Volume 44 No 1 January/February 2019

ACOUSTICS BULLETIN

in this issue...

The international conference on auditorium acoustics

plus... **The new Environmental Noise Guidelines for the European Region aim to support public health policy, to protect communities from the adverse effects of noise, and stimulate further research into the health effects of different types of noise**

National Planning Policy Framework guidance 2018 and the Agent of Change principle

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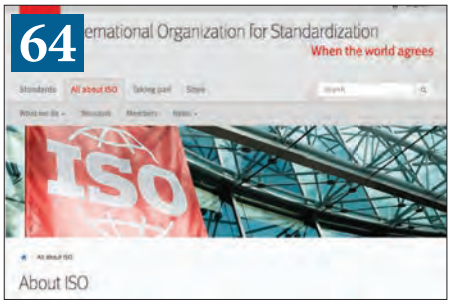

The Institute of Acoustics in the UK's professional body for those working in acoustics, noise and vibration. It was formed in 1974 from the amalgamation of the Acoustics Group of the Institute of Physics and the British acoustical Society. The Institute of acoustics is a nominated body of the Engineering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

The Institute has over 3000 members working in a diverse range of research, educational, govern mental 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, electroacoustic, engineering dynamics, noise and vibration, hearing, speech, physical acoustics, underwater acoustics, together with a variety of environmental aspects. The Institute is a

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Dear Members

This has been a busy period since the last letter. Reflecting on 2018, I took over from Jo Webb as President, with several friendly warnings that each presidency is challenged by an event, often unforeseen. Is mine to be Brexit? Fortunately, our Institute has its Parliamentary Liaison Group, steered by Peter Rogers and working so that we will be positioned to respond to any future developments. Presently, the group is consulting with other groups and branches on the present noise and vibration regulations and standards that should be preserved, modified or even replaced. Linked to this is the IOA's support of the United Kingdom Acoustics Network (UKAN), which, at the same time, is preparing a report on the value of acoustics to the UK. Join the network, if you have not already done so (**https://acoustics.ac.uk/join-the-network/**).

This 'ageing academic' recently spent a day, literally in the field, measuring ground-borne vibrations. It was a day of getting down and dirty and finding that 'spiking' is not straightforward, or that one cannot be sure that the day measured is representative of normal conditions. When is there a fully loaded articulated lorry driving past when you need one? Luckily, the young consultants with me knew what they were doing.

I attended the Institute of Physics annual awards dinner and shared a table with the presidents of other learned societies and institutes. The evening was celebratory with many awards given, but there was no time for accompanying presentations on the research that undoubtedly deserved the awards. Colleagues in IOA have expressed a preference for medal winners to give talks, as part of conference programmes, and I tend to agree.

Reproduced Sound

Which brings me to the Reproduced Sound conference in Bristol and the Tyndall Medal award to Fillippo Fazi. After receiving his medal, Fillippo gave an excellent presentation on the theory and practice of loudspeaker arrays for audio reproduction. It is the nature of this type of conference to accompany the presentations with aural demonstrations and the audience shuffled around various loudspeaker types and arrays to confirm that they were truly directional. It was all good fun.

In my part-time role at Liverpool University, I am able to observe the day-to-day activities of the Acoustics Research Unit. Recently, the IOA Laboratory School took place for students on the diploma course by distance learning. It is interesting to chat to them about their experiences so far, and they gave good reports of the tutorials taking place in our new seminar rooms at Milton Keynes. Dr Gary Seiffert, who runs the Laboratory School, recently returned from Dubai on an accreditation visit of a laboratory centre, which will be available to distance learning candidates, based in that region. If successful, the IOA will have laboratory centres in the UK, Ireland and the Middle East.

Best wishes for the New Year.

Barry Gibbs, President IOA

Engineering Division

By Blane Judd, Engineering Manager

Members of the Engineering Council attended head office on 29th November 2018, to review our processes as part of the Institute's licenses to offer professional registration. We hold licenses for both Incorporated and Chartered Engineer registration and they examined a number of candidates' documents. Feedback was positive and no major issues were raised. This feedback compares with the internal audit that was kindly conducted by Michael Swanwick CEng FIOA, earlier in the year, as part of our overall quality assurance processes. Credit for the success of the process goes to Emma Lilliman, IOA's Membership and Engineering Administrator, and the members of the Engineering Committee, chaired by James Hill BSc CEng MIOA of AAF Ltd. Special thanks also go to Andrew Monk-Steel, who supported the team and attended the Engineering Council visit.

Support and guidance

The team here at the Institute of Acoustics is dedicated to providing the necessary levels of support to assist members like you, through the process. We are recruiting more volunteers to the Engineering Committee so that we can increase support to the growing numbers of members who are coming forward for interview. We are now trialling guidance for those who do not hold exemplifying qualifications and so need to demonstrate academic attainment through experiential learning or technical reports.

Our next round of interviews will take place in February 2019 in Milton Keynes. We hold a number of interview events through the year, depending on how many candidates we have coming forward for registration and we are working with a number of candidates to prepare their paperwork in time for the next set of interviews. We can offer face-to-face interviews or by video link. If you are interested in taking the next step to becoming a professionally registered engineer, contact us on **acousticsengineering@ioa.org.uk** .

The requirements for academic qualifications for CEng and IEng changed in 1999. Pre-1999, an Honours Degree at 2:2 or above was required for CEng or a Higher Diploma/Certificate for IEng. Post-1999, this changed and for CEng, a master's degree was required or an ordinary degree for IEng.

There are two routes:
Standard route if you have the appropriate EC-accredited qualification (also referred to as an exemplifying qualification) in acoustics; and
Individual route, which requires further preparatory work from you before submitting evidence of your competence.

Remember that we are here to help you get through the process and advice and support is offered to every candidate personally.

For the individual route, the Institute accepts a number of courses in relevant subjects such as audio technology, from certain academic centres, as being equivalent to accredited courses for the purposes of EC registration, without the need for further assessment.

The Institute recognises the IOA Diploma course and the several masters courses linked to it as providing evidence if you are looking to gain CEng registration. You could also offer a PhD qualification, depending upon the content of the associated taught element. We can also offer support for registration via a 'technical report' route, if you do not have the relevant qualifications to help you demonstrate you are working as a professional engineer in acoustics.

The election process is overseen by the Institute's Engineering Division Committee, which is made up of volunteers from the membership, to whom we are extremely grateful. Representing the 300 or so members holding EC registration, they provide the essential peer review process that affirms that you are at the appropriate level for recognition as an Engineering Council Registered Professional Engineer.

The opportunity is there and we are ready to support you through it, so that you can become one of the 225,000 registrants that hold international professional recognition.

Institute Affairs

Fifty-one membership and applications have recently been approved by the Council following the recommendations of the Membership Committee. Of the total, 36 were new or reinstated, the remainder upgrades. One new application was received to be a sponsor for the Institute, which was approved.

Fellow

Rachel van Besouw	Neil Ferguson	Joel Lewitz

Affiliate

Dominick Gallagher	Edward Taylor

MIOA

Zanyar Abdairahman	Edward Barnett	Charlie Bladon
Tommy Burn	Mac Fuzellier	Piotr Golacki
Siddharth Grover	Lewis Herd	Will Kerr
Lilly Nikolova	Rohan Ramadorai	Jonathan Roberts
Adam Sharpe	Patrick Smith	Alexander Stoker
Aidan Tolkien		

Tech IOA

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Jack Human	Ian Inman	Steven Jakubowski
Thadchajini Jayadevan	Alison Marston	Samuel Monk
Paul Pearse	Dominic Perrett	Andrew Regan
Martin-Ricahrd Uusmae	Paul Robert	Thomas Shemeld
Drew Waller	Gregory White	Adam Woolley
Jessica Wright		

2019 CONFERENCE PROGRAMME

16 January
The new WHO Noise Guidelines for Europe
London

12 February
Organised by the Young Members Group
The Art of Being a Consultant
Salford

17-18 April
Organised by the Underwater Acoustics Group
Sixth International Conference on Bioacoustics
Loughborough

13-14 May
ACOUSTICS 2019
Milton Keynes

For up-to-date information visit www.ioa.org.uk

IOA membership benefits

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Make the most of your IOA membership.

We've created a simple scoring system so you can check your level of engagement with the IOA. Work out your score and see if you are taking full advantage of our wide range of member services and benefits.

Next to each activity, there's a score to mark your level of involvement. Adding these up will give you an idea of your current membership engagement and it also serves as a reminder of some of the benefits you may have been missing.

IOA meetings and events
The IOA organises monthly meetings, branch activities and conferences, with details published in our monthly newsletter and on the website (**www.ioa.org.uk**). These events provide opportunities to discover, learn and network. Give yourself 2 points for every meeting/event you are likely to attend in 2019. (Points: 2+).

Your score: _____

CPD hours
IOA meetings/events and training also contribute to your Continuous Professional Development (CPD) hours. Ongoing learning is a key part of keeping yourself readily employable and in high demand in the acoustics workforce, and by getting more involved with the IOA you can accrue CPD hours. Give yourself 2 points for every CPD meeting/event you are likely to attend and 5 points if you are taking or planning to take any of the IOA education courses in 2019. (Points: 2+).

Your score: _____

Networking
IOA activities provide an ideal environment for members to maintain their personal contacts with colleagues. This friendly networking environment is a key member benefit. Give yourself 5 points if you plan to network at some of the IOA events/meetings, and add an extra 10 points if you plan to do this regularly. (Points: 5+10 = 15).

Your score: _____

Local and specialist areas
Specialist interests are catered for via IOA specialist groups, and regional activities are promoted by their corresponding regional branches. The work of the Institute relies heavily on the voluntary efforts of many members of Council, Standing Committees and the Group and Branch Committees. Add 5 points if you plan to attend the IOA locally, or in a specialist area in 2019. If you get involved in both areas, add 10 points. (Points: 5+)

Your score: _____

Keeping up-to-date with IOA
The Institute publishes its bi-monthly Acoustics Bulletin, in both paper and electronic formats, containing articles of professional, academic and technical interest and we publish a newsletter each month. Give yourself 10 points if you regularly read the IOA Bulletin, and another 10 for reading the newsletters. (Points: 10-20).

Your score: _____

Education
The IOA is expanding its educational programme for UK and international students via distance learning, comprising a Diploma in Acoustics and Noise Control and several Certificate of Competence courses offered at a number of centres throughout the UK. The Diploma is also available by tutored distance learning directly by the Institute. Give yourself 20 points if you are planning to get involved in any of these in 2019.

Your score: _____

Medals and awards
The medals and awards programme is wide-ranging in its acknowledgment of academic achievement, practical engineering applications and innovations, student achievement, contributions to the Institute and to the world of science and technology. Give yourself 10 points if you plan to be involved in any of the medals and awards through submission, recommendation, or as an attendee at an awards citation. (Points: 10).

Your score: _____

IOA Elections
Each year, the Institute's Council is elected and members are put in charge of running and managing the various groups, branches and standing committees. There are many opportunities to become more involved in the way that the IOA serves the professional acoustics communities in the UK and internationally. Give yourself 25 points if you are planning to get involved in any of the IOA's committees. (Points: 25+).

Your score: _____

Lobbying and advice
The Institute engages with politicians and influencer groups to provide rigorous scientific insights on the challenges and impact that acoustics has on our world. Members are encouraged to contribute to these discussions. Give yourself 15 points if you plan to contribute in any way through speaking, submitting proceedings that have an impact on acoustics in our modern world, media relations, or any other kind of support. (Points: 15). Your score: _____

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The Institute provides career guidance and advertises the latest jobs on its website and in the monthly newsletter. The IOA encourages new entrants into the field and works closely with schools, colleges/universities and professional groups. Give yourself 10 points if you are planning to be involved in giving career guidance via the IOA in 2019, or plan to take an interest in advertised jobs. (Points: 10).

Your score: _____

Acquiring knowledge
The IOA proceedings have all been digitalised. These record the annual 200+ papers presented at our formal meetings, and are accessible to our members online or in the archive held at Southampton University. A library of professional acoustics books are also available at the Milton Keynes head office. Give yourself 10 points if you plan to access proceedings by the IOA and/or research books. (Points: 10).

Your score: _____

YOUR GRAND TOTAL: _____

How did you score as an actively engaged IOA member?

If you scored:

Under 20 points – Very light engagement. There are many more ways you can become more involved with the IOA and take advantage of our range of services.

21 – 40 points – Moderate engagement. You're well on your way to taking full advantage of the IOA's range of services and benefits, but there's so much more you could be doing.

41 – 60 points – Active engagement. You're already benefiting from the broad range of IOA services and benefits, and you may wish to become even more involved.

61 – 90 points – Highly active engagement. Congratulations, you are highly active with the IOA, and a key contributor to the ongoing success of the Institute.

91+ points – Ninja engagement. You're a Ninja user across the IOA's range of services and benefits. Thank you for all your valued support and participation.

We look forward to working with you in 2019 and beyond.

IOA award for Dr Ramamani Vasudevan

Dr Ramamani Vasudevan has been presented with an award for Services to the Institute.

This award acknowledges the debt owed to individual members who have provided sustained assistance over the years in some way with the running of the Institute.

Citation for the award:

Dr Vasudevan (Latha) has taught the IOA Diploma and MSc courses in Acoustics at NESCOT since circa 1992, initially working with Dr Bob Peters, and then subsequently as course leader since Dr Peters retired.

She also taught on the IOA Certificate of Competence courses in Workplace Noise Assessment and in Environmental Noise Measurement at NESCOT during this period. The MSc course gave the opportunity for IOA Diploma holders to use their Diploma to extend their study to gain an MSc qualification in acoustics.

Latha has been an IOA Diploma Tutor for more than 20 years, and it is likely that without her dedication and commitment, the course, particularly in its later years, when she single-handedly ran the Diploma, MSc and Certificate of Competence courses at NESCOT, would not have survived at NESCOT for as long as it did. Latha has also been an active member of the Education Committee, and has served for many years as an examiner for the Certificate of Competence in Environmental Noise Measurement.

The IOA is delighted to present Latha Vasudevan with an award for Services to the Institute 2018.

Dr Ramamani Vasudevan receiving her award from Professor Keith Attenborough, HonFIOA, IOA Education Manager

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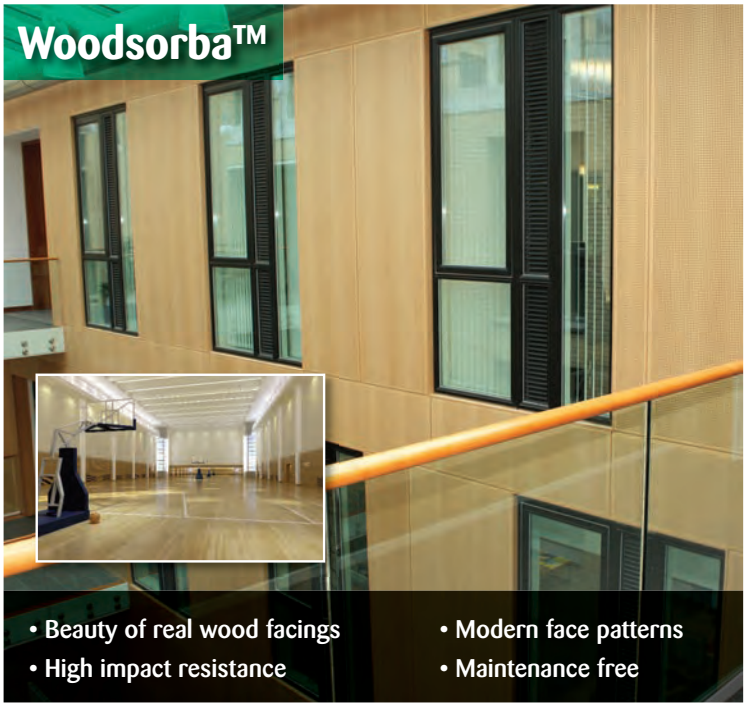

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Eastern Branch

Uses and abuses of sound power levels in noise impact assessments

By Jody Blacklock, Eastern Branch Secretary and Technical Director at Create Consulting Engineers Ltd

This was always going to be a well-attended event, considering the hot topic from such a knowledgeable source. Simon Scott is the Technical Permitting Specialist at National Permitting Service and his presentation touched on the basics of the various sound power level calculation methods, which we all are familiar with, but importantly, he delved into the depths and related issues with this and the long-standing Rathe theory.

I'm sure that we all know how sound is attenuated with distance, and that plane sources act differently to point sources, but Simon took this a step further in this presentation and provided real life examples of previously submitted noise impact assessments.

Whilst members of the technical permitting team were interrogating these reports, large deviations were discovered due to inconsistencies. In some cases, the sound power level had been incorrectly calculated by a factor of up to 20 dB. I have undertaken my own calculations for some fan units, and using the manufacturer's data sheets, found a difference of over 16 dB between the two sets of calculation methods, which could potentially result in catastrophic problems for any noise sensitive receptors.

This topic certainly drummed up a lot of post-presentation discussion, which hopefully benefitted all Eastern Branch members who attended. Many thanks again to Simon for a very interesting and well received presentation.

Southern Branch

IOA/ Chartered Institute of Environmental Health joint initiative – noise report framework

By Dan Saunders MIOA, of Clarke Saunders, and Southern Branch Chair

Local Authority Environmental Health Officers often encounter poor noise reports, usually in support of planning applications. Noise consultants often express frustration that Environmental Health Officers do not fully understand the reports submitted.

This joint initiative by the IOA and the Chartered Institute of Environmental Health (CIEH) seeks to address the concerns of both groups by agreeing on the elements which are important for the report writers to include and the report readers to check.

A previous pilot of this framework had been drafted back in 2013-2014 and in recent months, members of CIEH and IOA Southern Branch reconvened the working group to deliver a new, simplified and concise set of guidance notes for practitioners.

On Tuesday 16th October, Phil Tidridge, Chartered Health Practitioner from Winchester City Council and Peter Rogers, Sustainable Acoustics, presented the framework in an interactive meeting which resulted in lively debate and ended with the general consensus that the framework will have a positive impact by streamlining the consultation process.

Rather than a prescriptive set of criteria to be followed, the framework describes the process and conceptual model. Consultants are asked to complete a simple audit sheet to be appended to their report to demonstrate that this collaborative initiative has been followed.

A copy of the framework and the report audit sheet are available on the Southern Branch page in the members' area of the IOA website (**www.ioa.org.uk**). If you have any queries or comments, please contact Southern Branch.

If you would like to keep up-to-date with our activities, forthcoming events are posted under 'latest events' on the website. If you are not already a member, you can join by logging into the members' section.

Irish Branch

Noise policy and Environmental Noise Directive review

By Diarmuid Keaney

The Irish Branch had the pleasure of a detailed and very informative talk titled 'Noise policy and END review' on 22nd August 2018, presented by David Dodd of the Environment Advisory Unit of the Irish Department of Communications, Climate Action and Environment (DCCAE).

The event was well attended by Irish Branch members and provided an ideal opportunity to re-cap on key noise legalisation, the current position on the Environmental Noise Directive (END), some on-going Environmental Protection Agency (EPA) research, an update on wind energy

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development guidelines, the imminent WHO guidance* (at the time of writing) and Transport Infrastructures (TII) road noise updates.

The initial part of the presentation consisted of the definition of legislation that can be applied to noise matters, how it can be applied to specific situations and what powers that local authorities and the agencies have in relation to the control of noise.

The presentation discussed the aims of the END and the progress that the Republic of Ireland had made with regard to compliance and meeting the requirements of the END. The presentation touched briefly on common approach methods that have been adopted within the END, such as Common Noise Assessment Methods in Europe (CNOSSOS-EU).

Branch members were interested to see that some of the widely available published data suggests that up to 20% of member states still have not submitted all their noise maps for the first two rounds (2007 and 2012) and nearly 50% have not completed noise action plans.

The presentation touched on Dublin Airport's new northern runway and Fingal County Council's development plan (2011-2017). The presentation also included a discussion on some EPA-funded projects into research regarding the effects of traffic noise, as well as the National Planning Framework Document 2040, where National Policy Object 65 aims to promote the pro-active management of noise where it is likely to have a significant adverse impact on health and quality of life.

It is worth mentioning, that the Irish Branch of the Institute of Acoustics, made a submission and contribution to the National Planning Framework Document 2040 as part of the consultation process, which was discussed at the talk. The imminent new Irish wind energy guidelines were discussed, which are likely to include a more stringent noise limit, a visual amenity set back, elimination of shadow flicker and engagement with local community dividend measures.

The presentation then gave us some samples of TII's strategic noise maps, where they could be sourced online and the expanse and magnitude of the project. The presentation was very informative and worthwhile and a great overview of environmental noise legalisation, policy, directives, research and emerging guidance in the Republic of Ireland.

There was an engaging question and answer session and a discussion about the possible drafting of planning guidance on noise to help local authorities with the preparation of noise conditions during the planning process.

The meeting also included the Irish Branch AGM, at which Eugene McKeown of RPS Group stood down and was replaced by Paul McCullough of Armagh City, Banbridge and Craigavon Environmental Health. The role of Young Members' Representative was filled by David Coon of Ulster University.

*See page 54 of this issue for more information on the WHO noise guidelines.

Yorkshire and North East Branch

Autumn meeting reports

By Donald Angir AMIOA

In September, members of the Yorkshire and North East Branch enjoyed an informative presentation in Sheffield by Matt Torjussen, looking at the reference method for evaluating tone audibility in BS4142:2014. Noise samples were generated and subjectively evaluated by the attendees. A comparison with the objective method for assessing tonality was made and a lively discussion followed. The poor correlation between the subjective and objective method was demonstrated. Methods for objectively assessing tonality were presented and discussed.

Matt Torjussen presenting at the September Yorkshire and North East Branch meeting

In October the Branch joined forces with the Audio Engineering Society (AES) UK and the IOA Speech and Hearing Group for a screening of the film; 'In Pursuit of Silence' by director, Patrick Shen, at the University of York. The film is a meditative exploration of our relationship with silence, sound and the impact of noise on our lives.

In November, Charles Edgington, who has over 30 years' experience working with office noise provided a discussion on the practical considerations and experiences with sound masking. The meeting was held at the University of Sheffield and involved plenty of discussion with a lively atmosphere, which was enhanced by a practical demonstration of a noise masking system in action.

Midlands Branch

Professional practice guidance on planning and noise

By Young Youn

In May, the IOA Midlands Branch meeting was held at WSP in Birmingham for a presentation on the recent publication of ProPG. Colin Cobbing from Arup Acoustics introduced ProPG following his involvement in authoring the document. This presentation was rather more of a discussion on ProPG and our use of it in practice for environmental noise assessments.

Colin asked the audience what they thought of the document and whether anyone had already implemented the principle of the document into a project. He then explained how this document was initiated, developed and published. Acoustics was noted as a planning consideration that the public and local authorities take as an important environmental element to our lives. ProPG is aimed at practitioners to include good acoustic design.

ProPG provides a two-stage assessment, however, this two-stage assessment is not meant to determine the eventual planning conditions. The stage one assessment is to identify potential risks and manage them at the early stage of project, so the risks are minimised. The stage two assessment is to demonstrate evidence to the decision makers that good acoustic design has been achieved, considering the existing environmental conditions on a site. Furthermore, where practically possible, there is an emphasis on making the environment a more attractive place to live.

To finish his talk, Colin emphasised the variations that would occur on each planning case. Ideally, all practitioners should provide their experience on adopting good acoustic design so that the guidance can be improved.

The IOA Midland Branch would like to thank Colin for an interesting talk/discussion/presentation on ProPG and thanks to WSP Birmingham for hosting the event.

National noise attitude surveys

By Young Youn

In June, Charlotte Clark of Arup Acoustics presented the findings of the recent national surveys of noise attitudes undertaken by Defra, including the National Noise Survey 2012 and the Survey of Noise Attitudes 2013. Comparisons in the results were presented including the results from a previous survey undertaken in 2000.

Charlotte described the elements that contribute to current attitudes of environmental noise among the population, such as sleep disturbance, noise annoyance, ischaemic heart disease, cognitive impairment and tinnitus. Among those factors, noise annoyance was discussed further as well as acoustical factors (environmental noise sources) impacting the public

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attitude to environmental noise. Additionally, non-acoustical factors, such as the fear associated with the noise source, sensitivity to noise, expectations and anger can all influence people's attitudes.

The National Noise Attitude Survey 2012 was carried out by Defra as the UK Government Department with responsibility to manage environmental noise. From 2000 to 2012 there has been an increase in the proportion of respondents who report being bothered, annoyed or disturbed to some extent by the main man-made noise sources such as road traffic, neighbours, aircraft and building construction and demolition despite no increase in the proportion of the population hearing these sources. The findings from this study indicate that more and more people consider noise as an environmental issue.

The IOA Midlands Branch would like to thank Charlotte for giving an interesting talk and Arup for hosting the event.

How the Environment Agency regulates noise pollution

By Fiona Devine

In July, Jon Tofts and Tony Clayton of the Environment Agency (EA) came to the WSP Birmingham office to talk on 'How the Environment Agency regulates noise pollution'. Jon introduced us to the standard noise conditions set in environmental permits, then explained how the EA investigates noise complaints using a Common Incident Classification Scheme (CICS), which categorises the impact from noise ranging from Category 1 – serious effect on human senses to Category 4 – no impact. This was supported by examples of each category.

Finally, we were treated to an additional presentation by Tony on 'How well is uncertainty dealt with in acoustics reports submitted to the EA…or rather not'. Thank you to Jon and Tony for giving the presentation and to WSP for hosting the event.

University of Derby diploma projects 2018

By Heather Billin

September's Midlands Branch presentation featured three of the best IOA Diploma projects in the 2017/2018 intake at the University of Derby.

The trio of presentations covered a diverse range of topics, all presented with enthusiasm and fully deserved the awards presented by ANV Measurement Systems at the end of the evening.

Lewis Kelter started the evening with his talk 'The effect of anthropogenic noise on migrating fish in the UK', presenting an overview of how fish perceive noise and are affected by it and differences between how noise travels underwater.

He described the measurement element of his work conducted in the Albert Dock in Liverpool. In the absence of a hydrophone, this was based on airborne noise measurements at different distances from works near the water in the Albert Dock area and a transfer function to convert airborne to underwater noise levels.

The second talk was given by John Evans, 'Using tranquillity rating prediction tool (TRAPT) to assess tranquillity rating of Ashbourne Park'. He discussed definitions of tranquillity, his review of the literature, particularly following research based at Bradford University.

The practical element of the project was undertaken in a park in Ashbourne, with a busy road running to the side, measuring noise levels at a variety of locations. Volunteers filled in questionnaires standing at each location in the park to give a subjective tranquillity rating. He presented the results of his analysis to find which tranquillity rating model was closest to the subjective responses.

Finally, Anthony Coraci presented his project work on 'Measurement of road traffic noise exposure for cyclists on suburban roads'. Anthony's experience as a regular cyclist was used to good effect providing a practical bias for the project. Following a review of previous work, he undertook measurements on his typical bike journey to work and compared the results to the Noise at Work Regulations, concluding that they did not exceed the lower exposure action value and that the right ear is exposed to a higher noise level than the left.

The Midlands Branch would like to thank the three presenters for their excellent presentations and for Mike Breslin, Kiran Mistry and Jon Harriman of ANV Measurement Systems for sponsoring and presenting the awards. Special thanks to Dr John Pritchard for inspiring and recruiting the speakers and to the University of Derby for hosting the event.

John Evans presenting

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

IOA Diploma results 2018

By Professor Keith Attenborough, HonFIOA, IOA Education Manager

In 2017/2018, the IOA Diploma in Acoustics and Noise Control was delivered as a centre-based course at four institutions; (Derby University, Leeds Beckett University, Solent University and London South Bank University) and in its tutored distance learning (DL) version through four centres; (St. Albans, Trinity College Dublin, Bristol and Napier University).

There were 112 registered candidates (including 15 resits) for the General Principles of Acoustics (GPA) Module in 2017. This is lower than last year (123) and well below the peak of 216 in 2006. There were 11 candidates for examinations in Regulation and Assessment of Noise (RAN), 48 for Noise and Vibration Control Engineering (NVCE), 82 for Building Acoustics (BA) and 47 for Environmental Noise Measurement, Prediction and Control (EN).

Of the 102 registered for the project module, two candidates are listed as having failed the project in the table of results, but 28 of these did not submit and will be required to repeat the project module next year.

Short answer questions about A-weighting, BS4142 terminology and hearing loss respectively, in the General Principles of Acoustics written paper, were answered well. A longer question on process plant levels was most popular and answered well. A question requiring interpretation of the equation for a single frequency wave was least popular but, nevertheless, answered well by some candidates. Questions on noise impact assessment and construction noise and vibration mitigation respectively were popular, but not answered particularly well.

GPA coursework assignment topics were:
1. Sonic weapons, and
2. Noise from dockside operations,

resulting in mean marks of 68% and 74% respectively.

As in previous years, a merit threshold of 70% was applied to the written GPA paper and the conflated GPA mark. The examination scripts of candidates satisfying the conflated mark threshold but gaining between 67% and 69% on the written paper were examined at moderation, re-marked where appropriate, and judged individually as 'pass' or 'merit'. However, even if these criteria were satisfied, a merit was not awarded if the assignment mark was carried over from a previous year.

It was found necessary again to moderate some Centre marks for the Laboratory Module to bring them into line with those for DL candidates.

The specialist module coursework topics this year included vibration exposure of snowboarders (NVCE), design of a new train station building (BA), ProPG (RAN) and noise from a shooting range (EN). The mean mark for the BA assignment was significantly less than those for the other specialist module assignments. Indeed, the performance in the written examination for BA was also relatively poor, but these performances were considered and allowed for during the moderation meeting.

A criterion based on the means and standard deviations from the previous eight years was used again to decide whether or not to moderate marks for the specialist modules. On this basis, adjustments were made to the EN examination marks. To obtain a merit grade on the specialist modules, candidates were required to have conflated marks and written examination marks of at least 70%. No merit was awarded if it depended on a deferred score.

The numbers of candidates who gained merits (M), passes (P), or fails (F) in each module are shown for each Centre in the following table of results. The 'fails' include those who were absent from the written examinations. Three appeals against the results were not successful.

The prize for best overall diploma performance (based on gaining five merits for GPA, BA, NVCE, project and laboratory modules, is to be awarded to Kyriacos Demetriou (LSBU). Special commendation letters, offering congratulations on achieving four merits, have been sent to Dr Oliver Ryan (DL Dublin) who will be receiving the prize for the best overall diploma performance by an Irish student.

Barry Weldon (DL Dublin) has been awarded the 2016-17 ANC Prize for his project 'Quantifying fluid borne noise attenuation in automotive diesel fuel supply system and associated operation sonic velocity measurements'.

I would like to express thanks to all tutors and examiners, to Hansa Parmar who, sadly, has retired after many years in the IOA office, and to Edith Borowicz, who has taken over as Education Administrator, for their contributions during the 2017/2018 presentation year of the Diploma.

Project titles 2018

University of Derby

- A critical evaluation of measured noise levels by comparing the difference in noise measurement between those taken using a sound level meter and those taken using personal dosimetry
- The acoustic characteristics of barking dogs in relation to noise impact assessment
- An acoustic assessment of moveable partition walls
- Measurement of road traffic noise exposure to cyclists on main roads
- Using TRAPT (tranquillity rating prediction tool) to assess the tranquillity rating of ashbourne memorial park
- The effect of anthropogenic noise on migrating fish in the UK
- A critical comparison of the British Standards BS4142 1997 and BS4142 2014
- An investigation into the daily noise exposure of security staff at the Derby INTU shopping centre
- An investigation into the suitability of using BS4142 (2014) to determine if noise from recreational activities constitutes a Statutory Nuisance under the Environmental Protection Act 1990
- An investigation into the noise footprint of different breeds of domestic dogs
- Review of assessment strategies for noise impact associated with skateparks.

Leeds Beckett University

- An investigation into noise exposure within the orchestra pit at Leeds Grand Theatre
- An analysis of the acoustic absorption of the human body
- An investigation into the acoustics at Howard Assembly Room: an

issue with the focusing of sound due to a concave recess
- An assessment of noise exposure to volunteers working on the Elsecar Heritage Railway
- Considering soundscape as a tool for urban design: a review and case study
- An investigation into the suitability of the guidance proposed in DIN 18041: 2016, 'Acoustic quality in rooms – requirements, recommendations and instructions for planning' and the parameter Strength, G for the design of open plan dining spaces within secondary schools
- Investigation of multi-microphone binaural systems
- Theatre acoustics: 'in-the-round' The Royal Exchange Theatre
- Sound power level determination of a HVAC unit
- An investigation into the airborne sound insulation performance of the music teaching facilities at Bury College
- The acoustic properties of the balloon burst method for testing reverberation times and comparisons to other standard methods
- An assessment of the background noise level, LA90 measurement procedure
- A comparative study of industrial noise predictions using iNoise Pro and SoundPLAN 8.0
- Design, testing and investigation of various perforated acoustics panels in rooms.

London South Bank University
- Noise exposure in a pet grooming establishment
- An investigation into impulse sound sources for determining impulse responses in room acoustics
- Evaluation of acoustics, ventilation and overheating guidance
- An investigation into the noise from hand car washes
- The accuracy and limitations of speech privacy auralisations
- An investigation into the acoustic performance of a small professional recording studio
- Enclosure suitability assessment for construction site operation
- Noise impact assessment on Peregrine falcons in relation to a planning application for rebuilding works at Mercury Theatre, Colchester
- An acoustic assessment of air source heat pumps in situ and a critical review of the existing methods of nuisance prediction
- Victorian houses' sensitivity to railway development
- An investigation into the transmission loss between cellular and open plan office spaces
- Sound quality improvement proposal and noise survey in LSBU product design studio space.

Solent University
- The impact of façade reflections in measurements of environmental sound
- Assessing the Mill at Sonning Theatre's auditorium using Impulse Responses
- Free-field vs diffuse-field microphones in the field measurements of airborne sound insulation between rooms
- The comparison of attenuation between GSS and plastic ductwork.

Distance learning (St Albans)
- Acoustics of an open plan office in Beirut-Lebanon
- Assessment of acoustics of a lecture auditorium
- An investigation of specific non-compliances with prescribed test methodologies when determining airborne sound insulation in accordance with BS EN ISO 16283-1:2014
- An investigation into annoyance caused by low frequency noise from open-air live music events
- Acoustic treatment of classrooms
- Acoustic design of an 8,500-seater multipurpose arena
- Why are re-entrant horns not used in tunnel PA systems? A study of horn loudspeakers and audibility performance in road tunnels
- The acoustic performance and privacy of partially open meeting pods in an open-plan office environment
- The use of acoustics in monitoring Apis melifera colonies
- Assessment of proper HVAC design practices for fan coil units
- Study of noise from an all-weather seven-a-side football pitch
- A comparative study between measured and calculated reverberation times in rectangular rooms
- Professional recording studio treatment.

Distance learning (Bristol)
- The impact on the noise rating of an industrial noise source when using both the subjective and objective methods for the assessment of tones
- Noise levels and motorcycle riding
- Investigation of how the distribution of acoustic drapes within a multi-purpose hall affects the reverberation time within the space
- Improvements in perceived intelligibility from source oriented sound reinforcement systems
- A pilot study to assess whether a specific criteria for low frequency noise at music festivals should be included in the proposed new Environmental Noise Control Guidance document
- A site suitability assessment – DfT calculations vs noise measurements
- The effects of vegetation on the attenuation of road traffic noise
- An examination of practical façade treatments by field testing in an area of high conflicting building uses.

Distance learning (Edinburgh)
- Relationship between traffic speed and traffic noise
- A predictive noise assessment for a floating, production, storage and offloading (FPSO) vessels turret
- Can a spreadsheet model of ISO 9613-2 methods be as accurate as the dedicated commercial software package CadnaA?
- Coming clean about noise – the truth Hz
- The appropriateness of public entertainment license noise conditions for the Kelvingrove Bandstand.

Distance learning (Dublin)
- Assessment of the suitability of two proposed sites for outdoor music concerts using current UK guidance and global guidance for similar events
- Alternatives to purpose built acoustic materials
- The examination of a mineral extraction site to establish if a sufficient development free buffer zone can be established around mineral extraction sites to protect occupants from excess noise
- Environmental noise from music concert and the impact it has on the surrounding residential area
- Optimisation of room reverberation in a meeting room using wall absorption
- Investigate and measure reverberation time of a rehearsal room used by a concert band and identify possible improvements to the acoustic characteristics of the room
- Examining speech intelligibility in university lecture venues.

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IOA Diploma results chart for 2018

Centre name		GPA	Labs	BA	NVCE	RA	EN	Project
Distance learning (Bristol)	Merit	2	3	0	1	2	0	2
	Pass	7	6	8	3	2	4	5
	Fail	0	1	1	1	0	0	1
Distance learning (Edinburgh)	Merit	4	2	0	0	1	1	1
	Pass	9	10	2	4	0	7	4
	Fail	0	0	6	1	0	1	0
Distance learning (St Albans)	Merit	5	7	2	1	1	4	6
	Pass	14	9	9	6	0	3	7
	Fail	1	1	7	6	0	1	0
Distance learning (Dublin)	Merit	4	3	0	2	1	0	3
	Pass	6	5	3	2	2	5	4
	Fail	0	0	1	0	0	0	0
Leeds Beckett University	Merit	6	9	1	3	0	4	8
	Pass	14	9	11	5	2	5	6
	Fail	2	0	3	2	0	4	0
London South Bank University	Merit	7	4	1	2	0	0	6
	Pass	5	6	8	7	0	1	6
	Fail	2	1	3	1	0	0	0
Solent University	Merit	2	2	1	2	0	0	1
	Pass	1	2	2	2	0	2	3
	Fail	1	0	1	0	0	0	0
University of Derby	Merit	3	2	1	0	0	3	3
	Pass	9	10	9	1	0	6	7
	Fail	2	0	2	0	0	5	1
Totals	Merit	33	32	6	11	5	12	30
	Pass	65	57	52	30	6	33	42
	Fail	8	3	24	11	0	11	2

Diploma awarded 2018

Distance learning (Dublin)

Corry C	Heavey D	Martin D
O'Sullivan AT	O'Sullivan M	Roche B
Ryan O		

Distance learning (Bristol)

Cole AR	Fit Al	Forbes D
Laughland EM	Martin-Granizo I	Reid J

Distance learning (Edinburgh)

Beaugas J	Birchmore R	Bruce N
Shaw W		

Distance learning (St Albans)

Al Khatib M	Ashworth MP	Drenda AL
Knoppersen OB	Larcombe AD	MacKenzie JW
McConnell RIW	Mekkawy MAA	Newby-Walker R
Tadete CA	Whiddett-Turle J	

Leeds Beckett University

Bryan LR	Chamberlain R	Hayes J
Latue RM	Latue RM	Muxworthy JP
Ridley MF	Sandhu J	Schofield J
Stevens J	Whitehall L	Williams SE

London South Bank University

Amorim d'Aquino G	Barnard JR	Croll I
Gallimore JA	Hawkins L	Keegan J
Kubis M	Woolley JP	

Solent University

Birch C	Demetriou K

University of Derby

Bird M	Cattell A	Coraci A
Evans TJ	Kelter LR	Ozimek J
Sloan-Sekiguchi T	Tesson-Fell SL	

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Certificate course news

By Professor Keith Attenborough, HonFIOA, IOA Education Manager

This contribution has two purposes:
1. To report on the results from the latest presentations of the certificate courses; and
2. To outline recent developments.

For the Certificate of Competence in Environmental Noise Measurement (CCENM) examination on 12th October 2018, there were 56 candidates (including two resits) at seven centres, of whom 42 passed and four did not take the examination (i.e. deferred). Shorcontrol gave a one-off additional presentation in December for 10 candidates from an Irish company who covered the extra costs incurred by the Institute.

EMAQ+, a commercial provider of courses for local authorities (LA), has approached the IOA seeking accreditation for a new Certificate of Competence in Noise Evaluation, Assessment and Regulation, intended primarily for environmental health officers who are new to noise-related duties and in the context that LAs are unable to support such staff to take the IOA diploma. Among other aspects, the proposal suggests only online tests. The proposal was discussed at a meeting at the IOA on 17th December.

There were 20 candidates (including two resits) at four centres for the October 2018 Certificate of Competence in Workplace Noise Risk Assessment (CCWPNRA) and all were successful. Tim Ward has agreed to take over as Chairman of the management committee (from Dave Lewis) and will lead the consideration of ways of altering the course to make it more attractive. Potentially relevant will be the results of the recent IOA members' survey, which has sought views on whether the IOA's short courses should involve online tuition and an online examination as well as practical activities.

There were six candidates for the Certificate of Competence in Building Acoustics Measurement (CCBAM) at Solent University on 14th September and all passed. The first CCBAM examination for six candidates seeking accreditation for sound insulation testing through the Air Tightness Testing and Measurement Association (ATTMA) was held on 27th July and five passed. It is planned to offer courses for ATTMA candidates in alternate quarters to those used for the regular CCBAM courses. There continues to be insufficient recruitment for CCIBAM so Irish candidates are being encouraged to take CCBAM.

The Certificate of Proficiency in Antisocial Behaviour etc. (Scotland) Act 2004 Noise Measurements (ASBA) was delivered by Bel Noise Courses to eight candidates including one resit in October 2018 and seven have passed.

The Certificate of Management of Occupational Exposure to Hand Arm Vibration (CCMOEHAV) will next be offered in spring 2019. Following Tim South's retirement, Gurmail Paddan, from the Institute of Naval Medicine (INM), has taken over as chair and continues as examiner. Tim South will continue part time at Leeds Beckett University to enable CCMOEHAV to be delivered there as well as at INM.

Lists of successful candidates

Environmental Noise Measurement

Colchester Institute

Booth G	Buckles RJ	Norfolk S
Patrick H	Rana-Calvo M	

University of Derby

Armstrong SE	Guest JM	Hallett KC
Harris JH	Okikiade R	Withrington DE
Zawadzki PA		

Leeds Beckett University

Brown CF	Caygill CL	Dennis A
Erskine-Naylor L	Murray D	Parsons SJ
Salmon LC	Towers K	

Liverpool University

Clothier W	Davies NP	Dzimidowicz A
Forster E	Hadden C	Isherwood H
Jones J	McKinney C	Owen TP

Shorcontrol Safety Ltd

Gonzalez Troya M	McSwiney C	Moloney K
Rea J	Walsh A	

Solent University

Attieh T	Chmel M	Cubillas Martinez C
Devine P	Gibbard V	Green SK
Megeney L J	Parker TWJ	Roberts C
Sumpter GTN	Totty W	

Bel Noise Courses

Jardine L	Mayes EC	Russo L
Wager I		

Workplace Noise Risk Assessment

University of Derby

Allen JM	Busuttil A	Clemett PA
Haley RP	Hunt M J	Mills HC
Pritchard AM		

EEF Sheffield

Jenkins DB	Maxwell AF	Pither D

Moloney & Associates

Clery MP	Cooney J	Dunphy R
Mc Caul S	Mc Gowan RT	Mythen CS
O'Connell S	Ramos JA	

Shorcontrol Safety Ltd

Kennedy D	Poots AE

Building Acoustics Measurement

Solent University

(ATTMA July)		
Cunningham B	Hale K	McLaughlin W
Thomson PJ	Whitfield D	
(September)		
Bacchus J	Casey D	Finn G
Harper AJ	Kharel RP	Sandford L

Anti-Social Behaviour Noise Act (Scotland)

Bel Noise Courses

Black D	Gale MD	Gow R
Hutcheon RL	Marquetty J	Tortolano D
Tortolano D	Ure M	

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Sound intensity basics

By John Campbell, Sales Director at Campbell Associates Ltd

Sound intensity measurement is a useful technique when more information is required about the acoustic environment, or the acoustic test conditions themselves are not suitable for traditional measurement techniques. As sound intensity is a vector quantity we know its direction of travel in addition to its amplitude, so we have more information than provided by a traditional sound pressure measurement. This gives us opportunities to isolate sound sources in more complex acoustic environments and mitigate the effects of background noise and reverberation. The most common use of sound intensity is for sound power measurements in accordance with ISO 9614 series of standards. It is also useful for mapping of sound sources and for determining the performance of building elements.

Definition of intensity:
The rate at which sound energy passes through an area perpendicular to the direction of propagation of sound waves. ⇒ Sound power per area [W/m2]. When measured it is normally expressed as dB intensity, I, re 10^{-12} Wm^{-2}.

Basics of the measurement

Sound intensity measurements require the measurement of the velocity component of the sound wave. There have been several attempts to develop direct reading sound velocity measurement probes using ultrasonic waves as a carrier, or temperature gradient methods, but experience has shown that a conventional two channel analyser with two phase matched microphones provides a verifiable and reliable measurement system. These instruments are covered by International Standards and there are also Standards that specify this method in measurement procedures, covering many applications such as sound power determination and building acoustic measurements.

The microphones are orientated face-to-face as shown in Figure 1, sound travelling *along* the axis of the two microphones will arrive at one microphone before the other and hence we know the direction and velocity of the sound.

A sound wave travelling *across* the axis will arrive at both microphones at the same time and will therefore have zero velocity.

The sound pressure is determined from the average value of the two microphones. So, we have the two parameters we need to determine sound intensity; the velocity and the sound pressure.

As intensity is the product of sound pressure and sound particle velocity, I = P.V, then as the time taken for the fixed distance between the microphones gets shorter, the velocity gradient, and hence the intensity, increases. When the sound wave is across the axis the velocity gradient is zero and so is the intensity. The system therefore has a figure of eight response with zero response across its axis and can resolve +ve and -ve magnitudes and direction along its axis.

The distance between the microphones is important for the measurement as this controls the effective measurement range in terms of frequency. To measure low frequency (longer wavelengths) we need a bigger distance. This distance is controlled by spacers (three shown in image below), which typically range from 6mm to 100mm. Figure 1 also shows the typical frequency range by spacer. Note; with advances in signal processing and phase calibration, it is possible to measure a wide frequency range in a single measurement.

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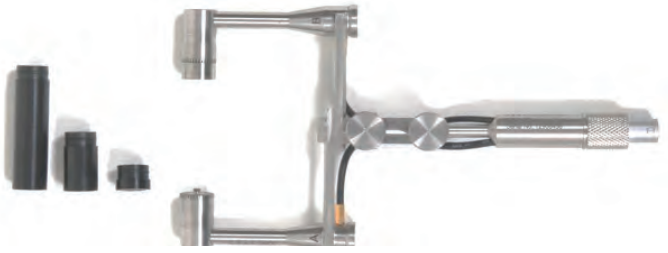

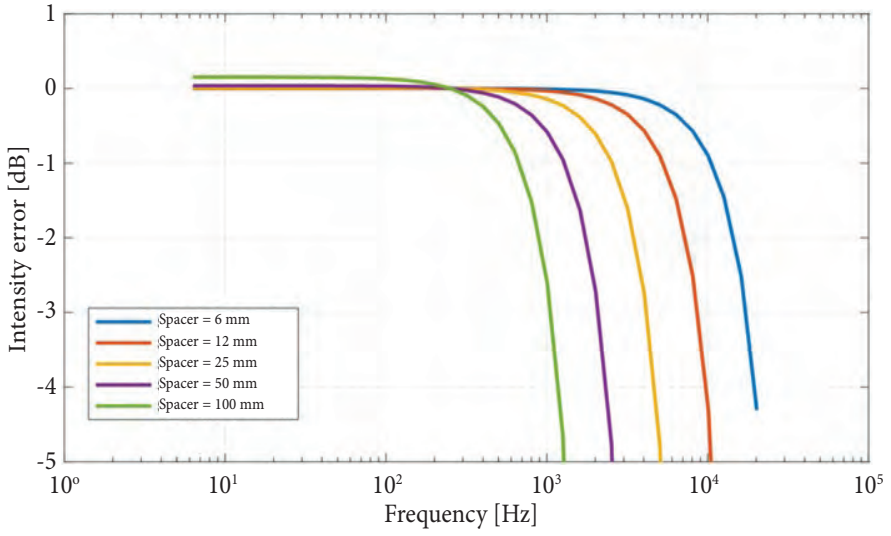

Figure 1. Intensity probe with spacers and frequency range

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Phase calibration

Sound intensity systems require the two measurement channels to be closely phase matched so that the time difference in the signals delivered from each channel are not distorted in the instrument. So, measurement microphones are carefully selected and paired for intensity systems. To verify this phase match before each measurement, an additional calibration procedure is required. For this the two microphones are placed in a phase calibration coupler as in Figure 2 below, and as the same signal is applied to both channels the complete system is checked in terms of phase.

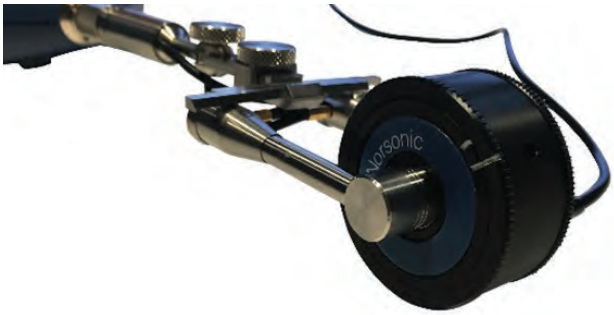

Figure 2. Phase calibrator

Applications for sound intensity

1. Sound intensity and sound power

In situ and laboratory sound power measurements. ISO 9614.
This enables us to accurately calculate sound power of equipment in situ, which is popular where equipment already installed and operating, is too large, or requires special services to operate; thus making moving to a laboratory or test area impractical for traditional sound pressure ISO 374x series tests.

The basic theory of the standard is to draw an imaginary test box encompassing the object under test. By measuring the average sound intensity for this surface and knowing the dimensions it enables sound power to be directly calculated. The assumption is that any sound entering from outside the box will decrease the sound intensity on the face it passes into, and increases the intensity on the side it leaves from. The net effect is that the total intensity, and therefore the sound power, remains unaffected. This minimises the influence of reflections and background noise. Note; background noise and the source under test should remain constant.

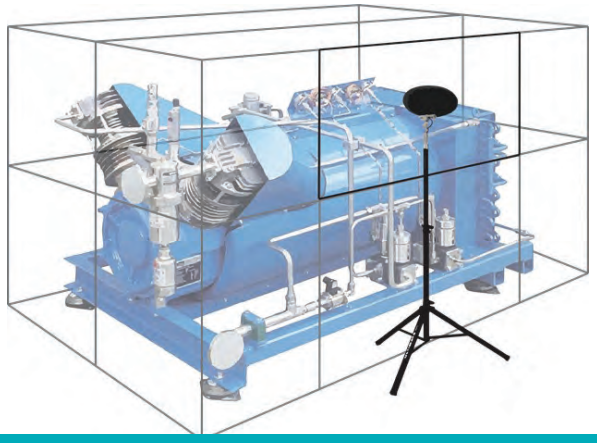

Figure 3. Part 1 – the fixed point method

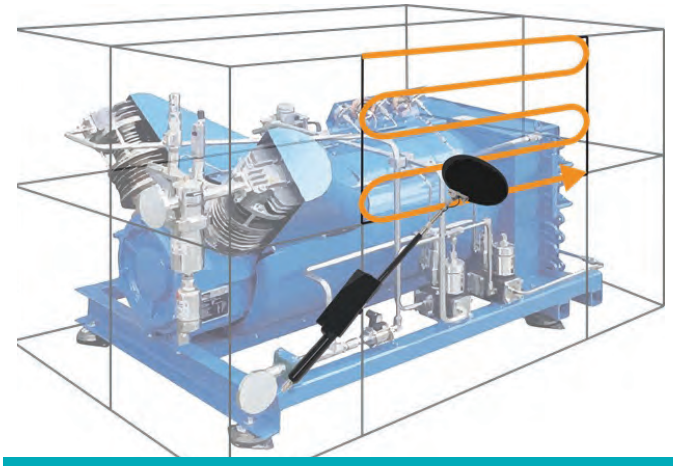

Figure 4. Part 1 – Parts 2 and 3 – scanning methods

ISO 9614 is divided into three parts:
Part 1: Measurement at discrete points (Figure 3).
Part 2: Measurement by scanning (Figure 4).
Part 3: Precision method for measurement by scanning.

Summary of ISO 9614 Parts 1, 2 and 3 can be seen in the table below. This summarises the accuracy grades associated with each measurement technique with the standard deviation and reproducibility in dB.

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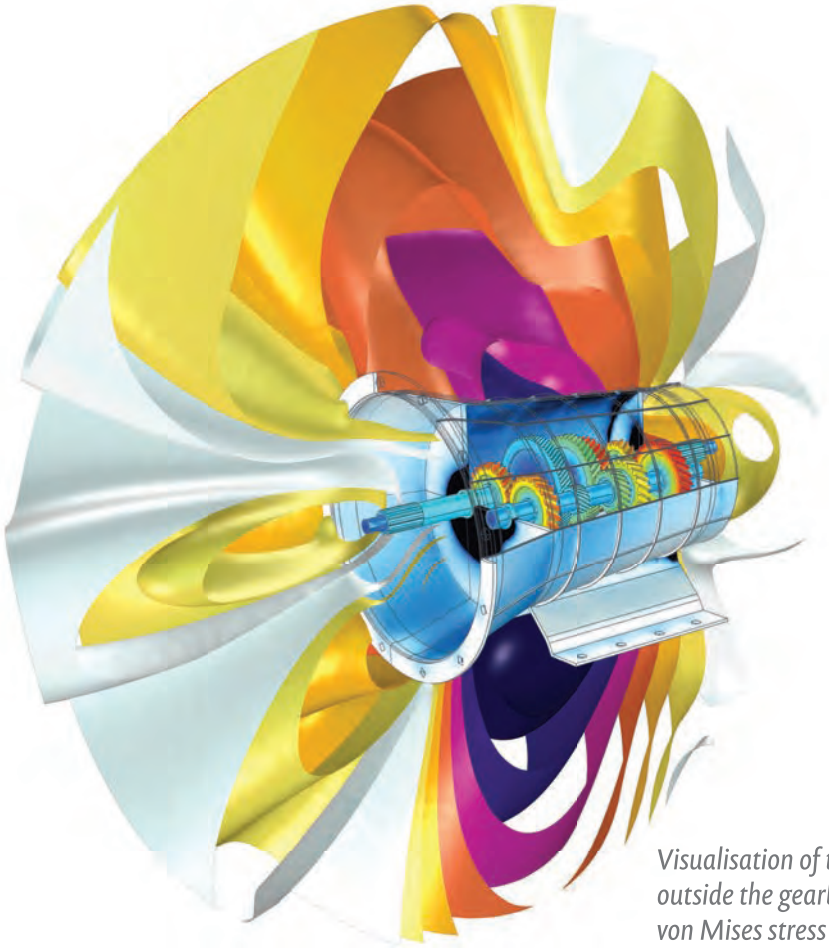
Standard	Measurement method	Accuracy grade	Test room	Character of noise from the source	Standard deviation of reproducibility [dB]
ISO 9614-1	Broadband, narrow-band or discrete frequency, if stationary in time	Precision, engineering or survey	Any	Broadband, narrow band or discrete if stationary	1 1.5 4
ISO 9614-2	Broadband, narrow-band or discrete frequency, if stationary in time	Engineering survey	Any	Broadband, narrow band or discrete if stationary	1.5 4
ISO 9614-3	Broadband, narrow-band or discrete frequency, if stationary in time	Precision	Any	Broadband, narrow band or discrete if stationary	1

How noisy is this gearbox design?



Visualisation of the noise pressure level outside the gearbox and vibration-induced von Mises stress in its housing.

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Troubleshooting

For measurements to be valid, certain conditions should be met. If not, you may have to report your test as a lower accuracy grade or repeat your measurement. These conditions are quantified and expressed as field indicators. They are detailed in in ISO 9614 and measurement systems will record these and indicate if they invalidate your measurement.

Field indicators:

- Repeatability – Too much variation in your data.
- Dynamic capability too low – You have reached the limits of your measurement system.
- Extraneous intensity – Indicates the difference between negative and absolute intensity.
- High Fpi – Indicator that sound field is too reactive.

Sound insulation measurements

ISO 15186-2:2010 Measurement of sound insulation in buildings and of building elements using sound intensity.

Part 1 covers laboratory measurements and Part 2 covers in situ measurement of sound insulation of walls, floors, doors and small building elements. Sound intensity enables us to measure the direction of the sound and localise sources. We can therefore gather information on certain parts of a partition in addition to calculating the sound reduction. ISO 15186-2 claims to have better reproducibility than ISO 140-4, -10

These measurements enable us to:

- Analyse flanking transmission.
- Compare with laboratory measurements, where flanking is suppressed.
- Rank partial contributions of building elements.
- Validate BS EN 12354-1 models.

The basic principle is to place a speaker in the 'source room' adjacent to the 'receive room', which is separated by the partition to be tested. A number of measurements are made in the source room to obtain the average sound pressure. Knowing the area of the partition of the source room, the incident sound power in the source room can be calculated. The sound power for the partition in the receiving room is calculated using the same principals as described in ISO 9614, by scanning the test area in sections. This is shown in Figure 5.

The difference in these two sound power values allows us to calculate the intensity sound reduction index.

The calculation can be seen below. The first term relates to the source room surface sound power and the second; the receive room radiated sound power.

$$R'_I = \left[L_{p1} - 6 + 10 \lg \left(\frac{S}{S_0} \right) \right] - \left[\overline{L}_{I_n} + 10 \lg \left(\frac{S_M}{S_0} \right) \right]$$

L_{p1} is the average sound pressure level in the source room;

S is the area of the separating building element under test or, in the case of staggered or stepped rooms, that part of the area common to both the source and receiving rooms;

S_M is the total area of the measurement surface (s);

$S_0 = 1\ m^2$

Limitations of measuring to ISO150186-2:

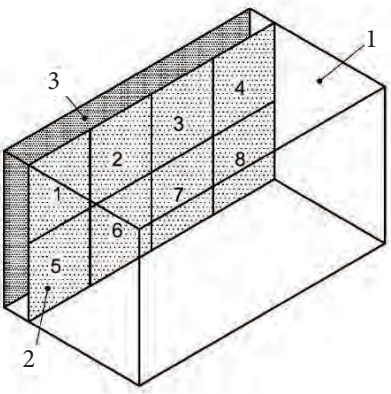
Receiving room cannot be too reactive or reverberant for measurements to be valid.

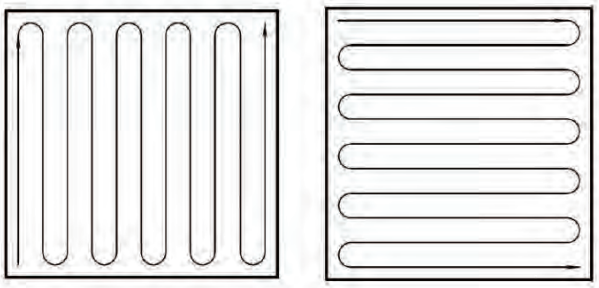
Repeatability of intensity scans can be an issue.

Conclusion

Sound intensity measurement systems have been available for many years but have tended to be complex and bulky bits of equipment to use. Advances in technology have meant small, two channel analysers can now do the job, and also guide users with an interface dedicated to the application. Intensity measurements are now far easier and provide an excellent option to the acoustic professional.

Figure 5. ISO 15186-2 sound intensity measurements





Key:
1 Receiving room
2 Measurement surface divided into eight sub-areas
3 Building element under test (dark shaded area)

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The Noise and Vibration Engineering Group

Noise and vibration control in sustainable engineering design.

By Malcolm Smith (ISVR Consulting), Ashley Gillibrand (Jaguar Land Rover), and Nathan Thomas (Dyson), all members of the Noise and Vibration Engineering Group (NVEG) committee.

The aim of the meeting was to offer different perspectives on how to rise to the challenge of sustainable noise and vibration engineering. Topics included lowering energy consumption, choice and use of materials, improved robustness for longer life, and the use of virtual methods to create more sustainable designs and reduce prototyping. The meeting also hosted a lively panel discussion on the critical sustainability issues we face today and in the future, and the potential impacts for noise and vibration engineering.

Acoustic design of lightweight cabin walls for cruise ships, presented by Malcolm Smith (ISVR Consulting, University of Southampton)

Ship design is increasingly moving towards the use of lightweight materials to reduce fuel consumption, but the acoustic transmission loss of composite panel materials for partition walls is generally worse than their metal counterparts. Malcolm provided a review of the acoustic design problem for a lightweight cabin structure, and discussed approaches to making most efficient use of the mass, stiffness and space available to reduce noise transmission. He examined the issues with relying on laboratory measurements using the Weighted Sound Reduction Index (Rw), when verification relies on in-situ measurements using the Weighted Apparent Sound Reduction Index (Rw'), leading to significant differences in performance. As a result, engineering design to meet the contrasting weight and acoustic requirements demands a full understanding of both the sound transmission characteristics of the partition wall, and the acoustics of the cabin interior. A variety of numerical and experimental techniques were deployed to investigate the problem. The danger of using single number specifications was highlighted, and he discussed proposals for a more nuanced approach to acoustic specification for future sustainable ship design.

Validating vehicle designs for noise and vibration harshness using driving simulators, presented by Ashley Gillibrand (Jaguar Land Rover)

New vehicle design requires sustainable solutions to reduce development time and minimise the use of materials and resources. Full vehicle driving simulators are a key technology to reduce the usage of prototypes and to understand how engineering designs will impact noise and vibration harshness. To understand performance at an early design stage, novel approaches are required for the integration of information from numerous sources. Ashley presented the data and methods required to develop a virtual acoustic vehicle simulation, along with a live demonstration. Delegates were given an immersive aural and visual experience as the simulated vehicle was driven round a test track, and the acoustic impact of the various vehicle noise sources and transmission paths was investigated.

Conceptual design and optimisation of silencers, presented by Simon Roberts (ISVR Consulting, University of Southampton)

Sustainable silencers of the future need to perform acoustically and be efficient in terms of aerodynamic flow losses, use of materials, space and weight. The design of reactive mufflers has historically relied on analytical 1D codes, which can quickly provide assessment of the performance of simple components and layouts, but result in rather crude designs. Access to 3D numerical tools, such as FFT-Actran, has improved prediction capabilities for complex geometries, but models are generally expensive to set up and run and so are more suitable for the detailed design phase, where the full design space cannot be explored any more. Simon explained how 3D numerical tools can be used in conceptual design in order to develop an efficient and accurate silencer design. By taking advantage of python scripting, schematic muffler components can be quickly assembled and optimised to achieve specific sound quality performance for a given set of sustainable design constraints (weight and space). He also showed how the optimisation loop could potentially be extended, to reduce aerodynamic noise and flow losses, using computational fluid dynamics.

The use of statistical energy method to help optimise the sound package design within a refined vehicle, presented by Steve Fisher (Jaguar Land Rover)

To create more sustainable vehicles and reduce emissions, weight reduction is key. Understanding precisely how noise transmits through a vehicle, and optimal placement of noise control treatment for maximum acoustic performance, allows more efficient use of materials, and lower weight. Finite Element Analysis has been successfully used to help improve the structure of the vehicle, but is not appropriate at much higher frequencies where air borne noise is dominant. Steve demonstrated how Statistical Energy Analysis (SEA) can be used at higher frequencies, to investigate and optimise noise control treatment used within a vehicle. The approach identified lower performing treatments, which could be removed to save weight and materials, along with the critical transmission paths which could benefit from targeted treatment. Deploying SEA at an early design stage can help ensure that design decisions are made with acoustic performance in mind.

Engineering a quieter and lower energy hand dryer (Airblade V), presented by Nathan Thomas (Dyson)

For products of the future to be more sustainable, lower energy consumption is required. Nathan described the noise and vibration challenges encountered in designing a high performance, lower energy hand dryer, the

P32 ▶

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second generation Dyson Airblade V. The core product function, flow architecture and key noise and vibration sources were identified along with an insight into the design vision and the fundamental physical mechanisms for drying hands. He described the development and validation of a predictive model for aerodynamic noise from low aspect ratio rectangular jets, and how this was incorporated into a system model to set the key product engineering parameters to achieve the optimum balance of drying performance, energy efficiency and noise. The aerodynamic performance of the Dyson V4 digital motor was discussed, along with the challenges associated with integrating a compressor into a product such as stall, rotating instability, and an aural demonstration of their impact on acoustics. The methods used to solve these problems were presented along with an insight into the innovative and offbeat approaches used within Dyson as part of the product development cycle. He concluded with claims of a 40% improvement in energy efficiency, 8 dB reduction in noise, and the signature class-leading performance expected of Dyson products.

The last session of the afternoon was a panel discussion, chaired by Ashley Gillibrand, on the critical sustainability issues facing our industries, including:

1. What new noise and vibration challenges are on the horizon due to new legislation?
2. How will the skillset of noise and vibration engineers need to change to meet the needs of a sustainable future?
3. What industry trends do we expect (power density / smaller / lighter / recycled materials) and how will this impact noise and vibration engineering?

New legislation challenges

The first discussion considered that legislation could take two forms: direct legislation on noise in the workplace, in the environment, or on products and machinery; and the indirect effect of legislation on other matters.

For direct legislation;

- whether the control of noise at work 85 dBA upper exposure action value might be reduced to 80 dBA at some point in the future;
- whether recent deafness claims in the music industry could lead to new legislation;
- possibilities for changes in legislation on grounds of nuisance or safety, including aircraft noise, nuisance from drones and on-shore wind farms,
- the hazards of electric motor vehicles and industrial machinery; and
- for product and machinery design, country or region-specific energy labelling.

With respect to the indirect effect of other legislation on noise and vibration engineering, the most likely areas where there could be an impact was legislation on energy efficiency or recyclability of products, which might add additional design constraints into the noise control problem. Examples included the prospect of new rules on natural ventilation in buildings and the eco design of consumer products.

Sustainability

The second discussion highlighted that many things will change over the coming years, however, the fundamentals of physics will not change, and a solid grounding must be gained as the starting point for any noise and vibration engineer. Artificial Intelligence is likely to replace the modelling that we do now, requiring our knowledge and guidance to set up place limitations and validate them against 'real world' data, adding the context and scrutiny. Core human skills, such as effective communication, will still be required. Since the IOA membership has shifted from academic to practitioners, communication becomes more critical internally to be able to link ourselves up effectively, and better promote acoustics as an important solution that forms part of sustainability. Part of this will be creation of a common language (word for positive sound for instance, soundscaping terms, clear narrative). It was agreed that the biggest need of all is for acousticians to know more about sustainability, and how that can contribute to sustainable outcomes in whatever field they operate in.

Industry trends

The final discussion examined materials, recycling, lifecycle management, electric motor technology and psychoacoustics.

- **Materials:** new passive technologies such as metamaterials incorporating Helmholtz resonators may offer lightweight solutions for noise isolation for specific applications. In addition, materials with embedded transducer technology offer the opportunity to integrate active control into a structure. A number of 'ecological' material choices are being offered for sound absorption, such as wool-based panels.
- **Recycling:** some interesting innovations are starting to improve sustainability by using waste from one industry in another. One example was use of waste calcium carbonate from the sugar refining industry as a filler for barrier layer materials in automotive acoustic packs. Minimising material use in the first place has significant value for sustainability via efficient design, or, for example, designing open plan offices to remove requirement for wall materials.
- **Lifecycle management:** this is the idea of evaluating the sustainable attributes of a product by incorporating all the energy usage for all processes from cradle to grave. Many recent development in perceived sustainability improvements in, for example, transport, have been assessed primarily at point of use. This does not take into account the economic and environmental cost of sourcing, processing and disposal of the materials required to deliver the new technology. The key motivation for technological advances in industry is economic. Legislative incentives can assist in creating the motivation to invest in new sustainable technology.
- **Electric motor technology:** electric motors are prevalent, being used across multiple applications. There is a key opportunity for the development of specialist knowledge in the control of electric motor noise.
- **Psychoacoustics:** deploying improved understanding of psychoacoustic phenomena offers the potential to improve the efficiency of engineering solutions for noise control. If psychoacoustic models can be used to prioritise noise features, solutions could be optimally engineered to address what's important, rather than as a catch-all.

Interesting papers and thoughtful discussion rounded off an interesting conference in this developing area, which will become ever more important for acoustic engineers moving forwards.

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The Senior Members Group

Sound Technology Ltd host October meeting.

Michael Sugiura, Chairman.

A half-day meeting was held at Sound Technology Ltd (STL), Letchworth Garden City, on 2nd October 2018. Members were given two excellent presentations by the STL Applications Team, who explained the features of BSS by HARMAN Audio equipment and the state-of-the-art developments in audio signal processing. This included a detailed overview on fixed signal processors and SoundWeb London network series configurable signal processors with BLU link.

The Applications Team gave a talk on the latest transducer technology developed by JBL, namely, its D2 Dual Diaphragm Dual Voice Coil Compression Driver. The driver improves the sound and performance of high frequencies giving significant output advantage over conventional systems with greater array power, and reduced distortion. It also has double the number of voice coils and more than double the power handling, which results in an increase in pure high frequency sound pressure levels in the same physical footprint with a 30% reduction in weight.

A demonstration of Sound Technology's Professional Audio Demo Facility was enjoyed by all the attendees. A committee meeting was held before lunch and the Annual General Meeting concluded the event.

The Measurements and Instrumentation Group

Developments in the measurement and prediction of ground vibration.

By Steve Cawser, MEng CEng MIOA.

The Measurements and Instrumentation Group held a one-day meeting on 16th October at the Royal Society, on the subject of ground vibration. The main focus for the meeting was the recent developments in the measurement and prediction of ground vibration, which is a topic that continues to be popular and subject to much discussion.

The first presentation of the day was by Jorge D'Avillez of WSP, who spoke about sources of uncertainty for railway vibration assessments. Jorge covered all aspects of uncertainty that should be considered when carrying out vibration assessments, from the uncertainty in measurement attributable to background vibration, transducer mounting, and ground conditions, right through to modelling uncertainties in numerical and empirical modelling techniques. Jorge finished his talk by covering methods for quantifying and reducing doubt when carrying out these types of assessment.

The next presentation was by Rupert Thornely-Taylor, on the importance of considering energy flow in the measurement and assessment of groundborne noise. Rupert started by covering the basics of power flow, why power is important and how to measure it. This led to a discussion on how this relates to vibration modelling methods and how power flow can be used to understand transmission between media, which is particularly important for the design of base isolated buildings, and how buildings couple to the ground upon which they sit.

Steve Summers, from Accon UK, presented their work on the prediction of high speed railway vibration using the pipe in pipe vibration model, which is a freely available modelling package for railway vibration. Steve talked about the details of the modelling method, how the software works and a measurement study that Accon UK carried out to determine the accuracy of the model for use on UK high speed railway projects. The results of their validation measurements were presented, along with recommendations for improving the accuracy of results for UK high speed railway predictions.

Mattias Skog, from Sigicom, spoke about work he had done to look into methods for mounting transducers on modern insulated floors, where the insulation can affect vibration measurements. He discussed controlled measurements on a shaker table to investigate how different mounting materials affected the transducer response, and presented the results of finite element simulations of the tests.

James Block, from AECOM, presented some work he has been carrying out recently on the Manchester Metrolink tram system. The work is for a new line which runs close to a television studio and required a groundborne noise assessment for the studio buildings. James talked about the predictions which had been carried out and a series of novel measurements of ground propagation using a large trailer-mounted vibration source to measure vibration at 30m from the source. James also discussed the uncertainties associated with carrying out this work and how a compromise was needed between the vibration requirements and the airborne noise requirements in the final designs.

James Talbot, of Cambridge University, talked about simplified models for base isolated buildings. This talk carried on from many of the points that Rupert Thornely-Taylor P36 ▶

Back row: Jorge D'Avillez, Richard Hazelwood, Steve Summers and Mattias Skog. Front row: James Block, Steve Cawser, Rupert Thornely-Taylor, Vincent Jurdic and James Talbot

had been discussing earlier in the day, where models of buildings and the ground need to be coupled to give sufficient accuracy. James discussed different, simplified methods for soil-structure interaction and the relative accuracies of these different methods, He described a case study where this had been applied to the model of a tall building.

Dick Hazelwood gave a talk on sediment modelling methods for vibration transmission. Dick is better known for his work on underwater acoustics, but talked about some work he had carried out looking into propagation in shallow waters using measurements and finite element modelling. He spoke about different wave types generated by seabed piling works and the methods used to analyse and understand how these propagate.

The final presentation of the day was from Vincent Jurdic, of Arup, who spoke about estimating train speed from vibration measurements. Having accurate train speed data when carrying out vibration surveys is important, but it is not always possible to accurately measure. Vincent talked through an approach that used a rail deformation model of a train to predict which frequencies should be within a vibration spectrum, and fitting measured data to these predictions to allow the train speed to be estimated.

All of the presentations were well received and generated plenty of interesting questions, many of which were continued during the breaks. The Measurement and Instrumentation committee would like to thank all the speakers who kindly gave their time for this very interesting day of presentations and discussion.

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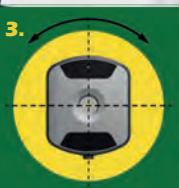
3. 
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Musical Acoustics Group

Measurements and modelling of musical instruments and performance spaces, St Cecilia's Hall, Edinburgh, 24th October 2018.

By Mike Wright MIOA, Chairman.

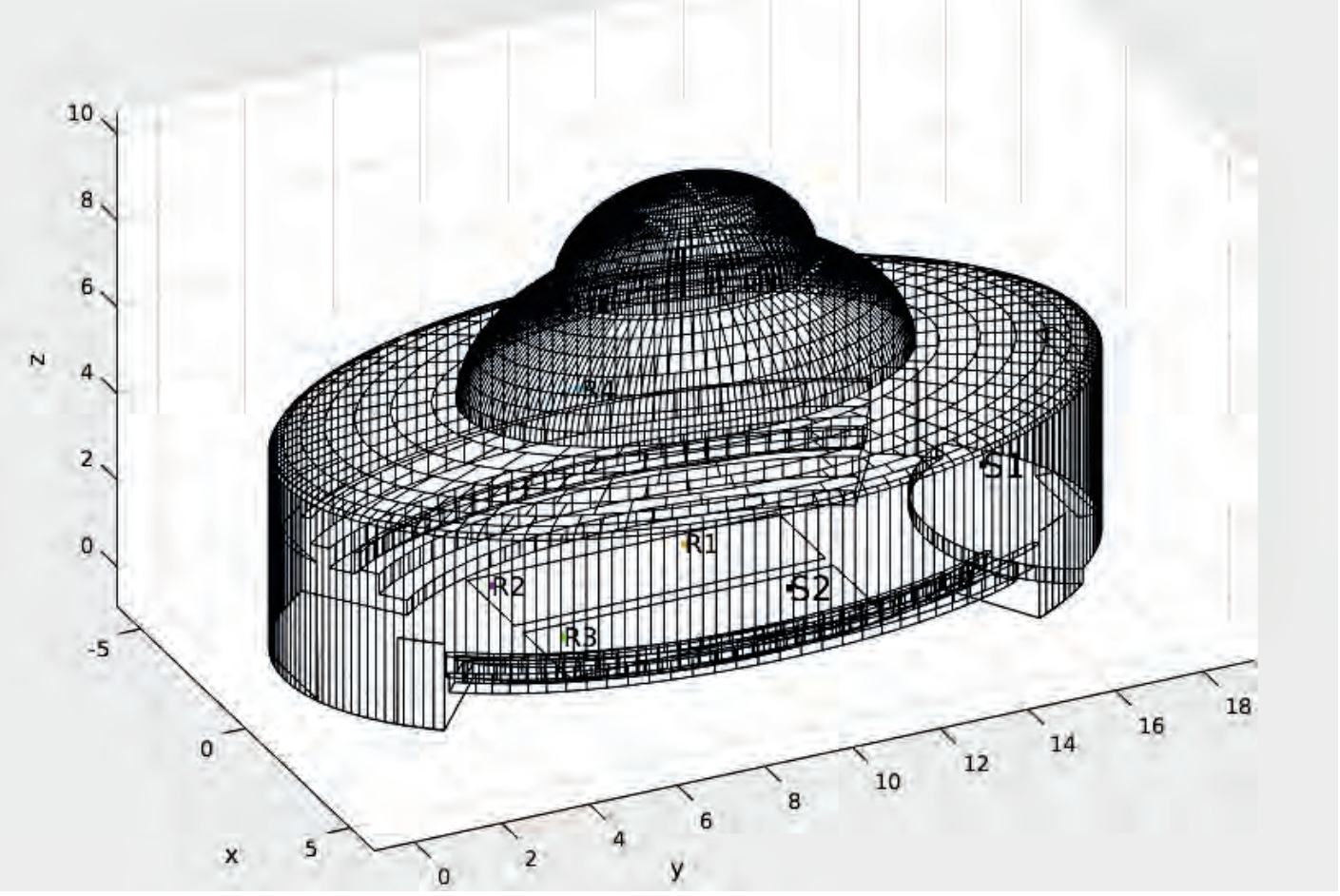
St Cecilia's Hall is a Category A listed building completed in 1763 and now owned by the University of Edinburgh. The oval shaped Sypert Concert Room is the oldest purpose-built concert hall in Scotland. The Musical Acoustics Group was privileged to hold its main one-day meeting in the magnificent and acoustically interesting setting of the 18th century Concert Room and the adjacent world class Music Museum. The meeting was hosted by the University of Edinburgh and supported by the UK Acoustics Network.

Anne Budd is Director Specialisms – Speech Intelligibility at New Acoustics. She gave the opening paper, describing the history of the Sypert Concert Room, which was designed to host small groups of players at a time when musical instruments were quieter than their modern day counterparts. The smooth elliptical shape of the hall leads to complex listening conditions depending on seating position. She described the recent acoustical adaptations which needed to take strict account of the building's listed status. This included the removal of the infamous 'porridge' (Audex), applied to the entirety of the double domed ceiling in the 1970s. (The 'wire-framed' CAD model diagram below, illustrates).

Staying on the subject of performance halls, PhD candidate, Doug Shearer, described acoustic work at Henry Wood Hall, a 6000m³ orchestral rehearsal and recording studio in Trinity Church Square in London, named after the renowned conductor, Sir Henry Wood. Formerly a listed late Georgian church with obvious constraints to making modifications, Doug described a remarkably flexible and low-cost solution to adapt the studio to suit a wider range of ensembles. While it could easily accommodate a full orchestra of 80+ musicians plus choir stalls, there was a need to be able to accommodate operatic orchestras and chamber ensembles. After reverberation chamber tests, and much to the delight of managers and users, this was achieved in the studio by the introduction of 30 self-inflating airbeds at a cost of about £1,500. The flexibility of the solution meant that the configuration could be changed in around an hour.

Modelling of the Concert Room

After coffee, Brian Hamilton described the preliminary results of modelling of the Concert Room at St Cecelia's Hall using a hybrid wave/ray approach, and compared these



P40 ►

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with measurements and outputs from geometrical acoustics software. As mentioned previously, the Concert Room is acoustically very complex. Its elliptical base should give rise to non-diffuse behaviour such as focusing effects and flutter echoes. The CAD wire framed diagram illustrated on page 38 and created as part of the work, shows the complexity of the room. This paper also outlined other work carried out to date, including laser measurements, impulse responses, importing the CAD model into ODEON, and taking into account different materials used within the hall. This was very much a work in progress which it is hoped the Musical Acoustics Group (MAG) would learn more about in future.

High resolution 3D acoustic measurements of musical instruments

David Carugo, from Oxford Brookes University, described another work in progress; developing a sensor grid design for high resolution 3D acoustic measurements of musical instruments. He was investigating this from the viewpoint of a recording engineer, looking at where the sound comes from, including the presence of the musician in measurements, using a 3D microphone sensor array. He looked at existing data and produced new data to increase resolution and fill gaps where no data existed. His work has involved developing an icosahedron-based 'geodesic' dome grid array. Despite the acoustic limitations of the hall and sound system in use for the meeting, he managed to demonstrate some significant variations in response by the microphones across the array to an acoustic guitar.

Comparing elephant trumpet calls with brass instrument 'brassy sounds'

Joel Gilbert from the University of Le Mans, France, gave the meeting a complete change of topic. His paper compared elephant trumpet calls with brass instrument 'brassy sounds' and the stepwise fundamental frequencies found in both. He demonstrated spectrograms of a descending arpeggio played by a trombonist (slide in first position, $B_{\flat}1$ being the lowest note). While a continuous fundamental frequency (glissando) is the most common case observed in elephant calls, stepwise regimes were observed. He concluded that comparing brass instrument behaviour in loud playing conditions (brassy sounds), the classical source-filter model of voice production should be extended to explain the rich harmonic structure (and high fundamental frequency) of the elephant trumpet calls. Linear propagation approximation should be dropped, and replaced by nonlinear propagation theory. He also suggested that this production mechanism may constitute a rare example of source-filter interaction (where the filter properties affect the behaviour of the source) in the vocal system of a terrestrial mammal.

AGM

At the Group's AGM, Mike Wright confirmed his retirement as Chair and referred back to the introduction he gave at the start of the day's meeting, in which he outlined the activities of the MAG since its revival in 2012. He also expressed his appreciation of the efforts of other committee members and Linda Canty. Stephen Dance was elected the new Chair of the IOA Musical Acoustics Group. David Sharp continues in the Secretary role. The strength of the committee is assured with Murray Campbell, Jemma Jones, Sara Rubio and Mike Wright re-elected. Mike Wright will be looking at ways to improve publicity and the profile of the Group. Jimmy O'Donnell was also elected as a new committee member.

Members were then invited to visit the University's collection of historic musical instruments, and to see items from the Rodger Mirrey and Russell Collections of early keyboard instruments, as well as the Anne Macaulay Collection of plucked string instruments.

Double reed instruments

After lunch, Alan Woolley described preliminary investigations of the behaviour of double reed instruments, part of a project by the University of Edinburgh. He noted that the first scientific study of musical instrument reeds was done by Helmholtz some 150 years ago. Much work has been previously carried out on single reed instruments like the clarinet and saxophone. This was the early stages of an experimental study of double reed instruments from the Renaissance period, to try to explain some specific playing properties of these relatively simple wind instruments. The crumhorn, a capped reed instrument most commonly used during the Renaissance period, was chosen. It has similar acoustic properties to the well-studied clarinet. Current techniques allow for more accurate measurements. The use of high speed cameras allows study of transients as well as steady state behaviour. It is intended to extend the study to other double reed instruments, including conical bored instruments such as the shawm and curtal, and there are potential applications to other aerodynamically excited vibrating systems.

Bowed string instruments

Sara Rubio from Sustainable Acoustics compared the objective and subjective acoustic properties of bowed string instruments. She was joined by Jonathan Beecher of Beecher Acoustics, a luthier and concert cellist who opened the presentation with part of a 'cello suite by J. S. Bach, most appropriate for the surroundings of the meeting. After briefing the delegates on the various parts and mechanics common in all of the violin family of instruments, Sara concentrated on the importance of the sound post of the violin. This was done objectively, demonstrating measurable effects of differences between various grades of violin ranging from a poorly set up, low grade instrument to a carefully set up, 18th century Italian instrument. Tests employed controlled conditions and involved a simple comparison based upon playing an open string A on each violin and FFT measurements at a normalised level. She described the adaptability between player and instrument and demonstrated that instrument quality is as important as fine tuning of configuration. Depending upon the player, one instrument can have a number of good settings to avoid false resonances.

P42 ►

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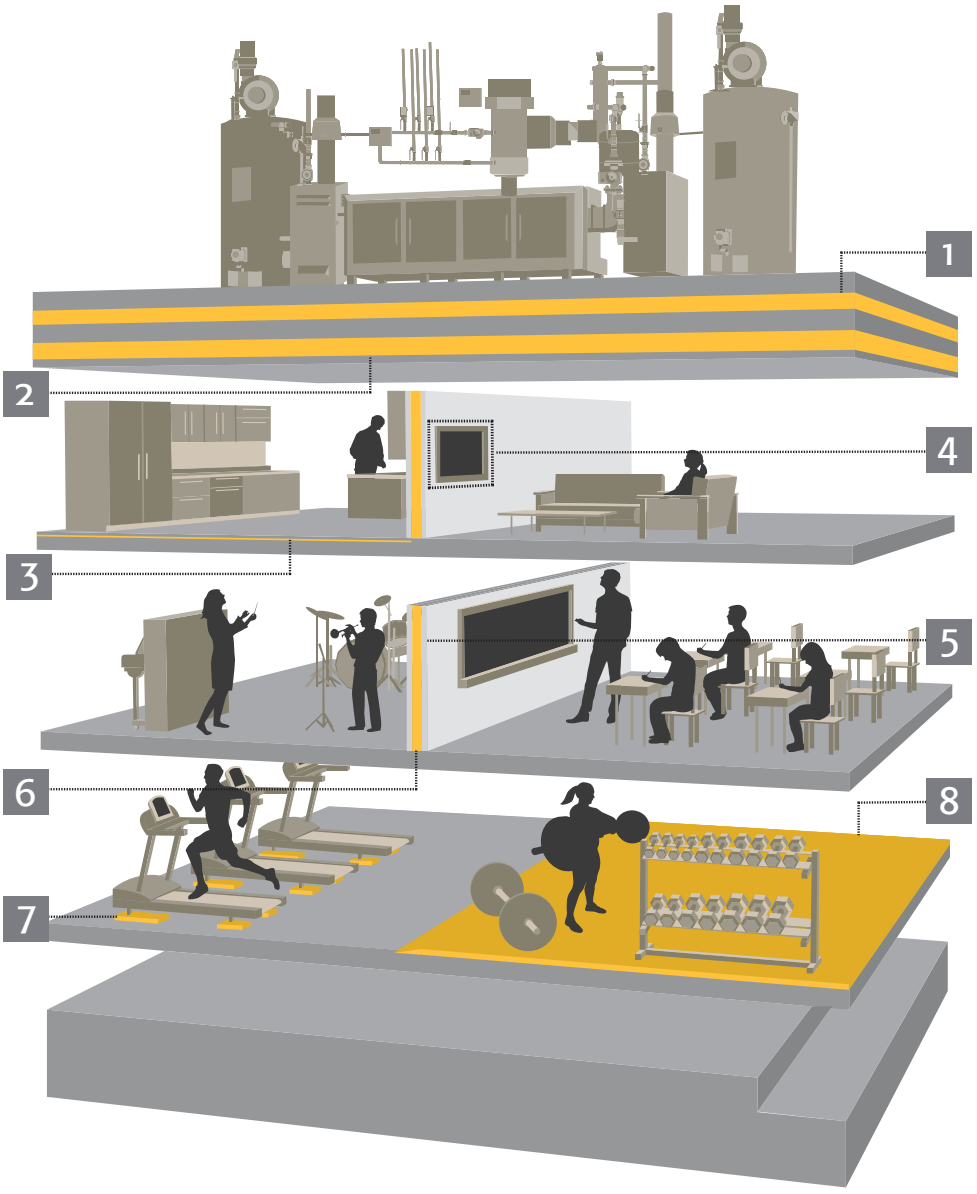

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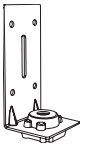

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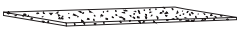

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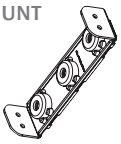

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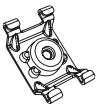

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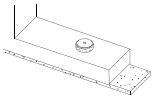

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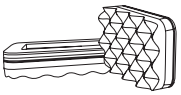
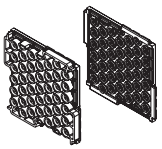


8 GenieMat FIT



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Dhruvit Zaveri presenting and then playing his Yaybahar

The Yaybahar

Keeping on the subject of string instruments, Dhruvit Zaveri, from London South Bank University, compared comparative measurements between the Yaybahar (invented by Gorkem Sen in 2014) and the long established 'cello. Although it was a cumbersome-looking device, the Yaybahar is a highly expressive instrument with a unique string-spring membrane system. No previous studies exist. His study to date has investigated directivity and FFT response. He showed that the observed sound pressure levels of the Yaybahar across the frequency spectrum are lower those found for a 'cello. However, the Yaybahar exhibits a fairly similar harmonic response. More studies on the behaviour of strings may help to further understand the signal transmission/amplification process, while additional structural integrity focused work may help in sustaining a note longer when plucked. Moreover, looking more deeply into the dimensions and configuration of the Yaybahar may enable higher sound pressure levels to be achieved.

Bassoon-form bass clarinet

In conjunction with the Open University, Keith Bowen, from the Royal College of Music, has been focusing on the bassoon-form bass clarinet, which flourished, then declined during the 19th century. There are over 70 such instruments in museums and collections but most cannot be played. Having access to a Heckel bass clarinet in A, circa 1910, but kept in playing condition, he has determined the input impedance of the instrument for different note fingerings via calculation and measurements. He described an iterative method of Plitnick and Strong, equations of Keefe/Cronin (segment and hole impedances) and Dalmont (embouchure). By comparing calculations with measurements of acoustic impedance using the BIAS capillary-based system, excellent agreement on resonance frequencies usually a few cents sharp was found. Following the verification that the computer modelling approach provides results to sufficient accuracy, this method may be used to study instruments that cannot be played. The method is also useful to investigate fingerings, temperaments and intonations.

Opera houses

The final paper session returned to buildings. Giulia Fratoni described simulations of four Italian opera houses, ranging from a large 18th century 'bell' shape, smaller 19th century 'horseshoe' shape to a large, modern design. However, opera houses can be flexible places allowing significant changes in their acoustical properties simply by altering the stages or closing the fly tower, i.e. the large space above the stage. Measurements were taken at these opera houses followed by detailed analysis of the sound field behaviour and calibration of 3D virtual models. These could be used to enhance the design and optimise different layouts.

For the first time in recent MAG meetings, the day was rounded off by a delightful performance by the Edinburgh Renaissance Band led by Murray Campbell. They are a group of 12, Edinburgh-based musicians specialising in the performance of music from the period 1200-1600, using a wide variety of instruments from a selection from over 100. Some of these instruments were to be seen in the exhibits surrounding the museum where the music rang out.

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10th International Conference on Auditorium Acoustics

By Raf Orlowski, Conference Chairman

Around 200 delegates from all parts of the world, attended the 10th International Conference on Auditorium Acoustics in the magnificent Elbphilharmonie in Hamburg, from 4th to 6th October 2018. Conference Chairman, Raf Orlowski reports.

Some 85 papers were presented covering a broad range of subjects on auditorium acoustics.

At the conference dinner on the Friday evening, IOA President, Barry Gibbs, read out the citation for Jeremy Newton and presented him with his Outstanding Services to the Institute Award.

On the Saturday, delegates had the privilege of attending a rehearsal in the Elbphilharmonie concert hall (the Grosser Saal) by the Hamburg State Orchestra led by maestro, Kent Nagano.

Chair, Uwe Stephenson's report

The Chair of the first session, Uwe Stephenson, introduced the first speaker, professor emeritus, Jens Blauert. This session focused on the fundamentals of room acoustics and is reported here by Uwe Stephenson:

Jens Blauert discussed the manifold components of the term 'quality of acoustics' (QoA) from the viewpoints of psychological, perceptual and physical acoustics. The impression arose that there is no chance to quantify a QoA as a single number, so it makes no sense to set up a statement on a hall such as; "this is the xth best concert hall in the world" (as it was often claimed about the Elbphilharmonie).

Among the community of room acousticians, it is well accepted that, beside the reverberation time, the fraction of laterally arriving energy at the listener is very important for the feeling of 'listener envelopment'. Winfried Lachenmayr's research reveals that the late directional reverberation (not only the level) also has a great influence on the preference and reflections from behind are equally important for that feeling.

Within the last decade, stage acoustics (do musicians hear each other well?) has become a special discipline although it is difficult to find objective parameters to correlate with the musicians' judgements. Moreover, as Liisa Kilpilehto and co-authors from Finland found out, it is amazing how musicians adapt to the sometimes adverse acoustic circumstances on the stage (especially in a vineyard hall like the Elbphilharmonie). While they complained about acoustics before, they sometimes state after some rehearsals: "We have learned to play in this hall".

The last presentation in this session dealt with stage acoustics. Jacob Wincentz and his group from the Technical University in Denmark compared the stage acoustic conditions of two new high-profile concert halls, the hall of Danish Radio (DR) in Copenhagen, a vineyard hall, and the LIVE Hall in Malmö (Sweden), a traditional shoebox-design. Due to the proximity of the two cities, many musicians have experienced both halls. Many stage acoustics parameters were measured, among them, on average, the strength G_{late} and the Stage Support ST_{early} were 3 dB higher in the LIVE Hall. Accordingly, the musicians complained they felt "very lonely" in the DR hall; they clearly preferred the shoe-box hall, LIVE.

IOA President, presenting the Services to the Institute award to Jeremy Newton

Chair, Robert Essert's report

Matthew Neal presented a progress report on a major project at Penn State University to develop a database of spatial impulse response measurements. Unoccupied measurements were made in 21 halls; 16 in the US and six in Europe. Standard parameter calculations were classified by hall typology, and spherical beamforming results allowed reflection detection in time and space. The team developed and used a 20-driver spherical loudspeaker array to allow formation of directional sources in post processing. A suggestion from the audience reminded us to consider the relevance of musician chairs and stands on stage.

The remaining four papers were about opera house design and analysis. Anton Schlesinger outlined SIMOPERA, an applied research project at Beuth and HTW Universities on

wave-based analysis and sound level reduction in the orchestra pit of the Deutsche Oper Berlin. The first part of the paper focused on Finite Element Modelling (FEM) of the pit and auditorium as coupled volumes, identifying modes in the pit in the range 20-50Hz as relevant to sound build-up in the pit. The second part dealt with FEM modelling of a Helmholtz resonator coupled to a room, considering the use of Helmholtz resonators to reduce loudness and smooth response in the pit. Again, a comment was raised regarding omission of the significant effect of occupants and furniture in the pit.

Alban Bassuet, and colleagues from Arup Acoustics, described the design of the new opera house in the Stavros Niarchos Foundation Cultural Center. A 1,400-seat opera theatre plus an alternative stage and chorus and orchestra rehearsal rooms in a park setting have been warmly received by the public and artists. Analysis specific to opera included difference between G from the stage and from the pit. Measured 3D impulse response hedgehogs illustrated the differences in spatial aspects of sound in the different areas of each hall.

Martijn Vercammen and Margreit Lautenbach, from Peutz, worked on a major renovation to the Staatsoper Under den Linden Berlin. Having undergone several renovations in its 200+ year life, the 1,350-seat theatre interior dating from 1955 had been considered too dry. In order to increase reverberance, the team raised the ceiling by 5m, re-using the central dome and opening volume at the upper sides. The project included scale model testing to evaluate focused reflections and laboratory work to minimise chair absorption and tailor the wall fabric characteristics.

Rounding out the opera session, Raf Orlowski presented the new Grange Park Opera House, a 700-seat festival theatre in the countryside, which took two years to design and build on a very tight budget. The key acoustical driver of volume was achieved by treating the precast slab roof as the ceiling. A concern of the focused reflections between the pitched/conical ceiling and cylindrical balcony fronts was investigated by Thomas Wulfrank of Kahle Acoustics, predicting limited focus zones and integration of the reflections with the direct sound within 45-60msec. Subjectively, the focusing provides strengthening of the singers' voices.

Chair, Evan Green's report

The final session on Thursday afternoon focused on aspects of the design of the Elbphilharmonie, but began with "the other concert hall on the river Elbe", the Kulturpalast in Dresden, Germany. Margriet Lautenbach, from Peutz, described the design process for the vineyard hall, inserted into the historic structure of a 1960s East German conference hall. A key conclusion from a concert hall tour was that the Dresdner Orchestra desired a darker sound quality with improved balance than is typical of vineyard halls. While maintaining the surround seating layout, aspects of shoebox hall design such as a flatter stalls, exposed vertical reflective surfaces and 90° cornices were integrated into the design.

A pair of papers from Nagata Acoustics were presented describing the design and modelling processes for the Elbphilharmonie. Keigi Oguchi presented the overall design aims and development of the room acoustics; the architect and client had already established the key theme of 'intimacy' for the 2,100-seat hall and chosen the surround typology in order to minimise the distance to the furthest seats. With the aim of enhancing acoustical intimacy, the subdividing walls between audience areas were optimised and acoustic diffusion applied to many surfaces.

The scale modelling process for the Elbphilharmonie and methods used to identify echo-generating interior surfaces were described by Marc Quiquerez, of Nagata Acoustics. Large areas of echo-eliminating surface texture were found to be needed which led to the development of the famous diffusing 'white skin' interior of the hall – a continuous flowing surface of computer-milled gypsum composite material with a mass of 125kg/m^2 to provide sufficient reflection at bass frequencies.

A modern concert hall must typically integrate sufficient efficient variable elements so that high quality amplified music and speech events can also be presented. This topic and the acoustic solution for the Elbphilharmonie were presented by Jonas Schira, of Gerriets, Germany. Critical for amplified music is sufficient control of bass frequencies, and his

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experiments showed how, by enclosing the airspace behind a fabric, the low-frequency sound absorption of free-hanging curtains or banners can be enhanced.

Uwe Stephenson, Professor at the HafenCity University in Hamburg, has followed the developments surrounding the Elbphilarmonie with interest from day one. The publication of a conceptual long-section of 'Elphi' in the local newspaper initiated a computer model investigation into the potential acoustics of the concert hall, including the effects of ceiling angle and audience rake on reverberation time and lateral reflection efficiency. While normalising for acoustical volume and total absorption, geometrical changes and differing scattering coefficients generated sometimes very large changes in the predicted reverberation time. Professor Stephenson was clearly relieved that by incorporating geometrical effects, his prediction for the RT of the Elphi fell from three to four seconds into the more generally accepted region of 2-2.5 seconds!

Helmut Fuchs was also somewhat alarmed by his initial predictions for the reverberation time bass rise of the Elbphilharmonie. He presented RT measurements for some acoustically well-regarded concert halls that show either no or only a very modest rise in reverberation time at bass frequencies. Even with the massive wall surfaces mentioned by Nagata Acoustics, the measured RT is relatively flat and Fuchs mused whether the support framing for the 'white skin' would create a bass-absorbing mass-spring system. Fuchs' proposal that a bass ratio of approximately one, rather than the more generally accepted 1.1 – 1.5, generated fierce discussion. While it is known that 'warmth' is a desirable acoustical attribute in classical music, it is clear that the topic of necessary bass strength and clarity, along with the appropriate objective parameter, deserves more research attention.

Chair, Anders Gade's report

The Friday early morning session comprised four papers covering very different topics.

Sir Harold Marshall's paper – like that of Jens Blauert the day before – opened up a more holistic view on the role of acoustics by addressing how acoustics can contribute to the sense of 'presence' in performing spaces. Beyond the nuts and bolts (Harold's name for those acoustic parameters that can be engineered such as dynamics, clarity, reverberation, envelopment and ensemble), there are certain aspects, which can only be achieved through a combination of the physical acoustic knowledge and a creative meeting of minds process. One such aspect is presence, a gift which is "one of the siblings of Love and Grace". As such, the presentation opened up a higher motivation and role of acoustic design than just achieving the 'correct' acoustic properties – a truly inspiring outlook on our field of work.

Hidaka Takayuki also gave a most interesting talk about the purpose of small scale diffusion as a means to avoid harsh tone quality. He showed through calculation that a reflection from a small scale diffusing surface will be subject to a high frequency attenuation, which is similar to covering the surface with a thin fabric (like the tapestries on the front of the side terrace fronts in the Musikvereingsaal) – however, without introducing more high frequency absorption in the hall. Hidaka suggests values for the attenuation of the early reflections versus frequency, which are assumed to be necessary for avoidance of 'glare' or 'harsh' sound quality. This suggestion is based on the assumption that the spectrum of the individual early reflections should be somewhat similar to the spectrum of the reverberation time of the hall in question. It is concluded that a standard deviation of the height differences in the fine scale diffusing surface should be in the range of three to seven millimetres.

The two last papers in this morning session both dealt with room acoustic simulations. Brian Hamilton, from the University of Edinburgh, presented work on the present state-of-the-art regarding wave-based room acoustic simulations and their own work on applying the finite-difference time-domain (FDTD) method, including its application for auralisation. Although the demand for computational power increases proportional to the room volume and the frequency raised to the power three, simulation of large rooms covering the full audio frequency range is now within reach, thanks to the development in computer power and cluster processing technology (multiple graphics processing units (GPUs)). The presentation included impressive examples of both wave field illustrations and hi-fi sound examples.

In the last presentation, Boris Mondet (ODEON, A/S), compared the virtues and drawbacks of two wave-based simulation methods (FDTD) and the Equivalent Source Method (ESM) using the image source method as a reference. The case for comparison was a simple, two dimensional rectangular model and the yard stick for comparison was how fast the two wave-based methods converged towards the image source solution known to be exact for this special case. As such, the results (so far) were of a more theoretical nature, unlike most of the other papers presented at the conference.

Chair, Mike Barron's report

In the second session of Friday morning, all four papers had some link with the issue of scattering treatment in auditoria, how much and where? Anne Minors, of Sound Space Vision, presented 'Architectural patterning and its influence on sound – a case for visual analysis', which raised questions relating to computer techniques now used by architects. She was particularly concerned with the matter of the scale of scattering surfaces, which can now be specified and machined by computer control. The paper concluded with a series of 'surface scattering maps', which demonstrate, if nothing else, the highly varied disposition of scattering at various scales in some famous concert halls.

Eckhard Kahle, of Kahle Acoustics, gave a stimulating reassessment of scattering/diffusing treatment in 'Halls without qualities – or the effect of acoustic diffusion'. Due to Lambert's law, there are two objective outcomes with highly diffusing room surfaces: that acoustic energy is 'held' in the region of the stage rather than radiating into the auditorium and that sound level Strength G drops off with distance more steeply than otherwise. This behaviour may result in a reduced sense of 'proximity'. The author concluded with the suggestion that high degrees of scattering treatment which may result in acoustic anonymity is worthy of further research.

As an illustration of minimal scattering treatment, Eckard Mommertz, of Müller-BBM, presented a paper co-authored by Eckhard Kahle, describing the new Bochum Concert Hall, which has 960 seats, but with a large

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volume of around 14,000 m^3. The hall is nominally rectangular in plan, the upper section being behind an acoustically transparent screen, where adjustable acoustic banners are housed. The result is a long reverberation time provided at modest cost and a satisfied client body.

In stark contrast, Michael Whitcroft, of Hoare Lee Acoustics, discussed the acoustic design of the Bradshaw Hall at the new Royal Birmingham Conservatoire. The wall surfaces are highly scattering using primitive root diffusers and vertically angled panels in a semi-random arrangement. The hall has a seat capacity of 490 and is used as a rehearsal space for an orchestra and choir, as a recording studio and as a high quality venue for all genres of music including classical music, jazz and cinema screenings. Retractable banners allow the 1.9 s reverberation time to be reduced to 1.0 s.

Chair, Eckhard Kahle's report

Anne Budd and Emily Tilbury, from New Acoustics Limited, Glasgow, spoke about one of the oldest – yet little known – concert halls, St. Cecelia's in Edinburgh. The elliptical concert hall has had a turbulent history and has undergone several renovations and improvement attempts in time. An interesting aspect is that during the most recent renovation, it was decided not to fix the focus because it was considered by stakeholders and audiences as an inherent, positive, part/aspect of the room. A room with personality!

Nikolaj Kanev, from Acoustic Group, Russia, spoke about three circular rooms that are not easily accessible for most European acousticians; Svetlanov Hall at the Moscow International Performing Arts Centre, Novosibirsk Opera and Ballet Theatre and Mansudae People's Theatre in Pyongyang, the capital Democratic People's Republic of Korea. All three rooms show problems due to the circular shape, but the proposed remedial measures are different, adapted to the use of each room.

Magne Skålevik, of Akutek and Brekke & Strand, recounted his experiences with the Bergen Philharmonic Orchestra in their various rehearsal and performance spaces. He showed that musicians' preference can be linked to an adequate balance between early and late strength. Too loud a late sound field (like in an orchestra pit or in too small a rehearsal room) is considerably more objectionable than too soft a late sound field. His regression model showed an optimum ST1 of -20 dB, probably influenced by the selection of test rooms but strongly hinting that overly loud conditions can be problematic for musicians.

Jürgen Meyer elaborated on some overlooked consequences of his life-long work on directionality of musical instruments; depending on direction, the orchestral (and timbral) balance between different orchestral instruments can vary considerably. Starting from the assumption that orchestral and timbral balance is controlled by both the composer and the conductor, the balance in any other direction than the conductor's will be significantly different, leading to highly audible changes. While it is understood that the room reverberation will diminish those differences, it should be kept in mind both when developing orchestra seating arrangements and in the design of rooms. Placing reflective surfaces in strategic locations can improve the blending and mixing, not only of orchestral instruments, but equally, of the varying emission direction for all instruments. In this context it may be interesting to recall that Lothar Cremer proposed an optimised soprano music stand (and acoustic reflector) for the Philharmonie Berlin as the first surround concert hall.

Chair, Chris Day's report

Evan Green, of Kahle Acoustics, Belgium, presented recent work on dynamic spatial responsiveness, which appears to be a key factor in acoustical preference. Measurements of perception thresholds using a binaural virtual acoustics system indicated that the subjective effect of reflections varies with overall listening level, even when the reflection level, delay and direction relative to the direct sound are maintained. An algorithm has been developed to visualise dynamic spatial responsiveness and applied to measured concert hall impulse responses.

Jukka Patynen, of Aalto University, Finland, also talked about dynamic responsiveness in concert halls in the context of emotional impact. He hypothesised that the emotional impact, and therefore the listening pleasure in concert halls, is influenced by the expressivity of the music performed in different room acoustics. He reported investigations about the connections between subjective impact from music listening and the expressivity-intensifying factors of concert hall acoustics.

Jerry Hyde, a consultant from the USA, discussed the relation between the initial time delay gap and acoustical intimacy. He explained how Leo Beranek originally proposed the concept of the initial time delay gap and linked it to the word 'intimacy'. From later research it became evident that the emotional feeling of acoustical intimacy is a multisensory effect, which is much more complex than a parameter based on time delays alone. Leo came to appreciate this and separated his earlier connection between initial time delay gap and 'intimacy'.

John Bradley, of the NRC-CNRC, Canada, described his communications with Leo Beranek over many years, which were frequently about his latest acoustical paper or often trying to understand the new results of others. John suggested that we now need another Leo Beranek to help us better understand the perceptual details of concert halls.

Mike Barron, of Fleming and Barron, in the UK, described how research in the 1960s laid the foundations for research investigating the relative importance of various subjective effects for concert hall listening. He highlighted key halls built during this period, which included the Philharmonic Hall, New York, Fairfield Hall, Croydon, the Philharmonie, Berlin, and De Doelen, Rotterdam. He discussed how the parallel-sided halls of the past had fallen out of favour due to architectural fashion and how these new halls form a fascinating group.

Fernando del Solar, from Pennsylvania State University, USA, described a subjective study to determine the just noticeable difference of EDT over several octave bands using room impulse responses (IRs) measured in concert halls with an Eigenmike 32-element spherical microphone array and reproduced in an anechoic chamber with a three-dimensional array of loudspeakers. IRs measured in several North American halls were employed as a reference and compared with stimuli in which EDT values were artificially modified in a specific octave band.

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Richard Talaske, of Sound Thinking, USA, discussed concert hall acoustics from a historical viewpoint and suggested that it was in 2008 that Leo Beranek identified EDT as the metric best correlated with subjective preference.

Chair, Anne Budd's report

This session began with a paper titled; 'Localisation, Loudness and Proximity' by David Griesinger, from the USA. David noted that the perception of 'proximity' to a source, is a major contributor to preference, and proposed that the perception of 'being close to a source' occurs when the azimuth of individual sound sources can be distinctly perceived. He described the, Limit of Localisation Distance (LLD), which he proposed in most venues is the distinct distance from a sound source where both proximity and localisation both become impossible to detect. David then presented the method he has developed, 'LOC', to predict whether a source will be localisable or not from a binaural impulse response.

Jens Aherns, from Chalmers University, in Sweden, presented a study into the use of small, spherical microphone arrays in the production of 'authentic' auralisation of spaces. The VariSphear single-microphone scanning array, which has a robotic arm equipped with a measurement microphone that is flush mounted in a rigid spherical scattering object of a radius of 0.875m, was used to make measurements using arbitrary sampling grids producing data for up to 1,202 microphones, which corresponds to order 27. Measurements made with this array, convolved with the HRTF of the dummy head for which outputs were to be compared, were presented to 20 subjects along with comparison recordings made with the dummy head itself.

The influence of detail in room acoustic calculations was presented by Jan-Inge Gustafsson, of Akustikon. Challenged with designing a modern shoe-box shaped concert hall in Malmö, Sweden, with acoustics comparable to the Grosser Musikvereinssaal in Vienna, the team took a laser scan of the Musikverein to capture every detail. They then produced three acoustic models with varying degrees of detail; high, medium and low, each in three different softwares. It was concluded that there are only small differences between calculated values across the models with varying degree of detail.

A large-scale measurement array for wave field analysis was presented by Ingo Witew, of RWTH Aachen University, Germany. Ingo explained how ISO 3382 parameters are susceptible to error due to their variation with location within a hall, and that increases in measurement sampling rate to overcome this have led to array-based measurements. An array also makes it possible to identify the origin of the respective sound waves and determines the cause of different reflections. The array used in the Aachen study is 8m x 5.3m with a 5cm sampling grid, adequate for frequency bands including the 2kHz octave band and corresponding to a 2D sampling area of 16,960 impulse responses. Animations showing the running time as a sequence of images are created with the amplitude of the impulse response shown through the colour.

Fabrizio D'Amelio, of Sound Space Vision, UK, discussed calibration requirements for room acoustic models. Concerned that calibration is based on comparing standard parameters and adjusting model material coefficients to bring the output in line with the measurements, Fabrizio evaluates the gross features of impulse responses. To do this, impulse response measurements using a quasi-binaural microphone were taken in the Colston Hall in Bristol. The hall was modelled and tuned in an ad-hoc way by adjusting the materials to bring the reverberation time close to measured results. Investigation of the measured and modelled outputs were then made in time and frequency domain, looking at energy growth curves, slope of the growth curve, energy difference, coherence and cross-correlation of the two outputs, to investigate where the model is most divergent from the measurements.

Chair, Tapio Lokki's report

Tor Halmrast discussed how diffuse field reverberation influences attack. He showed how reverberation smooths/prolongs the attack and discussed how this affects signals of different lengths and different musical instruments, which themselves have slow or fast onset. He also considered whether it is possible to smooth out attack by early reflections.

Paul Luizard presented his work on how singers adapt to different rooms based on correlations between room acoustical parameters and musical descriptors (analysed from recordings). Four singers and eight rooms were studied and the conclusions were that several adaptation strategies were used and they were highly individual.

Tobias Behrens presented two cases of reverberation enhancement systems based on the commercially available RES system.

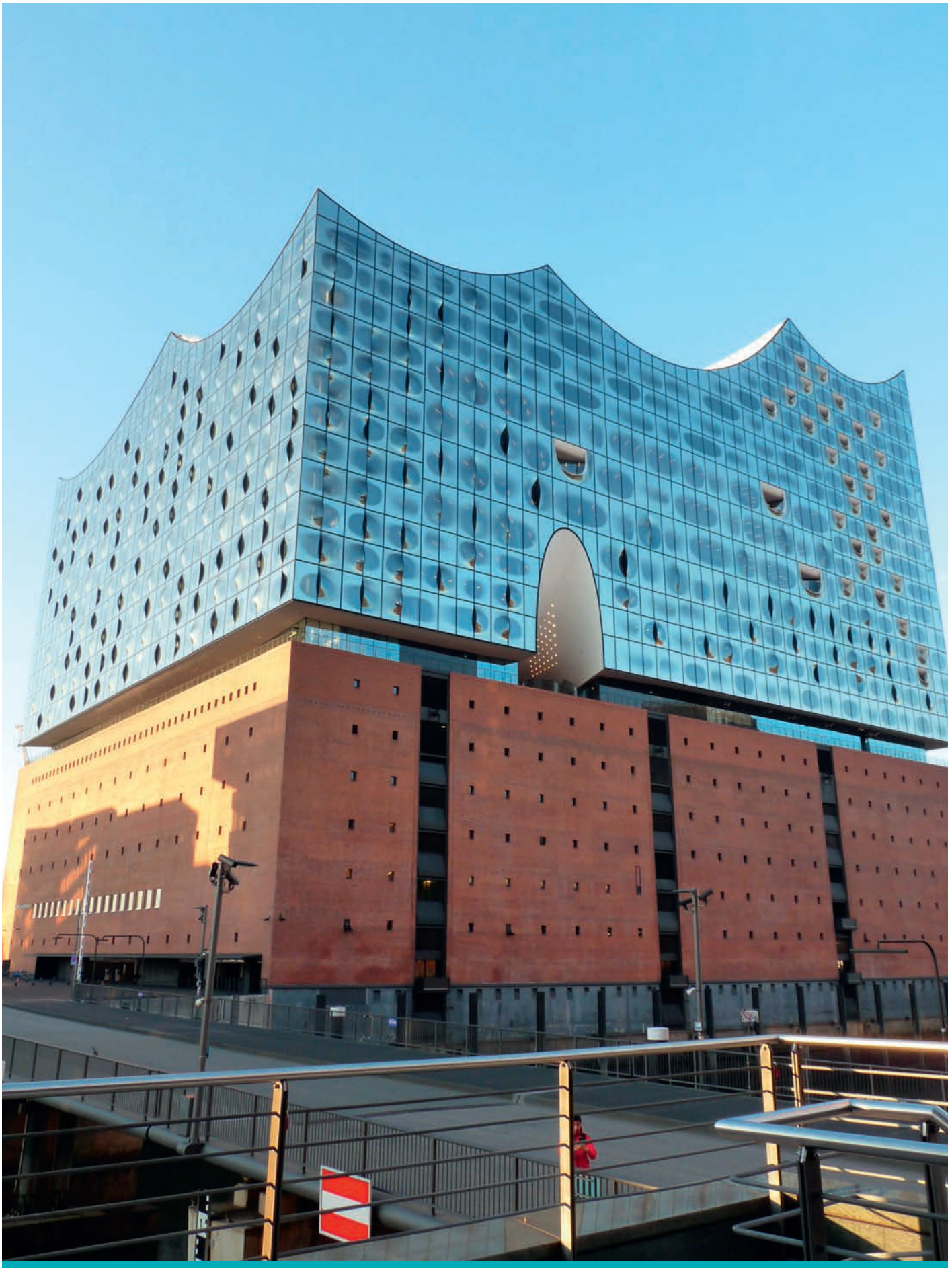
Rob Harris presented a very well thought-out paper on the pros and cons of vineyard halls, by comparing them to more traditional hall shapes. He had collected opinions and remarks from the points of view of audience and performers, as well as operational considerations. This paper was an important and objective contribution for new halls, when design decisions on the initial room shape are under considerations.

Paul Scarbrough presented a case study of a concert hall in Brazil. It was an interesting hybrid of a vineyard and shoebox hall, implementing the reverberant extra space in the upper volume of the hall. The paper was not scientifically based, but the solution was elegant and interesting and might inspire other designers. This idea is novel and seems to solve one of the problems in vineyard halls.

Chair, Anne Minors' report

Four very different papers were given by Tapio Lokki, Anders Gade, Fabiana Pion and Niels Adelman-Larsen, discussing the use of auditoria and theatres for unamplified sound, remote and dynamic recording and rock music.

Tapio Lokki offered a provocation to practitioner acousticians to concentrate fully on the impact of the sound when designing a concert hall to counter the over-emphasis on the visual sense within society. He acknowledged the marginalisation of the audience opinion and great variation in their motivation in attending a concert. Also, the political shading of conductors' perceptions of different concert halls, and recording engineers' different perspective on acoustics. Lokki's objective experiments, analysing impulse responses from different halls of an electronic orchestra source, have elicited a number of physical characteristics of halls that support the music, which he described, along with his analysis of sound in surround halls that result in the impression for



Elbphilharmonie in Hamburg

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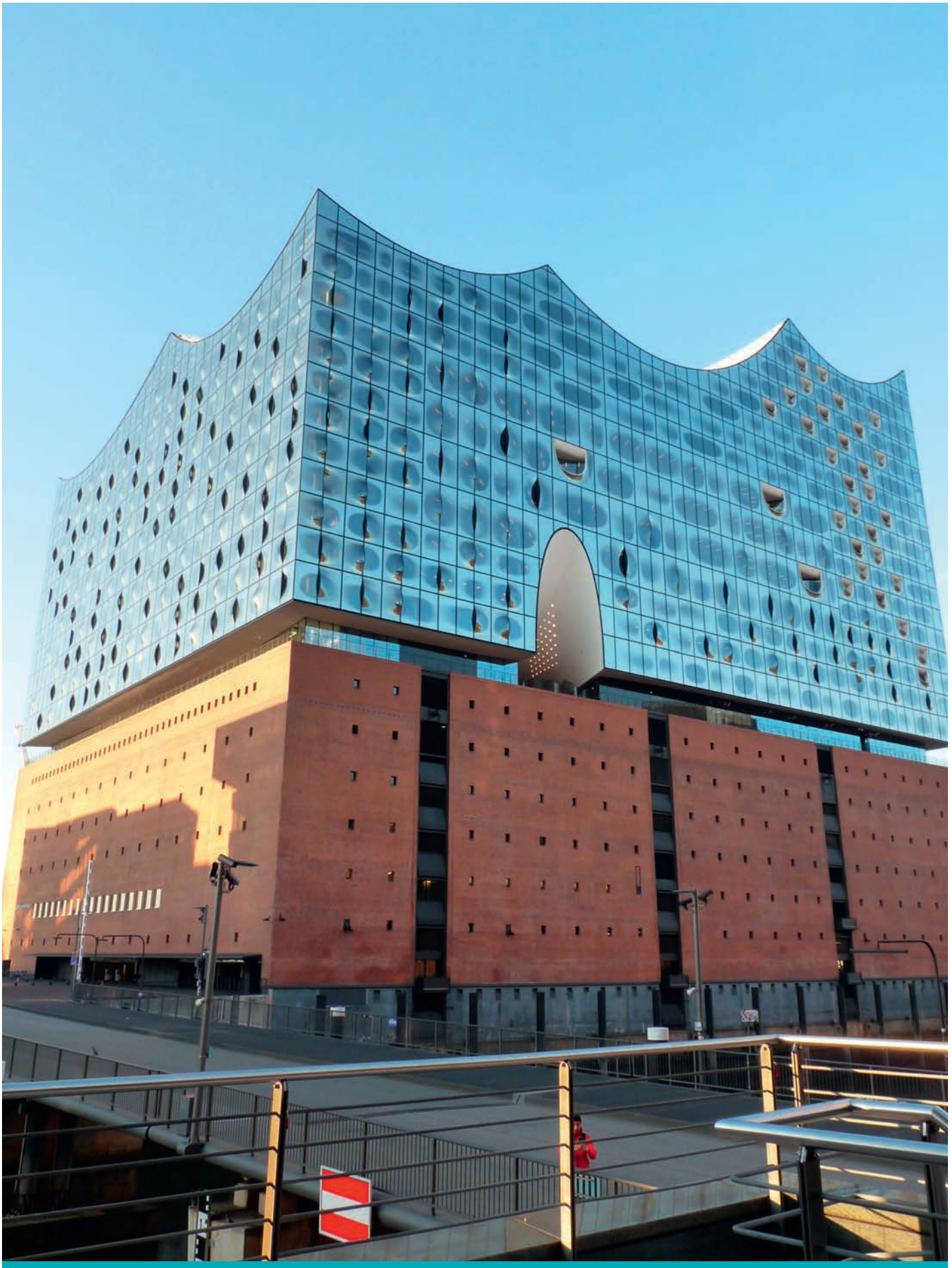

Elbphilharmonie in Hamburg

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audiences that they tend to be 'looking at the music' rather than be enveloped by it.

Anders Gade gave an illuminating talk about the practical challenges of designing two theatres in Denmark. In the first case, design issues of acoustic separation for a theatre often used for rock music from adjoining student accommodation were key. In the other, a multi-form auditorium with movable seats led to movable acoustic treatment also. After completion, concerns about open catwalks led to material changes that adversely affected the acoustic intent of the design. As is usual in consulting, there is a need for constant education of all parties on the importance of detail and to get the specification and budget aligned from the beginning. In Gade's case studies, there were historic budgetary challenges for the AV system and a poor understanding by the contractors of acoustical nomenclature regarding the acoustic door specification.

Fabiana Pion took the conference away from familiar topics and opened our minds to new considerations of accommodating drones into the designs for auditoria and what that might entail acoustically. A very well illustrated talk demonstrated the increasing desire to have simultaneous meetings with live streaming between venues and how an aviary of drones may be part of the near future at events. Fabiana also identified the different definitions of spatiality in an architectural sense and an acoustic sense, the latter being a result of defining air pressure behaviour within physical variabilities, while the former spatiality is the result of defining physical limits that can have different interpretations – political, religious, social, scientific, philosophical or economic.

Neils Adelman-Larsen has been undertaking research in occupied pop venues to increase the acoustic knowledge for this genre of music. Accepting that many acoustic measurements are made in empty halls, Neils measured two occupied halls in Denmark that have similar T30 at low frequencies but differ significantly in their reverberation time at high frequencies. He devised a survey for musicians and sound engineers who had performed and mixed sound in both halls. While the results for the sound engineers were less distinctive, the lead musicians with in ear monitors, expressed a strong preference for the hall with increased reverberation at mid to high frequencies, where the musician can have an increased sense of the vivacity of the audience, and a better exchange of energy. He concluded that it is likely that 125Hz octave band is the most important frequency band to control for reinforced music.

Concluding remarks

This conference was one of the most successful in the series of international meetings on auditorium acoustics and has been highly praised by attendees. It has become a regular touchstone for acousticians from around the world and the key question now is – "where will the next one be?"

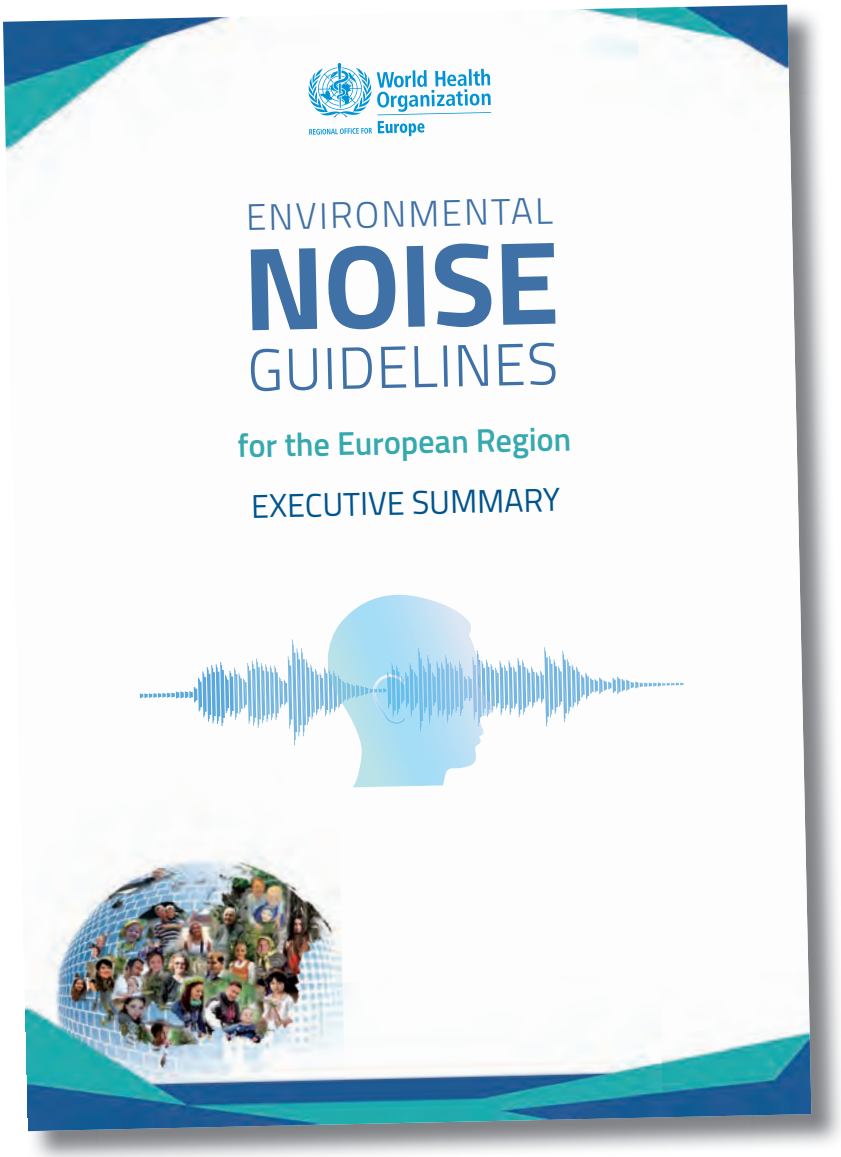
Inside the Grand Hall at Elbphilharmonie

WHO noise guidelines updated

The new Environmental Noise Guidelines for the European Region (ENG) are published by the World Health Organization (WHO) Regional Office for Europe. Here, Rupert Thornely-Taylor FIOA, offers his expert opinion on the new guidelines, which aim to support public health policy to protect communities from the adverse effects of noise, and stimulate further research into the health effects of different types of noise.

There are 53 member countries in the European Region, and, although the EU was a driving force in bringing about the publication of the new guidelines, they have wider application than the EU. The work was mainly financed by Germany and Switzerland.

The 1999 guidelines, referred to in the new document as the CNG, were published in hardcopy in 2000 on behalf of the WHO, by the Institute of Environmental Epidemiology of the Singapore Government, with the disclaimer that: *This document is not a formal publication of the World Health Organization.* However, from the outset, the content of the publication has been available on the WHO website.



Though based largely on research into the effects of transportation noise, the CNG presented guideline values which were, as summarised in the guideline values table, not source-specific in terms of indoor and outdoor noise. The ENG presents not just guidelines but recommended exposure values for protecting human health, along with guiding principles to support the incorporation of recommendations into a policy framework.

The ENG recommendations were formulated by a Guideline Development Group (GDG), chaired by Stephen Stansfeld, known for his work on the RANCH[1] study. They were informed by a systematic review team who looked at the evidence on which the guidelines have been based, and subject to assessment by the external review group.

The scope of the recommendations

The ENG recommendations are expressly source specific, and the sources are:

- aircraft noise;
- road traffic noise;
- railway noise;
- wind turbine noise; and
- leisure noise (meaning attendance at venues with high sound levels or listening to personal listening devices).

However, during the consultation phase on the draft document, some pointed out that the replacement of the CNG by the ENG would leave an absence of WHO guidelines in the European Region in relation to noise other than the specific sources covered. In the final document, the following statement was inserted: *The current environmental noise guidelines for the European Region supersede the CNG from 1999. Nevertheless, the GDG recommends that all CNG indoor guideline values and any values not covered by the current guidelines (such as industrial noise and shopping areas) remain valid.*

The guidelines do not include recommendations about any kind of multiple exposures, even though they note that, for example, in Germany, 44% of the population are annoyed by at least two and up to five sources. They note that combined exposure to several means of transportation is particularly harmful, but provide no recommendations for these cases.

The ENG are said to complement the Night Noise Guidelines (NNG). The distinction is

drawn between the No Observed Adverse Effect Level (NOAEL) and Lowest Observed Adverse Effect Level (LOAEL) approach of the NNG, which the ENG says were based on evidence-based, expert judgement, and the ENG recommendations more strictly based on the available evidence and following the guiding principle to identify exposure values based on a relevant risk, or increase of adverse health effects.

Thus, says the ENG, the recommended guideline values might not lead to full protection of the population, including all vulnerable groups. The GDG stresses that the aim of the ENG is to define an exposure level at which effects 'certainly begin'.

The ENG recommendations for sources except leisure noise are all made in terms of L_{den} and L_{night} as defined in the Environmental Noise Directive, which relate to outdoor noise determined as an annual average. (For leisure noise, $L_{Aeq\ 24h}$ is the index used.)

The approach taken in formulating the guidelines

The issues addressed by the guidelines were:

- In the general population exposed to environmental noise, what is the exposure-response relationship between exposure to environmental noise (reported as various indicators) and the proportion of people with a validated measure of health outcome, when adjusted for confounders?
- In the general population exposed to environmental noise, are interventions effective in reducing exposure to and/or health outcomes from environmental noise?

The approach taken has been to review the evidence to be found in research reports according to its 'quality' using the Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach. The evidence can be found in the open access International Journal of Environmental Research and Public Health, in which a series of reports were published containing the material that was assessed in the ENG preparation process.

The assignment of quality levels to the research was done by the GDG according to the AMSTAR checklist (a measurement tool to assess systematic reviews). Research was graded:

- **high quality** if further research is very unlikely to change the certainty of the effect estimate;
- **moderate quality** is applied to cases where further research is likely to have an important impact on the certainty of the effect estimate and may change the estimate;
- **low quality** refers to cases where further research is very

For road traffic noise and aircraft noise, the recommendation is to reduce noise by changes in infrastructure

P56 ►

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For road traffic noise and aircraft noise, the recommendation is to reduce noise by changes in infrastructure

P56 ►

likely to have an important impact on the certainty of the effect estimate and is likely to change the estimate; and
- **very low quality** relates to research where the effect estimate is uncertain.

Research was downgraded for study limitations or risk of bias, inconsistency of results, indirectness of evidence, imprecision of the pooled effect estimate and publication bias.

Research was upgraded for high magnitude of the pooled effect, a significant effect after all plausible confounders were considered and the existence of an exposure-response gradient.

The strength of the recommendations made was determined partly by quality of evidence, but also by the balance of benefits and harms, resource implications and five other parameters.

The health outcomes considered were classed either as 'critical health outcomes', or 'important health outcomes'.

Critical health outcomes are:
- cardiovascular disease;
- annoyance;
- effects on: sleep, cognitive impairment; and hearing impairment and tinnitus.

Important health outcomes are:
- adverse birth outcomes;
- quality of life, well-being and mental health; and
- metabolic outcomes.

(One of the studies considered includes a finding that there was correlation between waist circumference and noise level!)

For each noise source, plots are included showing the exposure-response results found in the studies, and the outstanding feature of these is the enormous spread of results. In each case, there is a quadratic regression curve produced by the WHO from the pooled data and called the Exposure Response Function (ERF).

For road, rail and air noise, the Miedema and Oudshoorn curves and their confidence limits are also plotted. The ERF for road traffic noise has the feature that %HA declines with increase in noise level between 40 and 45 L_{den}. Unlike the Miedema and Oudshoorn curves, no confidence limits are attached to the WHO regression curves. For health effects such as ischaemic heart disease (IHD) the relative risk (RR) from each study is plotted along with 95% confidence limits.

The eye-catching curve, perhaps not unexpected in the aftermath of ANASE[2] and similar studies, is the percentage 'highly annoyed' (%HA) for aircraft noise, where the WHO quadratic regression is of the order of 10 dB lower than the Miedema and Oudshoorn curve, which was used in the WHO publication: *Burden of Disease from Environmental Noise. Quantification of Healthy Life Years Lost in Europe*. The methodology of the Burden of Disease document was used to produce the WHO's headline that at least 'one million healthy life years are lost every year from traffic-related environmental noise in western Europe. A lack of noise exposure data in the central an eastern parts of the WHO European Region mean that it was not possible to assess the burden of disease from environmental noise for the whole region.'

In order to reach their recommendations, the GDG chose a set of benchmarks. These were set either in terms of:
- relative risk (RR);
- odds ratios (OR); or
- percentage highly annoyed (%HA).

The GDG engaged in extensive discussion in the process of setting some of the benchmarks. For example, in relation to ischaemic heart disease (IHD), where the GDG was confident that health risks result from exposure at a RR increase of the order of 5-10% in the incidence of IHD, "after extensive discussion at the very end of the guideline development process, the GDG decided to stick to 5% as the relative risk increase". The benchmarks they settled on are as follows – along with associated disability weightings as used in the Burden of Disease document. 'HSD' in the table below refers to 'highly sleep disturbed'.

Priority health outcomes and relevant risk increases for setting guideline levels

Priority health outcome measure (associated DW)	Relevant risk increase considered for setting of guideline level
Incidence of IHD (DW: 0.405)	5% RR increase
Incidence of hypertension (DW: 0.117)	10% RR increase
%HA (DW: 0.02)	10% absolute risk
%HSD (DW: 0.07)	3% absolute risk
Permanent hearing impairment (DW: 0.0150)	No risk increase due to environmental noise
Reading and oral comprehension (DW: 0.006)	One-month delay in terms of reading age

An important feature of the approach taken in the preparation of the document relates to 'interventions', i.e. mitigation or measures taken to reduce noise. Both interventions that have the effect of reducing outdoor noise levels, and interventions such as sound insulation schemes, are considered, but the essential difference between the two is not fully taken into account.

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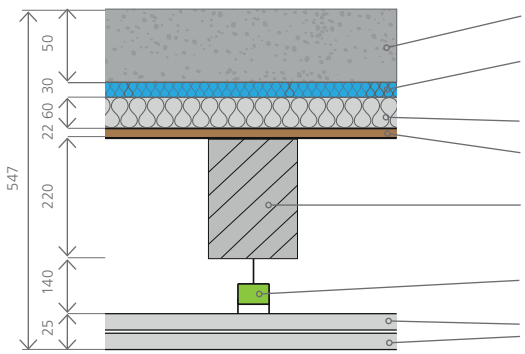

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SCAN FOR FULL REPORT

IMPACT NOISE

$L_{n,w}$ **30 dB**

$L_{n,w,*}$ **30,0 dB**

max Abw. 10,4 dB / 100 Hz

Summe 31,8 dB

Norm DIN EN ISO 717

$L_{n,sum,\ 100\text{-}2500}$ 46,6 dB

$C_{I,\ 100\text{-}2500}$ 2 dB

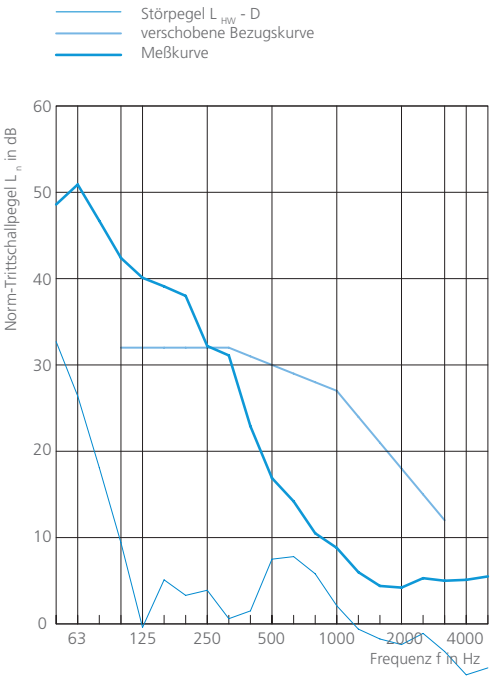
$L_{n,sum,\ 50\text{-}2500}$ 54,6 dB

$C_{I,\ 50\text{-}2500}$ 10 dB

f(Hz)	L_n (dB)	L_{HW}-D	L_b
50	48,6	-	-
63	50,9	-	-
80	46,7	-	-
100	42,4	-	-
125	40,1	-	-
160	39,1	-	-
200	38,0	-	-
250	32,2	-	-
315	31,1	-	-
400	22,9	-	-
500	16,9	x	x
630	14,2	x	x
800	10,5	x	x
1000	8,8	x	x
1250	6,0	-	x
1600	4,4	-	2,6
2000	4,2	-	4,0
2500	5,3	-	4,2
3150	5,0	-	5,0
4000	5,1	-	6,1
5000	5,5	-	6,9

x <=> Wert korrigiert
99.9 <=> Korr.= +1.3 dB

Probekörper Nr. 44694/19 Klima 10°C, 61%



Report reference X37

AIRBORNE NOISE

R_w **82 dB**

$R_{w,*}$ **82,3 dB**

max Abw. 11,1 dB / 100 Hz

Summe 27,9 dB

Norm DIN EN ISO 717

$C_{100\text{-}3150}$; $C_{tr,100\text{-}3150}$ -4;-11

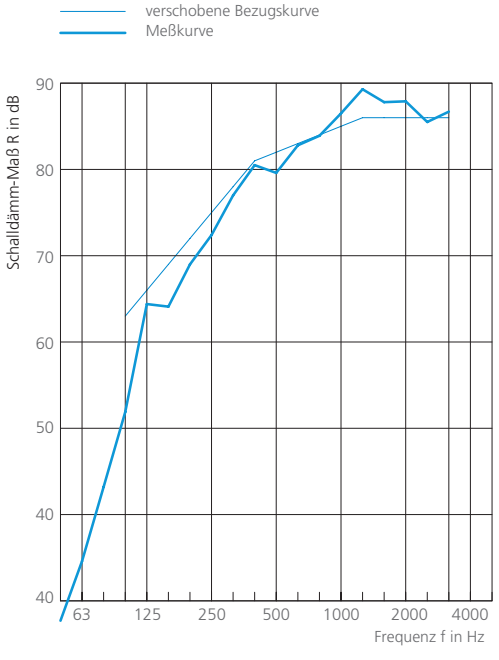
$C_{50\text{-}3150}$; $C_{tr,50\text{-}3150}$ -17;-31

$C_{100\text{-}5000}$; $C_{tr,100\text{-}5000}$ -3;-11

$C_{50\text{-}5000}$; $C_{tr,50\text{-}5000}$ -16;-31

f(Hz)	R (dB)
50	27,7
63	34,6
80	43,2
100	51,9
125	64,4
160	64,1
200	69,0
250	72,4
315	77,0
400	80,5
500	79,6
630	82,8
800	83,9
1000	86,5
1250	89,3
1600	87,8
2000	87,9
2500	85,5
3150	86,7
4000	90,0
5000	87,5

Probekörper Nr. 44694/19 Klima 10°C, 61%



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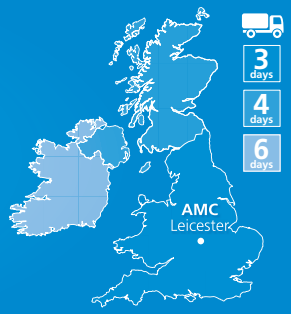

Regarding the first kind, if there is a causal relationship between outdoor environmental noise and the benchmarks, then an intervention that reduces outdoor noise levels must have a direct effect in reducing the benchmark effect. Otherwise, there must be a confounding factor in the research relied on.

By contrast, interventions in the form of sound insulation have no effect at all on outdoor sound levels and the question that arises is whether the incidence of annoyance and, in particular, the percentage highly annoyed is different in populations living in sound-insulated dwellings.

It is remarkable how little attention is given to this question in the underlying research, and indeed in the recommendations. For example, the strong recommendation for aircraft noise is to reduce it to 45 dB L_{den}, regardless of whether the airport concerned has a sound insulation scheme. One potential effect of this could be to remove any incentive for airports to introduce sound insulation schemes. The same goes for highways and railways.

What the guidelines say about interventions is difficult to interpret, given the fact that the guidelines deal solely with outdoor noise levels. For road traffic noise, the statement is included that 'path interventions such as insulation and barrier construction reduce noise exposure, annoyance and sleep disturbance', but noise insulation has no effect on exposure in terms of L_{den} and L_{night}.

The ENG makes clear that L_{den} and L_{night} are as defined in Annex I of the Environmental Noise Directive. It follows that when the ENG makes statements such as "measured at the most exposed façade" it means, to use the words of the END, "in which the incident sound is considered, which means that no account is taken of the sound that is reflected at the façade of the dwelling under consideration (as a general rule, this implies a 3 dB correction in case of measurement)."

The reference to indoor sound levels is confined to the statement that 'nevertheless, in certain cases it could be helpful to estimate indoor levels based on outdoor values. The differences between indoor and outdoor levels are usually estimated at around 10 dB for open, 15 dB for tilted or half-open and about 25 dB for closed windows'. In several passages, the ENG recognise the relevance of indoor noise levels on, for example, the effects of noise on sleep, but they give no new recommendations in terms of indoor noise levels, leaving the CNG guideline values in place for these.

The recommendations

The recommendations are of two kinds, 'strong' and 'conditional'. A **strong recommendation** can be adopted as policy in most situations. The guideline is based on the confidence that the desirable effects of adherence to the recommendation outweigh the undesirable consequences. The quality of evidence for a net benefit combined with the other factors inform this recommendation, which should be implemented in most circumstances.

A **conditional recommendation** requires a policy-making process with substantial debate and involvement of various stakeholders. There is less certainty of efficacy due to lower quality evidence, opposing values and preferences and high resource implications, meaning there may be circumstances or settings in which it will not apply.

The recommendations can be summarised as follows, along with the outcomes and the levels which are associated with the benchmarks:

Source	Strength	Outcome, level for benchmark and quality	Recommended level	
Road traffic noise	Strong	IHD 59.3 dB L_{den} High %HA 53.3 dB L_{den} Moderate	53 dB L_{den}	45 dB L_{night}
Railway noise	Strong	%HA 53.7 dB L_{den} Moderate	54 dB L_{den}	44 dB L_{night}
Aircraft noise	Strong	IHD 52.6 dB L_{den} Very low %HA 45.4 dB L_{den} Moderate Reading skills and oral comprehension in children 55 dB L_{den} Moderate	45 dB L_{den}	40 dB L_{night}
Wind turbine noise	Conditional	%HA 45 dB L_{den} Low	45 dB L_{den}	
Leisure noise	Strong	Health effects 70 dB $L_{Aeq\ 24h}$	70 dB $L_{Aeq\ 24h}$	

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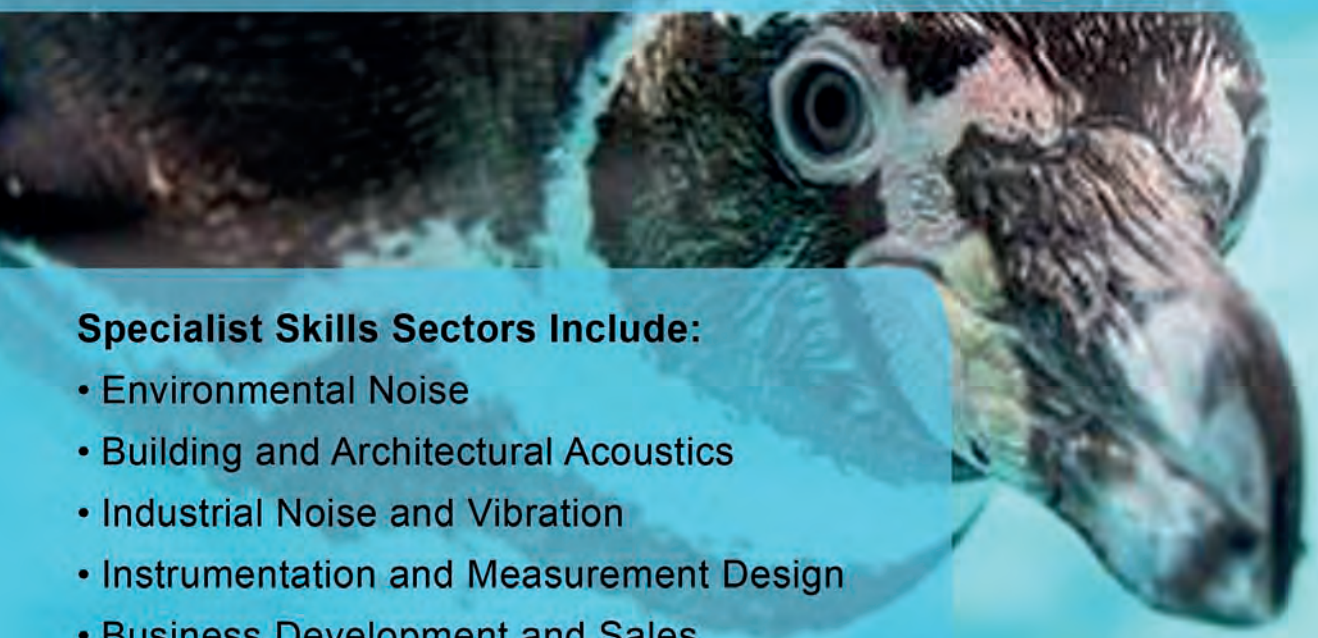

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- Vibration and Stress Dynamics
- Noise, Vibration and Harshness testing

For an informal chat please call Amir on 01792 365 007, or alternatively email amir.gharaati@penguinrecruitment.co.uk

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It is notable that while the message the EU has received from this work relates to the number of healthy life years lost, following the finding that there is a causal relationship between road traffic noise and IHD after removing air quality as a confounder, the recommended L_{den} values are all driven by the level at which the WHO's ERF shows 10% highly annoyed.

For road traffic noise and aircraft noise, the recommendation is to reduce noise by changes in infrastructure. For railway noise and wind turbines, the guidelines say that there is insufficient evidence to recommend one type of intervention over another.

Carry-over from the 1999 Guidelines for Community Noise

The parts of the Guideline Values table from the CNG that are still valid are indicated as follows:

Specific environment	Critical health effect(s)	L_{Aeq} [dB(A)]	Time base [hours]	L_{Amax} fast [dB]
Outdoor living area (**noise from sources other than road traffic, railways, aircraft or wind turbines**)	Serious annoyance, daytime and evening Moderate annoyance, daytime and evening	55 50	16 16	– –
Dwelling, indoors	Speech intelligibility and moderate annoyance, daytime and evening Sleep disturbance, night-time	35 30	16 8	 45
Outside bedrooms (**noise from sources other than road traffic, railways, aircraft or wind turbines**)	Sleep disturbance, window open (outdoor values)	45	8	60
School classrooms and pre-schools, indoors	Speech intelligibility, Disturbance of information extraction, Message communication	35	During class	–
Pre-school bedrooms, indoors	Sleep disturbance	30	Sleeping time	45
School playground, outdoors	Annoyance (external source)	55	During play	
Hospital ward rooms, indoors	Sleep disturbance, night-time Sleep disturbance, daytime and evenings	30 30	8 16	40 –
Hospitals, treatment rooms, indoors	Interference with rest and recovery	#1		
Outdoors in parkland and conservations areas	Disruption of tranquillity	#3		

#1 As low as possible
#3 Existing quiet outdoor areas should be preserved and the ratio of intruding noise to natural background sound should be kept low

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For railway noise and wind turbines, the guidelines say that there is insufficient evidence to recommend one type of intervention over another

Bustling night life on its doorstep; Ham Yard Hotel still offers a peaceful night's sleep with Selectaglaze

Located in one of the most vibrant parts of London, lies the stunning Ham Yard Hotel. Centred around a pedestrian thoroughfare connecting Great Windmill Street and Denman Street, Ham Yard Hotel has everything guests could want on its doorstep, from an eclectic nightlife of buzzing bars and restaurants to quirky shops and quaint cafes.

Built on a plot that has been vacant for a number of years, the site has had a creative past. During the 1920s, Ham Yard was home to the Hambone Club for writers and musicians.

Numerous plans had been put forward over the years to develop the site, all were rejected until permission was granted for Firmdale Hotels to redevelop the area. They went on to create 91 individually designed hotel bedrooms and 24 apartments, along with a 1950s style bowling alley, theatre and restaurant.

Although new double glazed windows were installed throughout the building, the corner of the hotel on Great Windmill Street still suffered high exterior noise levels. The introduction of secondary glazing is one of the most effective ways of combating outside sound. A reduction of 45 dB is possible when there is a gap of at least 100mm.

A total of 37 openings have been treated in three different unit styles. The secondary glazing was finished in a dark grey colour to match the existing primary windows, making them as unobtrusive as possible. Acoustic laminated glass was also used, which absorbs the external noise levels, to support in creating a peaceful and tranquil atmosphere.

As testament to the detailed planning throughout the design and build phases, Firmdale's efforts were rewarded when the hotel gained a BREEAM 'Excellent' rating.

Established in 1966 and Royal Warrant Holder since 2004, Selectaglaze has a wealth of experience working on many building types, from new build to Grade I Listed buildings. Selectaglaze offers a comprehensive free advisory service to help with any specification queries, as well as RIBA approved CPDs and factory tour. Selectaglaze will be showcasing a variety of secondary glazing products at Futurebuild from the 5th – 7th March, ExCel London at Stand D21.

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Implications of the guidelines for decision-makers

Given the statement about parts of the CNG being still valid – internal noise and source not covered – it becomes necessary to construct a hybrid summary table to cover all currently valid WHO guidance and recommendations. Given the fact that outside noise nearly always contains significant contributions from transportation noise sources, the surviving recommendations in the above table regarding outdoor noise from sources other than road traffic, railways, aircraft or wind turbines has very restricted meaning.

The principal part of the CNG table that survives intact is the line for dwellings, indoors. It is interesting to place this alongside the new recommendations of the ENG for transportation noise with regard to L_{Aeq}-based units as follows:

Source	CNG guideline indoors all sources	ENG guideline outdoors noise from specific source only
Road traffic noise	35 $L_{Aeq\ 16h}$ 30 $L_{Aeq,\ 8h}$	53 dB L_{den} 45 dB L_{night}
Railway noise	35 $L_{Aeq\ 16h}$ 30 $L_{Aeq,\ 8h}$	54 dB L_{den} 44 dB L_{night}
Aircraft noise	35 $L_{Aeq\ 16h}$ 30 $L_{Aeq,\ 8h}$	45 dB L_{den} 40 dB L_{night}

Depending on the circumstances, L_{den} is often about 2 dB greater than $L_{Aeq,\ 16h}$ for the same environment, so placing the recommendations alongside each other makes them consistent if the outside-to-inside difference is of the order of the reduction of a partially open window for road and rail sources, but less than the reduction for a wide open window for aircraft noise.

It may be that residents affected by surface transport noise have their windows partially open, but on the whole, one does not see wide open windows in the vicinity of airports. On the other hand, remote from airports where aircraft noise is not far above 45 dB L_{den} it would not be surprising to see wide open windows.

As far as decision-makers are concerned, there can be hardly any (if any at all) airports so remote from dwellings that a noise exposure of 45 dB L_{Aeq} can be achieved by infrastructure changes, short of drastic measures such as closure of runways. It is difficult to know how there is any practicable way of making use of his recommendation. Only by going beyond the ENG and taking sound insulation into account, thereby using indoor noise criteria, does it have realistic meaning. By contrast, the recommendations for surface transport noise can at least be achieved in some circumstances by the provision of noise barriers and other path interventions that have the effect of reducing outdoor noise levels at receptors.

It must not be forgotten that the recommendations are for noise from the sources alone, and there are no recommendations for locations where there is noise from combinations of these sources. Given that current practice regarding assessment of noise from windfarms does take background noise into account, the recommendation in terms of wind turbine noise alone is a departure from current and emerging practice – at least in the UK.

The use of BS 4142 for assessing industrial and commercial noise is unaffected by the ENG.

Conclusions

The partially superseded Guidelines for Community Noise attained an extraordinary status, with their applicability stretched to cover many sources of noise not specifically addressed in the underlying research, and they have formed the basis of some important court judgements and other decisions.

Following the publication of the WHO Environmental Guidelines for the European Region, it is going to be quite difficult for expert witnesses to present a clear statement of what are acceptable standards of noise to tribunals of one kind or another. It will be even more difficult for decision-makers to follow what is being presented to them, and to make unchallengeable decisions.

For more information visit **https://www.ioa.org.uk/news/new-who-environmental-noise-guidelines-2018-european-region**

Author

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[2] Attitudes to noise from aviation sources in England (ANASE) Final Report for the Department for Transport

IOA WHO noise guidelines meeting

The Institute recognises the importance of this document and is holding a one-day meeting on the guidelines on Wednesday 16th January 2019 at RIBA, 66 Portland Place, London W1B 1AD

One of the key speakers will be Professor Stansfeld, so to book your place visit **www.ioa.org.uk**

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Institute of **Acoustics**

ISO/FDIS 19488:2018 update

In the November/December 2018 issue of the Acoustics Bulletin, you should have read an article about ISO 19488:2018 – Acoustic classification of dwellings, but it had to be withdrawn. Phil Dubavin explains the unusual circumstances surrounding this decision.

Phil Dunbavin FIOA

The draft standard was issued as a Final Draft International Standard (FDIS) to the international community for comments and voting. An FDIS is issued with the instruction that only editorial or typographical errors are to be considered. All the technical issues should have been dealt with earlier in the drafting process.

In this instance though, the FDIS was voted on and unexpectedly disapproved. Over the many years that I have been involved in international standardisation, I cannot recall an FDIS not becoming an ISO. This was such an unusual event that I consulted the ISO Secretariat to find out what would happen next with this draft standard and they said that the parent committee ISO/TC43/SC2 would make that decision at the ISO meetings in Japan during the week beginning 15th November 2018.

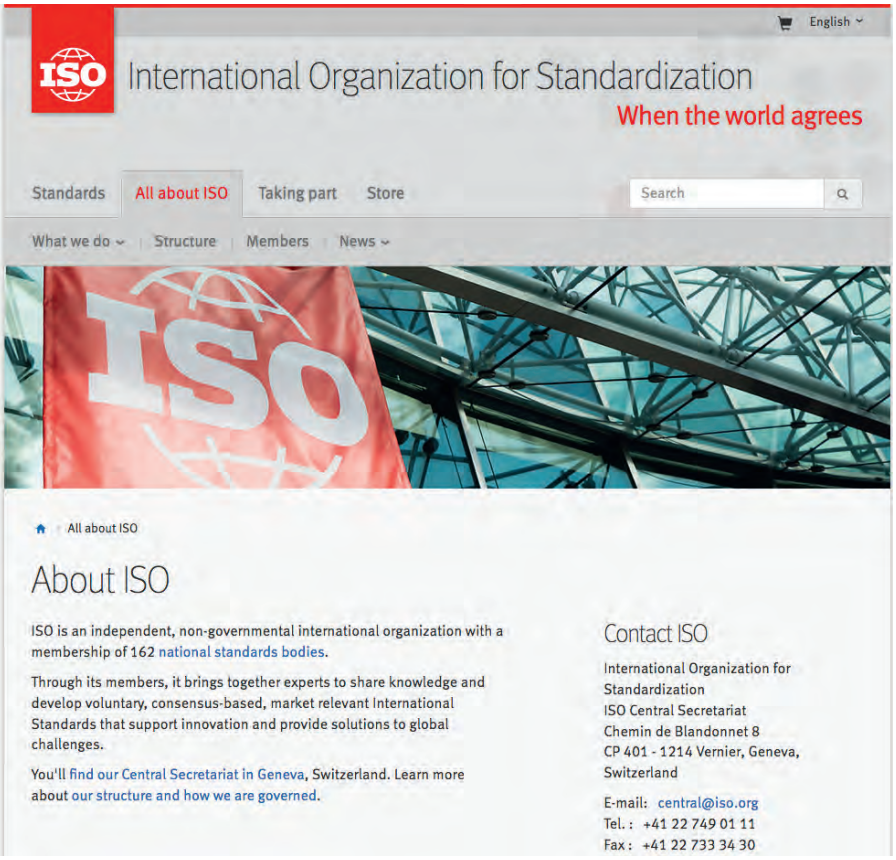
The voting to become an ISO requires that these two criteria are met:

1. **P-Members voting: 14 in favour out of 20 = 70% (requirement >= 66.66%)**

(P-Members having abstained are not counted in this vote.) So this criterion was met.

2. **Member bodies voting: seven negative votes out of 22 = 32% (requirement <= 25%)**
   Disapproved

This is the unusual result. When we examined the voting, it became clear that there had been significant lobbying by industry. The cause of the unexpected disapproval rested with two countries, who had not been involved in the creation of this standard and who had never voted on it at any time, suddenly voted to disapprove it.



Any progress was constrained by time, in that there was no opportunity for a second FDIS to be considered and even less time to go back to a modified DIS.

Consequently, the working group meeting decided to change the status of this standard from an ISO to an ISO/TS which is a Technical Specification.

Technical Specifications are prepared where there is no consensus, or when there is an emerging science, such as Soundscape.

The important thing about a Technical Specification is that only the first of the two criteria is used to decide its future. Given that and in this case, the FDIS would have moved forward to become ISO/TS 19488. 2018.

The plenary meeting of ISO/ TC43/ SC2 voted to reissue the existing FDIS as an FDIS/TS for voting early in 2019.

This *should* mean that I will be able to report on the content of ISO/TS 19488:2019 towards the middle of 2019. However, in all honesty, I cannot state that this is a certainty – given recent events.

Phil Dunbavin
Chairman BSI /EH/1 Committee

The Agent of Change Principle

By Scott Castle

The article in the Acoustics Bulletin (Volume 43, No.5, Sept/Oct 2018), titled: *'Theatres and Live Venues Win Protection From Noise Complaints'*, piqued my curiosity. The article related to the newly published National Planning Policy Framework guidance 2018 (NPPF 2018) and more specifically, the 'Agent of Change' (AoC) principle. While much is written about the planning concepts within the revised 2018 policy, limited reference is made to the importance associated with paragraph 182.

It is interesting to explore the origin of the AoC principle, how the concept was introduced, its intended application, who it seeks to protect, what it means for the development control process and importantly, what summaries may be drawn for the acoustics community who are likely to engage with the principle.

The NPPF 2018 (MHCLG, 2018) was published on 24th July 2018, replacing the original NPPF (DCLG, 2012) and after a consultation draft was issued in January 2018. Both Wetzl (2018) and Roberts (2018) comment that the policy was published on the last day of parliamentary business before the summer recess and accordingly, avoided any detailed debate and argument.

Paragraph 182 of section 15 states as follows:

'182 – Planning policies and decisions should ensure that new development can be integrated effectively with existing businesses and community facilities (such as places of worship, pubs, music venues and sports clubs). Existing businesses and facilities should not have unreasonable restrictions placed on them as a result of development permitted after they were established. Where the operation of an existing business or community facility could have a significant adverse effect on new development (including changes of use) in its vicinity, the applicant (or 'Agent of Change') should be required to provide suitable mitigation before the development has been completed (MHCLG,2018).'

Put simply, Dempsey (2018) states that the AoC principle is the notion that a party introducing a new use should be responsible for managing the impact of the same, including where the new use is more sensitive than existing uses around it. This is developed further by Greig (2018) stating that the intention is that issues of potential noise conflict are considered and resolved by the housing developer at the planning application stage.

Two contributors frame the context of the principle well:

Sajid David, as reported by Daly (2018) *"Cabinet minister Mr Javid, said he wanted to "'right the wrong'" of the soundproofing "'burden'" being placed on venues in the past. "'I have always thought it unfair that the burden is on long-standing music venues to solve noise issues when property developers choose to build nearby'".*

John Speller MP (2018) who presented his bill to the House of Commons (discussed further below) goes onto state: *"I accept that there is a variety of reasons for the decline in venues, but many relate to changes in the neighbourhood, increasingly when redundant commercial or industrial premises are converted to residential, or are knocked down and rebuilt, or as empty sites are developed. Of course, much of that is very welcome. It is part of the regeneration of our inner cities, restoring their historic vibrancy and creating much-needed homes. However, it can sometimes lead to the loss of what makes parts of those areas attractive in the first place, especially to younger residents. Incidentally, that applies not just to music venues but to the wider fabric of inner-city life, and there are important questions as to how we preserve the vibrancy and diversity of city life more generally across our main conurbations."*

It is useful to explore the origin, where it applies, what alternatives are being implemented and ultimately, whether these are successful in achieving the aim.

- On 4th September 2014, the AoC principle was introduced in Victoria State in Australia and requires a developer to include specific noise attenuation measures where a proposed development is within 50m of a live music performance venue. Lee (2016) reports that the new principle has been in place for 20 months and has been tested in several planning cases.

- Looking at the now replaced NPPF 2012, the element of integration was previously apparent in both paragraphs 109 and 123 as follows:
  - **Para 109** *"preventing both new and existing development from contributing to or being put at unacceptable risk from,*

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or being adversely affected by unacceptable levels of soil, air, water or noise pollution or land instability."

- **Para 123** *"recognise that development 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 was already included in terms of existing land uses and compatibility with regards to external drivers such as the soundscape."*

- **National Planning Practice Guidance 2014: Noise**. *"The factors influencing the 'character of the locality' may include long-established sources of noise in the vicinity – for example, church bells, industrial premises, music venues or public houses."*
- **National Planning Practice Guidance 2014: Noise**. *"Noise needs to be considered when new developments may create additional noise and when new developments would be sensitive to the prevailing acoustic environment. When preparing local or neighbourhood plans, or taking decisions about new development, there may also be opportunities to consider improvements to the acoustic environment."*
- In February 2017, DCLG published *'Our Broken Housing Market'* containing a supporting Annex, which made specific reference to the *'proposal to amend national policy to emphasise that planning policies and decisions should take account of existing businesses when locating new development nearby and, where necessary, to mitigate the impact of noise and other potential nuisances arising from existing development.'*
- On 10th January 2018, under the Ten Minute Rule Bill, MP John Spellar presented the Planning (Agent of Change) Bill 2017-19. Ten Minute Bills and readings are a mechanism for gaining publicity for a cause with it being presented in the House of Commons. The Bill was withdrawn on 10th September 2018, however, as the principle is now enshrined as policy within the NPPF 2018.
- On 30th January 2018, the Draft NPPF 2018 was published for consultation.
- On 24th July 2018, the final NPPF 2018 was published, which replaced the 2012 version.

It is relevant to note that the NPPF 2018 only applies to England, with Wales and Scotland adopting similar rulings. Greig (2018) comments that: *"The Welsh Government, for its part, wrote to all planning authorities in May 2017 indicating its intention to incorporate clear and explicit reference to the Agent of Change principle in Planning Policy Wales and advising that planning authorities should begin to apply the principle to the decision-making process with immediate effect"*, whereas the Chief Planner of Scotland, McNairney (2018), writes that the AoC principle will be written into the next revision of National Planning Framework and Scottish Planning Policy.

The AoC principle is also specifically written into the Draft London Plan D12 dated December 2017, which provides greater depth to the subject; rather than just referencing existing businesses, it also advises that development should be designed to ensure that established noise-generating venues remain viable

S182 – Planning policies and decisions should ensure that new development can be integrated effectively with existing businesses and community facilities

and can continue or grow without unreasonable restrictions being placed on them. Stronger still, it stipulates that where plans are unable to demonstrate that noise impacts have been considered and mitigated, these should be refused.

Forsberg (2018) comments that policy D12 places responsibility explicitly on the entity causing change (most often a new development), and is clear and direct about responsibility, the burden of cost and actions that are now compulsory. (At the time of writing this article, the London D12 plan had not yet been published.)

While the NPPF 2018 paragraph 182 discusses existing businesses and community facilities (such as places of worship, pubs, music venues and sports clubs), there has been a large drive in protecting live music venues and areas where the night time economy is critical in generating income in city centres.

Aside from the policy argument for the formalisation of recognising noise sensitive sources and existing noisy premises, the live music industry has also been very vocal with regards to noise complaints about live music venues being responsible for their closure. Rahman-Jones (2018) and Gleeson (2016) both report that approximately 35-40% of live music venues have closed across the country within the last decade. While complaints about noise are relevant, GLA (2015) also cites business rates, a growing population, an urgent need for housing, the planning system, local authority licensing requirements and a decline in police resources as being instrumental in the decline of such venues.

Safeguarding residents

A useful example of the AoC principle in operation was seen when Boris Johnson as then Mayor of London (2013), exercised his power to 'take over' a planning application from Southwark Council, which saw new residential development proposed in close proximity to the Ministry of Sound. The 'take over' process allowed a definitive conclusion to the planning process and encouraged debate between the developers (Oakmayne) and the Ministry of Sound to come up with proposed conditions (maintained in perpetuity) to safeguard the end residents. London SE1 (2016) comments that while the agreement reached allowed the Ministry of Sound to continue, protecting an important cultural and musical icon, the leases would each make specific reference to the existence of the noise source.

Greg Latchams Solicitors (2017) also highlights that, while far from ideal in general terms, the development principle of using sealed windows and balconies was approved during the case by the Mayor. This struck a balance between housing need and high-quality housing verses the interests of a noise making business that had operated for many years. Clover (2018) articulates the concept of AoC further in that mitigation measures could include sound insulation at source, sound insulation of the receivers, agreements about tenancies, financial exchanges or other arrangements entered into, possibly as a result of section 106 or tenancy agreements.

The idea of making future occupiers aware of the measures taken by the developers to mitigate noise is also made by Hughes (2018) who comments that, only at that point can an informed decision be made on the choice to buy or not to buy. While caveat emptor (buyer beware) is not new, it should be recognised that it will only come into play for those who exercise a choice in where to live, as not everyone is that fortunate and sufficient safeguards need to be included into builds to protect all of society.

Paragraph 182

Recent publicity within the licensing area has also hinted at the effectiveness of the newly implemented paragraph 182 with a more anatomical dissection of the wording, implications and applicability of the principle. The point is also made by numerous authors such as Clover (2018) and Humphreys (2018) that, whilst the AoC principle is now being driven from the development control framework in terms of place setting, the NPPF 2018 remains policy only and does not have a definition within statutory law. While decision-makers are required to have regard to policy in determining planning applications, Humphreys (2018) and Clover (2018) both make the point that the Agent of Change principle could still be outweighed by other material considerations and the principle is placed at the discretion of decision-makers.

The wording of paragraph 182 has also been subject to criticism in that many of the definitions will have to be determined in time through either case law, additions or modifications to the NPPF, NPPG or indeed, the anticipated licensing framework and section 182 of the Licensing Act 2003. Definitions such as vicinity, specific but not exclusive premises, unreasonable restrictions, adverse effects and the evidence thresholds will all undoubtedly evolve in due course and will be important to apply on a case-by-case basis.

Greig (2018) also issues caution that while development control as the primary mechanism to deliver the AoC principle; can mitigate risk, it cannot eliminate risk entirely. The point is also developed, as seen above in the Boris Johnson case, that where there is clearly a need for housing, the technical evidence submitted in support of the new noise sensitive developments is likely to become the focus of increased scrutiny. The point is made in the draft Mayor of London Policy D12, which makes specific reference to technical material and acoustic assessment as follows:

'Noise impact assessments accompanying planning applications should be carefully tailored to local circumstances and be fit for purpose. That way, the noise characteristics of existing uses can be properly captured and assessed. For example, cultural venues can have peaks of noise at different times of the day and night and on different days of the week, and boroughs should require a noise impact assessment to take this into consideration. Boroughs should pay close attention to the assumptions made and methods used in noise impact assessments to ensure a full and accurate assessment.' London Assembly (2018).

An area of uncertainty for consideration in such technical evidence is that the acoustic report writing process can only ever represent a snapshot in time. While authors of technical acoustic reports will strive to intelligently tailor monitoring to representative periods of interest (i.e. live music events), there is always the possibility that, post-report, the site management may change and have an entirely different approach as to what draws the customers in and what is deemed to be acceptable in terms of day-to-day management. Caution will need to be exercised with regards to changes in management, equipment, extensions to premises, changes to hours and internal layouts, as all have the potential to generate different noise sources, which were not initially anticipated; a fashionable move towards roof terraces in commercial venues being one such example.

Application of the principle

Humphreys (2018) writing in the Institute of Licencing journal also makes an interesting point about the application of the AoC principle, in that it will only apply where planning

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Mixed commercial and residential development in Leeds

permission is needed. For many years now, the expedited planning process or prior approvals, which sought changes from offices into residential, saw minimal consideration to noise prior to 2016. Accordingly, cases are now being presented where developments are being completed and occupied, and residents are submitting complaints of noise nuisance regarding such venues that generate noise and which would have generated noise for many years in the past, albeit without such close, new, residential neighbours. While the AoC principle may be too late for such schemes, these will have to be resolved through other means, be these nuisance, licensing reviews or private means.

Hawkins (2018), writing for the Morning Advertiser, presents exactly this scenario for the Star Inn at Guildford, whereby it is suggested that a conversion of a nearby office block has led to complaints being generated about the pub and a subsequent noise abatement notice served by the local authority.

While the items presented above concern live music venues, one might also consider the wider implications of AoC. A useful example being the wider proliferation in short term lets being exploited worldwide, which have the potential to change an area's character. Guttentag (2018) writes about how Airbnb lettings have the potential to change a neighbourhood, which again, requires a consideration of the planning regime to carefully consider the wider implications of such changes from residential to short-term let properties. The use of party houses for stag and hen nights is another example, where the planning regime could be used first and foremost to control the growth.

In linking back to the original article, Hemley (2018) comments as follows: *'Theatres and music venues in England have secured much-needed protection from the threat of licensing restrictions and closure because of noise complaints from nearby developments.'*

Proactive noise management

While the comments come from the arts community, and it is true that new developments would, and indeed should, already take into account the presence of such premises, aside from the development control and planning regimes, consideration of the statutory noise nuisance and licensing regimes will also come into play as independent but applicable regimes. Commercial premises, while their proximity is recognised, will not have a permit to operate 'carte blanche'. Such premises and venues will still have to proactively manage their premises and exercise best practicable means, which is reminiscent of Greig's (2018) comments above in that the AoC principle may minimise risk, but as policy, will not eliminate risk from such premises altogether.

Good acoustic design from the start

There can be no doubt that there is a requirement for new housing, whether these be new developments, or renovations, which will benefit from a recognition of such commercial premises and the types of sound or noise that they may generate. It is questionable whether there may be a trade-off between the sound insulation measures applied (and associated costs)

versus those which make the project feasible from a developer's perspective, the latter of which is likely to want to keep costs low and maximise their revenues. In terms of scheme viability and costs, Forsberg (2018) makes the interesting point that in mitigating against the noise, the additional costs at the construction stage are likely to support properties that are still worth their marked price on completion of the project and benefit from a vibrant city centre location, where residents get to enjoy all aspects of city life. A property advertised as being in a 'vibrant location' is only vibrant if the commercial premises are still there and operational.

In summary, it could be argued that the AoC principle, while highlighted in paragraph 182 of the NPPF 2018, is not a new concept, but provides greater and clearer emphasis on the protections needed to ensure harmonious co-existence between land uses. While the driver for implementing the principle sits within the development control and planning framework as a material consideration in new consents, this is only within a policy setting and not enshrined or recognised in statutory law.

Accordingly, the requirement to consider numerous policies by decision-makers could well find the AoC principle over-ruled by other policy considerations. However, progress in case law, challenges and ultimately, liability, are likely to see the AoC principle rising up the agenda when considering new living accommodation in proximity to existing noisy land uses. Whether there is protection from noise complaints will depend on a case-by-case basis and utilise not only the development control regime as a starting point, but additionally, those of the statutory nuisance and local authority licensing frameworks. While the above items consider the regulatory frameworks and their role, one should not forget the part played by good acoustic design at the very earliest stage in minimising impact, and ultimately protecting venues and neighbours from one another.

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New office and new recruits for NCL

Noise Consultants Limited (NCL) have moved to new offices with room for further growth and to host its dedicated noise modelling hardware. To celebrate both the move and its birthday, the NCL team were joined by colleagues from sister company Air Quality Consultants (AQC), welcoming new recruits George Gibbs (Associate Director) and Lukas Drinkwater (Assistant Consultant).

In its first year, NCL has been part of key infrastructure projects including airport expansion and high-speed rail. It has also delivered over 50 other projects including those involving noise mapping, action planning and planning-related assessments.

Reflecting on NCL's first year, James Trow, the Managing Director of NCL, said: "It has been a fantastic first year for NCL. The diversity and quality of our project work coupled with the commitment of our growing team has been excellent."

NCL and AQC staff

NCL are currently considering applications from driven and enthusiastic acousticians for all grades, including placements, at their Warrington and their London offices.

Noise experts shortlisted for top industry award

For the second year running, Echo Barrier is a finalist in the Equipment Supplier of the Year category of the 2019 Construction News Specialists Awards, which recognise the best specialist contractors from across the UK.

Peter Wilson, founder and Technical Director of Echo Barrier, said: "We strive to ensure our products deliver the required results for our customers, and this shortlisting demonstrates our emphasis on high quality."

The Echo Barriers are used by some of the world's biggest construction companies and have already been credited with reducing building noise at the World Trade Centre in New York and on the London Underground.

Echo Barrier reducing building noise on the London Underground

For more information about Echo Barrier visit **www.echobarrier.co.uk**

Noise issues in UK hospitals must be addressed

The one time we all need to have real peace and quiet is when we are in hospital but research is showing that noise levels in hospitals are getting worse.

The World Health Organization (WHO) advises that patients shouldn't be exposed to noise louder than 35 decibels when in hospital. But researchers from King's College London say noise levels in intensive care regularly exceed 100 decibels. While these high levels may not be constant, they can be intrusive and add to stress levels. In the worst-case scenario, noise pollution has been implicated in the development of a condition known as intensive care psychosis.

Increased stress, greater pain sensitivity, high blood pressure and poor mental health are also possible side-effects.

Dr Andreas Xyrichis, lead author of the latest noise report believes that three key areas must be addressed:

- The hospital soundscape must be considered as a whole – not just the noisiest elements such as hospital machinery and alarms, but also low but intrusive sounds, such as the noise of keys in locks and squeaky doors.
- Patients' perception and response to a variety of common hospital sounds should be more thoroughly researched. Researchers were surprised to learn some sounds, such as the tea trolley, brought a degree of comfort to patients – as a signal of social interaction.
- Patients and families need clear information about noise levels during admission, so they can consider simple solutions such as bringing their own headphones or earplugs.

Low-level solutions that are easy to adopt, such as personal dosimeters that could be worn by staff – or even patients – offer accurate noise level data making it easier to address noise problems.

The doseBadge5 is powerful and simple-to-use, it gathers robust information that can be used for the assessment of occupational noise exposures and includes all of the features of the original doseBadge, such as no controls, cables or displays, with a range of new functions and features.

Tony Towle, Group Marketing Manager at Cirrus Research

In addition to the four independent channels or integrators (which can be configured to meet any combination of Regulations, Standards or Guidelines), the doseBadge5 provides real-time octave band analysis over the entire measurement and, when combined with the NoiseTools software, allows individual noise sources to be identified, making the selection of hearing protection, quicker, simpler and effective.

Read more at: **https://www.nursingtimes.net/news/research-and-innovation/researchers-warn-noisy-hospitals-can-lead-to-staff-burnout/7026837.article**

Acta Acoustica

Acta Acustica united with Acustica, published together with the European Acoustics Association (EAA), is an international, peer-reviewed journal on acoustics. It publishes original articles on subjects such as general linear acoustics, nonlinear acoustics, macrosonics, flow acoustics, atmospheric sound, underwater sound, ultrasonics, physical acoustics, structural acoustics, noise control, active control, environmental noise, building acoustics, room acoustics, acoustic materials, acoustic signal processing, computational and numerical acoustics, hearing, audiology and psychoacoustics, speech, musical acoustics, electroacoustics, auditory quality of systems. It also reports on original scientific research in acoustics and on engineering applications.

IOA members can access this publication at **http://bit.ly/2BqNHWi**

You will need a login code, which will be supplied to you by Emma Lilliman, Membership and Engineering Administrator at the IOA. Email her at: **Emma.Lilliman@ioa.org.uk**

Acoustic tractor beam can grab objects from behind obstacles

An acoustic tractor beam that can bend sound around an obstacle to lift an object on the other side has been created by researchers in the UK. Dubbed SoundBender, the device combines an ultrasound transducer array with an acoustic metamaterial.

Acoustic metamaterials have been used to produce acoustic holograms, bend beams of sound and create static acoustic levitation devices, but the team behind the SoundBender, at the University of Sussex, say that these technologies have key limitations.

Devices based on transducer arrays cannot bypass obstacles that lie between them and the levitating object. Furthermore, the complexity, or resolution, of the sound fields they produce is constrained by the physical size of the transducers. An important drawback of using acoustic metamaterials is that the shapes of the sound fields they create cannot be adjusted.

But by combining a transducer array with acoustic metamaterials, the researchers say, you can move past these limitations. The metamaterial produces a more complex field of sound than possible with a transducer array, while the array of transducers adds dynamic, real-time control to the metamaterial's static hologram.

SoundBender comprises a metamaterial created from 16 different 3D-printed bricks on top of a programmable array of 16×16 off-the-shelf loudspeakers, operating at 40 kHz. The metamaterial provides a low modulator pitch to create high resolution, but static, acoustic fields, and the transducer array adds dynamic amplitude and phase control of the field.

Long-term exposure to road traffic noise may increase the risk of obesity

A study involving the participation of the Barcelona Institute for Global Health (ISGlobal) concluded that long-term exposure to road traffic noise is associated with an increased risk of obesity.

The authors of the study that was published in 'Environment International' wanted to find out whether new research would confirm the results of the few earlier studies that had demonstrated associations between traffic noise and several markers for obesity. To do this, they studied 3,796 adults who took part in the population-based Swiss SAPALDIA cohort study and had attended at least two follow-up visits between 2001 and 2011. The study was based on objective measures, such as the participants' weight, height, body mass index, waist circumference and abdominal fat. The data was analysed together with estimates of exposure to transportation noise developed in the context of the Swiss SiRENE project.

"Our analysis shows that people exposed to the highest levels of traffic noise are at greater risk of being obese" explains ISGlobal research Maria Foraster, first author of the study. "For example, we observed that a 10 dB increase in mean noise level was associated with a 17% increase in obesity."

The study authors also analysed exposure to noise generated by aircraft and railway traffic and found no significant associations, except in the case of long-term exposure to railway noise, which was associated with a higher risk of being overweight but not of obesity.

Sustained exposure to noise pollution is a widespread public health problem that is more serious than previously thought. Noise generates stress and affects our sleep, it alters hormone levels and increases blood pressure. Moreover, among other effects, sleep disturbance deregulates glucose metabolism and alters the appetite. "In the long-term, these effects could give rise to chronic physiological alterations, which would explain the proven association between persistent exposure to traffic-related noise and cardiovascular disease or the more recently discovered associations with diabetes and obesity. Our findings suggest that reducing traffic-related noise could also be a way of combating the obesity epidemic" she added.

More consistent approach to acoustics needed to help protect public health

The Association of Noise Consultants (ANC) has called for a more consistent approach to acoustics to protect society from the impact of excess noise.

The move comes as a new White Paper, 'Building Our Future; Laying The Foundations For Healthy Homes and Buildings,' reveals that almost 40% of the UK population is subjected to noise pollution, with a knock-on effect on public health.

Now, the ANC says that a greater awareness of how to build good acoustic design in homes and buildings from industry, coupled with knowledge of the key issues involved from regulators, is needed to address the trend.

The White Paper, produced by the All Party Parliamentary Group for Healthy Homes and Buildings, cites that the presence of noise pollution is reported to be suffered by 37% of the population and that it can cause long-term health issues, notably increasing levels of stress hormones and increasing the risk of cardiovascular effects such as heart disease and hypertension.

It cites a number of exacerbating issues, including the fact that most people spend 90% of their time indoors and that many modern homes and buildings are located in urban and brownfield sites affected by significant levels of noise. The noise impact of solutions designed to reduce overheating in homes is also flagged up.

Dan Saunders, Chair of the ANC, said: "The White Paper sets out a clear link between good acoustics and public health in the built environment.

Dan Saunders, Chair of the Association of Noise Consultants

"It calls on the Government to adopt a holistic approach to address the situation to ensure that future renovation of homes and buildings improves other elements vital for health and wellbeing in a number of areas, including acoustics.

"We would strongly support that message. Ultimately, there needs to be greater consideration and consistency given to acoustics in the built environment at an early stage of a project's development to ensure a better outcome."

The ANC points to the Professional Practice Guidance (ProPG) – referenced in the White Paper – as a key resource to help address the issue.

Launched in 2017 by a consortium of the ANC, along with the Institute of Acoustics, and the Chartered Institute of Environmental Health, the ProPG complements the UK Government's National Planning Policy Framework and Guidance to provide practitioners with an industry-recommended approach for the first time for new residential developments, both internally and externally.

Developed to encourage better acoustic design for new residential development and at the same time to protect people from the harmful effects of noise, the ProPG advocates full consideration of the acoustic environment through state-of-the-art design principles from the earliest possible stages of the design and development control processes.

It outlines what should be taken into account in deciding planning applications for new noise-sensitive developments, improves understanding of how to determine the extent of potential noise impacts and effects, and assists the delivery of sustainable development.

Mr Saunders added: "We'd urge the industry and regulators to get up to speed with the ProPG and understand how it can address the issues raised in the White Paper.

"Over recent years, we have seen the introduction of the Noise Policy Statement for England, as well as substantial changes in national planning policy, but these developments have not been accompanied by detailed, technical acoustic advice.

"This lack of guidance can lead to inconsistent application of policy, and that may in turn result in unsatisfactory development and affect quality of life.

"ProPG has been developed to fill that gap and facilitate efficient and consistent decision-making in the development control process."

More details about ProPG can be found at **http://www.association-of-noise-consultants.co.uk/propg/**

The White Paper can be viewed at **https://healthyhomesbuildings.org.uk/wp-content/uploads/2018/10/HHB-APPG-White-Paper-V1.pdf**

Moth fur is the ultimate acoustic armour

New research explains how earless moths manage to elude predators. The moths' minuscule, muffling fur locks in the clicks produced by echolocating bats and prevents them from echoing back to their sonars. Thomas Neil, of the University of Bristol, calls the system "acoustic camouflage" in a study presented at a conference of the Acoustical Society of America.

To measure the fur's sonic absorption capabilities, Neil and his team sent pulses of ultrasonic frequencies out to target moths through a loudspeaker. A microphone next to the speaker captured the resulting echoes and measured their strength.

The team repeated this process from hundreds of angles for 10 moths across two species, measuring how different parts of the body absorbed sound to different degrees. The fur on the thorax absorbed up to 85% of the sound thrown at it and the team calculated that without that thoracic fur, moths would have a nearly 40% higher risk of being found.

According to Neil, absorptive moth fur could provide a useful model for developing "sound insulating technology." Their fur, he says, at least matches the capabilities of many existing technical sound absorbers.

Increasing integration in schools through acoustic control

The implementation of the Education Act 1981 led to changes, which imposed a statutory requirement that children with special educational needs should be educated in ordinary schools wherever possible. In recognition of the importance of integrating pupils as much as possible, BB93: Acoustic design of schools, has very clear criteria to ensure school buildings are inclusive environments for pupils with special hearing or other communication needs. With recent surveys of school populations showing that 85% of pupils with a permanent hearing impairment are educated in mainstream schools[1], it is more important than ever that appropriate consideration is given to the acoustic environment of schools.

Unwanted noise in an education setting can be especially problematic for pupils with special hearing requirements; leading to decreased speech recognition and understanding and potentially decreased academic performance if left unchecked

Creating inclusive spaces

The link between ineffective noise control and a poor education performance is a key consideration when building schools. Careful consideration should be given at design stage to ensure that the correct building products are specified to control external noise pollution, and safeguard the health and wellbeing[2] of the school's community and local residents.

Building products must be specified to ensure adequate reverberation time control within each particular room or space.

Unwanted noise has a detrimental effect on mainstream pupils in an education setting[3], and it can prove especially problematic for pupils with special hearing requirements. Poor acoustics have also been proven to leave pupils with special hearing requirements over-exerted, due to the extra effort required to distinguish speech. In this way, a poor acoustic environment can be a severe barrier to inclusion, leaving children with special hearing requirements feeling isolated and struggling to keep up with everyday demands.

While schools that meet BB93 effectively will not necessarily be suitable for all special needs pupils, it can generally be assumed that pupils with special hearing and other communication needs should be taught in rooms that meet this criteria. While there is a range of technological devices available to help pupils on an individual basis, strong consideration also has to be given to the entire building design from the earliest design stages. In order to build compliant education spaces, appropriate building products should be used to ensure the building is adequately insulated against noise inside and out. Acoustic control between rooms should be sufficient to prevent sound travelling from one area to another. The sound from plant and equipment should also be controlled adequately so that reverberation from one room to another is kept to a minimum.

According to Chapter 6 of the IOA's design guide for acoustics in schools, appropriate acoustic conditions set out in BB93 will benefit those with:

- permanent hearing impairment;
- speech, language and communication difficulties;
- visual impairments;
- fluctuating hearing impairments caused by conductive hearing loss;
- attention deficit hyperactivity disorders (ADHD);
- autistic spectrum disorder (ASD);
- an auditory processing disorder or difficulty; and
- those whose first language is not English.

(Sometimes, pupils will fall into one or more category.)

Catering to different hearing requirements

Audiogram figures say little about an individual's hearing for speech or the key skill of listening to speech with background noise. Pupils with similar audiograms can differ considerably in their ability to hear speech in normal listening environments. In an ideal world, a professional audiologist and acoustician would assess each individual pupil and specify exactly what each pupil needs in terms of acoustic conditions and special hearing requirements. However, as Chapter 6 of the IOA's Acoustic design of schools: a design guide, points out – 'in practice this is rarely practicable'.

This is why BB93 includes acoustic criteria for teaching spaces intended for mainstream pupils and the array of those with special hearing and communication needs.

Breaking down special hearing requirements

Even with modern hearing aids, issues of distortion mean that unwanted background noise still proves to be a problem. Unwanted noise masks the speech signal of devices, making it difficult to understand what is being said and can also leave pupils tired because of the effort

required to listen; making it preferable to keep background noise to a minimum.

As well as reducing background noise, it is also important to keep low frequency noise to a minimum – low frequency noise can have a substantial impact on speech recognition, masking important speech sounds in a manner that cannot be appreciated by those with normal hearing.

Effective building products with optimal acoustic absorption within the teaching spaces are a useful tool for ensuring short reverberation times, particularly at low frequencies, which is especially useful when creating a teaching space inclusive to those with special hearing requirements.

The importance of speech

Also set out in chapter 6 of the of the IOA's design guide for acoustics, speech is a critical aspect of classroom learning. Beyond teachers, listening to the speech of peers can also be an issue for those with special hearing requirements.

Given that approximately 38% of a pupil's time in the primary classroom might be spent working in groups with a further 31% spent on mat work[4], it is crucial that background noise is adequately controlled in a busy classroom so that they are able to hear the speech of peers amidst background noise from others.

Pupils with special hearing requirements should be included in all school activities according to the Equality Act 2010. That's why it's crucial that focus is not only given to classrooms, but to all areas where hearing-impaired pupils go about their day-to-day activities. While often overlooked in school design, outside-classroom learning is critical to overall learning and development, as such, attention should be given at the design stages to all areas of the school; from libraries to assembly halls, sports halls, gymnasia, music rooms and even ICT suites.

AG's Alphacrete® Acoustic sound-absorbing block was developed to help control acoustic reverberation within education settings and beyond. Independently tested by Sound Research Laboratories, AG's Alphacrete® Acoustic complies with the performance standards for the Department of Education's Priority School Building Programme (PSBP) and Class absorption levels to BS EN ISO1354:2003 'The Laboratory Measurement of Random Incidence Sound Absorption.'

For more details visit: **www.ag.uk.com**

References

'A full list of references can be obtained from the editor at **nickyr@warnersgroup.co.uk**

Alphacrete® acoustic block

Sto provides acoustic solution for museum

The StoSilent Distance system has been installed in the Garden Museum, Britain's only museum covering the art, history and design of gardens, located at the Church of St Mary-at-Lambeth.

Alun Jones of Dow Jones Architects, said: "The building work involved the creation of a cluster of copper-clad pavilions around a cloistered garden area. These house two new educational spaces and a cafeteria, and they are connected by a number of covered walkways. These spaces feature concrete floors and floor-to-ceiling glazing, so in order to achieve an acoustic environment with a reverberation time of less than 0.8 seconds, we used a Sto seamless acoustic ceiling."

The StoSilent Distance system provides a modern, clean, monolithic alternative to the standard, but limited, design options associated with exposed grid and tile systems, or boards with multifaceted holes or slots. It provides positive, balanced acoustics within buildings, helping architects and designers achieve clean and uncluttered lines. It is ideal for situations where, as with the Garden Museum, these surfaces must be suspended to accommodate services, and where the ceilings were being used as negative plenums for air extraction and movement.

The StoSilent Distance system utilises its own Sto SC400 metal framework, and StoSilent Distance 110 boards, which can be integrated with lighting, grills and other M&E considerations. Their honeycomb-like structure allows noise and sound to dissipate through a void space balancing the acoustic environment. The system can be used to create many different design features, including seamless, inclined planes or curves, or sharp and consistent joints.

The StoSilent Distance system at the Garden Museum in London (Image courtesy of Anthony Coleman)

New Rockfon® Metal™ ceiling tiles

Rockfon Metal ceiling tiles combine stone wool performance with attractive metal surfaces, offering Class A1 safest reaction to fire and the highest Class A (aw= 1.00) sound absorption from its stone wool core.

The bright white metal surface enables specifiers to create contemporary ceiling designs that offer the additional benefits of high light reflection and the ceiling's high absorption controls the ambient sound level, preventing echo and increasing speech intelligibility.

Rockfon's new brochure, 'Three Easy Steps', shows the two perforation patterns, sizes and edge details, such as clip-in concealed, semi-concealed and visible grid options. The tiles match the Chicago Metallic™ T15, T24 and Clip-in white grids, ensuring the colour is consistent throughout every project.

The stone wool core resists up to 100% relative humidity and the metal surface achieves corrosion resistance Class B (EN13962). The ceiling tiles are easy to demount and remount for access to services above. Produced from sustainable and recycled materials, the stone wool core of Rockfon Metal comes with a 15-year warranty.

For more details visit: **www.rockfon.co.uk**

Armstrong helps herald "All for one, and one for all"

Three Armstrong Ceiling Solutions, including TechZone™, the industry's first easy-to-specify-and-install ceiling solution with integrated technical services, have been used at a school campus in West Dunbartonshire.

The new state-of-the-art Balloch Campus features three acoustic Armstrong Ceiling Solutions throughout – Perla OP 0.95 Tegular mineral tiles on Prelude 24 TLX grid, Parafon Hygien Board mineral tiles on a 24mm corrosion-resistant grid, and Armstrong's TechZone™ integrated ceiling system incorporating Perla OP MicroLook planks.

For maximum acoustic comfort some 1,600m² of Perla OP 0.95 600mm x 600mm tiles with a Tegular edge detail within a standard 24mm grid were used in offices, classrooms and stores. These tiles perform to Sound Absorption Class A and were also the first mineral ceiling tile in Europe to win Cradle to Cradle™ certification as part of the new generation of sustainable and acoustic ceilings offered by Armstrong.

In the corridors and breakout areas, Armstrong's TechZone™ integrated ceiling system was specified with a 15mm XL2 grid, fabricated to special lengths of 900, 2100 and 2400mm.

Incorporating 800m² of Perla OP 0.95 1200mm x 300mm MicroLook, the TechZone™ system was specified to achieve the aesthetics of a linear plank system and seamlessly integrate and complement the 100mm wide linear lighting arrangement. In addition, it addressed the clutter of services above in a crowded corridor installation and provided an acoustic Class A product to reduce unwanted noise in the busy ceiling plane.

160m² of Parafon Hygien 600mm x 600mm tiles, which offer Class A sound absorption, 95% humidity resistance and clean room classification to ISO 4, were used within a 24mm corrosion-resistant grid in the high humidity zones such as the kitchen areas and stores.

For more details visit: **www.armstrongceilings.com/commercial/en-gb/**

Cirrus Research introduces new entry-level sound level meter

Cirrus Research's CR:308/310 sound level meters are aimed at the entry-level market. This robust sound level meter is ideal for basic noise information, it is capable of measuring the maximum sound level (LMax) and the sound pressure level (SPL) and meets current international standards for noise measurement instrumentation.

Both variants offer uncomplicated data along with other acoustic information and can measure different frequency weightings, to provide detailed and accurate data.

Other key features include:

- clear, backlit LCD display;
- custom adjustable noise level threshold (308);
- DC and AC output
- long battery life; and
- the CR:310 model can also send results directly to a portable printer.

For more details visit:
www.cirrusresearch.co.uk

Testing loudspeakers, headphones and audio systems in vehicles in a targeted manner

HEAD acoustics has introduced HQS-Audio, the new database for the analysis system, ACQUA, helps to test the quality of audio devices. Whether loudspeakers, headphones or audio systems in vehicles: HQS-Audio provides independent test runs for each application, consisting of various electroacoustic measurements. HQS-Audio is an essential tool to test and optimise audio devices in a targeted manner.

Besides the analysis of frequency response and signal-to-noise ratio, HQS-Audio offers extended tests of distortions: Measurements of intermodulation distortion as well as total harmonic distortion (THD) including noise (THD+N) are part of the database as well as Relative Approach analysis. Based on the hearing model, this algorithm can be used to highlight pulse-like noises. Therefore, Relative Approach is suited as an additional measurement to detect rub and buzz effects caused by misalignment of the voice coil of a loudspeaker. Additionally, HQS-Audio offers special performance tests for headphones with passive and active noise filtering (noise cancelling/ANC), this test verifies the tested headphones' ability to isolate the listener from the surrounding background noise. This is done either by passive noise isolation or by using modern signal processing techniques like active noise suppression. In combination with the high-precision HRT I turntable from HEAD acoustics, users are able to measure directivity characteristics of passive and active loudspeakers. HQS-Audio also offers the calculation of Thiele-Small parameters.

HQS-Audio uses various test signals such as realistic speech signals or logarithmic sine sweeps. Since the database is perfectly suited for testing smart speakers and other active speakers, both mono and stereo reproduction is taken into account. All measurements in the database can be conducted fully automated. Users are able to configure individual analyses intuitively and to adapt them according to the device under test. All measurement data is recorded and documented in ACQUA. The entire database of HQS-Audio is clearly structured and provides users with useful information on individual measurements.

With HQS-AudioBasic, HEAD acoustics provides a product variant of HQS-Audio that solely focuses on electroacoustic tests of loudspeakers. HQS-AudioBasic is a subset of the HQS-Audio database, which contains all measurements for testing and optimising active and passive loudspeakers.

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Committee meetings 2019

DAY	DATE	TIME	MEETING
Thursday	10 January	11.00	Meetings
Thursday	17 January	10.30	Membership
Thursday	7 February	11.00	Publications
Thursday	28 February	10.30	Diploma Tutors and Examiners
Thursday	28 February	1.30	Education
Tuesday	5 March	10.30	Diploma Examiners (London)
Wednesday	6 March	10.30	Medals & Awards
Wednesday	6 March	10.30	Executive
Wednesday	**20 March**	**10.30**	**Council**
Thursday	28 March	11.00	Meetings
Tuesday	9 April	10.30	CCWPNA Examiners
Tuesday	9 April	1.30	CCWPNA Committee
Thursday	25 April	10.30	Membership
Thursday	9 May	11.00	Publications
Thursday	16 May	10.30	CCHAV Examiners
Thursday	16 May	1.30	CCHAV Committee
Wednesday	22 May	10.30	Executive
Tuesday	23 May	10.30	Research Co-ordination (London)
Wednesday	**12 June**	**10.30**	**Council**
Tuesday	25 June	10.30	ASBA (Edinburgh)
Tuesday	2 July	10.30	CCENM Examiners
Tuesday	2 July	1.30	CCENM Committee
Tuesday	2 July	10.30	CCBAM
Wednesday	3 July	10.30	Distance Learning Tutors WG
Wednesday	3 July	1.30	Education
Thursday	4 July	11.30	Meetings
Thursday	1 August	10.30	Diploma Moderators Meeting
Thursday	8 August	10.30	Membership
Wednesday	11 September	10.30	Executive
Thursday	19 September	10.30	Engineering Division
Wednesday	**25 September**	**10.30**	**Council**
Thursday	10 October	10.30	Meetings
Thursday	17 October	11.00	Publications
Thursday	31 October	10.30	Membership
Tuesday	5 November	10.30	Research Co-ordination(London)
Tuesday	19 November	10.30	CCWPNA Examiners
Tuesday	19 November	1.30	CCWPNA Committee
Wednesday	20 November	10.30	Diploma Tutors and Examiners
Wednesday	20 November	1.30	Education
Thursday	21 November	10.30	CCENM Examiners
Thursday	21 November	1.30	CCENM Committee
Thursday	21 November	10.30	CCBAM Examiners
Tuesday	26 November	10.30	ASBA Examiners (Edinburgh)
Tuesday	26 November	1.30	ASBA Committee (Edinburgh)
Wednesday	27 November	10.30	Executive
Wednesday	**11 December**	**10.30**	**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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CadnaA & CadnaR 2019

Cadna A®

Main New Features

- Calculation in 1/3 Octave Bands with spectrum conversion tools.
- New evaluation parameters for Maximum Level calculation for industrial sources.
- Direct Import of Ms Excel (.xlsx) databases, besides ODBC sources.

Cadna R®

Main New Features

- New auralization feature. Listen to your room before and after your acoustic optimization and make anyone understand its benefits!
- Calculation and evaluation of the STI-matrix, determining the speech intelligibility between all pairings of speaker to listener within a room.

ANV MEASUREMENT SYSTEMS

SALES - HIRE - CALIBRATION

UKAS accredited calibration facility, see UKAS website for scope of UKAS accredited calibrations offered: **anv.ms/ukas**

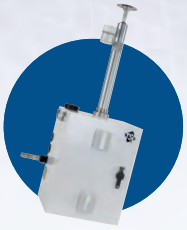
UKAS CALIBRATION 0653

THE PROFESSIONALS CHOICE... FOR A COMPLETE ENVIRONMENTAL MONITORING SOLUTION

ANV enviro

ANV Leq

Class 1 Type Tested by PTB



ANV PM10

MCERTS PM10 and PM2.5 up to 10,000 µgm⁻³

ANV Met

Sensors with no moving parts

ANV PPV

Simultaneous VDV, PPV, Dominant Frequency & Displacement

Have you noticed that there's quite a few

"Noise, Vibration, Dust and Weather - All on One Website"

products appearing?

Well, imitation is the sincerest form of flattery but don't be fooled.

Not all Remote Systems are created equal.

- Real Time (1 minute uploads) Data; Essential for Pro-Active Control
- Data is avaliable from the server (you don't have to download it from instruments in the field)
- Noise and Vibration sensors excellent for use beyond the monitoring
- Google Maps based interface
- Designed for professionals
- Full control and access to data from any web-enabled device
- A minimum of 5 simultaneous limits available for each sensor
- Up to 24 sets of limits per day and different limits each day

RION

Rion VM-56

A groundborne vibration meter that is as easy to use as a Rion NL-52

NEW

- Simultaneous VDV, PPV, Dominant Frequency and Displacement
- BS 6472:1, BS 7385:2 and BS 5228: 2, all covered with a single meter
- Equally suited to be attended, unattended and Live to Web measurements (using ANV's LivEnviro system)
- Wide frequency range (0.5 - 315hz)
- Third Octave option available
- Wav file recording option available

RION

Rion NL-52

Setting the Standard for Environmental Noise Measurement

- Class 1 - PTB Type Tested with and without Outdoor Microphone Protection
- Low Power Consumption - 10 days on a single 12Ah gel-cell battery
- Single 130dB range
- Unrivalled Reliability
- Easy to Use
- CSV data on an SD card
- 10 msec sampling as standard
- Options transferable between meters
  - Audio (WAV) recording
  - Octave/Third Octave
  - FFT
  - Reverberation Time