspectors respectively) who rightly depend upon the advice of professionals. If the prevalence of effective and lawful noise conditions is to be increased, as it needs to be, it is imperative that the two key professions become more closely aligned. More active collaboration, within LPAs in particular, would increase the level of scrutiny of draft noise conditions and encourage the cross-discipline professional development that is so important. How this can be achieved within the current climate of resource reduction and efficiency savings is another question entirely.

The views expressed above are those of the author and do not necessarily reflect the views of employers past or present.

***Toby Lewis** has 25 years' experience as an environmental noise specialist in local government and consultancy and he is currently based at the WSP Parsons Brinckerhoff Cambridge office. He is particularly interested in the planning, licensing and statutory nuisance regimes and in the provision of training and expert witness services.*

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Key issues in aviation noise management

By Nicole Porter and Andy Knowles of Anderson Acoustics

Introduction

Effective airport noise management strategies should protect people from noise associated health hazards, deliver real value for communities, and allow for sustainable growth.

Traditionally noise management strategies and policy instruments have focused on reducing noise levels and population exposed through advances in technology to reduce airframe and engine noise, optimising operational procedures and introducing operational restrictions. As a result there is a general overall downward trend in the magnitude of key noise contour areas (as judged by the conventional metrics), with mitigation solutions focussing on noise insulation schemes of varying scales.

Improvements in technology have made aircraft 75% quieter than they were 50 years ago, however our demand for air travel continues to grow and air traffic has increased more than 150% in the same period [1]. According to Sustainable Aviation in the UK, aircraft noise (as described by conventional metrics) is not likely to increase even with the doubling of movements in the next 40 years [2].

However, despite these reductions, noise still remains the major cause for community reaction to airports operation and expansion. In general, studies over the last 20 years suggest increased sensitivity and community concern. Research has also indicated that, at most, only 30% of the annoyance response to aircraft noise actually relates to noise level. The recent report of the Airports Commission clearly indicated lack of trust between communities, the aviation industry and towards policy makers as a key issue.

So it seems that policy makers and the aviation industry have been aiming at only a section of the problem. The industry therefore faces the challenge of providing effective noise management with workable solutions for all – promoting people's quality of life and allow for sustainable growth.

Within this context, the aviation industry faces a number of challenges:

- To understand the development of responsible management of the impacts of aircraft noise on health and quality of life.
- To engage with local communities and develop actions that tackle community perception, integrating non-acoustic factors within current airports noise management strategies.
- A need for metrics that describe noise in a meaningful and transparent way and enable conversation.
- To address the concerns of the local community on the potential effects of significantly improved accuracy of Performance Based Navigation (PBN) – resulting in significant concentration. How can the benefits of PBN be shared?
- To understand the perceived value of respite for communities and how to deliver effective respite from aviation noise.

This article provides an overview of these issues and builds on previous conference papers that have specifically covered some of these issues [3, 4, 5, and 6].

Understanding impacts of aircraft noise on health

Protection of health must be the priority for noise management. It is generally agreed that long-term exposure to aircraft noise can have implications for human health. Research indicates that there is sufficient evidence to support an association between aircraft noise and annoyance, sleep disturbance, cardiovascular diseases and cognitive development in children [7, 8 & 9]. However, causal relationships and pathways are less well understood and robust. When managing the impacts of aircraft noise we need to understand the relative scale of the impacts and make sure that we are comparing outcomes in the same language and in the context of a sustainable approach.

Monetisation is becoming an essential tool for policy makers and airport operators to facilitate decision-making that includes the effects of noise in a sustainability context. This has partly been driven by the need for adequate policies that minimize the potential adverse effects from noise on health. In addition there is a need for a common language across all aspects of sustainability that enables to put into context the balance between benefits and negative effects of aviation.

Nevertheless, limitations of the scientific evidence base to establish causal relationships and thresholds have prevented the calculation of accurate monetary values. There is currently no simple cause-effect model between aircraft noise exposure and its potential health impacts, due to the complexity of human response to noise and the influence of many other elements such as physical, social and economic factors.

We have previously undertaken a comprehensive review of the most up to date and practical methodologies for valuing aircraft noise effects and developed a process for planning and undertaking monetization. This is presented below in figure 1 [3,4].

In 2014, an update of the UK Government's environmental noise appraisal method was published [10]. The report revises previous methodologies and recommendations for monetising the impacts of noise on sleep and hypertension, and includes guidelines for productivity effects and quiet areas. In 2015 the Government updated its WebTAG tool for undertaking monetary appraisal of the health costs of a development (including aviation noise). They also removed the hedonic pricing (revealed preference) technique as a result of significant concerns about the validity of this approach in an aircraft noise context. Our approach is consistent with the UK Government's recommendations.

It is important that policy makers are aware of the many limitations and uncertainties in this process in order to responsibly use the outcomes for informing noise management or policy decisions. It is important to note that this is complex field of work that requires the interaction of academics, practitioners and policy makers.

An overview of the process for each of the effects, including the best available dose-response relationships appropriate monetisation method and analysis of limitations and uncertainties, is presented in figure 2. The colour coding indicates the reliability of the stage in the process:

- Green: Sufficient available evidence to robustly apply within the monetisation process.
- Amber: Insufficient evidence to enable robust application and limitations and uncertainties should be considered.
- Red: Should not be applied within the monetisation process at this time.

In an attempt to improve understanding and guide towards a better use of the monetised cost of the effects of aircraft noise, we have proposed a range of guiding principles [4]. These include the precautionary principle, protecting human health, transparency in published data, and contextualisation of results to local conditions. Given the limitations inherent within the monetisation process we believe that it provides a tool to enable comparisons between scenarios rather P54

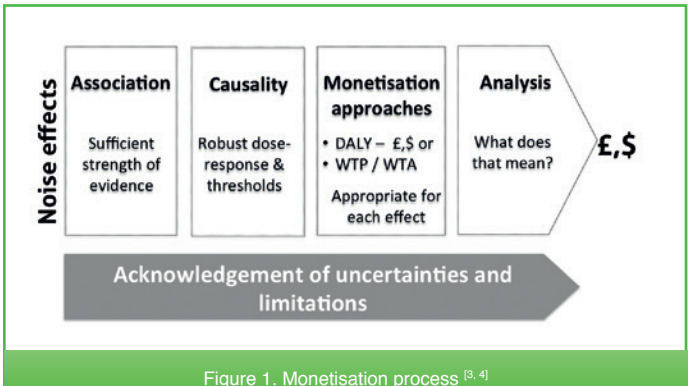

Figure 1. Monetisation process [3, 4]

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than provide absolute values or true "monetary costs". These principles should form the basis for responsible management of the impacts of aircraft noise at airports.

The importance of addressing non-acoustic factors in effective noise management strategies

Policy makers and the aviation industry have focussed on noise-reduction through engine and airframe technologies, innovative operational procedures and mitigation generally in the form of dwelling and school insulation programmes. It has been estimated that the three major aircraft engine manufacturers spend more than $70 million annually on noise reduction technologies and research [11]. As a result of these efforts, a downward trend in noise contour areas and the population exposed has been observed [12]. But noise remains the single most significant concern for communities around airports.

However, as indicated above, research suggests that, at best, only a third of the annoyance response to aircraft noise relates to noise level [23]. So while significant reduction in noise levels has been achieved, it is not surprising that adverse community reaction around airport has increased over time – the industry and policy makers have been addressing only part of the problem.

A new perspective is required to provide effective management strategies. Treating aircraft noise annoyance around airports as a mere technical problem, involving exposure levels and dose–response functions is only one side of addressing the noise problem [13]. The management process needs to acknowledge the role of non-acoustic factors including the differences in local perception and attitudes of residents.

Sanchez et al [5] identified these non-acoustic factors that could significantly affect an adverse response, based on an extensive review of available literature. This included, the feeling of being fairly treated, the trust or misfeasance in airport authorities, control and coping strategies, and satisfaction with noise insulation.

It is argued that management of non-acoustic factors cannot reduce noise levels or the number of people inside noise contours. Thus, the ultimate goal of including non-acoustic factors within noise management strategies is to improve relationships with the community in a fair and reasonable manner, ensuring the airport is a good neighbour. This is fundamental for the sustainable growth of the aviation industry.

Indeed, addressing these factors should be seen as complementary to the traditional "noise reduction" approach to managing aircraft noise. Airport noise has become a social and political risk for constraining growth, requiring a renewed focus towards a "social license to grow". This implies a co-responsibility of all parties to achieve objectives that benefit all.

An "onion rings" conceptual framework [5] for providing practical guidance on how to integrate and address the non-acoustic factors within an airport's noise management strategies is presented in Figure 3. This shows the adverse response in the centre, surrounded by core feelings that could lead to that response. The third ring presents principles that have been shown to affect or shape those feelings. The outer circle presents some of the initiatives and actions that, in consideration of those principles, could help to reduce the adverse response. We would note that the overriding principle for an effective non-acoustic strategy would be "open engagement" to understand and address local community priorities. Without this, airports and policy makers could find themselves addressing matters of little concern or value.

Metrics to enhance the conversation

Previously we identified the core principle of "open engagement" as an essential part of a non-acoustic strategy. Successful engagement requires effective means to describe and communicate noise exposure effectively - in a meaningful and transparent way.

Porter et al [6] examined the limitations of traditional noise contours for describing noise exposure and considered a more targeted contour based on shorter-term noise measures. They promoted the principle that noise descriptors should be tailored towards the specific questions that are being addressed i.e. whether the metrics are fit for purpose.

According to their research, standard noise metrics are essentially based on long-term averages and use noise contours to depict areas exposed to different measures of noise, for example Lden in the EU, LAeq in the UK or DNL in the US. Although these descriptors have particular roles to play in strategic noise impact and planning related assessment, they do not adequately describe the actual community experience. These metrics have been criticised by local community groups as being unhelpful, lacking transparency and sending the wrong message [6].

In Australia, supplementary noise descriptors were developed which have been globally adopted. These includes flight movements charts to which was added information on respite, numbers of noisy events (N70), Person Event Index (PEI) and the Average Individual Exposure. (AIE). Often the long-term average noise contours are presented with these supplementary data to give a more transparent and more complete picture of aircraft noise exposure. These metrics aim to better reflect what community experience in simpler language.

Technological advances and increased capabilities in applying these metrics have led to the development of new ways to present information in a more meaningful and tailored manners. This has been termed a new generation of supplementary noise metrics. Examples of how this new generation of metrics have been applied at airports are presented in a previous paper presented at Internoise [6] and at the

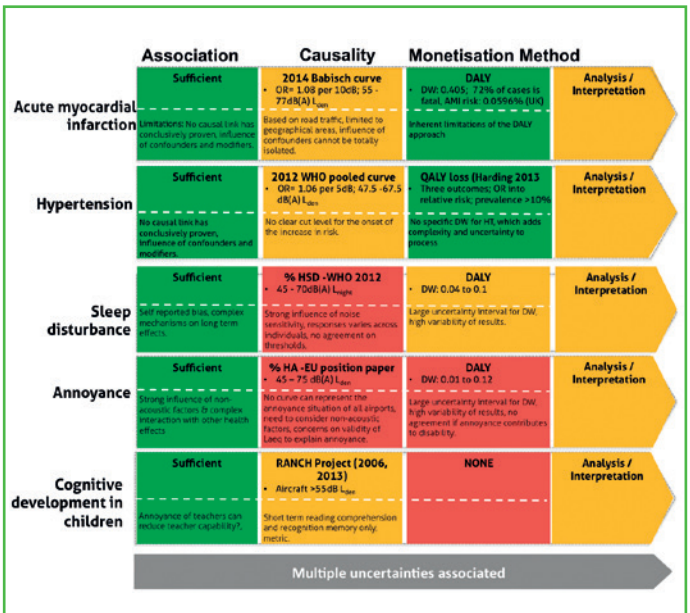

Figure 2. Summary of monetisation process for aircraft noise effects, based on [3, 4, 7, 8, 9,19]. OR = Odds ratio, DW= Disability Weight.

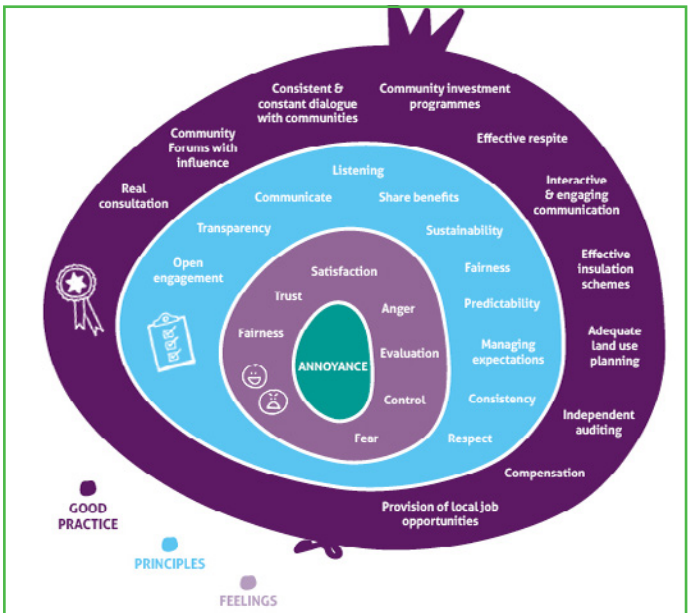

Figure 3. A conceptual model for addressing non-acoustic factors within noise management strategies

recent IOA workshop on Aircraft Noise (see page 24).

For instance, conventional contours based on long- term average metrics can be optimised with shorter-term targeted contours to better reflect community experience. Also, it is possible to develop PEI or N above contours, grid level information, or at postcode level using Geographical Interface Systems (GIS) to show noise load and noise sharing, focusing on people and not only areas. Moreover, this can be used to demonstrate how potential respite from aircraft noise could be delivered at specific locations. Health effects and monetary information can also be included to create a comprehensive picture of where to focus strategies (e.g. noise insulation) and facilitate decision-making. Figure 4 summarises what we mean by the terms standard and supplementary metrics.

These targeted noise descriptors and meaningful ways of presenting them, together with information on health, costs, and agreed policy objectives can be drawn together to provide a balanced scorecard for use in effective aviation noise decision-making worldwide.

It is important to keep in mind that as acousticians we should aim to provide all the relevant information in a simple and transparent way to further facilitate the decision making process and engagement with local communities.

Design sustainable airspace to share benefits of PBN

This topic has been most recently highlighted with the implementation of Performance Based Navigation (PBN) routes in Europe and the US.

There are on-going plans to modernise the airspace both sides of the Atlantic such as the Single European Sky (SES) [14] launched by the European Commission and the NextGen [15] modernisation programme lead by the Federal Aviation Administration in the US. Both programmes are aimed to bring important benefits in terms of strengthening the resilience of the airports and achieve time, fuel and CO_2 savings by adopting more direct routeings and increasing efficiency.

These programmes are supported by the transition to satellite-based PBN routes, which are more flexible and precise than conventional routes. PBN allows complex airspace with more accurate and direct routes to be re-designed. However, this can lead to greater concentration of traffic around route centrelines. While fewer people may be exposed to aircraft noise, those directly under the centreline might experience an increase in disturbance due to the effects of increased concentration of flights.

A significant number of trials for PBN have been implemented across different airports in Europe and the US. For example, trials at Heathrow showed that flight patterns have changed from sharing of noise with general dispersion pre-trial to a more consistent pattern of shared concentrations‡ of noise along the new routes [16]. Research [17] was commissioned to investigate community response to this particular trial. Results indicate that a single precise navigation route would be perceived as unattractive and unfair to most of the residents. However, alternating precise navigation routes was perceived as a possible suitable compromise between the implied benefits of efficiency and safety, and fairness.

A major challenge for an effective and sustainable PBN implementation is the question of "concentration versus dispersion" i.e. how to distribute routes and avoid over concentrating noise over a few corridors. If a concentration policy is adopted, this may need to be presented alongside a respite policy to provide a break from the overflights.

Understanding respite

Respite has become a key issue and prime demand from communities and residents near airports, as well as a significant issue within the noise policy agenda. Due to expanding airport capacity, a key issue for communities has become not how many movements or how much noise they experience, but whether they were able to receive a break from the noise [18, 19 & 20]. Although policy, in particular in the UK, refers to respite as a principle, there is no guidance on its definition, implementation or delivery.

‡ Shared concentration is a term that has been used to describe the use of multiple PBN routes within a specific Standard Instrument Departure (SID). This could result in the concentration of noise along several different PBN routes within that SID, which can be alternated so that noise is shared.

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There are many concepts associated with providing respite from aircraft noise. Figure 5 presents some of these concepts. In addition, since airspace modernisation programmes can lead to a higher concentration of flights tracks, respite appears to be a vital mitigation measure to provide a break from more concentrated flights.

As a response, a Respite Working Group (RWG) was established in the UK with the purpose of providing advice on management and assessment of respite from aircraft noise at Heathrow Airport. Representatives from government, regulator, airlines, industry, community, residents and academics formed this group.

At the time of writing this paper, a report from this Group is due to be published by Anderson Acoustics [21]. The following key conclusions were drawn by the RWG:

- There is currently no clear, consistent or universally accepted definition of respite and a working definition was developed for use within the RWG process.
- What the community values as respite is not fully understood. Despite a number of related studies and examination of respite implementation examples, there is at present no clear understanding of what the community values as effective respite. Effective provision of respite depends not only on operational features but also specifically on how the community perceives and values respite. Community-level understanding is therefore a priority in developing any effective respite strategy.
- There is no universal formula for the successful implementation of an effective respite strategy. Operational design for respite needs to consider operational conditions at an airport, including factors such as safety, efficiency, aircraft and avionic capabilities and controllers' workload, amongst others.
- There is currently no single acoustic metric that can adequately describe respite. Since it is not clear what the community deems as effective respite, and therefore which parameters are useful in describing its key elements, it is not possible to choose a suitable metric that is fit for purpose at this time. Instead, the RWG suggested a list of guiding principles and a candidate list of metrics to describe the noise environment in terms of offering respite.
- Further work is needed to develop a clearer understanding of which parameters are useful in describing respite, in a way that is valued by the community. We also need to understand the relative importance of acoustic and non-acoustic metrics in evaluating respite, so that we can put the usefulness and limitations of any acoustic metric in context.
- A strong and effective communication strategy and good community engagement is essential for the successful implementation of respite. Two key conclusions were drawn: multi-stakeholder engagement is fundamental and more efforts in communication are needed.
- There is currently insufficient information on the benefits of respite to health and on the economic value of the effects of respite. There is clearly no one-size-fits-all solution, every end solution will vary – there is a need for further research.

The RWG agreed that priority must be given to gaining a better understanding of how the community values respite, before considering operational feasibility, cost-effectiveness and the development of metrics. The following key objective was identified specifically for Heathrow: To better understand the key characteristics of an effective respite strategy for Heathrow Airport and its local communities, consistent with efficient operations.

To this end, a new project, funded by Heathrow Airport Ltd, is due to start in 2016 with both laboratory and fieldwork. The project aims to develop a set of initial principles for providing effective respite from aviation noise at Heathrow. Two key questions are to be addressed, (1) What is the spatial variation in routes required to make a perceived difference and be of potential benefit, in terms of height and position for both arrivals and departures; and (2) what are the optimum temporal separations or patterns required in order for the community to value it as effective respite?

Conclusions

This article has identified a number of current challenges facing the aviation industry in relation to the effective management of aircraft noise to protect health, promote people's quality of life and also enable sustainable growth. It has presented the specific challenge of responsible aviation noise management requiring an understanding and need for action that tackles community perception and non-acoustic factors, the need for the right tools to describe noise and its impacts in a meaningful way and the trade-off between sharing and concentrating noise amongst communities and the complexity of providing effective respite.

Effective noise management often requires decisions to made based on complex, incomplete and (often) contradictory information. The important thing is to openly engage (even in the face of what is likely to be an initially conflictual situation), understand the concerns, listen and "have a go".

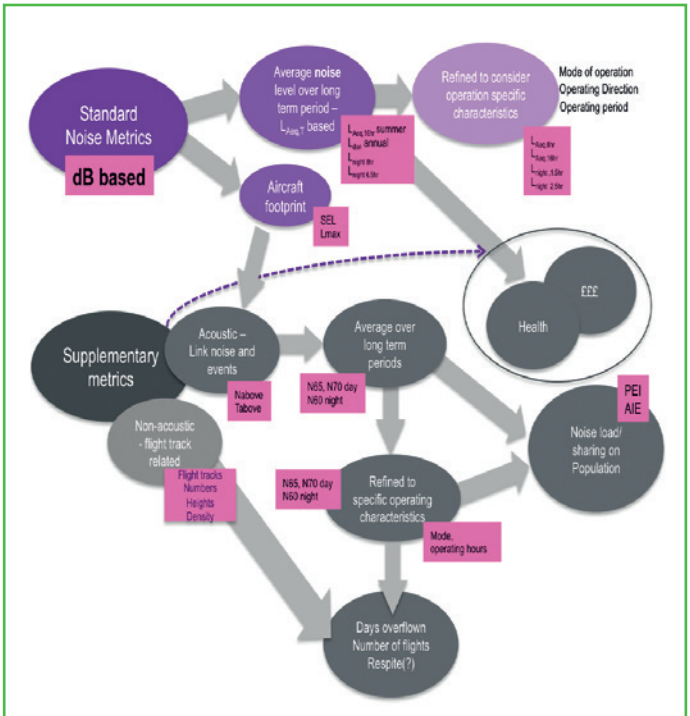

Figure 4. Standard and supplementary noise metrics.

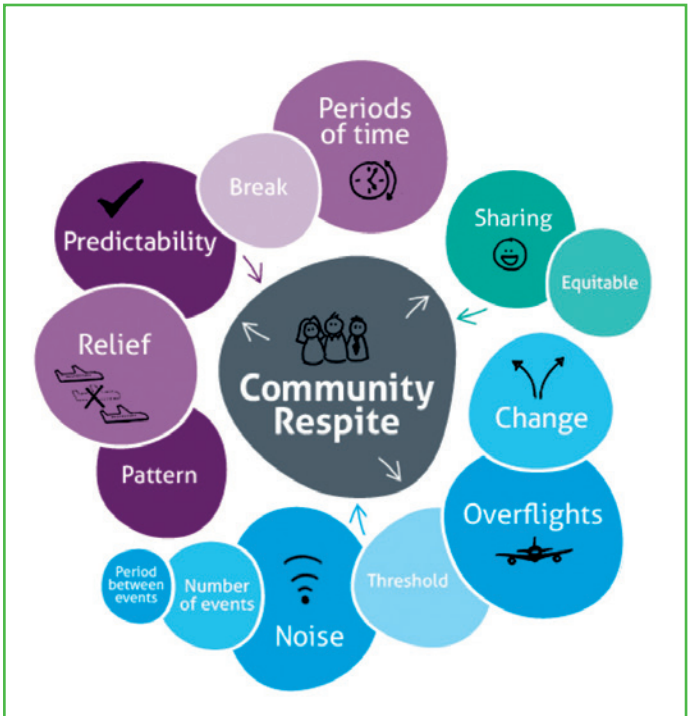

Figure 5. Concepts associated with Respite from aircraft noise.

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Nicole Porter *has more than25 years' experience in environmental noise work. She is an Associate Director of Anderson Acoustics and a committee member of the IOA Environmental Noise Group. She has worked at NPL, CAA and as a freelance consultant with the aviation industry for many years.* ***Andy Knowles*** *is Managing Director of Anderson Acoustics. He has 25 years' experience working in and around airports and noise. Recently he was involved in Heathrow Airport's noise proposals for the Airports Commission.*

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Drumgrange wins £4.8 million Ministry of Defence sonar contract

Drumgrange has been awarded a £4.8 million contract by the Ministry of Defence's (MoD's) Defence Equipment and Support (DE&S) organisation for the support and advancement of sonar systems, sonar calibrations and related equipment.

The three-year contract is the MoD's JC026 project. It is the third time the contract has been awarded to the company. The initial contract was secured in 1999 and re-competed in 2002 and 2007.

The contract will be managed from Drumgrange's Portland site and will utilise the company's extensive platform integration expertise and in-service support specialised facilities which includes an anechoic water tank for testing sonar systems.

George Howe, Managing Director, said: "Securing the JCO contract for the third time reflects the dedication, professionalism, and 'can do' attitude of the support and trials team whilst demonstrating the MoD's continued confidence in the company's ability to deliver critical capabilities for the armed forces."

Cole Jarman opens regional office in Manchester

Cole Jarman has opened a regional office in the heart of Manchester to enhance the service provided to existing clients in the area and to develop new business.

The office is headed by Matthew Heyes who has embraced the opportunity to return to his home city.

Matthew joined the company seven years ago as a trainee consultant at the head office in Surrey on graduating in acoustics from the University of Salford.

He has gained a wide range of consulting experience in environmental and building acoustics, developing particular expertise in school design, planning noise, industrial noise control, logistics noise, low frequency noise and residential design.

Matthew Heyes

QuietStar rises out of the ashes of IAC Acoustics

Four former employees of IAC Acoustics which went into administration last year have banded together to form their own company.

QuietStar, which is based in Fleet, Hampshire, has been set up by Scott Simmons, Jason Saunders, Luke Willis and Graham Dale, who collectively have more than 100 years of experience.

It offers a range of products and services for noise control, from architectural doors and windows, to acoustic packages for heavy industries, which include testing facilities and audiology and studios.

Scott said: "After the closure of IAC we were keen to stay together so we've set up QuietStar with the view to preserving some of the legacy left behind by IAC. Thus, we will continue a commitment to good customer service and passion for quieter, healthier environments.

"Business has gone fantastically well and the response has been incredible, partly due to the void that IAC has left in the market but also because of the contacts we have with clients and consultants. The main focus for us is acoustic doors/windows, architectural products generally, audiology, industrial and test and because of the history we all have in these areas it's made for some very encouraging conversations and more importantly commitments by way of orders."

New team: (left to right) Graham Dale, Jason Saunders, Scott Simmons and Luke Willis

Vision of the future: Sound Space Design combines with Anne Minors

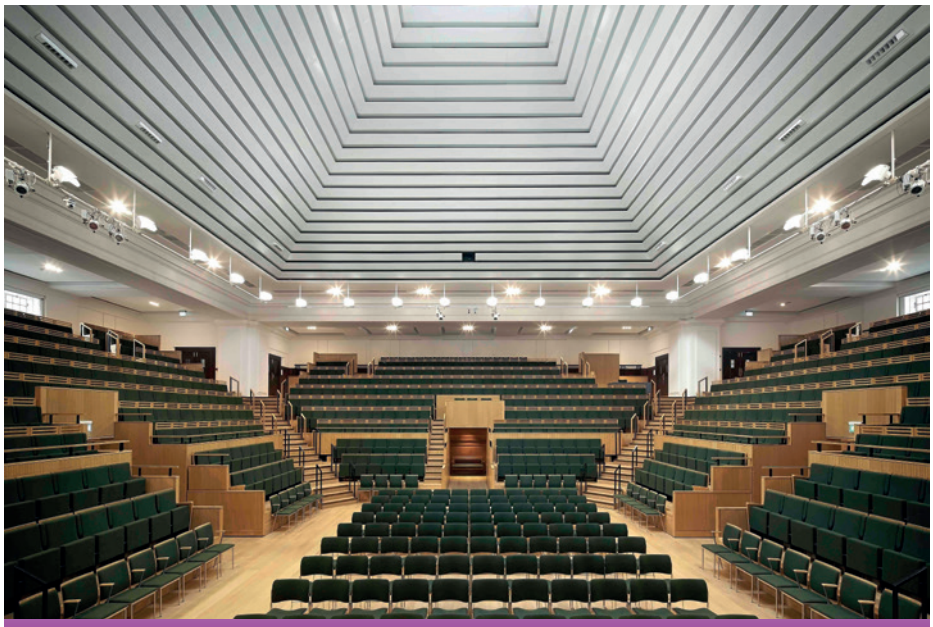
Acoustics design and research consultancy Sound Space Design (SSD) has combined with Anne Minors Performance Consultants (AMPC) to form Sound Space Vision.

The new company, which is based in a new office close to Sound Design's former base in Putney, London, said: "This move formalises our long standing working relationship and will broaden, strengthen and deepen our work within our specialist disciplines of acoustics and theatre planning."

AMPC, founded in 1996, was performance consultant for The Royal Opera House redevelopment, Barbican Theatre BITE Festival, Wigmore Hall, Roundhouse, BT Centre and Godolphin and Latymer School in London. Theatres include Hull Truck, The Egg, Bath Theatre Royal, E15 Acting School, Princess Royal Performing Arts Centre and New Theatre Royal, Portsmouth.

Sound Space Design, established in 2002, was design acoustician on La Maison Symphonique in Montreal, Toronto Four Seasons Opera House, Dallas Winspear Opera House, Lyric Theatre Belfast and Xiqu Centre for Chinese Opera in Hong Kong as well as numerous school music and theatre buildings.

The two companies have collaborated on many projects including Koerner Hall at the Royal Conservatory of Music and Trinity St Paul's Church for Tafelmusik in Toronto; Zorlu Cultural Centre, Istanbul; Palace of Peace Opera House, Astana; Annette Strauss Square, Dallas; King Edward's School, Birmingham; Attenborough Centre for Creative Arts, University of Sussex; Menuhin Hall, Surrey; Royal Academy of Arts; Institute of Engineering and Technology; Friends House in London and St Peter's Ancoats for the Halle in Manchester.



Friends House, London, a joint AMPC and SSD collaboration

Sound: A Very Short Introduction

By Mike Goldsmith

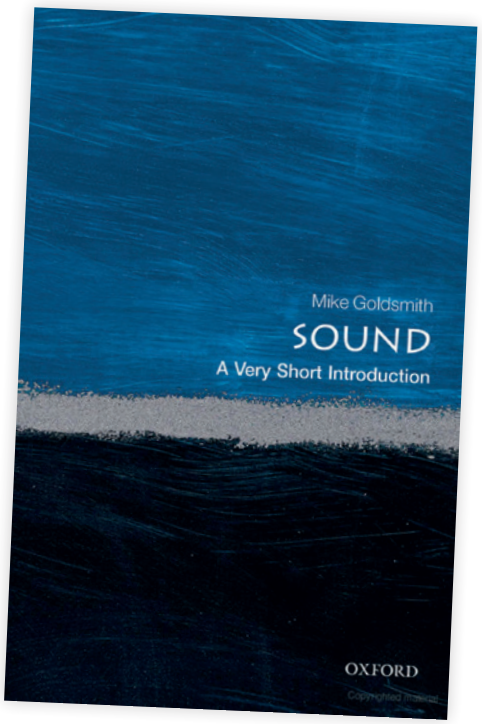
Review by Dan Boote, Atkins

As you may infer from the title of the book, this is not one for the hard-core academic. Even the readership of this magazine would find the information contained in the book to be very basic. But that's the point of it; it's meant to provide an introduction to the world of sound, and it does this very well.

Through simple, easy to understand language, Goldsmith takes us from the origins of sound, through what we now call noise, via explanations of music, the hearing system and sounds we can't even hear. The paragraphs in each section, whilst short, flow nicely into each other, with the odd humorous quip thrown in here and there to keep the reader amused. Although the target audience is the layperson, there's still enough technical detail to hold the attention of the majority of the acoustics community.

There are a couple of flaws; mostly relating to the formatting, particularly of equations which results in them not reading correctly. However I don't think this detracts from what the book sets out to do, and those who read it and are interested in learning more will find the correct equations in due course.

This book was never going to replace Woods' *Practical Guide to Noise Control* or any of the other well-thumbed reference material adorning our desks and book shelves, but answer this question: Do you have at least one person you know, either professionally or privately, who you're fed up with because no matter how many times you explain sound to them, they just don't understand what you're saying? If you answered yes, then I'd recommend it.



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Two senior appointments at RBA Acoustics

Robert Barlow

Andrew Heath

Robert Barlow has been appointed a Director of RBA Acoustics and Andrew Heath an Associate.

Robert joined RBA Acoustics as a consultant in 2005, having worked in consultancy since 2000. Over the past 10 years he has helped to develop RBA from a group of only five engineers to the team of over 20 that it is today. He has been a key part of RBA's management team for several years, leading the company into new sectors, in particular environmental impact and heads RBA's team in this field.

Robert said: "I have been lucky to be part of a great team at RBA. We work hard, but RBA has always been a fun place to work, from the early days working on small sites in London to the huge developments we now work on all over the world. I hope we can continue to be as successful as a team over the next ten years as we have done over the last."

Andrew has been with RBA since 2011. He has huge experience in building acoustics, including previous consultancy roles and undertaking research at BRE. Having developed RBA's already strong residential sector, he is also responsible for some of RBA's largest commercial projects such as the Coca Cola headquarters in London and financial offices in Oman.

Obituary

Derek Sugden (1924-2015): Unique contributor to architectural acoustics

By Richard Cowell

Derek Sugden, an Honorary Fellow of the Institute, and a unique contributor to the field of architectural acoustics, died on 30 December 2015.

Born in Hitchin, of Yorkshire parents, in 1924, he traced his fascination with sound back to his boyhood, listening to his father whistling under a railway bridge. He began attending concerts in 1940, in Watford Town Hall, the Queen's Hall, London and then in the National Gallery, Royal Festival Hall and Wigmore Hall. At the Albert Hall, he met his first wife, Jean, in the queue for the Proms. He was a regular listener to live music and good recordings throughout his life.

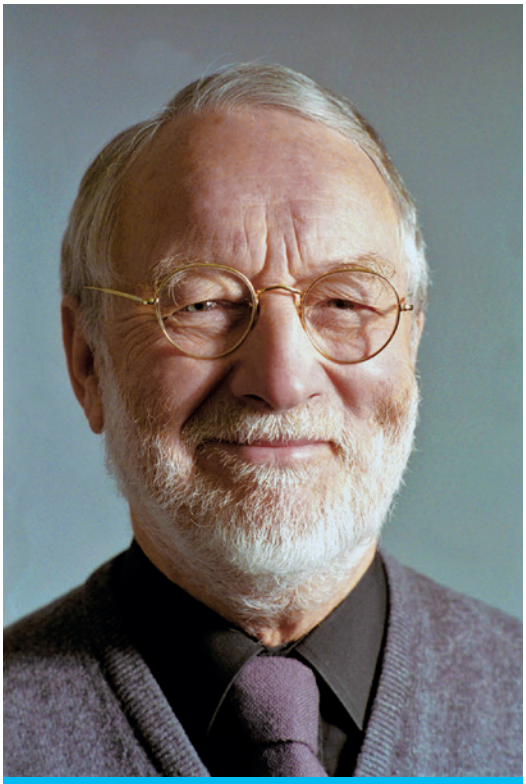
Derek studied structural and civil engineering at Westminster Technical College. After apprenticeship in engineering construction and consulting, he joined Ove Arup in 1953, becoming an Associate Partner in 1957. In 1963, with Ove Arup, Philip Dowson and Ron Hobbs, he founded Arup Associates, a multi-disciplinary firm of architects, engineers and quantity surveyors. With his colleagues he developed proposals for conversion of the Maltings at Snape to a concert hall that delighted Benjamin Britten and Peter Pears. They felt that results would be better with an acoustician, so Derek, working with Decca and colleagues, took on the role and pursued his preferred volume, reverberation characteristics, sound insulation and noise control. Snape was an enormous success. Sadly it burnt down, but was rebuilt exactly as before within 42 weeks.

In 1970, he reported on the acoustics of Orchestra Hall, Chicago for Sir George Solti and the Chicago Symphony Orchestra, and guided acoustic design for rehearsal and recording at the Henry Wood Hall in Southwark, for Buxton Opera House and, in 1974, Theatre Royal Glasgow. He also integrated successful acoustics into music schools at UEA and the Britten-Pears school at Snape.

He was close to architects and emphasised the importance of acoustics. His view was that "our ears provide definition of the nature of space". He spoke at the RIBA on The Sound of Architecture and was visiting Professor at the Bartlett School of Architecture and the University of Plymouth School of Architecture and an external examiner in Schools of Architecture at the South Bank, London and Birmingham and Leicester Polytechnics. He lectured widely in the UK, Munich, Stuttgart and Eindhoven and was Visiting Critic at the University of Pennsylvania School of Architecture.

With Richard Cowell, John Martin and Professor Peter Parkin, he formed Arup Acoustics in 1980 and set priorities to enjoy the work and achieve excellent results. With Peter Parkin, he reviewed the acoustics of the Royal Festival Hall and the Barbican Concert Hall. He worked with Rob Harris on the Britten Opera Theatre at the Royal College of Music and with Sir Neville Marriner on a scheme for a recording studio and rehearsal hall for the Academy of St Martin in the Fields.

Derek engaged with conductors, musicians and music-loving clients, users and design colleagues, bringing insights from his wide construction and listening experience. An excellent example of this was Glyndebourne Opera House for which he worked closely with Sir George Christie, Michael Hopkins, Iain Mackintosh and Rob Harris to create a wonderfully integrated auditorium with first rate acoustics. He made key contributions to the acoustic designs for Bridgewater Hall Manchester, improvements in the Royal Opera House, the Coliseum, the Wigmore Hall and BBC Maida Vale Studio 1, and guided further developments at Snape.



Derek Sugden (1924-2015)

Smaller projects included a recital room for Lady Walton and the Walton Foundation on the island of Ischia, the recital room at Clare College, Cambridge, The Queen's Building Emmanuel College, Cambridge, and, with Raf Orlowski, the Jacqueline du Pré Memorial Hall at St. Hilda's College, Oxford and a rehearsal/recording room for the Hanover Band near Brighton.

He shared his enthusiasm for music, once reporting back on listening to 39 Haydn quartets in two and half days – and on the Côte du Rhone enjoyed in the evenings. He championed his preference for a bass rise in reverberation and shared Lothar Cremer's belief in the importance of loudness. He was suspicious of multi-purpose halls and discouraged the proliferation of technical "kit" in concert and recital spaces. He chose best halls and best orchestras and considered the way music is played in different cultures. The Markgrafliches Opernhaus, Bayreuth and the Salle Garnier Monaco were favourite opera houses. He gave papers centred on his love of opera, opera houses and their history such as *The opera house – complexities and contradictions* and *Thinking about the opera house*. Derek was particularly well read in philosophy, architecture, music and the work of pioneers in acoustics. He paid great attention to the balance between pit and stage sound, preferring to tuck the pit well under the stage, taking lessons from Bayreuth.

Retiring from Arup Acoustics in 1998, he offered guidance whenever needed and continued his frequent attendance at concerts in the UK and on the continent. His devotion to music, good wine and sleep were well articulated.

It was disappointing that his first application for IOA membership was turned down despite the fact that he was a chartered engineer in a related discipline and had designed one of the best concert halls in the country. He became a member in 1981 and was pleased to be awarded Honorary Fellowship in 1996 and the IOA Engineering Medal in 2012. He was a member of the Institution of Structural Engineers, the Institution of Civil Engineers and the Institute of Welding. He received an honorary Fellowship of the RIBA in 1992 and was Chairman of the Building Centre Trust from 1993-1996.

Derek inspired many acousticians, architects and engineers. In the words of the citation for his Engineering Medal, he "provided a deeply informed holistic view of acoustics fully integrated with architecture and engineering, combined with an unfailing enthusiasm for only the best".

He was critical of those who "know the cost of everything and the value of nothing". He was a fundamental thinker, a great listener, an engaging raconteur, and a mischievous and charming rebel who loved debate and even argument. He will be sorely missed by friends and colleagues.

Jean died in 2007. He is survived by his second wife, Katherine, three children and four grandchildren.

Two new arrivals at ANV Measurement Systems as growth booms

Lee Bearman and Adrian Mancell have joined ANV Measurement Systems at Milton Keynes.

Lee's background is in noise equipment, consultancy and engineering, He has joined the sales team dealing with the supply of Rion sound monitoring equipment, in particular the Rion Noise Nuisance Recorder NNR-03.

Adrian, who has joined the services delivery team, has extensive experience in engineering fabrication, materials technology and quality control.

Managing Director Mike Breslin, in welcoming the new recruits, said "Their arrival is a strong indication of our market growth which has been boosted by advent of our LivEnviro system which enables the remote monitoring of noise, vibration and noise."

Lee Bearman

Adrian Mancell

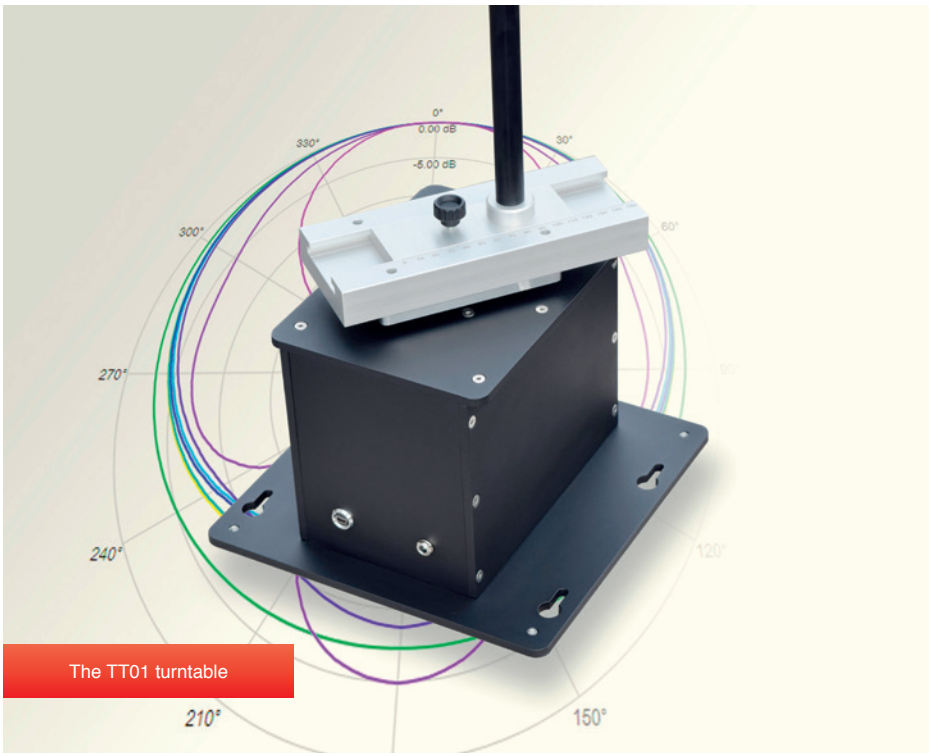
New turntable for measurement of sound directional characteristics

The new TT01 turntable from NTi Audio is designed to determine the directional characteristics of microphones, small loudspeakers and portable devices.

The turntable mechanism produces definitive results from a choice of recording methods and configurations, it says. Pre-configured microphone and loudspeaker test software packages drive the turntable via USB, while an intuitive programming interface is available for custom applications.

The TT01, linked to the FLEXUS FX100 Audio Analyzer and driven by the NTi Audio software packages, aims to make the measurement of polar diagrams for audio devices "convenient and conclusive", it states.

For further information visit **www.nti-audio.com**



The TT01 turntable

New version of AVANet vibration monitoring system

Campbell Associates is offering an upgraded version of AVANet, the open vibration monitoring system that allows users to control field instruments over the Internet with a web browser.

It is intended to take care of all data collection, communication, processing, remote monitoring and data storage, providing a simple solution for remote monitoring vibration from road and rail traffic to blasting and piling.

The new version, which has more than 300 measurement channels, has a new system for graphs and data presentation, support for raw waveform recording and functionality for FTP import for measurement data.

For more details go to **www.campbell-associates.co.uk**

The AVANet open vibration monitoring system

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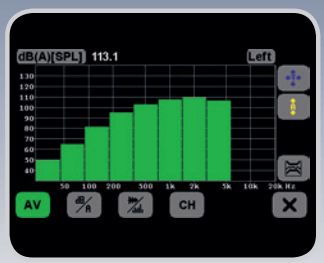

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Committee meetings 2016

DAY	DATE	TIME	MEETING
Tuesday	8 March	10.30	Diploma Examiners (London)
Tuesday	**8 March**	**10.30**	**Council**
Wednesday	6 April	11.00	Research Co-ordination
Thursday	7 April	11.30	Meetings
Tuesday	12 April	10.30	CCWPNA Examiners
Tuesday	12 April	1.30	CCWPNA Committee
Thursday	28 April	10.30	Membership
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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