Vol 43 No 4 **July/August 2018**

ACOUSTICS BULLETIN

Keeping things quiet at One New Ludgate

in this issue...

Low noise road surfacing materials

plus... **Acoustics 2018: The IOA annual conference**

Measuring noise exposure from headsets and earpieces using a head and torso simulator

Institute of Acoustics

ACOUSTICS BULLETIN

Volume 43 No 4 July/August 2018

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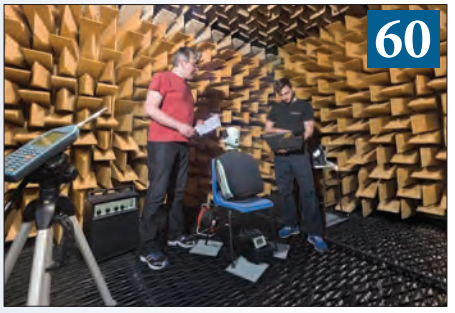
Institute affairs

General news

Technical contributions

Instrumentation Corner



Industry update

Regulars

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 Registered Charity no. 267026

Institute of Acoustics

WE MAPPED THE SOUNDS OF CHILE

With a population of around 17 million and roughly one-third of that living in Chilean capital of Santiago, traffic noise mapping wouldn't seem top of the urban research agenda.

Not so, last year a report stated that new car sales were up a staggering 27.3% in the country as the economy continues to improve. Santiago is also one of General Motors' manufacturing bases in South America. That's why Prof. Jorge Arenas undertook a two-year noise mapping study using equipment from Cirrus Research.

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Dear Members

Change is at the forefront of my mind at the moment. The Greek philosopher, Heraclitus, is credited with saying – over 2000 years ago – "Nothing is permanent except change". I've been wondering why something so commonplace and necessary causes us so much difficulty as human beings?

Change can cause uncertainty resulting in fear, which is probably why we hear so much about the importance of 'managing' change. If times have been good, looking back can be more comforting than looking ahead into the unknown. But to achieve some measure of control over our future we must look forward too. Somewhere there is a balance to be struck; learning from and/or celebrating the past to inform decisions for the future.

New IOA officers

The IOA's approach to leadership succession aims to strike this balance, with two years served each as President Elect, President and Immediate Past President. I'll be passing the leadership role into the safe hands of Prof Barry Gibbs at the AGM in September and look forward to supporting him. I would like to say thank you to William Egan, who will be leaving Exec, and without whose support I wouldn't have been able to navigate through the last four years. His personal support and his business skills and clarity of thought have all been invaluable.

I'm pleased to welcome Stephen Turner as President Elect. Stephen brings many years of experience in the acoustics industry, and a unique knowledge of government, which will be vital for the IOA at a time when there is much uncertainty regarding the future of UK legislation.

Office move and staff changes

Looking back over my term as President there has been some change which I have personally found difficult, and which has diverted me from things I'd hoped to move forward. To our staff, for whom the office move has had serious implications, I must send thanks both to those who are leaving and those who are moving with us to Milton Keynes. For those unable to come with us – Sue, Hansa, Hazel and Chantel – our thanks for your years of services, and for sticking with us to the end to ensure a smooth transition.

To those moving with us – Linda, Allan and Elaine – my thanks for your continuing service. And to our new staff – Edith, Emma and Annie – welcome to the IOA and to the acoustics community. I'm confident that you will all help move the Institute in the intended direction in the future. I'm also confident that you'll receive full support and encouragement from membership, particularly those whose volunteering enables the Institute to succeed. I hope members will drop in if they're passing our new office, to get to know the team and familiarise themselves with the new premises.

New IOA education and learning platform

My personal thanks go to Council and Exec, our volunteers and our membership for their continued support of the Institute, and for that given to me personally during my term. I'm also grateful to my employers – Arup and (from July) Wood Group – for their generosity in providing me with time to carry out my duties.

Professional trainers tell us that the speed of change is increasing, so we need to run fast to keep up. The IOA is responding by providing more electronically shared and recorded meetings via our new education and learning platform; this should enable more members both in the UK and abroad to gain access to our excellent programme of talks and conferences at a time that suits them. New courses and training material will be produced or sourced to ensure we provide as equitable a service as possible. We'll need to know what topics members are interested in learning more about, so please watch out for questionnaires over the next 12 months from our team seeking your views.

As Kennedy said, "…those who look only to the past or present are certain to miss the future." And while reflecting with great satisfaction on the success of the recent Cardiff conference, I look forward to seeing many of you in the near future at the AGM, being held at our event on Acoustics of Places of Entertainment and Sports Venues in Salford, in September.

Jo Webb, President

Conference programme

Please turn to page 7 for the updated conference programme.

Engineering Division

By Blane Judd, Engineering Manager

The Engineering Division is still working to support members who wish to join the growing number of engineers professionally registered with the Engineering Council (EC). We are still maintaining our target of double figures, although the June interview dates had to be postponed until September based on numbers and availability. The increased volume of enquiries is, however, still providing a pipeline of applications going forward. Professional registration at CEng or IEng is featuring more prominently in the expectations of employers and, as a result, is continuing to grow in recognition. Employers and their customers look to professional registration as a way to demonstrate to society and the rest of the engineering community that you operate at the level of professional competence and ethics expected today.

IOA support

The team here at the Institute of Acoustics are dedicated to providing the necessary levels of support to assist members like you, through the process. We are lucky to have a dedicated group of volunteers on the Engineering Committee who are willing to give candidates a steer on draft submissions. We have been successfully using improved guidance for those who do not hold exemplifying qualifications and so are demonstrating academic attainment through experiential learning or technical reports.

September interviews

Our next round of interviews will take place in September 2018 and we already have some candidates booked into that session. We hold a number of interview events through the year, depending on the number of candidates we have coming forward for registration. There are a number of candidates we are working with 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:

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

Remember 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.

Technical report route to registration

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. They represent 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 almost 225,000 registrants that hold international professional recognition.

Institute affairs

Seventy-eight membership applications have recently been approved by the Council following the recommendations of the Membership Committee. Of the total, 54 were new or reinstated, the remainder upgrades.

MIOA

Ben Bielicki
Cesar Bou
Patrick Carpenter
Steven Edwards
Filippo Fazi
Benjamin Gaten
Adeyemi Gbenga Joshua
Nathan Green
Benjamin Groves
Christina Ioannidou
Francois-Xavier Lallemand
Dunstan Langrish
Matt Markwick
Adam Mayes
Stephen Mole
Benjamin Mosley
Patricia Reed
Michael Rickard
Matthew Robinson
Luis Ruivo
Antonio Sanchez Parejo
Timothy Sherlock-Brown
James Slater
Matthew Thomson
Jack Traveller
Alan Wills

AMIOA

Safa Al Gburi
Joseph Allen
Joseph Archer
Elizabeth Bruce
Saif Bunni
Byron Davies
Tom Deering
Sarah Dennison
Joshua Evans
Thomas Everson
Kirsty Farquharson
Rahiel Ghani
Louis Hadaway
Keir Hannan
Daniel Hilsdon
Corinne Hooley
Ross Latue
Samantha Liu
Martin Loft
Stephen Martin
Harry Matthews
Miles May
Laura Mazzeo
Josh McLelland
Thomas Orbell-Bailey
Robert Paton
Michael Pau
Laimonas Ratkevicius
Oliver Roberts
Jeeva Srilal
Athanasios Synodinos
Charles Toher
Neil Voce
Jake Woolley
Chun Kit Yeung

TechIOA

Anthony Coraci
Ullas Edayillam Karicherry
David Jenkins
Dhruv Joshi
Stephen Lewis
Daniel Moore
Luigi Papa
Luke Pickering
Andrew Regan
Chris Selkirk
Colin Thomas
Charl Verster

Affiliate

Ayan Booyens
Wesley Highton
Amanda North
Joshua Symes
George Xanthoulis

Conference Programme

5-7 September
Organised by the Underwater Acoustics Group
4th International Conference on Synthetic Aperture Sonar and Synthetic Aperture Radar
Italy

12 September
Organised by the Building Acoustics and Environmental Noise Groups
Acoustics of Places of Entertainment and Sports Venues
Salford

20 September
Organised by the Physical Acoustics Group
Acoustic Materials and Metamaterials
Birmingham

4-6 October
Organised by Building Acoustics Group
10th International Conference on Auditorium Acoustics 2018
Germany

17 October
Organised by Measurement and Instrumentation Group
Ground Borne Vibration
London

24 October
Organised by the Musical Acoustics Group
Measurements and Modelling of Musical Instruments and Performance spaces
Edinburgh

8 November
Organised by Noise and Vibration Engineering Group
Sustainable Engineering Design
Southampton

27-29 November
(Organised by the Electroacoustics Group)
Reproduced Sound 2017 – Putting Sound in its place
Bristol

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

Eastern Branch

Acoustics, ventilation and overheating residential design guide

David Trew, of Bickerdike Allen Partners, provided IOA Eastern Branch members with an entertaining presentation at their April meeting about the new residential design guide focusing on acoustics, ventilation and overheating.

As this is currently a very hot topic, this very well-received presentation generated many questions.

The guide is currently in draft format, which is out for consultation and any constructive criticism or comments would be very welcome by either David Trew or the group, who are looking to finalise and issue the design guide soon.

The presentation covered the existing chasm between those of us in the field of acoustic consultancy, the expectations of the contractors and design teams, right through to the degree of laboratory testing that is available, therefore showing the difficulties faced by the Planning Officers and Environmental Health Officers when faced with a new system for noise control at the design stages.

What became clear during the presentation was that there are systems already in place in other countries, such as Denmark and Germany, but the amount of test data and the associated acceptance of these systems by the end users (residents) appeared to be very limited.

London Branch

Gym flooring – designing for impact and prediction

February's London Branch evening meeting focused on the topic of vibration from gym flooring. It is becoming more common for gymnasia to be installed within mixed use developments such as office or residential buildings, often without consideration for the detrimental effects of noise and vibration arising from equipment such as treadmills and free-weights.

Quantifying, predicting and treating high energy impact can be complex, with many variables, large uncertainties and lack of established guidance or source data. Regarding the latter, test data does often not relate to the structure or consider the transitory nature of impact energy. This talk focused on recent testing carried out in conjunction with Salford University in an effort to understand the dynamics of impact on typical gym floating floor systems and the pitfalls in usual test methods.

Adam Fox, from Mason UK, discussed the practical limitations of testing and experiments carried out in combination with Salford University to characterise high energy impact and he also discussed the practicalities of absorbing impact.

Martin McNulty, of Hoare Lea, then spoke about the theory of impact in more detail and described how the underlying structure has to be considered. He also discussed research which had been carried out in an effort to understand the perception of impact.

(L-R) Martin McNulty and Adam Fox

The Speech and Hearing Group report

The talk at the March London Branch evening meeting was called 'Audiology for Acousticians'.

P10 ►

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Although there are many disciplines within the specialty of acoustics, acoustics is, in general, regarded as the branch of physics concerned with the properties of sound. It is also recognised that sound is generally understood to be something that can be heard.

It was therefore considered appropriate that, as acousticians, we should revisit the acoustics of the ear itself and the use of acoustic stimuli in the assessment of hearing function.

Graham Frost, formally an audiologist and Technical Director for a leading audiological equipment manufacturer and supplier, and now a technical consultant, presented an overview of the anatomy and physiology of the human ear and details of its various components with their acoustic properties and functions.

The presentation explored the ear by considering its three major parts, the outer ear, (consisting of the pinna, ear canal and eardrum) the middle ear, (consisting of the middle ear bones (ossicles), their associated muscles and the eustachian tube) and the inner ear, (including the cochlea and its mechanisms for sending encoded neural auditory information along the auditory pathway).

The Speech and Hearing Group is considering organising further meetings relating to relevant aspects of audiology. If anyone has any specific topics that they wish to be covered then please get in touch.

Binaural audio research and applications

The April London Branch meeting, Lorenzo Picinali, Senior Lecturer in Audio Experience Design in the Dyson School of Design Engineering at Imperial College London, spoke on binaural audio research and applications.

The binaural technique allows you to create three-dimensional audio using a simple pair of headphones. While binaural recordings have been around for almost a century, binaural synthesis (i.e. creating new sound scenes using computational models, in order to allow real-time interactions, such as changing listener and sound sources positions) has only recently become widely available and used, thanks to the increase of power and memory in consumer devices. Despite the fact that a lot of research has been done in the past 30 years in the area of spatial hearing and binaural spatialisation techniques, there are still a number of open challenges.

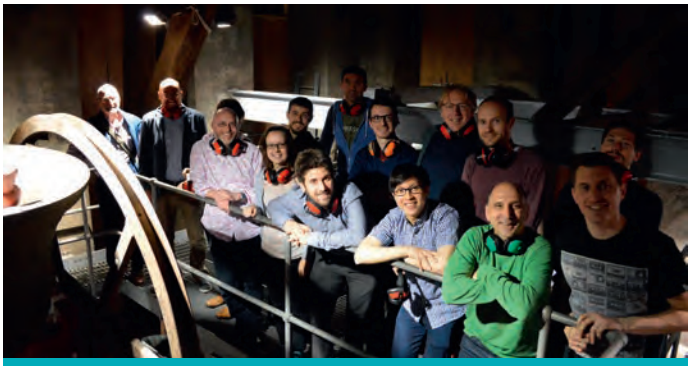
Lorenzo also presented the work done by the Sound and Audio Systems team on the development of a novel binaural spatialisation algorithm/library (the 3D Tune-In Toolkit developed within the 3D Tune-In project **http://3d-tune-in.eu/**), and on various other research projects related with audio and acoustics.

South West Branch

How many acousticians can you fit in a bell tower?

On 13 March 2018, Dr Anthony Chilton of Max Fordham presented to the South West Branch on the Association of Noise Consultants' guide for assessing acoustics, ventilation and overheating (AVO) in residential development. The presentation was recorded for future publication on the IOA YouTube channel.

On 17 May 2018, South West Branch members were kindly hosted by St Mary Redcliffe church in Bristol for a bell tower tour and bell ringing demonstration. The event was over-subscribed due to the small space but if there is enough interest we will organise a second visit for those who missed out. Please let us know if you would be interested.



Members of the South West Branch at St Mary Redcliffe

Bell ringing at St Mary Redcliffe

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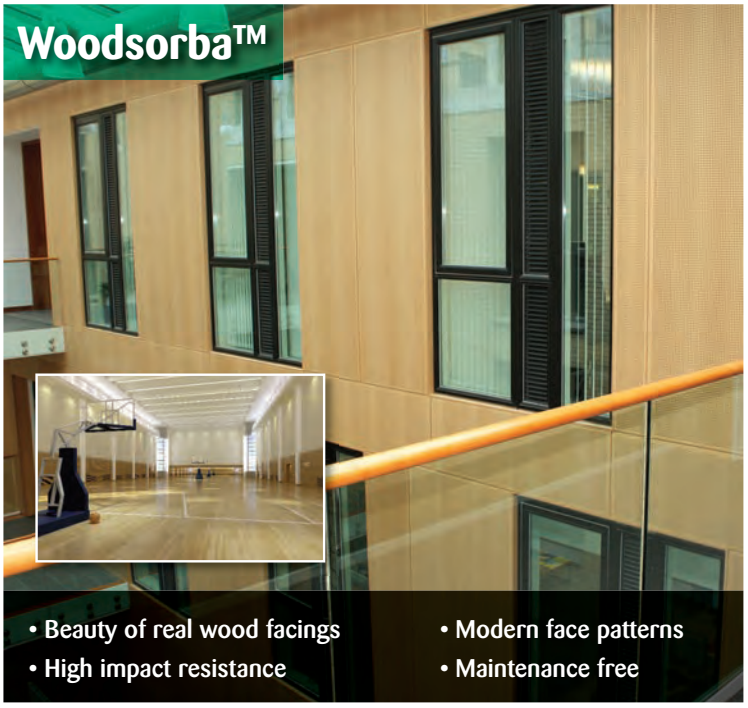

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Yorkshire and North East Branch

Award for Tim South

At the well-attended April meeting of the Yorkshire and North East Branch, held at Arup`s Leeds office, IOA President, Jo Webb, presented the IOA 'Services to the Institute Award' to Tim South FIOA.

During his lifelong work in acoustics, Tim has taught the IOA Diploma course at Leeds Beckett University since 1995 and has been course leader for most of that time. He also teaches on the IOA Certificate of Competence courses in Workplace Noise Assessment and in Environmental Noise Measurement there.

He has also developed and taught acoustics modules on several other undergraduate and postgraduate courses and in 2015, was instrumental in the setting up of an MSc course in Acoustics at the university.

Tim has served on the IOA Education Committee for many years and has played a major part in the introduction of the IOA Certificate of Competence course in Hand Arm Vibration. He is currently the Chair of the course advisory committee. He regularly assists examiners by proposing possible exam questions and assignments.

He carries out consultancy for the university on many areas of acoustics including the assessment of workplace exposure to noise, hand-arm and whole-body vibration; sound insulation measurement and the specification and design of educational buildings.

Tim has contributed to IOA response to various consultations including to those on the CNWR, BB093 and the 2003 Building Regulations. He is a regular supporter of IOA Group and Branch activities and is a former secretary of the Yorkshire and Humberside Branch.

At the presentation of the lifetime achievement award, the room was full with his professional friends, branch members and former and present students who came to congratulate Tim for his contribution to acoustics.

Tim South and Jo Webb

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Southern Branch

Gym noise transfer presentation

Southern Branch members travelled to Farnborough Technical College to maintain efforts to bring quality meetings to all members in their area, to hear about the thoughts and work of Adam Fox of Mason, and Martin McNulty of Hoare Lea in relations to gym noise transfer.

Around 35 members listened intently as Adam and Martin shared the work they had collaborated on with Salford University that had developed a drop test rig to provide an approach to test materials, and constructions' performance under heavy impacts.

It became clear that their results showed as many questions as answers, but the rigorous work that had been done, and the wide ranging questions shows that this topic is coming of age.

It was announced that work to form a working group to explore the issues of standardising a test method in gyms had begun, and that there is a hope that guidance will be soon developed.

Particular areas of challenge were identified as the non-linearity of many elastomeric materials, and a lack of suitable criteria. However, Adam and Martin have shown that they have made a big impact in getting things moving.

If you want to know more about getting involved in the working group please contact **progers@sustainableacoustics.co.uk** , so you can be added to the list of interested parties to be kept informed of progress.

Welsh Branch

Draft Planning Policy Wales discussions

The Welsh Branch of the IOA held a meeting at Rockwool in Bridgend on 8 May 2018. First on the agenda was a presentation by Rowan Green, Specifications Manager for Rockfon. Rowan explained the benefits of mineral wool as an acoustic insulator and the ways in which it can be used to improve the sound insulation of various building structures and to provide acoustic absorption to improve room acoustic conditions. Rockwool have undertaken extensive laboratory tests of various configurations of mineral wool-based build-ups and have test

Abergwynfi windfarm

data available for airborne and rain noise performance, which can be made available to consultants who are interested in knowing more about this subject.

Recent innovations include a hybrid roof build-up featuring both PIR insulation and Rockwool 'Recovery Board' mineral wool-based topping, which the tests show result in a significant improvement in both airborne and rain noise insulation in comparison to standard PIR insulation-based roof build-ups.

Next, Martin McVey, of the Welsh Assembly Government, presented the key aspects of the draft Planning Policy Wales (PPW), which is currently out for consultation. One of which is the strong link between air quality, noise and the wellbeing agenda. Martin confirmed that the 'agent of change' principal is also being adopted in the revised guidance and that there is a high level ambition in the document to create more attractive communities, with consideration of the wider area, not just the individual development going through the planning process.

Martin confirmed that there is no official announcement that the current Welsh noise policy document (TAN11) will be re-issued, but it is likely that it will need to be updated in order to fit with the language of the new PPW, subject to ministerial approval. The process is anticipated to start in early 2019 with collaborative workshops with stakeholders, including EHOs and consultants. The new policy document may cover both air quality and soundscapes. Martin recommended that if consultants believe TAN11 should be updated, they should respond to consultation on PPW stating this. (The closing date for responses to the consultation was 18th May 2018.)

Questions were raised regarding the status of the recently issued English planning guidance documents (e.g. ProPG and PPG-Noise) and Martin encouraged people to follow the ProPG appendix on good acoustic design, despite the fact that ProPG and other English documents have no official status in the Welsh planning system.

Next, Malcolm Hayes, of Hayes McKenzie Partnership, talked about renewable energy in relation to the draft PPW. Malcolm's experience is that only large scale windfarms with large turbines are financially feasible in Wales with the current planning policies, and highlighted the different approaches to wind farms in other parts of the UK, which directly affect the feasibility of such developments. In Wales, wind farm developments are subject to the policy document TAN8, which refers to ETSU-R 97. Malcolm suggested that the revised policy should also refer to the IOA Good Practice Guide.

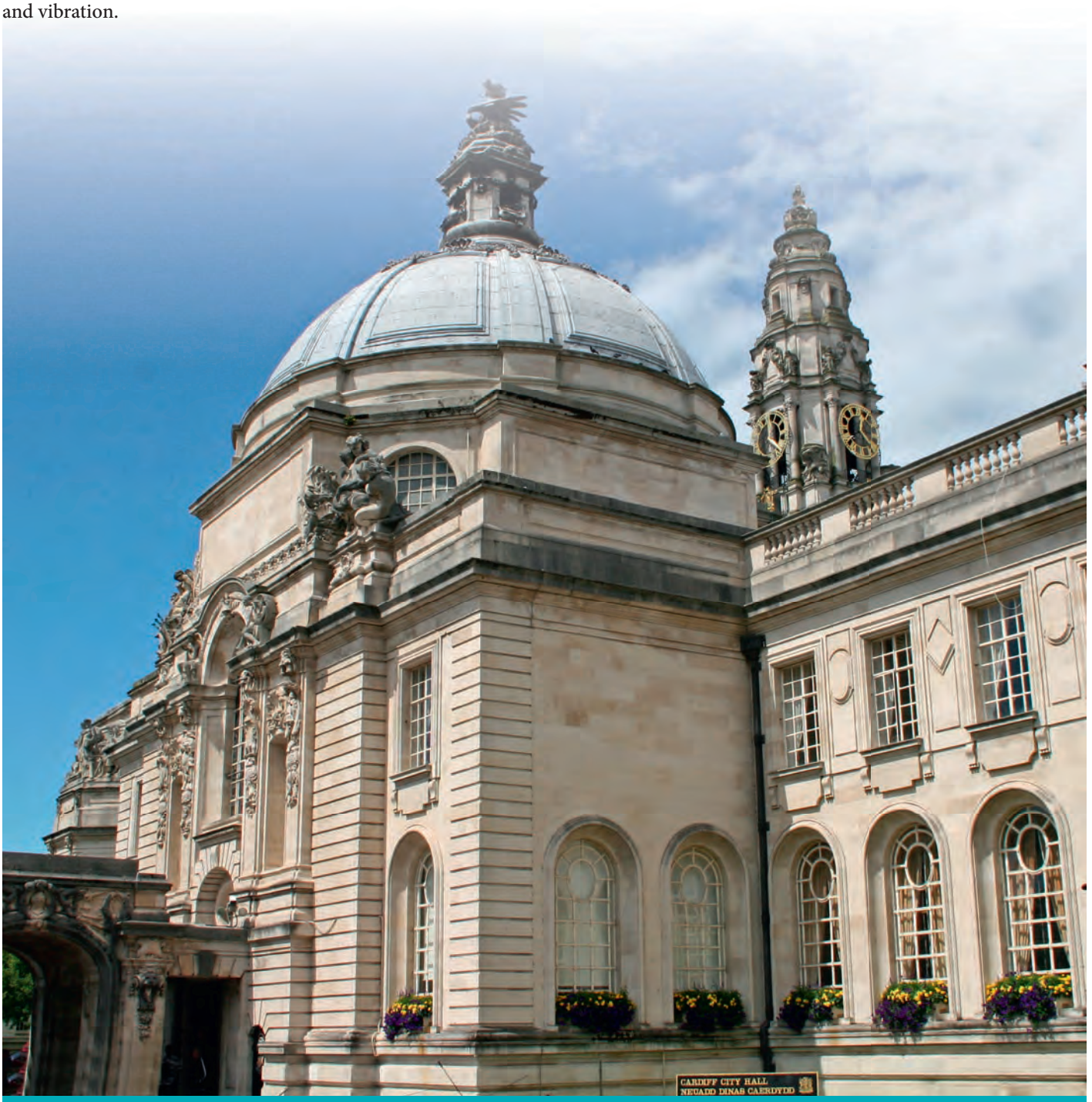
Finally, there was a discussion on the best way to strike a balance between the needs of society to provide affordable housing and to develop sites for housing, and the potential conflict with Local Authorities' desire to minimise the risk of future complaints of noise disturbance from industrial and other non-transport related noise sources. In particular, the implementation of the agent of change principle was discussed and the potential conflict between the requirements of the planning system to assess amenity versus the desire of the Local Authorities' desire to minimise the risk of future noise complaints. It was suggested that the revised TAN11 may be a vehicle to address this in more detail, whereas the PPW's role is more of an overarching document setting out the policy framework behind the planning system.

Acoustics 2018: The annual conference

Acoustics 2018 was held at the City Hall, Cardiff, in April and provided an interesting and diverse technical programme of events. The historic venue had splendid rooms for the plenary and parallel sessions, exhibition space, and for the reception and conference dinner. Opening the event, President-Elect, Barry Gibbs, spoke about the Rayleigh Medal award and the presentation 'On track for a quieter future' by Professor David Thompson of the Institute of Sound and Vibration Research (ISVR), on railway noise and vibration.

The three parallel sessions on each day covered topics ranging from physical acoustics, to noise and vibration engineering, environmental noise (including windfarm noise), building acoustics, musical acoustics and speech and hearing. The Measurement & Instrumentation Group provided expert presentations in the 'Instrumentation Corner Live' on day two. In addition to the three parallel sessions, there were poster sessions, where presenters were able to field questions during refreshment and lunch breaks.

P18 ►



City Hall, Cardiff

Barry Gibbs, President Elect and Chairman of Acoustics 2018

Jo Webb, IOA President

AWARDS
Rayleigh Medal

Professor David Thompson has made an outstanding contribution to acoustics, recognised by the award to him of the IOA's premier accolade – the 2018 Rayleigh Medal.

David is a leading international authority who has worked at the forefront of research on railway noise and vibration control for 35 years. His international standing has been recognised widely, for example by researchers across Europe, who have sought his involvement in numerous EU projects, and more recently in China, where a number of research teams are keen to co-operate with his group at ISVR. The increase in rail traffic and the dramatic development of high speed rail networks across the world is leading to an increased need to understand and control railway noise and vibration.

The scientific impact of David's research is evidenced by his outstanding publication record. His research has led to the publication of the definitive book in this area which has sold over 800 copies, has been cited 600 times and has also been translated into Chinese. He is also joint editor of the second edition of *Fundamentals of Sound and Vibration* published in 2015 and he has published over 150 refereed journal papers.

Throughout his work, his approach has been to develop fundamental understanding leading to the solution of practical problems. He has worked on many aspects of railway noise including wheel and rail noise, rail dampers, ground vibration from trains and aerodynamic noise from high speed trains.

Although railways are the main application area of his research, David's work has covered a wide range of different aspects of noise and vibration. He is also a very keen educator in the field of acoustics and vibration, demonstrated through his training of PhD students; 35 of whom have graduated over the past 20 years. In 2015, he won the Faculty 'Supervisor of the Year' award. David Thompson is a very able scientist who has made an outstanding contribution in the area of railway acoustics and vibration. In his Rayleigh Medal address, he provided an accessible insight into some areas of his research work at the forefront of this field. His dedication to communicating his knowledge was clear in the presentation, which included a number of live physical acoustic demonstrations (as well as the more familiar electronic ones). The presentation is available on YouTube here: **https://www.youtube.com/watch?v=6QSymd2-u9o**

Institute of Acoustics Engineering Medal 2018

Professor Andrew (Andy) Moorhouse has been an influential figure in acoustics for three decades. He is a top class engineer who particularly excels at experimental methods needed to solve real industrial problems. In the course of his career at the University of Salford, he has been a highly respected teacher of students and supervisor of doctoral

Professor David Thompson, winner of the 2018 Rayleigh Medal

Andrew Moorhouse, winner of the 2018 Engineering Medal

candidates. He is very much a team player and is much respected by colleagues.

Andy is best known for his work in structure-borne sound and low frequency noise. To take one example, research by Andy and colleagues led to the 'blocked force method'. To a large extent this method solves the problem of how to characterise vibrating machinery and equipment as sources of structure borne sound and vibration. The work has been widely adopted as the standard approach across the automotive and aerospace industries. The blocked force method has also led to advances in diagnostic test methods, including the 'in situ transfer path analysis' method and in-situ characterisation of isolators.

Andy has led the expansion and development of commercial acoustics work at the University of Salford for a decade; and the income and staff have both more than doubled during this period. In addition to providing UKAS accredited test, calibration services and R&D to hundreds of clients, the labs have made a significant contribution to two spin out companies. One of these, CarbonAir now provides spring technology for the main suspension of Audi 6 and 7 vehicles.

Professor Andy Moorhouse was awarded the Engineering Medal For recognition of his outstanding engineering endeavours and his contribution to furthering acoustics through education, commercial work and research.

IOA Award for Promoting Acoustics to the Public

Alistair Somerville started his career in acoustics over 34 years ago when, as an EHO, he began noise control and environmental planning work at Edinburgh Council. There followed a career-long passion in the professional discipline of acoustics. He completed the IOA Diploma in 1986 and Master of Science Degree in Acoustics, Vibration and Noise Control at Heriot Watt University in 1988. Since 2013, he has acted as an independent acoustics consultant.

Alistair has constantly sought out opportunities to talk about 'noise' to anyone who is prepared to listen. He began talking about noise control in 1985 and hasn't stopped. He has organised conferences, delivered conference papers and written and delivered undergraduate and post-graduate noise and vibration modules for various university courses. He is still delivering on the Institute's Certificate and Diploma Courses.

He has contributed to the work of the IOA at national level, having served on Council for many years and on the IOA Executive as Honorary Treasurer. He currently serves on the Education and short course (CCENM) Committees. He has been a Corporate Member of our Institute since 1988 and is now an Honorary Fellow.

He has been Chairman of the Scottish Branch since 2005 and it was in this capacity that Alistair received the following

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Alistair Somerville receiving the award for Promoting Acoustics to the Public

request in March 2016: *I work with the development team at Edinburgh International Science Festival (EISF) and was hoping you might be able to help. ... We operate a number of education programmes throughout the year that aim to support children and young people to engage with science, technology, engineering and mathematics (STEM). We even have an entire workshop within our Generation Science programme that teaches children about acoustics. We are currently developing our stakeholder network with the aim of recruiting supporters and volunteers who can work with us to deliver STEM careers advice to young people. Our aim is to showcase the full spectrum of careers available through studying STEM.*

Alistair saw this as an opportunity to promote the acoustics profession, particularly to young people and to those giving advice regarding career options. He responded by co-ordinating a proposal, with EISF, to Council, which agreed to support the joint working initiative. Last year, with IOA funding and volunteer support, acoustics career opportunities advice was delivered at a week-long event visited by 2,403 pupils from 38 secondary schools. Presentations of sound and vibration science shows reached 472 children in 10 primary schools. Following positive feedback from all involved, the IOA is repeating and extending support for this year's programme.

Alistair was given the IOA Promoting Acoustics to the Public Award for identifying this promotional opportunity and potential; developing the partnership between the IOA and EISF; and co-ordinating the IOA's contribution to promoting acoustics to young people, their teachers and visiting parents, politicians and public.

NOISE AND VIBRATION ENGINEERING GROUP

By Malcolm Smith (ISVR Consulting), Nathan Thomas (Dyson) and Sarah Haynes (ASL Consultancy), members of the NVEG committee

The variety of papers presented in this session was testimony to the diverse range of interests within the group, indicating that there is a continuing interest in noise control and noise engineering among IOA members.

A recurring theme throughout the presentations was the drive to improve modelling techniques to help the development and selection of techniques in real life applications, and balancing acoustic considerations with others such as cost.

Session 1, chaired by Sarah Haynes

Lifecycle evaluations of railway turnout crossings, presented by Sakdirat Kaewunruen, University of Birmingham.

This paper considered the effectiveness of noise mitigation measures in use at railway turnout crossings in urban environments, looking at conventional and 'low-cost' barriers, use of pads and composite bearer systems. All these methods are recognised noise control methods and Sakdirat and his colleagues carried out a cost analysis over the 50 year lifecycle of these solutions, including allowance for the effect of extreme climate events. He concluded that use of composite bearers was the most efficient method for mitigating noise, while the noise barrier was the worst counterpart for such crossings.

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ACOEM Group

Assessment mitigation and prediction of gymnasium noise background, presented by Paul Gartenberg, Piteq.
This paper described work that considered structure-borne noise and vibration created by dropping fitness weights onto different floor constructions, and the prediction of performance of the flooring type independently to the flooring slab, by use of a 'drop tower' to simulate weight drop. A relationship was found between elongation of the force pulse and resulting reduced sound pressure and vibration level within the slab at certain frequencies. Further work is being planned to discover whether field trials show this and to assess the effect of dropping different types of fitness equipment.

Assessing the vibro-acoustic radiation characteristics of a compact consumer appliance, presented by Daniel Taylor, Dyson.
This paper described the investigation of noise radiation from a compact consumer appliance, namely the cleaner head of a vacuum cleaner. Results obtained from the use of varying methods of far-field acoustic measurement were compared with a 3D scan, made using a pressure/velocity probe to see which far-field method gave the closest result and thereby identifed a quick and representative method that can be used in field tests.

Session 2, chaired by Nathan Thomas

Sub-structuring approach and blocked forces method: application for structure-borne vibration prediction in heavy weight assemblies.
Diego Miguez from the University of Salford described combination of in-situ blocked force, and sub-structuring to characterise the key elements of a building assembly for prediction of vibration. His approach showed good correlation with measures obtained from the whole assembly. This step forward gives building designers the confidence to predict vibration performance from sub-assembly measurements.

Vibration isolation performance for industrial metal forming presses.
Chad Himmel, from JEAcoustics in Texas, described his investigation into anti-vibration mounts for a large industrial process with 3000 tonnes of downforce.

Chad covered a wide scope, including attenuation performance, natural frequency, agreeing specifications for sensitive nearby processes and ancilliary impacts such as building damage and soil settlement. It was refreshing to see practical examples of vibration isolation concepts applied on such a huge scale. Lively discussion followed his presentation, examining whether expanding the measurement programme to include phase would help identify natural frequency in this application, and whether the manufacturer could have saved time and money by employing some of the sub-structuring concepts discussed in the previous paper. (See above).

Challenges in monitoring construction noise in live Royal Opera House during open up project.
Tomaz Galikowski (renowned three-time winner of the Campbell Acoustics' five-a-side cup) of Bickerdike Allen Partners, presented their approach to construction noise monitoring in the Royal Opera house during a period where the building remained open for regular scheduled rehearsals and performances.

An innovative system was used to match structure-borne vibration measurements to internal noise levels, with very few sensors. Structure-borne noise concepts and radiation efficiency terms were applied to the transfer function to achieve a vibration acceptance criterion in terms of SPL in the auditorium. The wider context of text message reporting to client and contractor, and verification of the source of noise events was also covered. There was an interesting post-talk discussion centred around why small room detection was strong, and how to improve large room detection, possibility for sensors at source locations in addition to receiver locations, and whether signal processing techniques including phase and transfer function would help confidence in source location.

Session 3, chaired by Malcolm Smith

Measurements of a hockey ball hitting backboards covered by different materials.
Jack Harvie-Clark, of Apex Acoustics, described a series of tests that were carried out to investigate ways of reducing the noise of ball impacts to that required by a planning consent. The presentation prompted a lively discussion on the merits of various methods of reducing impact noise, some of which could provide the solution to the problem.

Industrial applications of metamaterials.
Nicolas Etaix, of Dyson, introduced the concept of various forms of metamaterials, in which geometry plays a key part in the acoustic performance. These included arrays of resonators, metaporous materials with solid inclusions embedded in foams, and a 'super-absorber' to guide sound waves into absorbing materials. Nicolas outlined a number of obstacles that needed to be tackled to make these materials suitable for implementation in commercial products.

Lateral vibrations of curved railway tracks to transient excitations.
Sakdirat Kaeweunruen, from the University of Birmingham, described a number of possible mechanisms for curve squeal noise, focusing particularly on mode-coupling theory. The simulations of tracks with different curve radii that he outlined had provided a comprehensive understanding of lateral track dynamics, including the effect of the rail, cant, gauge and the overall track responses.

THE ENVIRONMENTAL NOISE GROUP

By David Waddington and Steve Mitchell

Session 1, chaired by David Waddington

The environmental noise sessions were attended by about 100 delegates in the main conference room and comprised three sessions. Environmental Noise Session 1 was chaired by David Waddington of the University of Salford and had an emphasis on noise policy and planning, a theme that would be returned to in Session 3. The first paper was presented by Martin McVay, of the Welsh Government, and gave a review of 'The well-being of future generations (Wales) Act 2015'. Nigel Jones, of Extrium, presented the second paper about the synergies and conflicts between air quality and noise action planning, before the final paper in Session 1 on P24 ▶

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the future of strategic noise mapping-intelligent design to support intelligent policy was presented by Matthew Burdett, also of Extrium.

Session 2, chaired by Steve Mitchell

Environmental Noise Session 2 followed the Rayleigh Medal Lecture and lunch, and was chaired by Steve Mitchell of ERM and Chair of the IOA's Environmental Noise Group. This second session comprised three papers on the use of BS4142, Method of rating and assessing industrial and commercial sound, 2014. The first presentation was by Jon Tofts from the Environment Agency. Jon discussed four examples of BS4142 assessments that the Agency had encountered in fulfilling their obligations to assess permits for waste management licences. Jon's presentation was mainly around considering context, which he interprets as the balance of factors that make it more sensitive or less. The case studies he described were quite extreme examples of context where the numerical assessment warranted additional consideration. Generally, the Agency look to enforce best practice to reduce noise and where necessary have to consider the value of the operation in making their licencing judgements. One questioner asked how a consultant could be expected to judge the value of a commercial operation in weighing up the noise impact. In discussion, it was felt that the consultant could at least raise the other issues that need to be considered by a regulator in weighing up the given situation, even if they were unable to comment categorically on some of those issues.

The second presentation was by Rahiel Ghani, who described his research at the University of Salford into the tonal, impulsive and character corrections of BS4142. Rahiel had carried out a laboratory study where subjects were asked to adjust the levels of various sounds, with varying degrees of character, so as to make them equally as disturbing as a reference sound. He found 6 dB adjustments were reasonable in some cases, but there were differences between experienced and naïve listeners. The study shone some light on the BS4142 corrections, but the sample size of 13 was too small to arrive at firm conclusions in this regard.

The third presentation was by Shanti Wisniewska, of Jacobs, who presented her diploma study on the subjective method from BS4142. The project compared the subjective and objective methods and investigated what was meant by 'suitably qualified' using 35 acoustic professionals to make subjective judgments of 12 sound samples containing tonality, impulsiveness intermittency, combinations of all three and three control samples with none. 50-90% of subjects identified character, as found in the objective method. Subjects were more likely to identify tonality than the 1/3 octave objective method which casts doubt on the validity of the 1/3 octave method. Impulsiveness was well judged or over-estimated. The level of experience with BS4142 assessments of those making subjective judgments did not seem to correlate with objective methods. The study gave some interesting insight into the merit of the subjective method in BS4142.

Session 3, chaired by David Waddington

After refreshments, David Waddington resumed the chair and Environmental Noise Session 3 continued on the BS4142 character corrections theme with Naomi Tansey, of Arup, describing a step-by-step guide to evaluating the prominence of impulsive sounds from an audio recording. Changing focus back to noise planning and policy, Nick Conlan, of Apex Acoustics, discussed using planning conditions to improve indoor environmental quality (IEQ) of new residential developments. This theme was elaborated on in the last paper of the day, a three-way presentation by Anthony Chilton, of Max Fordham; Jack Harvie-Clark, of Apex Acoustics, and James Healey, of WSP, reviewing the ANC Acoustics, Ventilation and Overheating Guide. The Environmental Noise sessions closed with an update that the ANC Acoustics Ventilation and Overheating Guide (AVO Guide) has been published as a draft for consultation that can be downloaded from the ANC website.

THE PHYSICAL ACOUSTICS GROUP

By Mike Swanwick CEng FIOA, Chair of the Physical Acoustics Group

The Physical Acoustics Group (PAG) presented a one-day session of nine presentations, the first of which was from Daniel Elford, on 'Acoustic metamaterials for low frequency industrial applications', where Daniel started with an explanation of what is a metamaterial, and how acoustic properties can be built into structures and surfaces to provide additional characteristics over and above conventional means.

A case study included the masking of transformer noise as fundamental and harmonic frequencies by the use of strongly coupled resonators built into specially constructed panels. No in-fill absorber was used; therefore no degradation over life from particulates or water ingress is claimed. This culminates in a practicable alternative to conventional noise barriers, and research continues into future challenges.

The second offering regarded the '*Influence of flare variation on the low frequency sound absorption of mufflers based on the acoustic black hole effect*', presented by Neha Sharma. This investigation considered passive mufflers and the challenge of efficiency versus physical size. The application of a 3D printed, Acoustic Black Hole (ABH) based design is studied. The enclosed chamber is designed to allow the passing of flow, whilst impeding the transmission of sound. The muffler is tested on a proprietary 'impedance tube' in both narrow to wide and wide to narrow directions with several repeats. Significant absorption in the low to middle frequency range was observed. Future work includes alternative quadratic and square root flares, and variation of the internal ring spacing.

Daniel Brooke presented his work on the '*Interaction of high amplitude waves with acoustic metamaterials*', where two acoustic metamaterial based properties (Dead-End Pores (DEP) and Acoustic Black Holes (ABH)) are considered together. A broader-band absorber is investigated that retains a thin profile as the lateral dimensions are responsible for the greatly improved (non-linear) acoustic wave absorption of this muffler design. A 3D printed ABH structure shows a higher absorption coefficient than expected for a high amplitude incident sound. This is thought to be due to a strong non-linearity of the muffler. This is a promising conclusion and will lead to further work in this area.

The paper: '*Development of an optimal array of sensors for the reconstruction of a rigid rough surface based on scattered ultrasound*', was presented by Giulio Dolcetti where a non-traditional method is proposed for the reconstruction P26 ►

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of a water surface for the characterisation of flow, velocity and depth of water courses. This surface reconstruction method extends from earlier two-dimensional work to three dimensions and has the potential to improve current techniques in almost one order of magnitude. This is achieved by the known location of the source and the optimal spacing of the receivers. Future studies will investigate accuracy and statistical analyses.

A paper entitled '*Approximation to wave propagation through periodic array in poro-elastic medium*', was then presented by Anton Krynkin. A numerical study of wave propagation through doubly-periodic arrays of scattering objects has been performed. This was demonstrated to solve wave propagation in a periodic poro-elastic medium using matched asymptotic expansion. This was solved for waves decoupled in the vicinity of a band gap. This approach yields a solution that is further simplified to analyse band gap phenomena. This method is proposed to derive coupling of plane compressional and shear waves within a periodic poro-elastic medium.

Victor Krylov presented: '*Acoustic emission spectra associated with the formation of brittle cracks*' starting with a useful reminder that acoustic emission is a spontaneous radiation of elastic waves within solid structures during an irreversible process. One such occasion is the formation and development of a crack in a structure, which could present information regarding a potential danger. Following a detailed discussion on the theory of crack formation, the theoretical predictions obtained illustrate frequency spectra, directivity functions, and recent developments based on previous work in the modelling of opening cracks.

'*Tailored acoustic filtering and absorption using compound rigid gratings*', was presented by Tim Starkey. This presentation started with an introduction into acoustic and fluid-dynamical metamaterials studied by Exeter CDT XM2, and some topical history dating back to Kirchhoff and Rayleigh. The presentation continued with a thermo-viscous loss study where the sound in air is seen to be mismatched with the impedance of a seemingly solid material having arrays of slits, holes etc. Thermodynamic losses exist in the holes and the surface bound energy absorbs incident sound. It is concluded that these textured features can be used to control surface transmission, propagation and reflection. Thus providing an absorption mechanism tuned by the design of the feature sizes and their spacing.

The next paper was entitled: '*Influence of activation processes on the activated carbon felts microstructure and impact on the acoustic performances*', was presented by Hugo Karpinski. Predictions from an acoustical model with a dual porosity scaled structure, compares well with impedance tube measurements. The two porosity scales are defined as inter-fibre channels, and nanometre scaled pores within the fibres themselves. These physical dimensions were measured from scanning electron microscopy (SEM) images. Future work will include testing at room temperature and ambient pressure where the characterisation of the bulk modulus can be derived from recording small pressure increments for small displacement within the test cavity under isothermal conditions.

Finally, the last presentation was an insightful paper by Kirill Horoshenkov, on '*What is the actual influence of a nano-fibrous membrane on the acoustical property of a porous substrate*?' The problems associated with characterisation of a thin membrane by its thickness and porosity; is marred by the inability to measure it accurately. Hence substantial variance in its acoustical properties is observed. Classical methods fail to explain flow resistivity and surface impedance observed. The discrepancies appear to stem from a complex interaction between substrate and membrane, hence air flow and acoustical characterisation is problematic. This leads to a clear need for more research into these complex effects.

During the day's programme, an opportunity was taken to hold the PAG AGM, which was attended by a quorate representation of the membership.

The PAG session included nine excellent presentations, seven of which were supported by published papers. Many thanks go to all contributors and supporters of this event.

BUILDING ACOUSTICS GROUP

By Roger Kelly, of CDM UK and Chair of the IOA Building Acoustics Group

How sound or noise can either be beneficial or detrimental. At the end of the previous mini-session I was intrigued to hear from Bridget Shield that increased noise levels of 65 dB and above significantly impacted on the concentration of school children. The first paper after morning tea was from Andrew Parkin on the push to create a new international standard for the design of open plan offices. One of things that will be a hot topic was the maximum allowable noise level in open plan offices – the conundrum will be to achieve the right balance between enough noise to create a dynamic working environment, while also quiet enough to encourage communication and to allow good levels of concentration and productivity.

It was a joy to hear from Deborah Dawson, a nurse who in her own time, has gathered large amounts of noise data from a working ICU unit in a hospital. Noise sources from alarms and other hospital equipment made average noise levels of between 60 dBA and 70 dBA at patients' beds. Interestingly, the noisiest location was the single occupancy room, which is the one used for the most critical patients. Surely these high noise levels will impact on the patients' ability to recover and the doctors' and nurses' ability to make the right decisions? Hopefully, her work will lead to more money being spent on improving acoustic conditions in hospitals and to find equipment and alarms that are less acoustically intrusive.

Jack Harvie-Clark, from Apex Acoustics, then presented an empirical approach to designing for reverberation time in rooms. With measurements of reverberation time in 131 school rooms, and careful notes about the quantity of absorption on the walls and soffit, various relations between V/A and T were tested. The best fit straight line was shown to have a shallower slope than Sabine and one that didn't pass through the origin. His recommendation for "designing with confidence" was to design with 90% of measurements below this line.

The final presentation before lunch took an interesting look at how a soundscape was used to enhance a rather P28 ►

dull entrance stairway to the Petrie Museum of Egyptian Archaeology. This temporary installation was proven to have significantly improved the subjective response of visitors to the entrance staircase. This is surely a part of acoustics that will come to the forefront of acoustics in the coming years.

WINDFARM NOISE

By Gavin Irvine, Director at Ion Acoustics Ltd

Four interesting papers on windfarm noise issues were delivered on the Tuesday afternoon of conference. Two papers continued the ongoing debate in regard to amplitude modulation with collaborative contributions from Dick Bowdler, Matthew Cand from Hoare Lea, Malcolm Hayes and Tom Levet from Hayes McKenzie, and Gavin Irvine from Ion Acoustics. These discussed penalty schemes and site analysis of amplitude modulation data.

The paper on penalty schemes, presented by Matthew Cand, from Hoare Lea, considered various penalty schemes that should be added to wind turbine noise levels where there is amplitude modulation. Most studies on the subjective response to amplitude modulation have been carried out in laboratories using the LAeq metric. However in the UK, wind turbine noise levels are measured in terms of the LA90 and a nominal 2 dB correction factor is assumed to apply. However, when there are high levels of amplitude modulation, the 2 dB relationship is no longer valid. Therefore any penalty scheme should arguably account for this. Furthermore, annoyance from modulated noise increases with modulation frequency and therefore a correction for higher modulation rates should be investigated. The paper presented explored these issues and presented alternative penalty graphs. However, there are several ways of deriving alternative graphs and this leads to different results. The authors did not come to a conclusion in regard to a preferred method but presented some alternatives to encourage debate.

Then Malcolm Hayes from Hayes McKenzie discussed site analysis of AM data. The IOA Amplitude Modulation metric allows large amounts of data to be processed automatically. However that then begs the question: how should this data be analysed, particularly if determining compliance? The DECC Wind Turbine AM review report suggested that data is analysed over the periods of complaints but was not more prescriptive. Site data from Hayes McKenzie, Hoare Lea and Ion Acoustics was presented to show that different averaging techniques give different results. Some of this data was analysed together with diary responses from a complainant, which clearly showed how amplitude modulation was linked to the periods with the most annoyance. It was concluded that analysing data in 1m/s wind speed bins and 30° wind direction bins can lead to reliable results.

Dick Bowdler's paper was entitled '*A short history of the dangers of infrasound*' and described how the myth of harm from infrasound has developed. Much of the paper focused on the work of Vladimir Gavreau, who investigated a mystery illness affecting lab workers in France. The illness was attributed to a faulty ventilation fan in an adjacent building producing infrasound at 7Hz. Gavreau then set about building various infrasound sound sources and took out numerous patents. Dick Bowdler then reported the pseudo-science that followed this with reports of infrasound in the 'range of death' and internal tissues rupturing.

However, consideration of level, as well as frequency, is important. Gavreau's infrasound levels (as far as can be determined) were compared to levels measured in a car with an open window, with measured wind turbine noise levels and with the threshold of perception. Gavreau's experiments consisted of very high levels well above the threshold as is the case for travelling in a car with an open window. Wind turbine noise levels were below threshold until the audible frequency range was reached at around 40 Hz. Any response to wind turbine noise is therefore more likely to be an issue of annoyance from audible sound (which should not be dismissed) rather than harm from infrasound.

Lastly, Sylvia Broneske, from Innogy gave an update on recent research developments in Germany co-written with Sabine Schulz from UL DEWI in Germany. Field studies of wind turbine noise propagation have been carried out comparing calculated results with measured results at distances up to 1500m. The attenuation terms were obtained from the two methods in ISO 9613-2, also varying some parameters for the attenuation calculations. This has led to a revision of the German guidance on calculating wind turbine noise levels, known as the interim method, while more research is carried out. This interim method uses ISO 9613-2 but with a hard ground assumption (Agr = -3 dB). This is now more conservative than the UK IOA guidance.

MEASUREMENT AND INSTRUMENTATION GROUP

By Simon Bull of Castle Group Ltd

Instrumentation Corner Live.

This morning session was prepared and presented by members of the Measurement and Instrumentation Group Committee and was to bring many issues specific to instrumentation and its use to life.

As many of the presenters were instrumentation experts, they have found collectively that there are several recurring problems faced by acousticians, often caused by limitations of the technology that might not be fully understood!

First up was James Tingay, of Cirrus Research, who presented an up-to-the-minute run down of the latest standards for sound meters and how confusing the number and date can be for the manufacturers, let alone the unwary. For example, did you know that IEC651 and IEC61672 are incompatible?

The second presentation was by Simon Bull, of Castle Group Ltd, who spoke on 'dynamic range', which, it turns out is not actually a term in acoustics metrology at all – Simon delved into the highs and lows of measuring sound and the length you may have to go to if you want that extra few decibels at either end of the scale!

Mark Dowie, of Brüel & Kjær, then spoke on UK digital recording formats and their use and limitations in post analysis, with plenty of demonstrations on-screen of the effects of bit-depth, sampling rate and compression. One surprising element was the live playback of recordings made with different parameters, that sounded exactly the same! The inevitable conclusion is that for qualitative assessments almost anything goes, but beware if you want to re-analyse.

Taking us up to the break, Simon Bull returned to deliver a session on the pitfalls of measuring Ln's. We learned P30 ▶

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of how a sound meter figures out these illusive figures and the potential for variation in the methods employed. Once you understand how Ln's work it is important to follow some simple rules – NEVER add Ln values together and be careful with 1/3 Octave Spectra – they never really exist!

Practical presentations

Glynne Parry, of ACSL, presented a paper previously delivered by Richard Tyler based on the potential errors that can occur when field-calibrating a sound level meter. Glynne began with a couple of nice stories including one about sound meter send-in for calibration that had been on a site using Portland cement. Following some damp weather, the sound meter was not working correctly – probably due to a layer of solid concrete built-up on the microphone diaphragm!

Taking us through all the possible correction factors such as the nominal v actual level, free-field response and atmospheric pressure, Glynne illuminated an array of pitfalls that can create as much as 2 dB of error – not to mention cables, windshields and adapters!

John Shelton, of ACSoft, then presented a paper previously published in the Bulletin, but with additional live demonstrations involving a spaghetti of cables and lots of scope for 'technical issues'. All went well however, and John highlighted some special tricks of the trade to ensure that your environmental measurements stay within the specification of the microphone even when using various windshields – so long as they are the right ones for that meter!

As a special treat, John then risked all by soaking a windshield with water, demonstrating why measurements after rain are really not a good idea – even worse if that rain then freezes.

James Tingay, of Cirrus Research, was next to the podium, bringing to life a paper also written for the Instrumentation Corner section of the Bulletin in the September/October 2017 issue, delving into the murky world of measuring sound using mobile phone-based apps.

Diving straight in, James showed us results from recent testing carried out at Cirrus, comparing the results from various combinations of devices and apps against that of a class 1 sound meter. Shockingly, the results were wildly varying, ranging from plus nine decibels to minus 26 decibels! James offered to stop the presentation at that point, but thankfully continued to show us some of the detail behind the testing and hopefully put everyone off for good regarding the use of apps for sound monitoring.

The last session of the morning saw John Shelton, of ACSoft, bringing to life another Instrumentation Corner article, which looked at the differences between accelerometers and geophones for environmental vibration monitoring. Once again, John had brought an impressive array of test equipment to demonstrate the principles in action.

Starting nice and simply, John explained that going to work could even be described as vibration due to its repetitive nature (we all feel that sometimes.) With a vibration refresher out of the way, John showed us phase shifted signals from a geophone and proved that high frequency = small things and low frequency = big things (that was John's take-home of the day!).

The conclusion after a very illuminating session was that accelerometers are better for VDV (acceleration P32 ▶

Musical Acoustics Sessions in the magnificent Council Chamber

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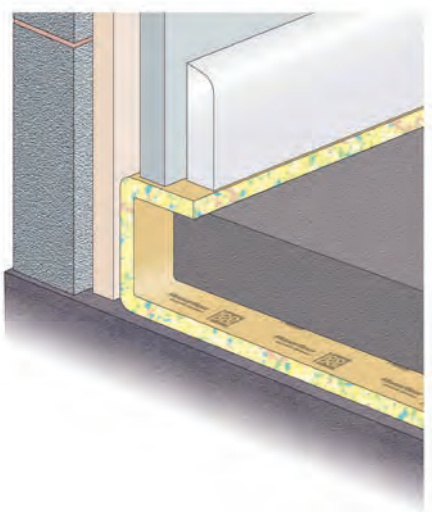

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Alan Taylor without a pipe organ in sight!

parameter) and geophones are better for PPV applications (Velocity parameter), but that if you need to do both, then it is quite feasible to use an accelerometer with the right equipment.

Final session, chaired by John Shelton

The final session of the day returned to a more traditional format, with technical contributions from three speakers.

The first was John Campbell, who described the application of sound intensity measurements to determination of sound power (ISO 9614) and sound insulation (ISO 15186). After a little theory, there followed a rather commercial presentation of a new intensity measurement system, and John described a new field calibration technique, which should extend the practical range of intensity measurements using a two-microphone probe. However, it was not clear how different this method was to other existing solutions on the market, but it was suggested that a frequency range of 25Hz to 10kHz is now possible with a single microphone spacer.

A useful summary of ISO 15186-2 was given, and how its method could improve the repeatability of results obtained when using the traditional ISO 140 series of pressure measurement standards.

Thermal testing

Rebecca Hogg, of BSRIA, presented a paper on thermal testing of HVAC products, and described the new facilities which have recently been installed for this purpose. Following the Ecodesign regulations from 2015, the unique anechoic and thermal chamber allows controlled test conditions for efficiency vs output over the range 100Hz to 10kHz.

This leads on to meaningful acoustic labelling of products to ensure the installation is correct and the acoustic specification is met.

Rail vibration

Jorge De Avillez, from WSP, discussed VDV measurements and its relevance to rail vibration. BS 6472-1 made an appearance, and some of the details were discussed such as co-ordinate system, which is now geocentric, and the use of transfer functions in each axis.

The calculation of eVDV from velocity levels was also discussed, and Jorge showed measurements which suggested that for LUL trains, the ratio of VDV to eVDV is around 1.36, and for surface trains, more like 1.45.

MUSICAL GROUP

By Michael Wright, Chair of the IOA Musical Group

The Musical Acoustics sessions were held in the magnificent Council Chamber just below the famous grand dome of City Hall. Whilst featuring some splendid Edwardian 'baroque' architecture including stained glass windows, carved oak panelling and marble pillars, it had some tricky acoustic characteristics and the microphone became an

P34 ►

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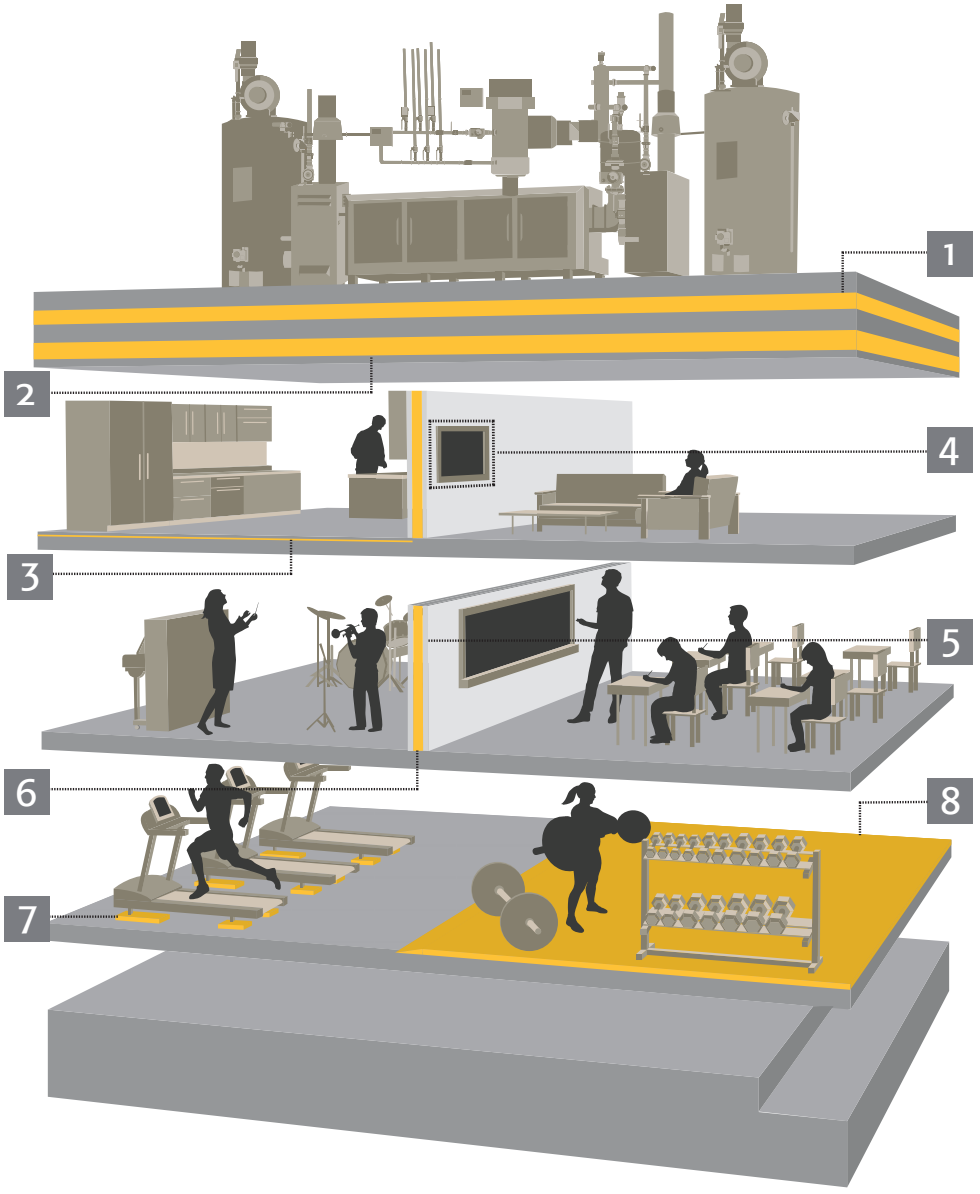

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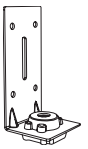

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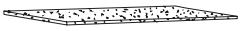

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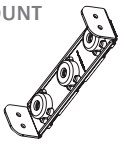

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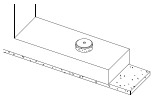

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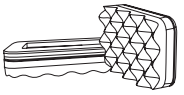

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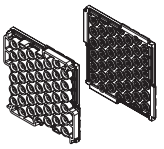

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Steven Dance speaking at the Speech and Hearing session (Image courtesy of Mike Wright)

essential item for all! Nevertheless, there were three well-presented papers given and the session, which started dead on time seemed to fit the ornate setting. Around 25 delegates were present to learn more about solid body electric guitars, flutter in organ pipes and a 'which do you prefer' experiment to electronically emulate the sound of a Stradivarius violin.

Solid body electric guitars

Andrew Elliott, from the University of Salford, opened the session describing a Vibro-electric transfer path analysis of a solid body electric guitar. Leading a group of other postgraduates, he had undertaken research on an age-old argument put forward by some musicians that the construction and material of solid body electric guitars has some effect on the tone.

Some players claim that mahogany bodies give a 'warm' tone, whereas maple gives a 'brighter' tone. Andrew described a method known as 'Vibro-Electric Transfer Path Analysis' to show how the effects of the body of the guitar on its tone and the frequencies where this might be significant. However, over the tested frequency range from 10Hz to 12800Hz it was found that the body borne contribution was some 30 to 50 dB lower than the total voltage output. In other words, you will not hear it! Modifying the electric signal from the guitar, for example using an EQ will have far more effect. The findings were presented for a Gordon Smith Graduate and Gibson Les Paul electric guitar and point to further research needed, as it is possible that the vibrations of the guitar strings may be affected by the guitar body and neck. This may affect the tone and sustain and the results imply that this may be the case.

Pipe organs

Moving on to the instrument that seems to attract a lot of interest by acousticians, Alan Taylor, from University of Salford, has done much over the years to increase awareness of the acoustical complexities of pipe organs. Being an organist and acoustician, he has looked at the effects of organ pipe flutter that may be caused by the centrifugal blowers and reservoir resonance. He surveyed 83 pipe organs and ran some experiments using a pipe organ wind system. Pipe flutter is a well-known problem, which builders and tuners have known for many years. To get a pure tone, the wind supply must be absolutely steady. Pressurised air is held in a reservoir with some form of mechanism to admit the air into the pipes under the control of a player. This is the basis of all pipe organs, which have been made with increasing complexity over the last 2000 years or so. While it sounds simple, various factors mean that this is far from the case. In more recent history, the air contained in a reservoir, which is held up under a pressure of 500Pa or more using weights or springs applied to the top. This is released by valves to the organ pipes. Air was originally supplied to the reservoir by a system of hand cranked feeders. Today most organs have replaced this feeder arrangement with an electric centrifugal fan, which reduces the age old issue of running short of air during loud passages of music! From the survey, the presence of amplitude modulation was found to vary with 39% showing some flutter.

Tests on a treble C open diapason pipe showed that the effectiveness of a wind system is hard to predict. The reservoir behaves like a mass, spring and damper system that, under certain conditions, may be excited by the organ blower P36 ▶

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to vibrate at the resonant frequency of the reservoir, resulting in organ pipe flutter and fine tuning of a pipe organ very difficult and it is, therefore, understandable that many of the more experienced tuners preferred cranked feeder systems. Some have a preference for weighted reservoirs while others prefer sprung reservoirs.

Organ builders are aware that some wind systems are not as consistent in operation as they would like. His research, a work still in progress, knowing the cause of organ pipe flutter and how it may be reduced or eliminated and considering the wind system from a resonant perspective will assist the pipe organ builder.

Thomas Lloyd, from the University of Manchester, presented a paper on perceptual investigations of acoustic and digitally emulated violins, based on controlled listening studies. The task to emulate the sound of the Italian 18th Century violin makers continues, this time with 21st Century technology! Until now, little investigation has been carried out into the use of virtual violins in a performance setting and whether listeners prefer a characterised virtual violin when compared with the original instrument. Two experiments, both using virtual violins in a performance setting were undertaken. The first experiment explored the listener's preference – the characterisation process. This is where measurements are taken of a real violin to form the basis of a digital filter. The virtual violin in the first experiment characterised a Stradivarius, c 1732, starting at 4096 coefficients, which was truncated in powers of two down to 16 coefficients resulting in nine separate virtual violins. The results suggest that only 1024 coefficients are required for a virtual violin to gain the maximum perceived perceptibility by listeners.

The second part of the experiment asked participants to identify which of the samples was the genuine article. Interestingly, the results showed that those with musical training could provide identification 71.4% of the time while those untrained could only provide identification 47.6% of the time. This suggests that subtle acoustic properties can be picked up by musically trained participants. However, it is also speculated that familiarity with the sound of the instrument may also contribute to this result. The test as demonstrated in the domed Council Chamber with all its acoustic foibles seemed to go along with this!

SPEECH AND HEARING GROUP

By Gordon Hunter, Kingston University and Chair of IOA Speech and Hearing Group

The session on topics related to speech and hearing attracted four papers on quite a diverse range of topics covering:

1. The effects of hearing loss on health and cognitive function
2. The effects on performers of altering an operatic chorus practice room
3. The HSE guidance on hearing protection and hearing aids at work, and
4. Innovations in speech recognition technology for creating and editing mathematical equations and formulae in electronic documents.

The effects of hearing impairment on general physical health

Professor Bridget Shield (London South Bank and Brunel Universities) gave an overview of a variety of studies over the past 15 years relating to the impact of hearing loss on people's physical health and cognitive function. She noted the earlier findings of her 2006 report for the European Hearing Instrument Manufacturers Association, 'The Economic Cost of Hearing Loss in Europe'. Her updated version of the latter is due to be finalised this summer. Bridget summarised the findings of a large number of studies from the past 12 years, looking at both longitudinal and cross-sectional investigations of and psychological and cognitive well-being of populations in a range of countries. Three out of 10 studies suggested a correlation between hearing loss and an increased risk of mortality, but some more recent reports on this link were not conclusive. However, it has been found that people with impaired hearing have a higher propensity of serious falls, lower gait speeds (indicating poorer health) and overall reduced quality of life. Importantly, the recently published report of the 'Lancet Commission on Dementia' found that hearing loss in middle age is a major risk factor for dementia.

Royal Opera House

Stephen Dance (London South Bank University) spoke about his recent work in collaboration with the Royal Opera House (ROH), Covent Garden, comparing objective acoustic measurements with the perceptions of operatic chorus singers regarding different configurations and fittings of the choral rehearsal room (capacity 110 singers). Operatic singers are prone to hearing damage, but cannot wear significant hearing protection whilst performing or rehearsing. The size and acoustic properties of this rehearsal room are very different to those of the ROH theatre and, curiously, the rehearsal room has a number of absorbent acoustic panels, upholstered seats and other features which reduce its reverberation time to 0.85s, whereas calculations by Beranek and (more recently) by Sinal & Yilmaz suggested that the ideal reverberation time of a room of that size should be between 1.2 and 1.6s.

Performers were used to rehearsing for up to eight hours per day, and that rehearsal room was particularly unpopular with both soloists and choral singers. Experiments were carried out using various sitting and standing arrangements of the chorus, and instructing them to sing at either full volume or (bearing in mind the space) half volume but with full dynamic range. The singers' opinions on the various situations were then canvassed, indicating that they largely preferred standing to sitting, and being more spread out to being very close together.

Workplace noise

Chris Steel, of the Health and Safety Executive (HSE) spoke about latest HSE guidance on the use of hearing protection and hearing aids in the workplace, with particular attention to the effects of workplace noise. The HSE is in the process of preparing documentation about the use of hearing aids in noisy environments – the primary recommendation being to reduce noise levels where possible. Their guidance on the use of hearing protection at work, including on the simultaneous use of hearing aids and hearing protection by the same individual, was to avoid over-protection (i.e. avoid reducing sound levels below 70dB) due to the need to be able to hear instructions and hazards.

P38 ►

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He also emphasised the need for even the most deaf of people to wear appropriate hearing protection in the workplace, to prevent other people thinking that such protection was optional. The HSE is seeking input from other bodies, including the IOA and the Association of Noise Consultants, regarding updating their guidelines.

Editing mathematical equations in electronic documents using automatic speech recognition technology

Gordon Hunter (Kingston University) presented the principles of, and some initial experimental results from, an innovative approach to using automatic speech recognition technology for the creation and editing of mathematical equations in electronic documents. Although the TalkMaths project had been running for around 10 years, the latest developments described here suggested that they would make the tasks of editing or correcting an equation or formula using speech input much more efficient. Previously, the whole revised or corrected expression would have to be re-dictated and re-processed, but the novel method based on incremental parsing meant that small changes could now be made much more easily, and only a relatively small amount of re-processing would be required.

The papers presented represented a good proportion of the areas covered by the general field of speech and hearing acoustics, and thus provided a good overview of the variety of interests of members of the group.

Poster sessions

By Barry Gibbs

The poster session covered a wide range of topics, which provided an opportunity for young researchers to present their work and then to field questions.

Barton, with Elliott and Moorhouse, set out the principles of real-time prediction of structure-borne noise using in-situ transfer path analysis and then they provided preliminary results. Traditional transfer path analysis requires the receiver of the assembly to be characterised separately from the source. In-situ transfer path analysis allows the source to remain in position, coupled to the receiver, throughout the measurement and analysis. This has obvious benefits, as moving and replacing a vibration source could be difficult and time-consuming.

Gaydecki, with Ismail and Lloyd, described progress on platforms for real-time emulation of acoustic violins. The instrumentation, when fed with an input signal derived from a simple electric violin, replicates the timbre, voice and tonal characteristics of an acoustic violin. The system is programmed with the impulse responses of high-quality, and in some cases, almost priceless acoustic instruments. These include violins built by Catenari, Guarneri, Stradivarius and Tononi.

Jayjun Lee reported on the active cancellation and enhancement of noise with two identical ducts. The poster described a simple demonstrator system, consisting of two identical ducts with Arduino Due control board, which allowed the phase difference, between the two arriving signals to be continuously varied.

Aygun and Apolskis reported on tracheal sound acquisition using a laser Doppler vibrometer and stethoscope. Clinical practitioners use mechanical stethoscopes to detect and analyse breathing sounds, but results show that traditional stethoscopes are not reliable for detecting lungs sounds. The sounds detected differ in terms of amplitude and wave shape at high frequencies. Laser Doppler vibrometers are a new and non-contact technique, but are expensive. The research reported was on the development of a smartphone-based system to detect and analyse complex lung sounds, with the aim of early diagnosis of respiratory disease.

Wooley, Campbell and López-Carromero reported on high-speed photography as a tool for musical instrument research. Much of the behaviour of musical instruments involves vibrations and other motions, which can be visualised with slowed down replay from a high-speed camera. The poster described a number of these applications, including studies of the lips of brass players, the shock waves from the end of a trumpet bell, the vibration of double reeds and the bow/string interaction of viols. High-speed photography is also used to study the simultaneous movement of the key and pallet of a mechanical action pipe organ as part of an investigation on whether players are able to influence the transients by varying the movement of the key.

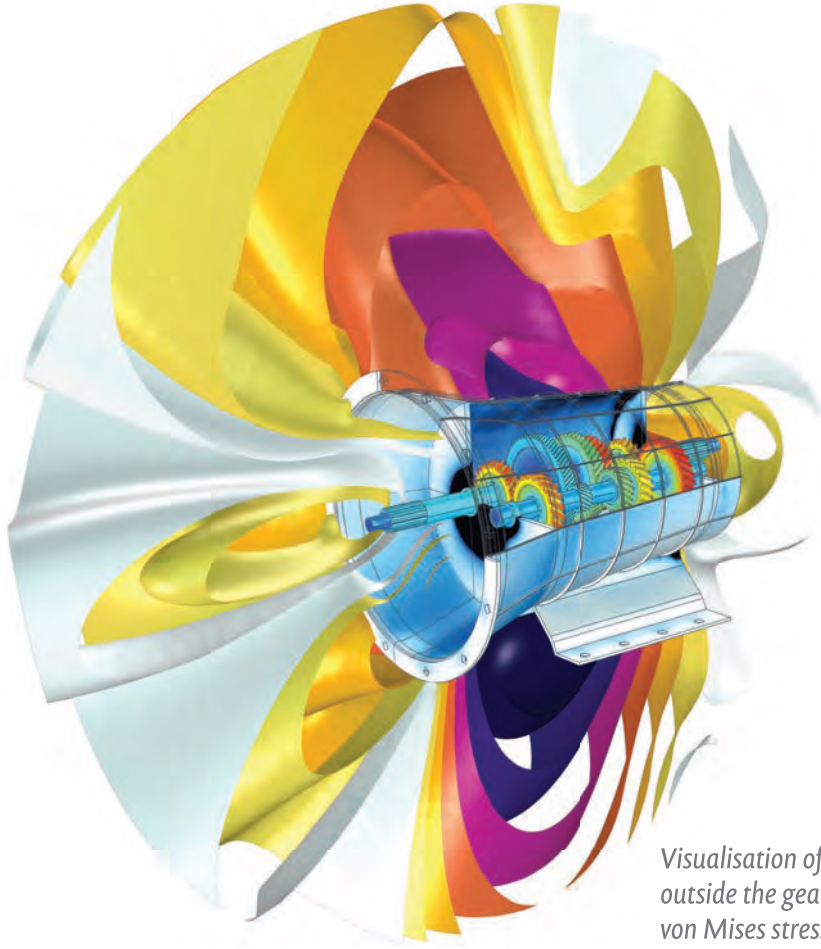
Gomez-Agustina and Rees presented on the assessment of ground-borne vibration from underground trains on a proposed residential development. A model updating approach, based on prediction software (PiP), used measured and predicted vibration levels at the surface and base of pile foundations. The uncertainty of the results originate from assumptions made on the soil loss factor, highlighting the future need for more detailed site measurements.

Acoustics 2018 was held at the City Hall, Cardiff, in April

The IOA would like to thank:

- Professor Barry Gibbs for chairing the conference.
- All the IOA Specialist Group chairs for organising their sessions to provide such a full programme over the two days.
- Professor Christopher Barlow PhD MSc BMus PgCLTHE MIOA MAES, Head of Solent Acoustics, School of Media, Arts and Technology, Solent University and three students Adam Ford, Emily Bergun and Barnaby Hewitt who looked after the presentations, av/pa and video.
- The 19 exhibitors, and
- Photographer, Mark Hawkins, who also provided a Flickr account for delegates to view photographs during the two days. **https://flic.kr/s/aHskwLeAap**

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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The descriptions of the sound effects are magically specific in themselves, for example: 'Ingersoil Rand compressor pump operating with start and stop. (Sewage pump, 1896, with belt-drive)' or 'Man drinking bucket of cold cocoa – 1967 (7F, reprocessed)'. Better still is the 'Jangle flong - 1967 (7A, reprocessed)'.

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The symphony of the sea is being silenced

The hush descending on coral reefs damaged by global warming is impairing the ability of young fish to find a home, research suggests.

Coral reefs are noisy places filled with the clicks, pops, chirps and chattering of numerous fish and crustaceans. But a study conducted on Australia's Great Barrier Reef shows that the 'coral orchestra' has been quietened in areas damaged by cyclones and bleaching.

Scientists found that without the noise, fish born outside the reef had difficulty locating a suitable place to live and breed and their experiments showed that the soundscapes of damaged reefs attracted 40 percent fewer juvenile fish than those of healthy reefs.

Lead scientist, Tim Gordon, a marine biologist at the University of Exeter, said: "It's heart-breaking to hear. The usual pops, chirps, snaps and chatters of countless fish and invertebrates have disappeared and the loss of reef fish could have devastating consequences."

Working on the Northern Great Barrier Reef, the British-led international team of scientists built experimental reefs from coral rubble on sand flats. Underwater speakers were then used to broadcast the sounds of healthy or degraded reefs to see how they attracted juvenile fish.

Coral reef animals produce a "dazzling array" of sounds to communicate while hunting, warn of approaching predators, or impress during courtship, said the researchers.

Together the noises combine to form a soundscape that can be heard for miles around. The sounds help young fish to navigate their way to suitable reef habitats after a period of early development in the open ocean.

Co-author, Harry Harding, from the University of Bristol, said: "If fish aren't hearing their way home anymore, that could be bad news for the recovery prospects of reefs.

"Fish play critical roles on coral reefs, grazing away harmful algae and allowing coral to grow. A reef without fish is a reef that's in trouble."

Tim Gordon added: "The damage we've done to reefs worldwide is horrific, but the fight isn't over yet. If we can fulfil our international commitments to dramatically reduce carbon emissions, it's still possible to protect some of the reefs that are left."

The research is reported in the journal Proceedings of the National Academy of Sciences.

NASA working on planes that quietly fly faster than sound

NASA's low boom flight demonstrator (LBFD) is a supersonic aircraft that reduces the sound of the sonic boom. Working with Lockhead Martin Aeronautical Company, NASA is aiming to prove that quiet supersonic commercial travel is possible by conducting a series of flights in November off the shores of Galveston, Texas, to determine how to best study people's reactions to quiet supersonic jets.

The commercial high-speed jet, Concorde, was popular in the late 1970s and 1980s, but its booming sound and exorbitant operating and ticket costs forced the British-French airliner to shut down in 2003. The loud boom that came with breaking the sound barrier was often described as "unsettling."

With the LBFD, NASA hopes to reduce the sound of the sonic boom to a gentle thump, similar to the sound of a neighbour closing a car door or thunder rumbling in the distance — that is, if anyone hears the sounds at all.

But because the LBFD won't be completed until 2021, NASA is simulating the sounds for now. For the tests in Galveston, an F-18 plane will conduct a dive manoeuvre offshore, diving 49,000 feet, briefly going supersonic and producing the sound likely to come from the LBFD.

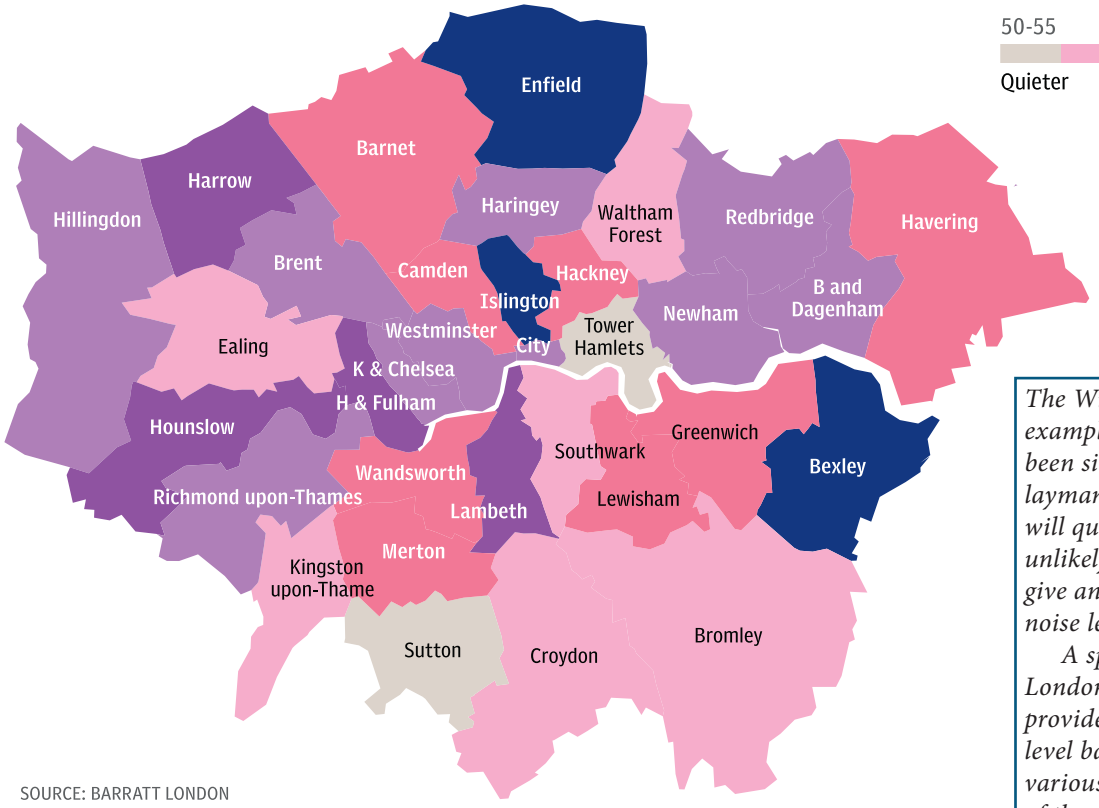
London's quietest borough

The quietest borough in London is…Tower Hamlets, the home of Brick Lane and Canary Wharf.

New research by Barratt Homes, shows average noise levels of 53.3 dB were recorded in the city centre district, helping it beat Sutton (53.8 dB), Waltham Forest (56.1 dB), Croydon (56.5 dB) and Ealing (57.3 dB) to the top spot.

They used crowdsourced sound data from 4,000 decibel readings made across the capital, to highlight the quietest areas. The data was taken from WideNoise, an app where users can make decibel level readings on the go.

Average decibel readings across the capital



SOURCE: BARRATT LONDON

The WideNoise app is just one example of how acoustics has been simplified for use by the layman. Experts in acoustics will question its validity as it is unlikely that these measurements give an accurate representation of noise levels.

A spokesperson for Barratt London said: "The research provided an average decibel level based on readings taken at various times of the day and days of the week, by individuals."

Traffic noise may leave butterflies de-sensitised to danger

The constant noise of heavy traffic on our motorways may have become a troublesome side-effect of modern living for humans but for butterflies it could be disastrous, scientists have revealed. A study of monarch butterfly larvae at the University of Georgia in the US, published in the journal Biology Letters, found if they were exposed to two hours of simulated motorway noise they became stressed, indicated by an increased heart rate of up to 17 percent.

However, if the larvae were exposed to continuous traffic noise over a seven or 12 day period they showed no signs of stress. Scientists believe this means the butterflies become de-sensitised to the noise which in turn can have its own environmental impact. "Habituation to stress as larvae may impair reactions to real-world stressors as adults, which could be problematic for a butterfly that undertakes an annual two-month migration that is fraught with dangers", the study concluded. Research with other animals has shown long-term exposure to stressors such as noise leads to weakened physiological stress reactions, which in turn affects reaction times or performance during real-world stressful events. The researchers now fear this de-sensitisation could have "far-reaching implications" for the billions of insects worldwide which make their home near roads.

Noise damages Nasdaq servers

The Nasdaq Nordic exchange was put out of order in April after a fire alarm in a Swedish data centre caused a fire suppression system to trigger. The system made such a loud noise that it shut down servers for the Nasdaq.

The noise created by the system — which sprays high-pressure gases — was so loud that it damaged Nasdaq's servers, leading to the outage. The incident is not the first time a fire suppression system has caused damage to a major financial institution; the BBC reported in 2016 that a similar incident in a Romanian data centre caused an outage for customers of Dutch bank, ING.

Voice quality is your auditory face

Humans communicate their intentions, feelings and desires verbally, so voice disorders can have devastating personal and professional consequences. A perceived voice abnormality may lead to a negative assessment of the speaker's intelligence, health and personality. Researchers described their work on voice perception and what it means for a voice to sound 'normal.' during the 175th meeting of the Acoustical Society of America.

Jody E. Kreiman of the University of California, Los Angeles (UCLA) is tackling the question of how we perceive voice quality by studying how people think of a 'normal' voice. She said: "Voice quality is your auditory face and how you sound affects every aspect of your existence as a biological being."

Volunteers listened to voice recordings and ordered them according to the perceived severity of vocal pathology. Each recording consisted of a one-second sustained vowel sound produced by 100 female speakers. Half of the vocalisations were obtained from clinical recordings of individuals with diagnosed voice abnormalities, while the remaining recordings were obtained from UCLA students with no known vocal disorder.

The results suggest that listeners were individually consistent in their judgments, placing voice samples on the spectrum from normal to abnormal, and sometimes agreeing on which voices sounded abnormal. However, within the group, respondents did not agree on which voices sounded 'normal.' This might be because they used different vocal characteristics when making their judgments. These results suggest that 'normal' quality is not a single vocal state.

"What these results are really saying is that the current view that voice perception is just the voice signal, or the person speaking, or the person listening, is wrong," Kreiman said. "We are dealing with a dynamic interaction between the speaker, the signal, the context and the listener, and we have to understand how all these different parts go together to really understand voice."

Kreiman acknowledges that there are limitations to the study. The recordings only included female speakers, but they are studying a collection of male speakers in follow-up work. In addition, the recordings only consisted of sustained vowels and used a limited acoustic model.

Sleep easy

In a bid to help guests get a good night's rest, one hotel chain is introducing a sleep tape featuring a range of household sounds, from dog barks to bubbling radiator pipes.

It is introducing the free lullaby playlist service at its locations in Glasgow, Newcastle and Croydon.

The tracklist will feature a range of everyday sounds to make guests feel more at home, including light hoovering, cats purring and the sound of a shower in action. One of the tracks will also play the hum of free-moving traffic, (minus honking horns).

More conventional soothing sounds, such as rainfall and lapping waves, will also feature via the Spotify app.

The lullaby track list

1. Washing machine in the distance
2. Dishwasher in the distance
3. Light hoovering downstairs
4. Free-moving traffic (no horns)
5. Cat purring
6. Clothes drier
7. Electric wall clock
8. Distant calm conversation
9. Radiator pipes
10. The sound of a shower
11. Dog quietly barking
12. Gardening programme

Measuring noise exposure from communication headsets and earpieces using a Head and Torso Simulator

By Liz Brueck MIOA, Health and Safety Executive, Buxton

Noise from communication headsets and earpieces can contribute to a person's daily noise exposure. There are two standard methods to determine personal noise exposure from these devices:

- Microphone In Real Ear (MIRE) technique BS EN ISO 11904-1:2002 [1]; and
- Manikin or Head and Torso simulator (HATS) technique BS EN ISO 11904-2:2004 [2].

There are also devices that monitor the electrical signal to the listening device used, and give an indication of the corresponding sound exposure. These are useful for long-term monitoring.

HSE scientists use a range of measurement methods within the laboratory, but when monitoring exposure from headsets and ear pieces in static work situations (such as call centres or control rooms) HSE scientists usually use a HATS method. This method allows us to copy how the ear piece is worn by the listener and allows the listener to work normally while we are monitoring. This is how we do it.

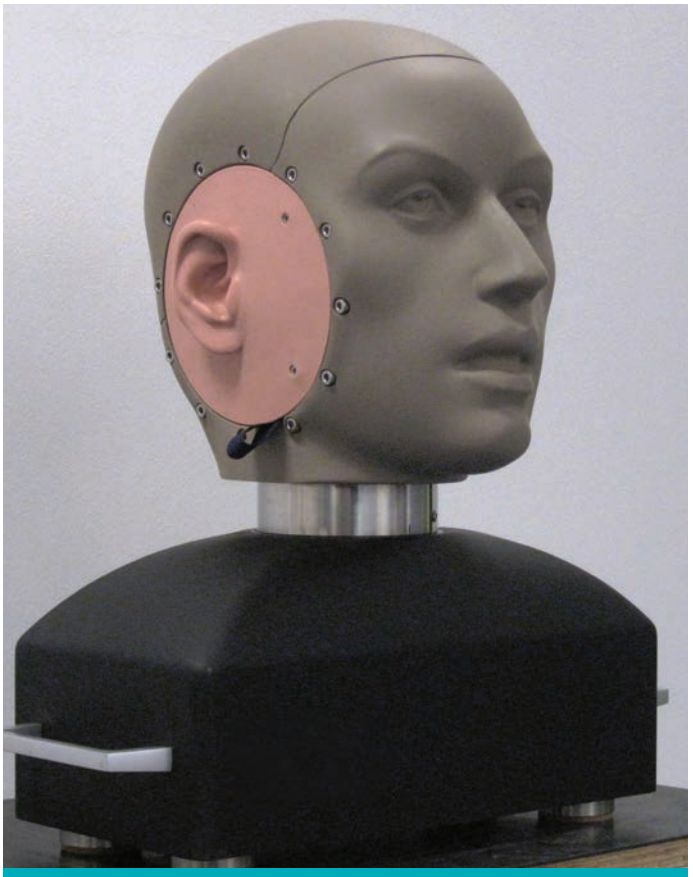


Figure 1 Head and torso simulator conforming to ANSI S12.42 (other models are available)

The HATS

Our HATS device is a simulated human head with simulations of the human ear; with a pinna, ear canal and a microphone at the ear drum to measure the sound. Sound is amplified in the ear canal so the sound measured must be corrected using a frequency dependent correction (transfer function) before it can be used to predict a person's noise exposure.

For reliable measurements, the HATS must match average human dimensions and include a realistic pinna and simulated ear canal. HSE guidance: 'L108 Controlling Noise at Work [3]' recommends the HATS should meet the requirements of clauses 3.4 and 4 in 'IEC/TR 60959:1990' or the equivalent US standard 'ANSI S3.36:1985'. These standards are now withdrawn. However, the HATS design has been adapted in 'ANSI S12.42:2010 [4]' which specifies a similar device, but with shoulders rather than a full torso. This is the type of device we currently use. An example is shown in Figure 1.

Why not use a MIRE measurement?

Measurements of sound from sources close to the ear are sometimes made using a miniature or probe microphone in a person's ear, also known as the MIRE (microphone in real ear) method. However, when the person is speaking as well as listening, the MIRE measurement will pick up the sound of their own voice reaching the ear by bone conduction. This will invalidate the measurement.

The HATS transfer function

Personal noise exposure is normally calculated from the sound level and time spent in noisy locations by the individual during their working day. This value is directly comparable to the exposure action and limit values given in the 'Control of Noise at Work Regulations 2005 [3]'. Sound is amplified in the ear and a transfer function must be used to convert the in-ear level to the equivalent level in an open space.

The ear canal amplification varies with frequency. The transfer function is therefore frequency-dependent and is usually applied as a series of corrections in decibels for each frequency band of the sound spectrum. We use a third octave band spectrum and associated transfer function. You can use narrower frequency bands, but an octave band transfer function has insufficient resolution.

We use a free-field transfer function corresponding to the equivalent level if the person was facing a single source of sound. (An example is given in Table 1 on the next page). You can also correct to the equivalent diffuse field level.

Obtaining a transfer function

Some manufacturers will supply a generic transfer function for their HATS model. This should be adequate, but HSE

Table 1: Example free field transfer function measured for a HATS

Frequency Hz	Unweighted transfer function dB		A-weighting dB	Weighted transfer function dB(A)	
	Left ear	Right ear TF		Left ear TF	Right ear TF
40	-0.8	-1.1	-34.6	-35.4	-35.7
50	0.5	-1.8	-30.2	-29.7	-32.0
63	0.9	0.8	-26.2	-25.4	-25.4
80	0.8	0.9	-22.5	-21.7	-21.6
100	-2.0	-1.6	-19.1	-21.1	-20.7
125	-1.5	-2.2	-16.1	-17.6	-18.3
160	-3.4	-7.3	-13.4	-16.8	-20.7
200	-0.5	-0.8	-10.9	-11.4	-11.7
250	1.6	-0.1	-8.6	-7.1	-8.7
315	0.2	1.4	-6.6	-6.4	-5.2
400	-1.9	-2.4	-4.8	-6.7	-7.2
500	-2.2	-1.9	-3.2	-5.4	-5.1
630	-2.7	-2.3	-1.9	-4.6	-4.2
800	-3.6	-3.8	-0.8	-4.4	-4.6
1000	-7.0	-6.4	0.0	-7.0	-6.4
1250	-6.7	-6.6	0.6	-6.1	-6.0
1600	-7.7	-8.1	1.0	-6.7	-7.1
2000	-13.7	-12.8	1.2	-12.5	-11.6
2500	-16.5	-14.4	1.3	-15.2	-13.1
3150	-16.0	-14.6	1.2	-14.8	-13.4
4000	-16.8	-15.3	1.0	-15.8	-14.3
5000	-13.5	-11.6	0.5	-13.0	-11.1
6300	-11.9	-9.2	-0.1	-12.0	-9.3
8000	-12.8	-11.1	-1.1	-13.9	-12.2
10000	-9.0	-8.2	-2.5	-11.5	-10.7

scientists would recommend you measure a transfer function for each ear of your HATS. Individual HATS of the same model, and even the left and right ears on the same HATS, can vary in response. It is useful to repeat the transfer function measurement after any repairs or part replacements as a performance check.

This is how to measure a third octave band transfer function:

Equipment needed

- the HATS and its associated sound calibrator;
- a third octave band analysis system for measurement of the spectrum from the HATS;
- a sound level meter with third octave band analysis or free field response microphone and third octave band analyser combination that meets Class 1 requirements of 'BS 61672-1' (or Type 1 of older standards);
- a source of approximately pink noise providing sound over a range from at least 100 Hz to 10 kHz; and
- a quiet, non-reverberant test space (we use an anechoic chamber) with background levels in each frequency band at least 20 dB below the test levels.

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Transfer function measurement steps:

1. make calibration checks of your HATS and measurement instrumentation with the associated sound calibrators;
2. position the HATS facing the sound source and measure the third octave band levels from the instrumented ears of the HATS;
3. replace the HATS with the open space measurement microphone/sound level meter at a position corresponding to the midpoint between the HATS ears and repeat the spectrum measurement;
4. the open space level in dB minus the HATS ear level in dB gives the HATS transfer function value in dB for the frequency band; and
5. arithmetically add the A-weighting values to your unweighted transfer function to obtain an A-weighted transfer function, which can then be used to obtain the equivalent A-weighted spectrum in an open space from the HATS measurement.

Applying the transfer function to the HATS spectrum:

1. arithmetically add the transfer function values in dB(A) to your third octave band levels measured from the HATS to obtain the equivalent A-weighted spectrum in an open space; and
2. sum the equivalent A-weighted spectrum levels from each frequency band using a dB summation (not an arithmetic summation) to obtain the equivalent broad band A-weighted level in an open space.

At HSE, our scientists use a computer-based analysis system that applies the transfer function and A-weighting to give the broadband equivalent A-weighted level in real time.

Measurements of a headset

Measurements of a headset sound level usually need to be made while the headset wearer is taking working calls. We use a second headset of the same model for the HATS measurements and work next to the call handler.

If a second headset socket is available at the call handler's work station we connect to this. You need the output set to the same listening level as the call handler uses. If there are no fixed gain settings we would ask the call handler to subjectively set the HATS headset to their chosen listening level.

Alternatively, split the signal between the HATS headset and the operator headset and ask the operator to restore the output of both headsets to their chosen listening level.

Fit the headset on the HATS ear as the operator chooses to wear it. If the operator is listening with the headset resting on the side of the head, i.e. listening primarily by bone conduction, a valid measurement is not possible.

Background noise measurements and influence

If the HATS is close to the workstation you are monitoring, you will record all the sound entering the ear, the background noise, the call handler's voice and the sound from the headset. However, it is important to have a separate measurement of the background noise level as excessive background levels could affect the chosen listening level. If background noise is intrusive, most people choose to listen at a level 5 to 10 dB above the background. Logging noise dosemeters positioned on the edge of workstations, or at a vacant workstation in a busy area, provide a useful indication of the variations in background noise throughout the day.

Calculation of daily personal noise exposure

Guidance on calculating daily personal noise exposure can be found in 'Controlling Noise at Work [3]'. An exposure calculator is also available at **http://www.hse.gov.uk/noise/calculator.htm**. You will need estimates of the sound level and duration for each activity and type of call in a working day.

Control of noise exposure

We have not often found instances where people choose to listen to speech communication from headsets at levels likely to give a noise exposure over the action values. But if the background noise is intrusive, listening levels can be raised to excessive levels. Background noise in the workplace should be controlled using simple actions such as removing or screening off noisy equipment, providing screens around work stations, sound absorbent materials on surfaces in the work space while also minimising the intrusion of outside noise.

Modern headsets are designed to cut out sustained tonal sounds such as some alarms, dialling tones and sounds that might occur with a fault, or during a malicious call. HSE encourages duty holders to supply appropriate headsets and access to replacements if faulty. If there are calls which are known to have excessive noise (such as radio static) it is best to filter the noise from the signal before it reaches the headset.

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Developing a durable, quiet road surface

By Dr Matthew Muirhead and Dr Iswandaru Widyatmoko

Introduction

Road traffic noise can have a significant impact on the quality of life for residents close to major road networks [1]. One of the most effective measures for reducing the noise from road traffic, particularly on high-speed roads, is to ensure the use of a low noise road surface. Research on pavement construction and the measurement of its acoustic properties has shown that significant noise reductions can be achieved through the use of certain road surface types [2]. However, certain low noise road surfaces do not exhibit the desired durability associated with more traditional pavements, leading to costly and disruptive maintenance regimes [3].

As such, Highways England, the Mineral Products Association and Eurobitume UK have come together to fund collaborative work into developing an asphalt surfacing material with enhanced durability without compromising safety or increasing noise levels [4,5].

This article looks at the mechanisms involved in tyre/road noise generation and how these interact with various road surface properties including a brief overview of some common surface types. It then goes on to explain how these concepts informed the development of a new Premium Asphalt Surfacing System (PASS) and summarises the progress made towards a safe and durable low noise surfacing material, including the completion of a successful network trial.

1. Tyre road noise generation

The mechanisms of tyre/road noise generation are often divided into three classes covering impacts and shocks, aerodynamic processes and adhesion effects.

Impacts and shocks describe the interaction forces between the tyre tread and the road surface. The tread block is compressed and is said to be snapping out as it leaves the road surface and returns to its uncompressed state and this tends to generate noise below 1 kHz.

Aerodynamic processes include the compression and decompression of air trapped between tyre tread blocks as it passes over the road and this process, called air pumping tends to generate noise above 1 kHz. Theoretically, this process is a significant source of tyre/road noise for smooth, non-porous surfaces, which have fewer avenues for the dissipation of the compressed air.

Adhesion effects include frictional forces between the tyre and road surface causing vibrations in the tyre, which are then dissipated by the tyre slipping on the road surface. These noise generating mechanisms are amplified by the local geometry of the tyre and road surface, at the rear of the contact patch (the

Pilot scale demonstration at Alrewas Quarry

area where the tyre touches the surface forming a horn like geometry), and this is known as the horn effect. It can result in substantial amplification of the noise above 1 kHz.

The relative importance of these different mechanisms varies between tyre types and surface designs. As well as the generation of noise, surface design can influence noise propagation. For example, porous road surfaces can result in destructive interference between the direct sound wave and that which penetrates the surface layer and is reflected back towards the receiver. In addition, porous surfaces mitigate the amplification of noise caused by the horn effect.

Below, we discuss some important road surface properties and how they influence tyre/road noise before giving a brief overview of the properties of some common surface types.

1.1 Road surface profile

A road surface profile can be visualised by taking a virtual cross section of the pavement and considering how the top layer of this cross section appears. It will consist of a continuous series of peaks and troughs, which may be randomised or reasonably well defined depending on the pavement type. This profile shape can be interpreted in terms of the summation of a number of sinusoidal variations of different amplitudes and wavelengths. Each sinusoidal variation is called a waveform and the associated amplitudes and wavelengths are referred to as texture amplitudes and texture wavelengths.

Research has shown that increasing texture amplitudes at wavelengths between 0.5 and 10mm reduces air pumping noise as the air between the surface and tyre is released more smoothly [3]. However, research has also shown that increasing texture amplitudes at wavelengths between 10 and 500mm increases low-frequency noise as a result of higher vibration levels in the tyre carcass.

In addition, the way the texture is applied can have an effect. Research has indicated that noise levels associated with surfaces with transverse texture (i.e. a relatively regular profile across the width of the road surface) are higher than those associated with surfaces with random texture even if the texture amplitudes are similar [2]. This is down to the synchronised forces in the transverse texture enhancing the associated tyre vibrations.

As well as texture amplitudes and wavelengths, road surface profile may be referred to as having either a positive or negative texture. Positive texture refers to a surface where ridges protrude above the plane of the surface whereas negative texture refers to a surface which is largely smooth, save for some voids between the aggregate. In general, positive texture encourages higher levels of vibration (and therefore noise) in the tyre than negative texture.

1.2 Road surface durability

Achieving good durability is often in conflict with attaining low noise and therefore creating a surface that performs well in both areas is a key challenge in pavement design.

The durability of asphalt surfacing may be defined as the ability of the surfacing material to resist degradation in service (such as fretting, cracking and delamination) due to P50 ►

changes in the chemical and mechanical properties of the material. Not only is good surface durability desirable in terms of increasing the lifetime of the surface, it also has a beneficial impact on traffic noise compared with another surface with poor durability. For example, traffic can wear down the texture amplitudes associated with shorter texture wavelengths, increasing aerodynamic noise. Porous surfaces are particularly susceptible to degradation as the high void content can result in the surface becoming clogged, reducing acoustic absorption and causing the surface layer to break apart [6].

There are a number of factors to consider in achieving good surface durability. Firstly the asphalt mixture, typically a combination of aggregates, fines, filler and bituminous binder, needs to be balanced. The ideal mixture has the right amount of air voids (gaps between the materials) and a good compatibility between the components in terms of their physical and chemical properties.

Typically, an in situ air void range between 2% and 6% is ideal for dense asphalt concrete [4]. A lower air void content is not conducive to a quiet surface and a higher air void content is not conducive to good durability, as moisture enters into the voids and leads to fretting and cracking of the pavement.

In addition to considering the risk from moisture damage, winter maintenance practices also need to be considered. The effect of de-icing fluids on asphalt pavements has been reported as causing degradation and disintegration of asphalt pavements [7,8]. Improving the properties of binders and/or aggregate may reduce or even eliminate the problem.

1.3 Other road surface properties

The environmental noise from traffic is also influenced by the absorption of the sound generated and one of the key parameters in this regard is porosity. Porosity is a measure of the fraction of the volume of voids to the overall volume and, with respect to road surfaces, the residual air void content is the fraction of voids open to the air in a given volume of pavement mix.

For tyre/road noise, increased porosity reduces air pumping and generally increases sound absorption, which in turn reduces the horn effect. There are also other parameters which influence sound absorption including the thickness of the porous layer, airflow resistance and tortuosity (a measure of the curved/meandering nature of the air path through the surface layer).

These parameters have complex and interdependent relationships with the air flow through the surface and the frequencies which are mostly absorbed [9,10]. Research in the area of porous surfaces has shown that porosity decreases as the surface becomes clogged.

Skid resistance requires a degree of surface texture amplitude over a wide range of texture wavelengths. Achieving the desired texture amplitudes for skid resistance at the texture wavelengths that do not adversely impact the noise generation is the key to having a low noise surface that meets the necessary safety requirements.

Rolling resistance and noise are more closely related and reducing texture amplitudes at certain wavelengths tends to be beneficial for both properties [11].

1.4 Road surface types

Current road surfaces each contain their own combinations of properties discussed above, leading to varying levels of acoustic and structural performance in practice. Hot rolled asphalt (HRA) for example often uses a 20mm pre-coated chipping and has been widely used in the UK for many years. It is a durable surface that can last over 20 years; however, it results in higher levels of traffic noise than most other randomly textured surfaces including thin surface course systems and porous asphalt.

During the laboratory and field assessments, the test results were benchmarked against the UK Specification for Highway Works (SHW) Clause 942 for Thin Surface Course Systems

Thin surface course systems have been used in the UK since the late 1990s and encompass a variety of bituminous products with a surface layer less than 50mm deep. These surfaces tend to be classified either according to their surface thickness or in terms of the aggregate size used. The nominal aggregate size used in these surface layers is in the range 6-14mm and the open and smooth surface texture lends itself to low noise performance. In general, thinner layers and smaller aggregate sizes result in quieter surfaces with less durability and greater deterioration in acoustic performance over time [2].

Porous asphalt surfaces can be constructed with either a single layer or two layers usually around 40mm thick; sound absorption is achieved by a gap-graded aggregate distribution resulting in a high void content. They are common low noise surfaces in Denmark and the Netherlands and their acoustic properties have been investigated in several studies [12-15]. They are not commonly laid in the UK however as they do not exhibit good durability because of the rapid ageing of the binder and the clogging of the voids. The surface also requires more frequent salting in winter conditions and surface repairs are more problematic [3]. Reported measurements indicate that high initial noise benefits, around 5 dB quieter than some thin surfaces, are achievable but that the clogging of the voids in the surface leads to most of this benefit disappearing over the first five to six years of the surface's life. Also, noise levels are reported to increase by around 3.5 dB in wet weather and the surface takes longer than other surfaces to dry out [16].

2. Developing a durable quiet surface

2.1 Stage 1: Concept generation

Initial work focused on developing new and innovative asphalt surfacing materials with significantly enhanced durability, whilst balancing other performance demands such as noise, skid resistance and safety. The major factors considered were:

- understanding issues and failure mechanisms;
- performance requirements;
- assessment criteria;
- mix design and specification; and
- construction techniques.

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A workshop was organised in June 2015 drawing upon leading experts' and international experience. In this workshop, the participants were challenged to come with ideas for the next generation of asphalt surfacing for use on Highways England's motorway and all-purpose trunk road network, that will increase durability without compromising the current performance.

Ideas presented in the workshop were collated into broad concept groups and an initial high-level evaluation of each concept was undertaken against durability, ease of implementation and likely relative cost.

Several ideas generated at the workshop related to the category of 'good practice'. The key factors to be considered for potential options were:

- the mix design process;
- a better understanding of aggregate packing;
- constructability – improving workmanship/operational upskilling/training;
- substrate condition;
- the bond between layers;
- improved safety and joint workmanship; and
- temperature control and prevention of mix segregation.

The dual layer Premium Asphalt Surfacing Systems (PASS) was the top idea amongst a range of other options [3]. The concept is based on a low voided, dense body of material with improved surface characteristics.

2.2 Stage 2: Laboratory testing

The mix design explored aggregate packing theories to produce the PASS [17]. The desired properties for the PASS include resistance to rutting, long-term durability, improved skid resistance and reduced noise properties. The packing characteristics are determined by several factors that include the shape, strength and texture of the aggregates.

Other factors include the aggregate gradation and compaction effort applied. For example, cubical particles form a denser configuration in comparison to flat and elongated particles while smooth particles slide together more easily than those with a rough surface texture. To better understand aggregate packing, it is important to establish what particles form the coarse aggregate structure and which ones fit into the voids created within the structure.

A binder for the PASS was selected, which allowed for easy compaction under adverse weather conditions and had sufficient flexibility against surface cracking and did not compromise the desired texture of the surface course.

2.3 Stage 3: Demonstration trial

Following laboratory tests a pilot scale demonstration was undertaken at Alrewas Quarry, Staffordshire, in June 2016. The PASS samples showed optimal packing of aggregates and laying characteristics were very similar to those of a thin surface course. The demonstration trial showed that the PASS material was relatively easy to batch with no problems encountered at the asphalt plants. The obtained in situ air voids was around 4%.

During the laboratory and field assessments, the test results were benchmarked against the UK Specification for Highway Works (SHW) Clause 942 for Thin Surface Course Systems. The results found that the new PASS material showed mechanical properties at least similar to, or better than that of the Clause 942 reference [3].

2.4 Stage 4: Road network trial

The next phase of work involved laying the PASS mix on Highways England's road network. The road network trial involved the installation of two PASS mixes (PASS 1 and PASS 2) targeting 50mm nominal thickness for the mixtures. The same equipment and procedure used in the installation of typical thin surface course materials were utilised for the PASS trial. Following installation, the PASS appeared to be dense with a high coarse aggregate content showing good interlocking properties.

The major advantage of the PASS material is the fact that the design is based on closely controlling the amount of in situ air voids. This parameter is aimed at helping to improve the in service durability of the PASS mixtures. The skid test results showed encouraging values for the asphalt mixtures. The mechanical test results on cores recovered from these sections showed performance at least comparable to, or better than, the result obtained from the Alrewas trial [4].

The Statistical Pass-By (SPB) measurement is the most frequently used procedure in the UK for assessing the influence of road surfaces on vehicle noise emissions. During an SPB measurement, the maximum pass-by noise levels and speeds of individual vehicles selected from the traffic stream are P54 ►

Noise measurements on the road network trial

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Trial site at Alrewas, Staffordshire

measured at a reference distance from the centre of the vehicle lane and these data are used to infer the acoustic performance of the road surface [18,19].

The SPB method was used in assessing the noise properties of the PASS mixtures following the road trial to obtain a Road Surface Influence (RSI) which describes the acoustic performance of the surface relative to a standard HRA surface. The obtained value for the PASS from this survey was -5.7 dB(A) which compares well with the acoustic performance of existing low noise surfaces and meets the requirement of SHW Clause 942 for "very quiet surfacing".

These results point towards the PASS being a very promising surface for achieving low noise and good durability but the key test will be how the surface stands up to the next few years of use. In addition to further testing of the PASS material on the trial site as it is ages, recommendations have been made to:

- develop guidance documents and specifications for the design, testing and use of these next generation asphalt mixtures;
- develop a more advanced assessment of in-situ density that isolates the effects of surface texture. These are important parameters required in order to produce durable PASS mixtures within the design air void target limits of 2-6% and texture values between 1.0 and 1.4mm,
- make use of a mobile load simulator to better understand the long-term performance of the mixture, relative to a control thin surface,
- measure the wet skidding resistance of the mixture and
- look into using different aggregate sources and suppliers.

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ISO/TS 12913-2:2018 – Soundscape – Part 2: Data collection and reporting requirements – what's it all about?

By Philip Dunbavin

By the time you read this, ISO/TS 12913-2:2018 should have been published, or at any rate is about to be published. It is notoriously difficult to predict exact publication dates for new ISO documents.

Part 1

Part 1 was published in 2014 [ISO, 2014] and considered to be the definition and conceptual framework. It is a very short standard three pages plus a bibliography. So, what is it all about and what is getting more and more acousticians interested in what is an emerging science?

Soundscape represents a paradigm shift from noise control policies towards a new multidisciplinary approach as it involves not only physical measurements, but also humans and social sciences with a focus on how people actually experience an acoustic environment in context. Soundscape started as a research field in the late 1960s, was defined more specifically by R Murray Schafer in the 1970s [Schafer, 1994 and 1977] and has grown significantly over the past 20 years in the field of community noise and environmental acoustics [Kang, J., and Schulte-Fortkamp, B., 2015; Kang and Aletta, 2018]. More recently it has come to the attention of policy makers [Payne et. al, 2009; Defra, 2010; Easteal et. al, 2014; City of London Corporation, 2017; Welsh Government 2018], as well as practitioners and acousticians in consultancy practices.

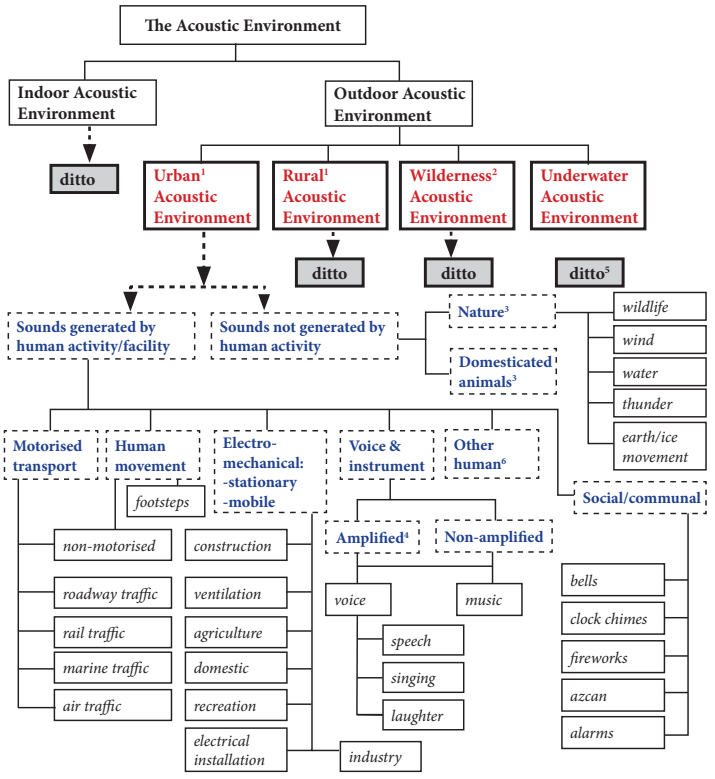
In Part 1, soundscape is defined as 'the acoustic environment as perceived or experienced by and/or understood by a person or people, in context' [ISO, 2014]. Much has been debated in recent years about exactly what 'context' is in the light of BS4142:2014. In soundscape, the context is meant as the physical place where the acoustic environment exists and according to the ISO definition, it 'includes the interrelationship between person and activity and place and time and may influence soundscape through the auditory sensation, the interpretation of auditory sensation, and the response to the acoustic environment' [ISO, 2014].

The main thrust of soundscape is that it is a holistic approach, meaning that it requires assessing the acoustic environment based on the contribution of different disciplines [Kang et. al, 2016].

Part 2

According to Kull [1] a soundscape is the entire acoustic environment resulting from natural and man-made sound sources. To assist in source reporting a classification for all sounds sources should be used. The taxonomy proposed in Part 2 at Annex C, Figure C1 – A taxonomy of the acoustic environment for soundscape studies [2] is shown below [Reprinted from ISO/ PRF TS 12913-2:2018].

Note: Bold boxes = types of places, dashed boxes = types of sound source; italics = sound sources.



Key [Figure and key reprinted from ISO/ PRF TS 12913-2, 2018 Acoustics — Soundscape — Part 2: Data collection and reporting requirements. Geneva, Switzerland: International Organization for Standardization (ISO)].

1. *The urban/rural distinction is not always readily defined but remains useful.*
2. *The wilderness category includes national parks, undeveloped natural and coastal zones and large recreation areas for example, though the wilderness/rural divide is not always clear-cut.*
3. *While 'nature' and 'domesticated animals' sources are shown as being 'not generated by human activity' there are many areas of overlap, e.g. the sounds of running water in constructed water features or the sound of wind on buildings. Domesticated animal sounds are generally from animals associated with a human activity/facility.*
4. *Recording, replay and amplification can occur for any type of sound, e.g. in installations playing nature/wildlife sounds.*
5. *Because of the different acoustic impedances in air and water, many of the terrestrial sound sources would not normally be observed under water, but overall the same classification system is still applicable.*
6. *Coughing for example.*

Measuring a soundscape

The big challenge with respect to measuring a soundscape is that soundscape is a multifaceted phenomenon and hence P56 ▶

cannot be measured with a few single numbers. In general, soundscape has to be measured, assessed/evaluated through human perception of the respective acoustic environment.

The soundwalk method is an empirical method for identifying a soundscape and its components and is the most frequently applied method to collect data to explore areas of human response to an acoustic environment. The essential purpose of a soundwalk is to encourage participants to listen discriminately and to make judgements about the sounds heard [3], but the protocols can vary and Part 2 presents three different approaches to this.

The more observant reader will have noted that Part 2 is an ISO/TS. A TS (Technical Specification) is a device used where a science is emerging and further research is required to provide the evidence that will result in it becoming a full ISO in due course. In the case of soundscape there is currently no "reference method" and logically then a TS is the right basis for Part 2. The lifespan of a TS is that it is reviewed after three years and then again at the six-year point. At either of those reviews it can be upgraded to a full ISO providing the evidence to do so is available.

Annex C of Part 2 describes three methods of data collection [Reprinted from ISO/ PRF TS 12913-2:2018]:

Soundwalk Method A [Figure reprinted from ISO/ PRF TS 12913-2:2018]:
This uses a questionnaire to collect data on how people perceive an acoustic environment in situ, e.g. in a soundwalk.
[See references 4, 5, 6, and 7.]

The questions are presented and the participants mark their perception using a five-point ordinal-category scale. A simple example is shown below:

Overall, how would you describe the present surrounding sound environment?

Very good	Good	Neither good nor bad	Bad	Very bad
☐	☐	☐	☐	☐

Soundwalk Method B [Figure reprinted from ISO/ PRF TS 12913-2:2018]:
Method B is very similar but uses five-point unipolar continuous-category scales with additional verbal labelling ranging from 'not at all' to 'extremely'. A simple example is shown below:

How loud is it here?
Mark your impression at any location on the scale below.

not at all slightly moderately very extremely

Method C [from ISO/ PRF TS 12913-2:2018]:
Method C is not an actual soundwalk but is instead, a narrative interview and is based on COST TD0804 STSM [8]. The guidelines refer to satisfaction with the living space, residential experience, experiences with/relation to sounds in daily life, daily routines, co-inhabitants, neighbours, spatial identification of sound effects within residences, effects of various kinds of sounds, assessment of the effect that varying sounds have upon overall sound exposure and actions to improve residences with regard to sound exposure.

In COST TU0901 [9] an attempt was made to produce a questionnaire that was harmonised and common for use in 29 European countries plus three countries outside of Europe. We came to the conclusion that one size fits all was not possible. Selecting the wording of the questions used for a questionnaire is a delicate task. The meaning and weight of some words would simply not translate adequately into other languages. The critical message is to design your questionnaire with great care.

As an aside, ISO TC 43/SC1/WG62 [ISO. 2018. ISO/TC42/SCI/WG62] is about to start on the task of revising ISO/TS 15666 Acoustics [ISO, 2003] – Assessment of noise annoyance by means of social and socio-acoustic surveys.

Physical measurements

So, what about physical measurements? Annex D of Part 2 [ISO/ PRF TS 12913-2:2018] specifies how to perform binaural measurements by means of an artificial head measurement system. In contrast to recordings based on a monaural microphone, binaural acoustic measurement systems record sound as if a human listener is present in the original; sound field, maintaining all spatial information.

Statistical analysis of responses from questionnaires can test the reliability of the responses and examine the relationship between subjective responses and objective measurements. Analysis of the results has frequently been performed using linear regression. Other correlation methods may be considered as well, e.g. multivariance analysis. The analysis of the data will be the subject of Part 3 of the standard and work on that will start later this year.

During the development of Part 2, there was much comment and debate over whether binaural measurements should be 'normative', which means they are mandatory, or whether monaural recordings would be adequate. This is one of the many areas in which research is required.

While it is understandable that researchers would like to use monaural recording, because it has much lower costs associated with it, there is no substantial evidence to demonstrate that no important information would be lost by using monaural recordings instead of binaural.

Having good recordings means that researchers can analyse them using a range of metrics depending on the nature of the sound sources. Classical acoustic indicators are to be measured and reported in accordance with ISO 1996-1. Psychoacoustic parameters play an important role with respect to auditory sensation. Such parameters as sharpness, tonality, roughness and fluctuation strength can yield information with greater differentiation than the consideration of sound pressure alone. [Fastl, H., Zwicker, E., 2007]

What next?

The European Environmental Agency in its Good Practice Guide acknowledges 'soundscaping' as one of the strategies

to identify and manage quiet areas [10], thus a lot of research efforts are focused on this one particular soundscape: quietness and tranquillity.

Much more effort should be directed to developing predictive models for the perception of the acoustic environment starting from physical features of the environment. This might provide 'tools' to link soundscape research, policy making and design practice.

Overall, soundscape research needs more scientific evidence of its potential to promote healthy urban environments. This will eventually integrate this emerging science into the broader framework of policy making and urban planning.

Author

Philip Dunbavin *is the Managing Director of PDA Ltd. He is a Fellow of the Institute of Acoustics and a Member of the Society of Environmental Engineers, and a past Chairman of the Association of Noise Consultants. He is the current chairman of the BSI committee EH/1/3 on environmental acoustics and also chairman of the BSI's overarching EH/1 committee on Acoustics.*

Philip is the convenor of ISO/TC43/SC1/WG54 on soundscape and also of the newly formed ISO/TC43/SC1/WG62 for Social and socio-acoustics surveys.

Acknowledgment

The author wishes to acknowledge and thank, in particular, all the participants of ISO TC43/SC1/WG54 and BSI EH/ 1/3 committees for their considerable input and work over several years on the soundscape standards.

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IOA's 'Good Practice Guide on the Control of Noise from Places of Entertainment, 2018'

By Dani Fiumicelli, Technical Director at Temple Group Ltd

The assessment, management and mitigation of entertainment noise forms a substantial part of the professional activities for many members of the IOA. It is the regular subject of robust discussion at hearings and tribunals, and exchange of views between practitioners and enforcement bodies. However, guidance and advice on the subject is limited and the approach taken to apparently similar circumstances varies considerably.

Although the IOA published a guide to noise from pubs and clubs in the late 1990s, it didn't include any sound level-based advice, and since then, the relevant legislative and policy environment has changed radically across England, Scotland, Wales and Northern Ireland.

Consequently, it was decided that the IOA's guide needed refreshing. A small working group made up of consultants and environmental health practitioners was formed to review and where appropriate, update and amend it.

The working group consisted of individuals with substantial experience of entertainment noise. It was deliberately kept to relatively few people to allow the rapid completion of the task and delivery of a draft 'Good Practice Guide to the Control of Noise from Places of Entertainment' for consultation with IOA members and stakeholder professional bodies. The research base on which to try and establish sound level-based control thresholds is not extensive, so in a manner similar to other sources of guidance e.g. BS 4142 and BS 8223, the cumulative experience of the working group has been used to appraise the quality and support the interpretation of the quantitative evidence that is available.

The first thing to note is that the draft document is a 'Good Practice Guide' (GPG) providing advice for the interpretation of professionals who are assumed to have a reasonable understanding of the relevant acoustic principles, law and policy; not a statement of 'Best Practice', that fetters professional judgment and which must be slavishly followed to the exact letter of the text.

Practical advice

This means that a practitioner can choose to vary from the advice of the draft GPG, but it is suggested they will need to provide detailed justification for the approach they take; whereas by complying with the draft GPG, this is already provided by the text in the document and can simply be referenced in any report.

The draft GPG suggests a risk-based approach is taken to the assessment, management and mitigation of entertainment noise. This means approaching each case individually and using the draft GPG as a framework to establish noise level requirements appropriate to the degree of threat of a noise problem. For example, a rural pub that has music entertainment once a month ending before midnight, would not be treated as stringently as say; a nightclub in a densely populated urban area that operates every night until the small hours of the morning.

There are a range of factors to consider and the risk assessment derived from these factors establishes if the premises is rated as either low, medium or high risk. Dependent on the risk rating, appropriate sound level-based control thresholds can be derived from a range of metrics and values suggested in the GPG.

As well as providing a risk-based framework for establishing control sound level thresholds for places of entertainment, the draft GPG also provides practical advice on the management and mitigation of entertainment noise.

A rural pub that has occasional music entertainment would not be treated as stringently as a nightclub in a densely populated urban area

Consultation

The working group hopes to begin consultation on the draft GPG in the late summer or early autumn. A presentation and feedback session on the GPG is planned for the IOA meeting, 'Acoustics of Places of Entertainment and Sports Venues' on Thursday 13 September 2018 at Pier 8, The Lowry, Salford Quays M50 3AZ.

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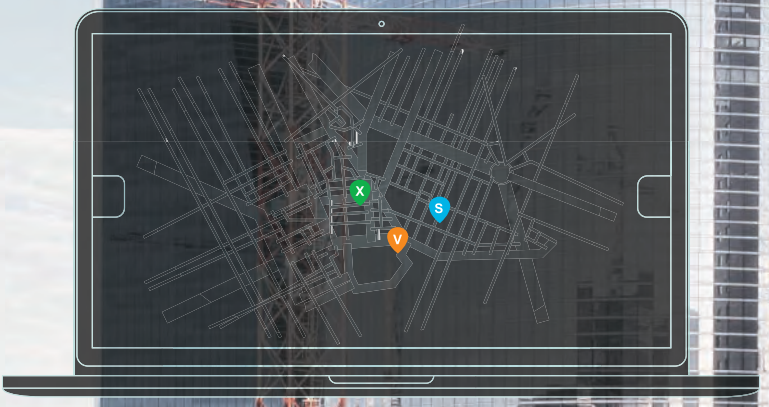

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Acoustic technician apprenticeship gets green light

By Richard Grove, Head of London Acoustics at BDP

Following more than a year of discussion, consultation and drafting, the Acoustics Engineering Technician Trailblazer Group is pleased to announce that the Standard for the Level 4 Acoustics Engineering Technician Apprenticeship has been published on the Institute of Apprenticeships website (**https://www.instituteforapprenticeships.org/apprenticeship-standards/acoustics-technician**).

The apprenticeship seeks to complement existing educational courses in acoustics, providing an alternative route into the acoustics industry and the necessary foundation to embark on a successful career in acoustics.

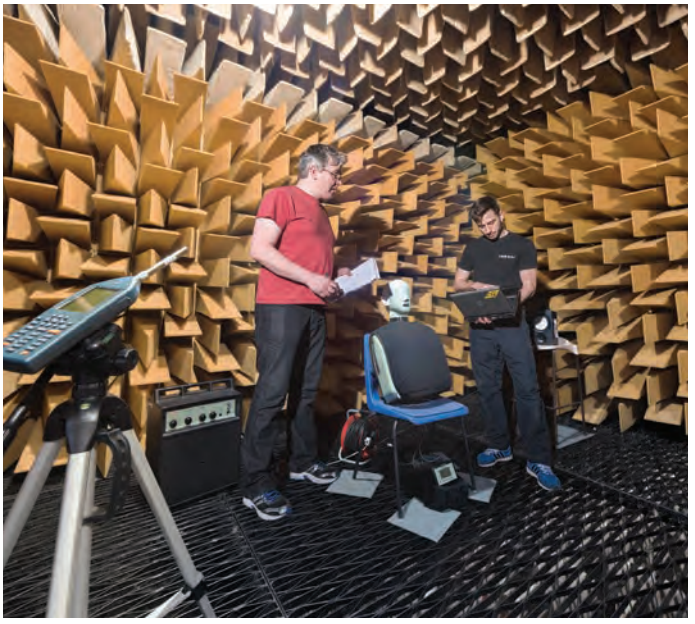
2019 intake

A great deal of work has been undertaken in the background to get us this far, so I would like to take this opportunity to thank the efforts of the Trailblazer Group, Institute of Acoustics, Association of Noise Consultants, and London Southbank University, as well as all of the people that responded to the round of consultation for their enthusiasm, knowledge and support, which has been critical to this process.

This support will be carried forward to now develop the course content and End Point Assessment, which we aim to align with the requirements for achieving Engineering Council EngTech recognition. We are currently aiming for the first intake of apprentices in 2019.

More information

Many companies have expressed an interest already. If you would like any more information please contact Richard Grove at **richard.grove@bdp.com**



Improving the indoor environment

for people with dementia through colour and sound

Photographer: Petra Appelhof,

Recent research has shown a link between hearing loss and dementia, individually these are socially isolating however a combination can lead to anxiety, frustration, aggression and loneliness. Using products that absorb sound to calm the environment and aid hearing; giving consideration to the siting of noisy equipment and processes; and affecting noisy behaviour to reduce sound and introduce constructive sound can have a positive effect.

Both ageing and dementia also affect our eyesight, making visual elements of a space more difficult to interpret; often leading to trips, falls and misunderstandings. Consideration to both natural and artificial light levels alongside colour, pattern and signage can all enhance the environment and make it easier to navigate.

Ecophon has been investigating the effects of changing the indoor environment in care spaces to reduce these barriers and so enhance life for both the people living and working there.

To learn more contact Andrea Harman on 07771565382 email andrea.harman@ecophon.co.uk or visit www.ecophon.com/uk

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Sto helps to keep things quiet for new landmark building

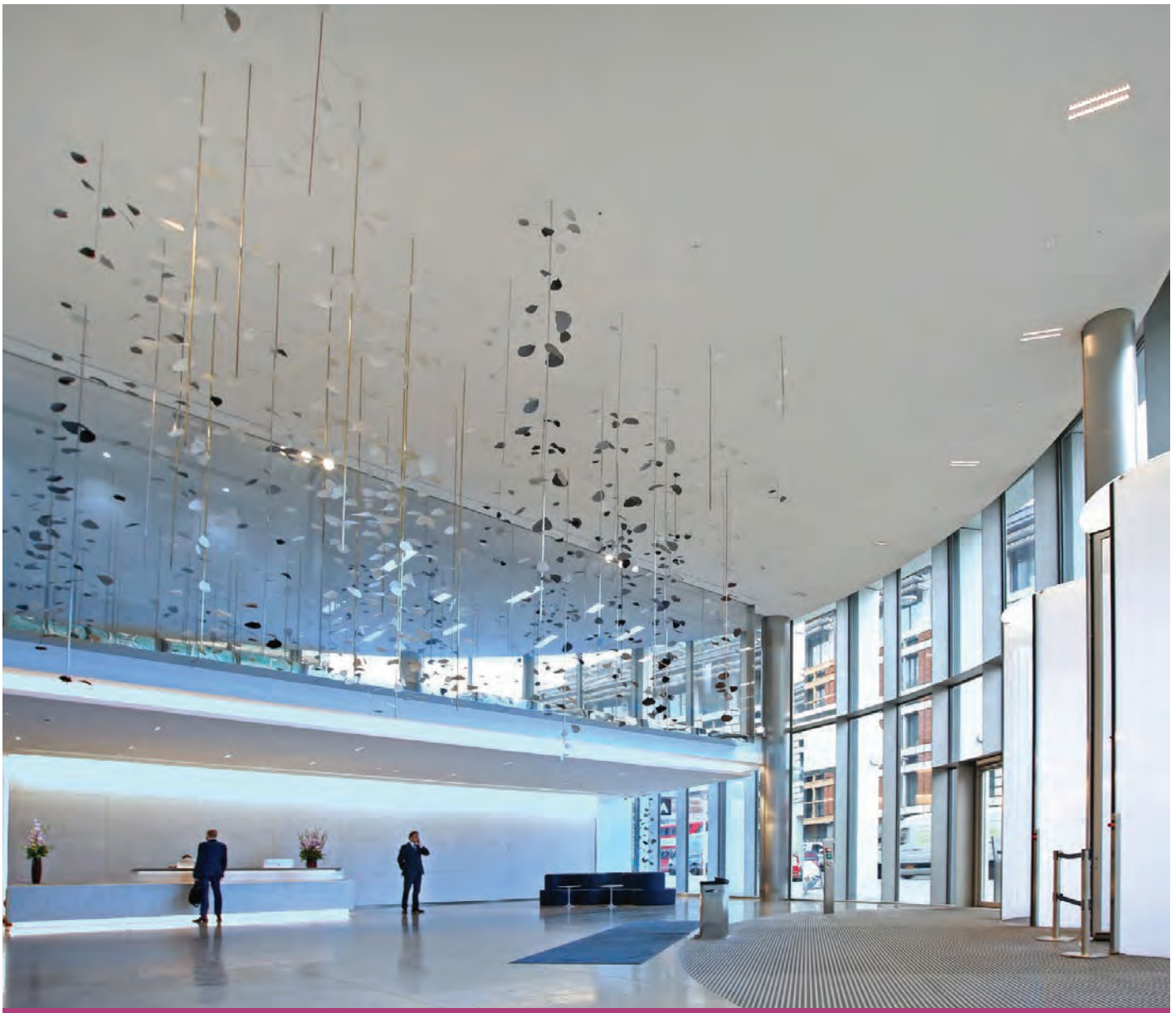
The StoSilent Distance A2 110 acoustic system has been installed at One New Ludgate, as part of a project to transform a 1980s city building into a contemporary new mixed-use development. It was installed to help with the acoustic challenges of attenuation and reverberation and also to enhance speech clarity within this major new London landmark building.

Built on an island site, the twin-height, multi-storey, refurbished building now offers over 179,000² ft. of busy office and retail space, where excellent acoustic design and balance formed an important part of the project. A limited void space, ceilings used as a plenum for air extraction and architectural requirements for clean uninterrupted lines, meant that the use of traditional tiles in an exposed grid or perforated plasterboard solutions were not an option – so StoSilent Distance system was the perfect choice.

Michael Wallace, Sto's Technical Consultant for Acoustics, said: "The system was initially installed in the ceiling of the foyer and was later added to a large dome structure in the same area, to further improve the acoustic performance."

Tony Partridge of Roskel Contracts Ltd, the suspended ceiling specialists who installed the StoSilent Distance system said: "It allowed us to achieve an attractive clean monolithic finish in the areas where this was required. It is a very light system, compared to more traditional systems, which makes it easy to work with."

StoSilent Distance allows the creation of large seamless areas of up to 200m², allowing architects and designers the freedom to incorporate sharp precise features, inclined planes and curved surfaces.



The StoSilent Distance A2 110 acoustic system installed at One New Ludgate

Pushing boundaries – Australian and Canadian acoustics companies unite to create unique opportunities

Making new friends in her exchange workplace – Aercoustics' Addie Denison in the Australian countryside

Australia's Marshall Day Acoustics and Canada's Aercoustics Engineering Ltd have more in common than being pioneers in the acoustics industry in their respective regions. They share a passion for innovation and creativity with an organisational culture that nurtures the growth of their young employees.

In the highly specialised and competitive industry of acoustical engineering, it is refreshing to see two firms come together to provide unparalleled opportunities for their team members.

Addie Denison from Aercoustics and Lachlan Deen from Marshall Day were the first participants in a collaborative global exchange programme. While Addie was enjoying a six-month placement at Marshall Day's Melbourne head office and relishing the Australian summer, Lachlan was immersed in Canada's winter wonderland, working at Aercoustics in Mississauga, just outside Toronto, during the same period.

Focus on what is important

For Lachlan, who has been with Marshall Day for seven years, his Canadian experience reinforced his philosophy on harmonising operations. When reflecting on his placement, he acknowledged that it showed him a way to focus on what was really important from a methodology and technical perspective. He plans to use these insights to synthesise work practices now that he is back at Marshall Day.

"I feel so fortunate that I was able to see if the grass really was greener on the other side, but in the best possible way, with the guaranteed safety of my position when I returned," said Lachlan. "Being able to share my technical knowledge with Aercoustics colleagues and look at their organisation as an insider was an invaluable experience and one that I will use to affect change and improvements at Marshall Day," he added.

Investing in employees

Addie has worked with Aercoustics since graduating four years ago. Like Lachlan, she too took in the similarities and differences that come with working half way around the world. "Offering an international exchange is a bold move and one that I was thrilled to take up," said Addie. "The fact that Aercoustics invested in me and my future speaks volumes for the way they feel about their staff and I know that Marshall Day shares that same dedication to progressing the careers of its team members."

The relationship between Marshall Day and Aercoustics began about five years ago, when key executives met at an international wind turbine conference. The initial employee exchange idea was sparked by an internal discussion at Aercoustics. President and CEO, Steve Titus, then went on the search to find a like-minded partner interested in an exchange programme. When an Aercoustics employee was looking for consulting work while on

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sabbatical in Australia in 2015, the company approached Marshall Day to discuss potential options.

The success of those initial interactions led Marshall Day's, Dan Griffin, to investigate introducing a more formal exchange of its employees. Dan's commitment to making the programme a reality may have stemmed from his own time spent living and working overseas, and he has been credited with driving the programme from its inception.

Professional development

Attracting and retaining talent is of paramount importance to both Aercoustics and Marshall Day, and the exchange programme is just one of the ways that these companies stand out in their commitment to provide their employees with the best possible opportunities for personal and professional development.

"Expanding our working relationships with international counterparts like Aercoustics, not only directly benefits our staff, it also widens our experience and the expertise we can provide to our clients," said Dan Griffin.

"Although this was a pilot programme, it has the potential to lead to more exchanges, both of people and ideas, in the future," he added.

Senior management at both firms were strong supporters of the exchange programme, recognising the long and short-term benefits to the employees involved, to the business and to the wider community. In addition to injecting new ideas and challenging the status quo, the programme continues to have wider advantages and flow-on effects that have enhanced internal systems and bolstered long-term relationships.

New ideas

"We encourage our employees to explore new ideas and experiences and an exchange program was a natural fit," said Steve Titus. "With Marshall Day Acoustics, we found a like-minded company that also believes that investing in their employees is the best way to deliver great work. The first employee exchange was very positive from both sides and we look forward to continuing the relationship," he added.

For Addie and Lachlan, the exchange was a big step in their career evolution.

Marshall Day Acoustics' Lachlan Deen taking in a different acoustic environment in Toronto

Working in a new environment was an opportunity for skill diversification, international networking, personal discovery and perhaps most importantly, social and cultural interactions that created memories to last a lifetime.

Aercoustics

Founded in 1974, Aercoustics is one of Canada's leading engineering firms with specialised capabilities in all aspects of acoustics, noise and vibration control. For more information visit **http://aercoustics.com**

Marshall Day Acoustics

Marshall Day Acoustics is one of the world's leading independent acoustic consulting firms, providing the highest standard of architectural and environmental acoustic services and theatre design. For more information visit **http://au.marshallday.com**

Brüel & Kjær Sound & Vibration and HBM to merge

Spectris plc (Spectris) (LSE: SXS), the instrumentation and controls company, has announced that Brüel & Kjær Sound & Vibration (BKSV) and HBM will be merging their activities from 1 January 2019. Both BKSV and HBM are operating companies within the test and measurement segment of Spectris. The new company will be named HBK (Hottinger, Brüel & Kjær).

BKSV and HBM have complementary expertise across the measurement chain, so by combining their respective strengths, they aim to create a business with the capabilities, breadth and scale to deliver customer value in propulsion, durability, safety, and noise, vibration and harshness for example.

A new management team will draw on the strengths and expertise from both BKSV and HBM. Merger preparation activities will be undertaken from now through to the end of 2018, and during this phase, the companies will operate in existing structures.

Eoghan O'Lionaird, Business Group Director responsible for the test and measurement segment, said: "By combining their activities, the two companies can deliver an integrated offering, combining sensors, data acquisition, preparation, evaluation and engineering services into one solution for its customers. This aligns with the Spectris strategy of focusing on the provision of complete solutions combining hardware, software and related services, and will enable us to provide a broader service offering and increased value to BKSV and HBM customers."

(L-R) Soren Holst President, BKSV and Andreas Hüllhorst, HBM CEO

VoCAS: Extending the possibilities for the evaluation of voice control systems

HEAD acoustics has launched a new version of VoCAS (Voice Control Analysis System), the software for evaluating voice control systems. It now supports the modular multi-channel labCORE technology, and offers manufacturers even more possibilities to test their Automatic Speech Recognition (ASR) systems in vehicles, mobile phones or smart speakers objectively and reproducibly.

Flexible channel selection for recording and playback

Now, VoCAS has an extended and flexible channel selection for recording and playback. This means that there is no longer a limitation to two channels. In addition, the audio configuration dialogue provides the user with visual feedback during calibration and mouth equalisation. The software allows an objective and quick quality evaluation of voice control systems under realistic and reproducible test conditions. VoCAS is a well suited software tool for benchmarking.

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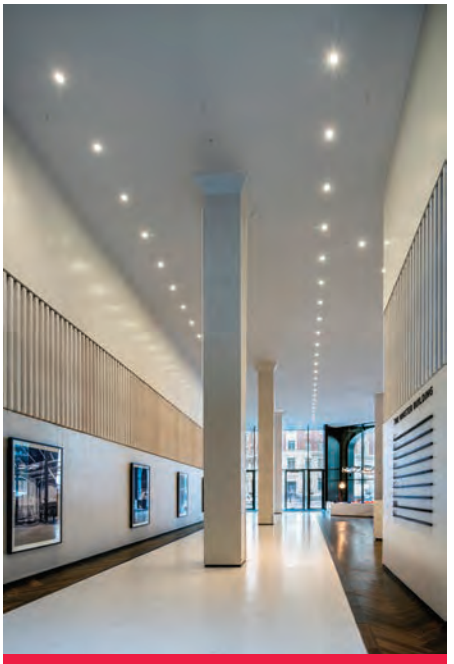
Optimising acoustics at the Minster Building

Armourcoat surface finishes have played a central role in the refurbishment of the Minster Building in London.

Measuring seven metres high and up to eight metres wide, the entrance boulevard has a polished floor of terrazzo with bronze inlays, edged by dark oak. Throughout the entrance and reception spaces, the walls are hand-finished in nearly 2,000m² of Armourcoat polished plaster and more than 600m² of the company's Acoustic Plaster System was applied to the ceilings.

Designed to optimise the acoustics of interior spaces, the Acoustic Plaster system offers a clean and smooth mineral surface that can be applied seamlessly over large expanses to both flat and curved surfaces. Comprising a special mineral wool composite panel that is bonded onto the substrate and finished with a seamless layer, the Armourcoat Acoustic Plaster System offers an elegant marble-based plaster finish while allowing sound energy to pass through the surface. The zero VOC system, which consists of 80% recycled material, achieves class '0' fire rating and a class 'A' Noise Reduction Coefficient rating.



Photography: ©Jonathan Banks

New software platform from Brüel & Kjær – BK Connect

BK Connect is the new software platform from Brüel & Kjær. It is a fully integrated, user-centric software solution for multi-channel data acquisition (with LAN-XI hardware), data processing, data management and reporting.

The BK Connect structure and concept are based on user-configurable workflows that provide users with exactly what they need, when they need it. This reduces the risk of error and the need for customer-specific development, while maintaining the full feature richness of a modern analysis platform.

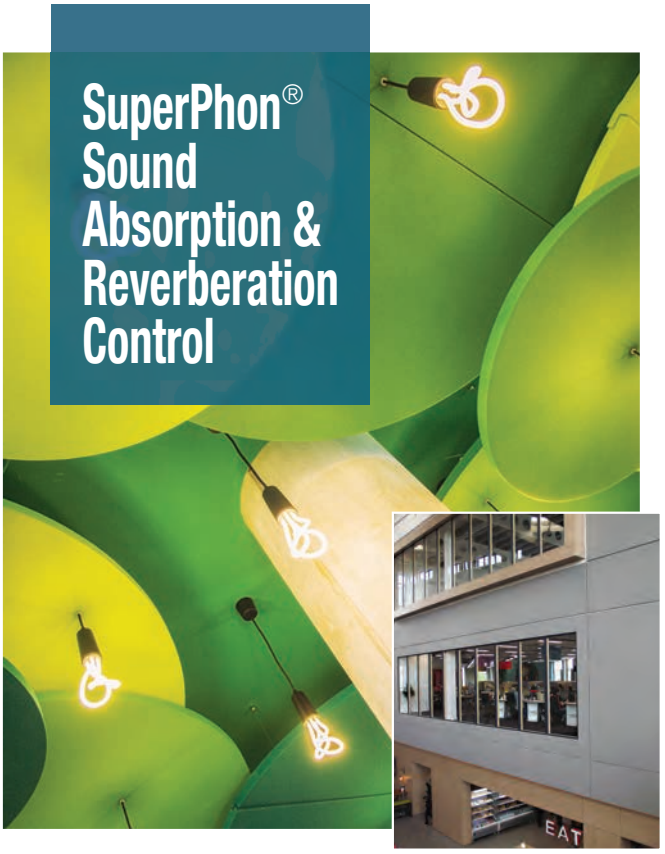
The BK Connect core applications are designed for general purpose sound and vibration engineering. Together, they provide a comprehensive set of tools for real-time measurement and data processing, with the flexibility to deal with a wide range of engineering scenarios from repetitive, standardised testing to complex troubleshooting investigations.

The BK Connect data concept is open, enabling full access to data regardless of its original format, from legacy LabShop data to third-party, universal and fine element model formats.

In addition, legacy LabShop functionality has been included to ensure that all existing capabilities are covered during the transition to BK Connect. The user interface is easily configured, so it can be adapted to the needs of different users within organisations, enabling operators or test engineers, specialists, managers and requesters to work together with maximum efficiency and productivity.

Each application is designed as a self-contained solution for a typical task (or set of tasks) within a more detailed test and analysis workflow. Users can then select the module or modules that will help them perform the task or combine applications to increase functionality and create tailored workflows for quick, easy completion of multiple steps in a sound and vibration test process.

For more information visit: **www.bksv.com/bkconnect**



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Armstrong's new ceilings and walls guide

Armstrong's new Main Line Brochure makes it easy for architects and designers to specify ceiling and wall solutions thanks to a simple but inspiring layout.

With architectural photography and technical drawings, the new catalogue illustrates interior solutions that help to enhance comfort, save time, improve building efficiency and overall performance, and create beautiful spaces for office, education, health, retail and transport applications.

The brochure guides specifiers through the myriad of design solutions available, from floating ceilings and suspension systems (including perimeter detailing and accessories), through materials such as mineral, metal, mesh and wood, to wall and special solutions for acoustic, healthcare and highly humid applications.

A product selector by performance helps specifiers to select the right systems for acoustics, light reflectance, fire reaction, humidity and recycled content, with Armstrong's pioneering recycling programmes and best in class 'cradle to cradle' credentials featuring in their own section of infographics.

Download the catalogue at **https://www.armstrongceilings.com/commercial/en-gb/commercial-ceilings-walls/product-catalogue.html#catViewer.**

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

StoSilent Direct calms London architectural practice

Over 200m² of the StoSilent Direct acoustic system from Sto has been installed in the offices of an architectural practice in London. It was specified for a number of reasons, including its acoustic performance, ease of installation and attractive aesthetic appearance.

The Hesselbrand architectural practice is located in a refurbished warehouse building, which it shares with a visual art installations gallery, and this prompted the need for reliable and effective acoustic design. "The building has brick walls, polished concrete floors and large picture windows," explains Hesselbrand's Patrick Morris. "During the refurbishment we wanted to create a modern, clean, minimalist, open-plan working area and the products in their natural form fitted with the final aesthetic. However, they have little or no acoustic value with regards to attenuation, reverberation and other considerations like foot traffic and speech clarity, so achieving the overall acoustic design and balance was a major consideration."

The StoSilent Direct acoustic system has been installed in the offices of an architectural practice in London

The Hesselbrand practice specified the StoSilent Direct system after discussions with Mike Wallace, Sto's Technical Consultant for Acoustics and this system can be applied directly onto walls and ceilings. "This was an especially important feature as it allowed the StoSilent Direct system to be applied without the need to drill the existing ceiling or install a mounting framework, which would reduce the internal dimensions of the space," added Patrick. The system features a porous texture and sandwich structure, which provides excellent sound absorption characteristics and it is finished in StoSilent Décor M. This fine-stipple finish is spray-applied and can be tinted to match a wide range of colours, a benefit to both the installer and main contractor as there is no mixing or tinting on site.

Patrick said: "The original ceiling was in less than perfect condition so being able to apply the StoSilent Direct system directly onto it allowed us to cover the original and create a fresh new appearance.

"The acoustic balance we achieved is very noticeable, making the space more comfortable to be in. Speech clarity is also improved, so communication is complimented and a much more relaxed atmosphere has been achieved."

The StoSilent Direct system uses composite mineral fibre boards with a pre-applied, textured surface. These are bonded directly to the substrate and their pre-chamfered joints can be left as is or filled, prior to applying one of the StoSilent textured finishes. Seamless surfaces up to 700 m² can be created without the need for a break in the system, as well as raked ceilings down to a radius of 6m.

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- peace of mind knowing the measurements are progressing well;
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- smart decision-making, "do we have sufficient data or shall we extend the monitoring"; and
- compilation of the client report even before the equipment has been collected from site.

Complete remote access and control of your measurement improves the success rate of unattended noise surveys, while reducing the lead time from measurement to client report.

For further information please contact NTi Audio at **UK@nti-audio.com**

Noise experts announce transatlantic partnership

A UK acoustic company has announced a three-year transatlantic partnership, which will see their acoustic barriers become available across North and Central America.

Echo Barrier, based in Bury St Edmunds, Suffolk, has signed a deal with Multiquip, a manufacturer and supplier of industrial products and solutions that will allow wider distribution of their acoustic products across the United States, Canada and Mexico by the end of the year.

Torsten Erbel, Senior Director of Multiquip Construction Equipment Group, said: "Our partnership with Echo Barrier reflects both companies' commitment to better daily life and the environment we have to work in – or be affected by, while providing products in the field of portable noise mitigation."

(L-R) Torsten Erbel of Multiquip and Gregg Murfin of Echo Barrier USA (Image courtesy of Echo Barrier US)

Echo Barrier launched its first noise reduction barrier in 2010 to help construction, rail, events companies and Local Authorities reduce the impact of works noise on local communities.

Commenting on the partnership, Gregg Murfin, Head of Corporate Business Development at Echo Barrier USA, said: "By joining forces with Multiquip, we ensure noise mitigation solutions are widely available and that we are better servicing clients."

Echo Barrier's acoustic barriers are used by some of the world's biggest built environment companies and have been credited with reducing building noise at the likes of the World Trade Centre in New York and on the London Underground.

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

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Committee meetings 2018

DAY	DATE	TIME	MEETING
Tuesday	26 June	10.30	ASBA (Edinburgh)
Tuesday	3 July	10.30	CCENM Examiners
Tuesday11	3 July	1.30	CCENM Committee
Tuesday	3 July	10.30	CCBAM
Thursday	5 July	11.00	Meetings
Thursday	9 August	10.30	Membership
Wednesday	14 August	10.30	Executive
Thursday	20 August	10.30	Diploma Moderators Meeting
Wednesday	26 September	10.30	Council
Thursday	11 October	11.00	Meetings
Thursday	18 October	11.00	Publications
Thursday	1 November	10.30	Membership
Thursday	15 November	10.30	Research Co-ordination (London)
Tuesday	20 November	10.30	CCWPNA Examiners
Tuesday	20 November	1.30	CCWPNA Committee
Wednesday	21 November	10.30	Diploma Tutors and Examiners
Wednesday	21 November	1.30	Education
Thursday	22 November	10.30	CCENM Examiners
Thursday	22 November	1.30	CCENM Committee
Thursday	22 November	10.30	CCBAM Examiners
Tuesday	27 November	10.30	ASBA Examiners (Edinburgh)
Tuesday	27 November	1.30	ASBA Committee (Edinburgh)
Wednesday	28 November	10.30	Executive
Wednesday	12 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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