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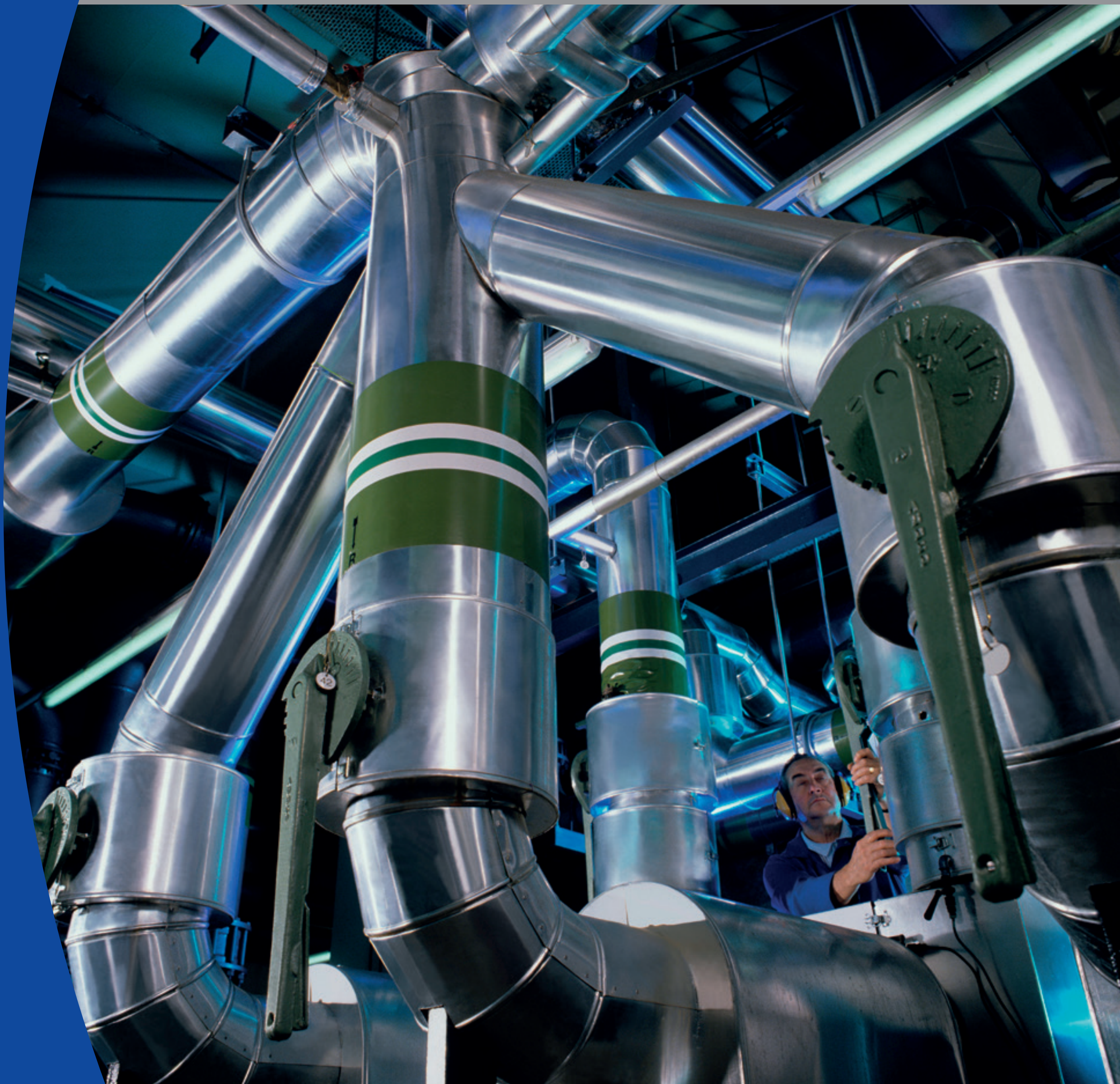
ACOUSTICS BULLETIN



in this issue... **Revision of the CIBSE Guides – An acoustician's view of the evolution**

plus... **Crossrail – how do you solve a problem like TCR?**

Consultants vie for honours in ANC annual excellence awards

One-third of Europe's countryside 'affected by noise pollution'

Institute of **Acoustics**

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Front cover photograph: An air conditioning and boiler plant room for a large office

Institute of Acoustics

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

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

Conference programme 2016

6 October
Organised by the
Measurement and
Instrumentation Group
When shall we three measure again – in thunder, lightning or rain
Moreton-in-Marsh

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

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

~

Upcoming meetings in
October / November
in *London* –
dates and locations
to be announced later

Organised by the
Parliamentary Liaison Group
Government noise policy and Brexit

Organised by the
Environmental Noise Group
Defra research projects

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

Dear Members

This first letter as incoming President gives me the chance to thank William sincerely for leading the Institute with such certainty and purpose for the last two years, and also to express my gratitude to Bridget and members of our Council for welcoming me and showing me the ropes. Barry Gibbs, our incoming President-Elect, can be assured of the same support as was generously offered to me.

The most recent Council meeting saw several of our longest serving members come to the end of their term. Our thanks go to them for all their years of service to the Institute, and for sharing their experience with such patience and good humour. This year the Institute will be recognising Geoff Kerry's huge contribution with the award of a new IOA medal – the Geoff Kerry Distinguished Service Medal which will be presented to him next month at Acoustics 2016.

Deadlines dictate that this letter be written before the results of the Council elections are known, but September will bring new members to Council. I'm looking forward to working with them, and must say a big thank you to all members who voted and, of course, those who stood in the Council elections – we had an excellent slate of candidates. To our unsuccessful candidate, well done for standing, and I urge you to put your name forward again in future elections.

One of my aims will be to encourage more members to get involved in the work of the Institute and the campaigns we support. We are volunteer-led, so we rely on our membership to provide energy and direction to the IOA, and to decide how best we can fulfil our charitable aims. Please email me at president@ioa.org.uk with ideas, comments or queries on any aspects of the Institute.

The outcome of the EU referendum brings both uncertainty and opportunity for our profession. Uncertainty regarding what may happen with legislation and how research will be funded, opportunity to be more nimble in our approach to prediction and assessment than may have seemed possible within the EU. The UK is a major player in acoustics and we are well-equipped to determine our own approach and methods, while continuing to meet international standards to preserve markets for our products. The Institute intends to take measured steps to support robust policy, legislation and regulation in the coming months and years. We'll soon be holding a workshop to pool our knowledge on the influence of the EU on acoustics in the UK; this will be the starting point for an exciting journey whose destination we may influence but can't predict.

UK universities are at the forefront of international acoustics research. I believe that as an Institute we should do everything within our power to negotiate for continued funding, and maintain opportunities for international collaboration. We can't afford to be inward-looking, and maintaining European-wide research connections will be a major challenge. I encourage universities to let the Institute know what it could do to assist, while urging companies to engage with universities and lend their support.

August saw the publication of *A Method for Rating Amplitude Modulation in Wind Turbine Noise*, the culmination of a significant amount of volunteers' work, and described on page six in this Bulletin. We hope this report will encourage a consistent approach to identifying and quantifying AM, and enable a body of comparable evidence to be gathered, permitting robust assessment and planning decisions in what has been a contentious area.

Becoming President is a huge privilege but admittedly a rather daunting one. However, I take much confidence from knowing we have an excellent team of staff at head office who ensure the mechanism of our Institute runs smoothly, and a group of volunteers whose collective knowledge and enthusiasm continue to move the Institute forward. It'll be an honour to work with you all in what I'm sure will be another exciting year for the Institute.

Jo Webb, President

New Institute President will champion education and professional development

Education and member professional development are two of the top priorities for new Institute President Jo Webb. "The IOA's current project to develop an online learning platform for students and members is very important to me, and something that I will be helping to drive forward," she said.

"We have built a solid foundation in formal education and established good relationships with higher education providers over the years. The challenge we now face is to build on what we have achieved and to see how we can assist members further with their professional development, complementing formal education with career-orientated material.

"Recruiting an IT specialist to project-manage the commissioning, integration and population of the learning platform will be vital in enhancing our CPD offering.

"I will also be encouraging the Research Co-ordination Committee in its aim of promoting acoustics research in the UK, at a time when the organisation of research councils is changing and funding streams are in doubt. For British industry to benefit from this research and be able to translate ideas into innovative products, bridges need to be built between researchers and industrial developers. Here the IOA could have a key role in facilitating such collaboration."

Still on the subject of education, Jo wants the Institute to explore how the content of evening branch meetings could be made available digitally to members who find difficulty in attending, although she is keen not to dilute the important social and networking element of the meetings.

Jo, who has taken over the presidency from William Egan at the end of his two-year stint, is an Associate with Arup in Manchester. On leaving Clevedon Comprehensive School she gained a BSc in electroacoustics at the University of Salford, from where she later obtained an acoustics MSc. A Chartered Engineer, she is also a member of the IET and AES.

She has been with Arup for 16 years but her career has seen her mix public with private sector work. Now managing teams working on large infrastructure, environmental and building projects, her special interests are railway noise and vibration, along with devising acoustic solutions in the refurbishment of historic buildings.

Another – and unexpected – priority for the IOA will be to ensure that the UK's acoustic environment is not negatively affected by the 'hand grenade' of the EU referendum vote.

"This means positively engaging with Government to ensure that the acoustic environment is still protected once EU directives are no longer driving legislation in force in the UK. We will also be supporting the work of CaSE (the Campaign for Science and Engineering) and the Royal Academy of Engineering in this area."

A further aim is to establish closer links with the Association of Noise Consultants. "Because many of our members' companies belong to the ANC, I would like to see us working in tandem in order to provide the best service for both," she said. "By co-ordinating our activities we could make better use of volunteers' time and so avoid duplication. Co-operation and collaboration are the way forward."

Jo Webb

Factfile

Born: Bristol, January 1965
Lives: Manchester
Personal: Partner Bernard is a vet
Likes: Travel, walking, cycling, particularly in the Lake District

Jo, who is a diversity "champion" at Arup, would also like to encourage greater diversity within the Institute membership, in particular in relation to gender, although she is pleased by the high proportion of women serving on committees relative to their overall numbers.

"It does seem to me that it's a question for the engineering profession as a whole, not specifically for acoustics. One approach is therefore to encourage more members to become STEM ambassadors and get the message out to schools that engineers can come in all shapes and sizes."

IOA publishes measurement guide for AM in wind turbine noise

The Institute of Acoustics has published its preferred method of measuring and rating amplitude modulation (AM) in wind turbine noise.

Known as the Reference Method, it is essentially a development of the Hybrid Reconstruction Method that was described in a discussion document published by the Institute's Amplitude Modulation Working Group (AMWG) in April 2015.

The recommendation is contained in the working group's final report, which follows a large-scale public consultation exercise that began with the publication of the discussion document.

The document explains how the metric has been derived, and how it is to be technically implemented to derive a value for the level of AM in a wind farm noise signal.

The Institute will be writing to the Department of Business, Energy and Industrial Strategy to inform it of the IOA metric publication, with a view to encouraging its use in planning conditions designed to control AM.

The AMWG has not addressed the question of what level of AM in wind turbine noise (when measured by a specific metric) may be appropriate. Establishing and setting appropriate levels of AM were outside of the scope of this study, but the proposed metric is intended to assist with further research.

Gavin Irvine, AMWG chairman, said: “The publication of this final report marks an important milestone for the IOA, as we are releasing details of what we believe to be the ideal metric for wind turbine generated amplitude modulation (AM) noise for the very first time. This metric has been extensively tested on real, measured data, from wind farms and elsewhere, and the code is being provided so that all stakeholders involved in controlling noise from wind turbines can understand how the methodology works and evaluate their own data. This should ensure a level playing field in the area of AM, and has the potential to ensure that such noise is better controlled by wind farm operators.”

The report and the consultation responses to the discussion document are available for viewing/downloading in the publications section of the Institute’s website by going to **http://ioa.org.uk/publications/wind-turbine-noise** . The code is available at **https://sourceforge.net/projects/ioa-am-code/**

Current developments in musical acoustics

By Mike Wright

The fourth consecutive annual one-day meeting of the Musical Acoustics Group (MAG) was held at London South Bank University in July. The meeting, billed as *Current developments in musical acoustics*, was possibly the group’s most diverse for many years. The setting for this meeting attended by around 30 members was ideal and, unlike last year’s meeting, it was not disrupted by Tube strikes. There were technical papers covering the understanding of acoustics of various instruments and possible ways to enhance sound. For those interested in improving outdoor music events, an innovative and sustainable design of acoustic shell was illustrated. We had a discussion on organ design and a reminder of the work of Sabine’s work and a total reappraisal and new developments based on 19th century piano design.

Kurjin Buys, no stranger to MAG meetings, described ways to improve the stability of a hybrid wind instrument using two microphones. Single reed instruments (such as a clarinet) are unstable nonlinear physical systems. They work by converting the wind force by the player on to the reed which sets up an oscillatory sound wave. The possibilities that could be realised mean that performers would be able to be in better control of a wide variety of timbres but at the same time, retain the acoustical qualities and fingering techniques. His paper was the product of a collaboration with Robin Laney and it highlighted the innovative work being undertaken at the Acoustics Research Group in the Open University’s Mathematics, Computing and Technology Faculty headed by Professor David Sharp, MAG secretary.

Professor Mike Hutley worked for the National Physical Laboratory and pioneered and developed "coherent photofabrication" generated at the intersection of coherent wave fronts from a laser. Now retired he has turned his attention an important aspect of musical acoustics, and at this meeting described his empirical study of how a three-hole pipe generates a musical scale by using the overtones of the air column. He went on to describe how the speed of air jet from the mouth piece appears to be the dominant factor in determining the note. By expressing airspeed in terms of the number of times the jet covers the gap in each cycle of oscillation, he found that the pitch of the note varies with the size of the gap.

Before lunch, Charlotte Desvages, who is researching physical modelling sound synthesis, violin acoustics and musical acoustics at the Acoustics and Audio Group as a graduate student from the University of Edinburgh, graphically presented her work in progress *Two-polarisation finite difference model of bowed strings with nonlinear contact and friction forces*. Using simulated sound and video examples of plucked, bowed and stopped strings along with varying playing techniques, she demonstrated effects.

After lunch, Alan J Taylor from the Acoustics Research Centre at the University of Salford asked the delegates the question “which is the best stop on the organ” and “what gives the organ its telling sound”. Quite a variety of answers emerged (with no agreement), demonstrating that there were quite a few acoustician / organists around! He cited the Atlantic City organ in America with 815 stops and 33,112 pipes and then the “modest” British-made Willis organ in Liverpool Anglican Cathedral with a mere 145 stops and just 10,268 pipes! A brief rundown of the notes you get with open and closed pipes, the various tones possible with wide (flute tone) narrow (string-like tone) and reed pipes followed. His presentation went on to demonstrate Sabine’s apparatus and, using “old school” measurement, to determine the reverberation time of the meeting room. Just like Sabine’s kit, it comprised a rather accurate timer, a battery operating an electro-pneumatic valve on an organ pipe blown by air from an air reservoir. Some quite credible results emerged! He took time during the break and after the meeting to explain more.

P8

Kurjin Buys (left) and Mike Wright

◀ P7

Serafino Di Rosario from Buro Happold Engineering, who has recently gained the Peter Lord award, has expressed an interest in the MAG for some time now. He presented an update from the paper previously given at the IOA 40th Anniversary Conference. He described ReS, (Resonant String Shell) a sustainable hand-built temporary acoustic shell created for chamber music performances in the open air. These are made out of mostly recycled chipboard featuring mechanical reversible joints between the parts and the structure. He discussed the latest improvements based upon calculations up to the 3rd order reflection and using proprietary ray tracing algorithms.

We then moved on to the subject of vocology, "the science and practice of vocal habilitation" and effectively issued a health and safety warning to acousticians that "the voice is a precious commodity which cannot be replaced when worn out or damaged". Gizem Okten and Stephen Dance from London South Bank examined the effects of room acoustics on the vocal loading of opera singers. Vocal loading is the stress inflicted on the speech organs when speaking or singing for long periods. Unlike other musical instruments, they cannot easily be repaired when worn out.

Wolf Leye, a pianist and organist and product manager of Chris Maene Instruments in West Flanders, discussed a new straight strung concert grand piano. The presentation described the differences between the keyboard instrument builders in the 19th century and the effects of the evolution in piano design, from the fortepiano of the classical period to the modern concert grand pianoforte as exemplified by Steinway and others. He then went on to explain the differences in construction between straight and cross-strung instruments and the subtle acoustic differences that result. His case study drew upon the collaboration with Daniel Barenboim in the evolution of the Chris Maene Concert Grand Piano. This involved changes to the frame and case construction along with splitting the bridge and sound board including its direction of the wood grain.

During the lunch break, the AGM was held and the committee will remain as before apart from Owen Woods, who has had to stand down due to work pressure. An expression of appreciation was given for his work undertaken last September for the joint IOA/ Galpin Society conference. Mike Wright (Chairman) emphasised some concerns that a newsletter needed to be revitalised after being dormant. He felt it was an important item to help to convince the wider acoustics community that MAG wasn't just a "hobbyist" group. However, the group now needs a new editor to take the helm.


Alan J Taylor

Gizem Okten

It's 'doctor's orders' again for young members at inter-professional bingo

By Angela Lamacraft and Adam Mayall

After the resounding success of London's inaugural Inter Institution Networking Event last year, the event returned in July this year to Baden Powell House, South Kensington.

Building on the success of the 2015 event, more than 80 engineers and architects from the IOA, Institution of Mechanical Engineers, Landscape Institute, Chartered Institution of Building Services Engineers Young Engineers Network and – new for this year – Royal Institute of British Architects and Forum for Tomorrow congregated for an evening of casual networking and chat with like-minded individuals.

The aim, as last year, was to encourage young members to meet new peers and learn about other professions in a casual environment.

The event began with attendees invited to participate in "networking bingo", i.e. seek out as many individuals as possible that fit the descriptions on the bingo card (such as "Find someone who.... has worked in Asia/is Chartered/speaks a foreign language"). This wasn't just an activity to break the ice: prizes were at stake!

With that in mind, the next 90 minutes were a hive of meet-and-greets between the attendees from a range of backgrounds: students, graduates at multinational companies, Chartered engineers, and budding entrepreneurs, all whilst being accompanied by complimentary food and drink. A five-minute-to-go announcement prompted a frantic flurry of last minute networking. With the bingo completed there was one task left to do: award the prizes. That marked the official conclusion of the event, though attendees were welcome to stay at their leisure.

As well as a good night out, it is hoped that the event enabled young professionals to become more familiar with other P10 ▶

◀ P8

technical aspects of projects they are working. Greater familiarity of associated technical fields may also help to provide a more sustainable design and can help young members in particular feel more comfortable in a room of their peers.

Plans are already under way to get more Institutions to participate in the 2017 networking event, so watch this space!

The IOA Young Members' Group would like to thank Adam Mayall of the IMechE, Vinesh Pomal from RIBA, Alex Logan from the CIBSE YEN, Ali Cairncross from the FFT and Tristram Bushby from the Landscape Institute in helping to organise and run the event.

Networking at the event

Sixty nine more applications for membership approved by Council

Sixty nine applications for membership were approved by Council at its June meeting following the recommendations of the Membership Committee. Of the total, 50 were new applications and reinstatements, the remainder upgrades.

MIOA

Matthew Brown	Paul Kendrick	Philip Robinson
Alberta Congeduti	Daniel Kinsman	Ricardo Sanles
Richard Earis	Achim Klein	Adam Scott
Prashant Fernandes	Francis Kneller	Graham Shaw
Trevor Ford	Sandeep Manilal	Gennaro Sica
Gary Hall	Duncan Martin	Matthew Spandl
Yiying Hao	Andrew Morgan	Timothy Tanzer
Jonathan Hargreaves	Edward Morgan	Tony Trup
Maria Heckl	Ruairi O'Duill	Jake Ward
Chris Jones	Andrew Pagett	Jiannan Yang
Jemma Jones	Andrew Peplow	

AMIOA

Emilie Carayol	Nicholas Dobbs	Colin Gummer
Christy Carr	James Gill	Lewis Hart
John Carrington	Matthew Gray	Will Kerr

AMIOA *cont.*

Tamasine Leighton-Crawford	Andrew Staines	Lander Yaben
Sam Message	Andrew Thomas	Chris Youdale
Andrea Muciaccia	Joseph Tony	Lawrence Yule
Rhodri Owen	Ramon Trigueros	Sharon Yung
Beth Paxton	Matthew Waring	Toby Zorn
Maro Puljizevic	Jake Willcocks	

Technician

James Allen	Mark Pickering	Shanti Wisniewska
Gareth Henderson	Leo Williams	

Affiliate

Thomas Farmer	Roger Schwenke
Morgan Long	Sarah Waudby
Philip Moss	

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More than 100 successful candidates in spring short courses

By Keith Attenborough, Education Manager

In spring 2016 there were 64 candidates (including four resits) at seven centres for the Certificate of Competence in Environmental Noise Measurement (CCENM), of whom 57 passed. The University of Ulster have been re-accredited to offer CCENM in addition to the currently active centres.

All 19 candidates at the two centres for the Certificate of Competence in Workplace Noise Risk Assessment (CCWPNRA) were successful. An agreement between the IOA and the British Occupational Hygiene Society (BOHS) in respect of mutual recognition of courses for membership purposes has been finalised. Andy Nicholls has stepped down as examiner shortly after succeeding Tim Ward so, again, we are seeking a new examiner. Also we still seek a successor for the current chairman of the management committee (Dave Lewis). Expressions of interest should be sent to education@ioa.org.uk.

The second delivery by Southampton Solent of the Irish version of the Building Acoustics measurement certificate course (CCIBAM) took place in April 2016 with seven candidates, all of whom passed. However plans for handing over the delivery of the course to AWN (Dublin) have been shelved for the time being. Fifteen candidates took CCBAM at Southampton Solent University including three resits and all passed.

The Certificate of Proficiency in Antisocial Behaviour etc. (Scotland) Act 2004 Noise Measurements (ASBA) was delivered in May 2016 by Strathclyde University with a total of 16 candidates (including two resits from Bel Noise courses). Only seven passed, an unusually low proportion, but five did not sit the written examination.

Antisocial Behaviour Act 2004 Noise Measurements

Bel Noise Courses		
McBride M V		
University of Strathclyde		
Davidson K	McAuley C	Sanderson J
Derrick A	Prescott M	Smith C

Building Acoustics Measurements

Southampton Solent University		
Agha F	Hooper-Jones A R	Message S
Ahmed Z	Johnson B S	Monk S J
Blaikie S J	Karpouzas G	Mungall H A
Cheshire P	King S P	Stec T
Hilsdon D T	Kukadiya A K	Vaughan N D
Southampton Solent University (Ireland)		
Clifford B	Loughran P	Quinn P
Coyle S	Murtagh P	
Donoghue C	O'Toole J	

Environmental Noise Assessment

Bel Noise Courses		
Groom S J	McFadyen L A	Stauber J H
Keaney E	Price C J	
Colchester Institute		
Austin H S	Egbuonu A E	Reilly D
Barkley E	Farmer T D	Roberts M
Brodie R P C	Feltham J	Smith D S
Brown A J	Gardiner M J	Van Oirschot R
Brown E	Lloyd J M	
Deering T	Onuoha G	
University of Derby		
Barker K A	Edwards L R	Metcalfe G
Berry K	Hassan J E	Rogerson M
Leeds Beckett University		
Booth A C	Hall G	Smith N E
Clark L F	Jenkins R	Tunstall M S
Denton P J	Shiers E A	

Environmental Noise Assessment *cont.*

Liverpool University		
Cusiter J	O'Hara S K J	Taylor A
Frankcom M R	Peters J	Youdale C M C
Jansson-Peremans M F	Pugh R	
Shorcontrol Safety		
Delargy G A	Holden S A	Kirk G
Hassard M	Holly L Y	McCarron A
Southampton Solent University		
Cartwright J T	Message S	Whittle A J
Evans P J	Moule D A	
Harper B	Tucker J C S	
University of Strathclyde		
Gilroy A J P		

Workplace Noise Risk Assessment

University of Derby		
Berry D	Fitzsimmons L	Thorn A
Brown A J	Hamer M S	Wonnacott J P
Chindripu A P	Howell J M	
Coote S G	O'Hare B	
EEF Sheffield		
Bond G L	Johnstone A	Schaeferbarthold M J
Denison M	Mee A D	Taylor D R
Hastings C	Morris T A	Walker M G

Hand Arm Vibration

EEF Sheffield		
Hanley I	Hastings C	Lewis S E
Leeds Beckett University		
John R		
Institute of Naval Medicine		
Blackall G	Scott M E R	Thomson K
Flanagan R	Storrs W	Tudor L
Jenkins R		

The Gerry McCullagh lecture: Developing new environmental noise guidance – noise impacts and constraints

Irish Branch report

By Chris Jordan

In recognition of the contribution that Dr Gerry McCullagh made to the promotion and education of acoustics throughout Northern Ireland and the Republic of Ireland, the Irish Branch holds an annual lecture to which an industry expert is invited to talk on his or her area of expertise. The 2016 lecture, the tenth, titled *Developing new environmental noise guidance – noise impacts and constraints*, was presented by Graham Parry from ACCON UK. Graham, as joint author of the IEMA *Guidelines for environmental noise impact assessment* as well as the co-author of the recently consulted *Professional Practice Guidance on Planning and Noise* (ProPG), was well qualified to speak authoritatively on the subject.

Graham opened the well-attended meeting with anonymised arguments with respect to a proposed new road scheme where one consultant argued that the increase in road traffic noise was significant whilst another argued that the increase in the ambient noise levels was insignificant. Different assessment directions will result in different conclusions and this epitomised the need for guidance.

Graham continued with an overview of the arduous journey the IEMA guidelines took before finally being published, before clarifying that guidance was guidance and hence was not required to be strictly adhered to, but any detours needed to be justified. The IEMA guidelines are noise focused but vibration is also applicable. They also only apply to humans!

He said to consider only change in noise levels in isolation was not appropriate, but absolute levels and context could be equally important. The important question was: What is the effect of the change in noise level? This led to discussion around cause and effect relationships with focus on sleep disturbance, cardiovascular effects and cognitive impairment to school children etc, with reference to HS2 and other transport examples.

A good impact assessment must be transparent, focused, practical, participative and credible, he said.

Baseline studies also needed to be well thought out. Times of year, weather conditions, days of week, time of day could all vary the baseline with variability highlighted in any assessments.

In predicting impacts source characterisation was key, he said. Giving the example of a proposed AD plant with 10 trucks in the morning but none the rest of the day, he said it was not acceptable to average this noise impact across the whole day.

Graham moved onto ProPG, highlighting the need for the guidance following the withdrawal of PPG24. The IOA intended to be at the forefront of future guidance, he said, and wished to expand the range of professional practice guidance. ProPG tried to promote sustainable development, improve certainty to applicants and decision makers and stimulate good acoustic design. Consultation comments were still being reviewed.

Comments from the floor highlighted the pressure from developers simply to improve the insulation properties of the building fabric, as it was often too late to redesign the whole site when consultants were engaged. Graham highlighted the need for good acoustic design and that the Planning Inspectorate Noise Handbook would be making reference to the Pro PG, reinforcing its credibility.

Graham was thanked for his informative presentation and presented with a framed certificate.

Graham Parry (right) receives a framed certificate from Martin Lester, Branch Chairman

North West Branch reports

Forensic analysis of speech and sound

By Hannah Jones

In April the branch enjoyed a presentation given by Dr Philip Harrison MIOA of I P French Associates on the forensic analysis of speech and audio. During the talk Philip gave an insight into the process behind the enhancement, transcription, authentication and analysis of audio recordings in criminal cases.

Philip started the presentation by giving a summary of the main sources of audio recordings and types of crimes which analysis may be required. The core of the presentation was on the process of speaker comparison. During which the phonetic similarities and differences are analysed through auditory and acoustic examinations. Philip further demonstrated the principles of speaker comparison with the use of example audio recordings. However it was explained that there are limitations with this method. A voice is not unique so the results of such analysis is an interpretation of findings and therefore should not be the only evidence used in criminal cases. Also, samples of the same speaker will always differ due to natural variations in people's speech.

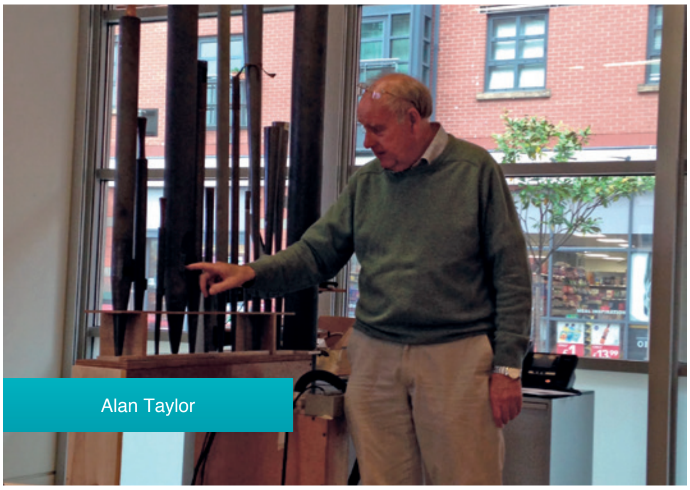
Philip then went on to discuss developments which have been made in the field of speaker comparison analysis and talked in greater detail about the use of automatic systems.

Another important consideration is the authentication of the audio recordings upon which the forensic analysis is based. Philip gave a brief summary of authenticity analysis techniques used and again further demonstrated the use of such techniques through example audio recordings, including the use of Electric Network Frequency (ENF) information.

In summary, this was a well-attended and really insightful presentation into the forensic analysis of speech and sound. We are grateful to Philip for sparing his time to travel some distance and talk to the branch.

The best stop on the organ

By Dave Logan



Alan Taylor

It is not often that the ceiling height of the meeting room becomes an issue, but fortunately no holes were required in the ceiling of BDP Manchester in May, when Alan Taylor gave a very interesting and interactive presentation.

Alan commenced by describing the construction and layout of a pipe organ, and the many factors that determine the tone or timbre of the pipes. A number of waveform plots were shown, where a simple flute design showed few harmonics and a dominant fundamental, while a reed design could contain many more significant harmonics, where the fundamental was not the largest in amplitude. This was illustrated by hearing a selection of pipes which Alan had brought with him, the largest being an 8ft open pipe.

Alan then moved on to describe how in 1895, as a young assistant physics professor, Wallace Clement Sabine was tasked with resolving the problem of the terrible acoustics of the lecture theatre of the Fogg Art Museum. In Sabine's words "*...the rate of absorption was so small that a word spoken in an ordinary tone of voice was audible for five and a half seconds afterwards*".

For his investigations Sabine needed a portable reliable sound source and used a one foot Gemshorn organ pipe fed from an air reservoir with an electro-pneumatic valve that stopped and started the sound source. A chronograph was used to determine the duration of audible sound after the pipe was not sounding.

For several years Sabine and his assistants moved cushions overnight into the lecture theatre from the adjoining Sanders Theatre and made thousands of careful measurements, using different numbers of cushions, different types and different layouts. All cushions had to be returned by morning. Because of his meticulous experimentation and ability to interpret data he was able to derive the empirical relationship that bears his name and is still used today. Many other experiments of this type continued, some with multiple pipes, and allowed the acoustic behaviour of a space to be predicted, so laying the foundation for architectural acoustics.

Alan went on to suggest that all should read the book *Collected Papers on Acoustics* by Sabine which was published after his death and is freely available on the Internet. Those who need to make measurements at low sound levels might be comforted to note that even in 1895 Sabine had numerous interruptions from distant road and rail traffic, although the chirping of crickets might be encountered less often today.

The evening finished with a hands-on session (literally) where the various pipes on display on display could be sounded, tuned, or just be admired for their argentine lustre.

Midlands Branch – the first six months of the year

By Chris Humphreys, Fiona Rogerson and Fiona Devine

Sound design for our sound environment: the science, art and industrial application of auralisation research

In January, Dr Damian Murphy, reader in audio and music technology at the University of York, gave a fascinating presentation on *Sound design for our sound environment: the science, art and industrial application of auralisation research*.

Hosted at the marvellous University of Derby, Damian introduced auralisation as the audio equivalent of visualisation; discussing how it enables us to audition virtual acoustic environments that have existed in the past, that are about to be built, or that are purely fictional. Damian examined how it can be used as a key part of the modern architectural and environmental engineering design process. The techniques used enable proposed buildings and spaces, from concert halls and classrooms, to major interventions in the landscape and countryside that surrounds us, to be auditioned and tested for the acoustic impact such developments may have on our day-to-day lives. This was demonstrated with an excellent array of slides that complemented the presentation providing both acoustic and visual interaction.

Damian discussed the challenges in modelling and simulation and how the quality of the user experience is affected by the research.

Thank you to Damian for giving the presentation and to the University of Derby for hosting the event.

Dealing with the "new whiplash": protecting yourself against the epidemic of occupational noise-induced hearing loss claims

The February evening meeting was held in the recently refurbished, Sir Frank Gibbs Building at Loughborough University.

The venue provided a comfortable setting for an entertaining presentation by Dr Sarah Haynes on *Dealing with the "new whiplash": protecting yourself against the epidemic of occupational noise-induced hearing loss claims*.

Sarah, of RHMA Forensic Expert and Witness Service, is an expert witness and former HSE Specialist Noise and Vibration Inspector.

She provided a background to noise-induced hearing loss, what the issues are, the statistics to the claims, the escalating number of claims and where these are now coming from. Sarah discussed her role as an expert witness to help the court on specialist and technical matters. Sarah talked through the stages of a claim and the evidence needed by the claimants to prove a case; drawing on her experience to give interesting and informative illustrations.

The presentation then focussed on the common oversight by employers and employees, whether out of negligence or sheer ignorance, to ensure robust noise control and management is in place, properly utilised and recorded. Sarah discussed what could be done to better manage the noise in future and provide good coherent evidence in the event of a claim being made.

The presentation stimulated a good debate from the well-attended meeting.

Sarah left the attendees with a final message "nobody should be made deaf by their work". Many thanks to Sarah for giving the presentation and to Loughborough University for hosting it.

Planning conditions for noise

The March meeting saw a return to Derby University for a very informative talk by Toby Lewis of WSP Parsons Brinckerhoff on *Planning conditions for noise*. Toby started with an overview of planning policy with respect to noise and then moved on to give further detail and examples of how the six tests as set out in NPPF (i.e. necessary, relevant to planning and to the development to be permitted, enforceable, precise and reasonable in all other respects) may be rightly, or as often happens, wrongly applied. He raised issues of whether the meanings of terms frequently used in planning conditions were sufficiently precise (e.g. “background noise level”, “perceptible”) and whether conditions were enforceable where they required noise assessments to be undertaken at a specific location such as a property façade or within noise sensitive rooms to which the assessor may not have access. Toby finished by explaining that the consequence of poor conditions is that the local planning authority are unable to act on the condition often forcing them into statutory nuisance action.

Following the talk there was a lively discussion around the issues of the wording of conditions to meet the six tests and what to do where an "unreasonable" condition has been imposed. Many thanks to Toby Lewis for presenting on this very pertinent topic.

ANC presentation on sound insulation testing issues

In May Atkins hosted the Midlands Branch version of the *ANC presentation on sound insulation testing issues* which has featured at a number of regional branch meetings. Bob Albon of Sandy Brown Associates presented on behalf of the ANC and he very much made the talk his own, providing the benefit of his own vast experience in an entertaining and informative way. The talk included many practical tips on reducing the likelihood of sound insulation test failures due to poor workmanship and common errors plus a run-down of some common problems encountered on site when turning up to undertake the tests (and some handy hints on how to minimise these). The branch extends its sincere thanks to Bob Albon for the presentation and to Russell Richardson for helping to organise it.

Safer suspended ceilings and acoustic solutions using stone wool

In June Tim Spencer, Technical Manager for Rockfon, gave a talk at WSP |Parsons Brinckerhoff’s Birmingham office on *Safer suspended ceilings and acoustic solutions using stone wool*. Tim gave a lively presentation using slides and videos to look at all aspects of suspended ceilings, acoustic wall absorbers/baffles and rafts. We heard that Rockwool was founded in 1937 and has 27 factories today across the globe. He highlighted some of the key performance features like thermal, fire and acoustic insulation properties and provided examples of its use in healthcare, education and offices. He even used a pint glass demonstration to highlight the water resistant properties of stone wool. Thank you to Tim for the presentation and to WSP | Parsons Brinckerhoff for hosting the event.

The challenges of measuring windshield self-generated wind noise using a practical rotating bar apparatus

By David Robinson, Cirrus Research

Designing a suitable windshield for outdoor noise measurement capable of reducing self-noise whilst not attenuating the measured noise significantly is a challenge for manufacturers of outdoor acoustic equipment. The requirement for limiting self-noise is often specified in standards or tenders, but the method of testing is rarely stipulated, which can lead to uncertainty as different measurement methodologies can provide distinctly differing results.

Ideally testing would be performed at accredited test facilities, which have limited availability so Cirrus tested various options for performing in-house tests, before deciding on developing a rotating bar apparatus. Results from the completed solution were then compared against real life outdoor tests and wind tunnel tests to verify the practicality and accuracy of the results.

Options available for wind speed testing

The obvious way for measuring self-noise generated in a microphone or windshield is a specialised wind tunnel adapted to reduce noise to acceptable levels. After contacting and discussing our requirements with a number of wind tunnel providers it was obvious that most were unsuitable due to the noise levels generated by the fans and the metal ducting.

An alternative option, which Cirrus recently investigated and quickly eliminated, is to support the preamp and windshield assembly on a vehicle and drive at the required speeds whilst measuring noise levels. Road and tyre noise was evident on the sound recordings and the noise levels measured were close to the threshold limits we needed to achieve, suggesting that the test method was creating more noise than the windshield.

Another option for measuring windshield performance is by measurement outdoors, whilst also measuring wind speed. This allows very little control of the test conditions and relies on extended testing to capture a range of wind speeds, making it unsuitable for a designer wishing to test numerous foam sizes, shapes, densities and designs for bird spikes. This is obviously the most suitable method for making real world measurements as it includes typical turbulence conditions and as such was used to compare final results.

After experimenting with the options, it appeared the most practical in-house method for testing self-noise of windshields is to develop a rotating bar apparatus.

P18 ▶

◀ P17

Requirements for self-noise measurements

The requirements for our in-house test system were derived from looking at a number of standards and tenders we had seen recently.

ISO 20906:2009 *Unattended monitoring of airport sound* states that A-weighted noise must not exceed 65dBA at wind speeds of 10m/s (36km/h), whilst some tenders state a level of 60dBA at 8.9m/s. Whilst it is often specified that measurements above 10m/s should be discarded, a system capable of operating at 15m/s would be suitable.

Rotating bar apparatus

The main concern with developing a wind test system is that it will create its own noise. With a rotating bar system, noise will be generated by the motor, gears, bearings and the air interaction upon the rotating bar.

A 3-phase AC induction 1400 rpm motor was used, having no commutators/brushes to generate noise meant that noise would predominately be from the bearings. The motor was coupled to a 10:1 worm drive gear, and the whole assembly mounted in a wooden enclosure, with an acoustic labyrinth arrangement for air inlet and exhaust. Transmission to the rotating bar shaft was made through a rubber v-belt and pulleys, with a slight amount of grease applied to reduce noise.

An extruded aluminium bar typically used in an architectural solar shading system was used for the rotating bar. This was elliptical, 100mm wide, 25mm high and capable of supporting the estimated mass of the preamp and windshield. The typical length of the bar spun from the centre point was 2.6m, requiring a spin rate of approximately 0.63Hz to achieve a speed of 10m/s. Although operators should not be in the near vicinity of the equipment whilst running, the v-belt provides the ability to arrest the bar with minimal effort and therefore damage.

Tests were performed in a local gymnasium, which although not ideal acoustically, provided low ambient noise levels less than 35 db(A). An anechoic chamber would be preferred. Speed of the windshield was measured by timing 10 or 20 rotations and confirmed with a small anemometer. The background noise of the bar and motor were also measured to during operation, and although varies with speed and load were typically less than 40 dBA for the required measurement range. Results using the rotating bar prove very repeatable, with identical setups providing measurements within 1 dBA of each other. See Figure 1.

Whilst the rotating bar equipment proved successful at operating as planned, there are challenges. The belt drive approach does limit the maximum speed of operation with some oversized windshields due to the drag causing the belt to slip.

Testing and comparison against other methods

Initial tests were performed using a range of available foam windshields, consisting of 200mm spheres with differing pore sizes 10, 20, 45 and 80 ppi and two 80mm spheres of 45 and 90ppi foam.

All measurements were made using a Cirrus Optimus SLM and repeated on both the rotating bar equipment and the wind tunnel at the University of Salford's acoustical laboratory. The wind tunnel facility at Salford provides considerable silencing of the fan noise with a 600x800mm metal duct. Ideally the wind tunnel would incorporate an anechoic chamber section to minimise noise reflections in the test area, but whilst it is accepted the wind tunnel facility at Salford was not designed specifically for this purpose the author believes it is amongst the most suitable facilities available within the UK.

Results from the comparison tests for 10 and 80ppi foams are shown in Figures 2 and 3, showing that the spun bar test results are approximately 7dB down from the duct testing over the range of wind speeds tested.

Both sets of results were then compared to outdoor measurements made over several months for the 20ppi foam. Compensating for the foam insertion loss (less than +/-1 dB between 63 to 4kHz) the rotating bar test results correlated better with the outdoor measurements than the wind tunnel confirming that a rotating bar method provides a practical and valid method for measuring self-noise of a windshield.

A method of testing self-noise is just the initial step for a manufacturer, and helps identify potential issues such as peaks seen at certain frequencies in the results shown. A reliable and repeatable method of testing enables investigation and optimisation of the windshield, which is an ongoing task for manufacturers with ever demanding requirements. ◘

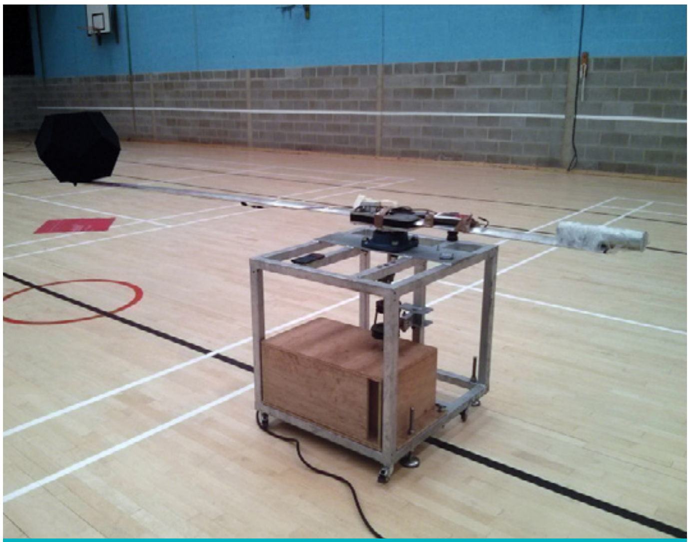


Figure 1 - The rotating bar equipment in the local gymnasium

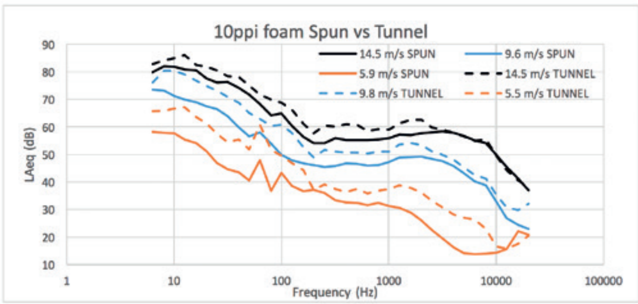


Figure 2 - 10 ppi foam Spun vs Tunnel

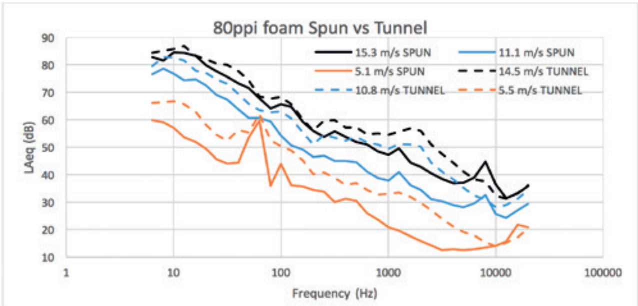
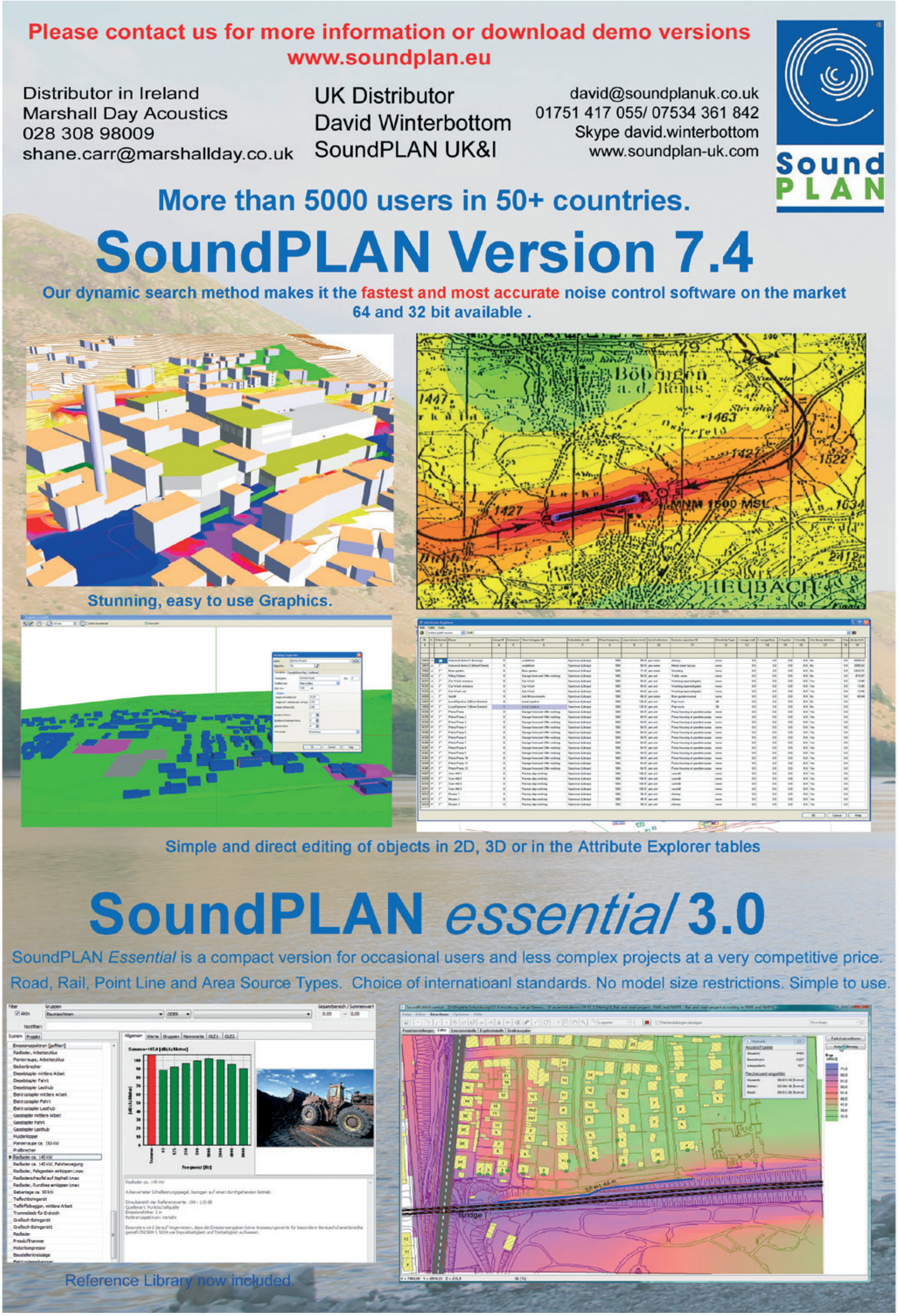


Figure 3 - 80 ppi foam Spun vs Tunnel

***David Robinson** is a Senior Design Engineer at Cirrus Research*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Consultants vie for top honours in ANC annual excellence awards

By Robert Osborne

Competition was again fierce at the Association of Noise Consultants' annual awards as entrants fought for the honour of best in class.

The judging panel, drawn from academics, consultants and other professions, and chaired by former President Sue Bird, drew up a 14-strong shortlist before making their final decisions in the five categories.

All shortlisted entrants gave a five minute presentation at the association's annual conference at the Crowne Plaza, Birmingham. An award for the best presentation, based on votes from the audience, was made to Hoare Lea.

Mike Bedford (right) of Hoare Lea with Helen Czerski and John Tebbit from Robust Details (sponsor)

The judges did not visit any of the projects or hear any of the results so their decisions were based on a review of paperwork only. In a number of cases the projects had not yet been built and so it was not possible to validate the results, which in some cases influenced their final decisions. The awards were launched in 2013 to promote and recognise excellence among UK acoustic consultants and look for examples of work that display innovation and originality in acoustics design or approach to a particular project. Thought is being given to introducing a small consultancy award next year.

An award was also presented to Mateusz Garbala for the best project in the IOA Diploma in Acoustics and Noise Control for his paper *Passenger noise exposure in London Underground*.

The awards were presented by Helen Czerski, a physicist at University College London and a science presenter for the BBC.

Mateusz Garbala (centre) with Andy Parkin and Helen Czerski

Architectural acoustics: commercial buildings

Winner: Cundall

Virtual Acoustic Reality (VAR)

This project is a unique and cutting-edge tool for both clients and design teams and could transform building and infrastructure design with a combination of audio-prediction modelling and gaming-quality graphics. It involves the design and development of a portable, interactive audio and visual virtual experience. Acoustics is often referred to as a dark art. It is full of different notations and definitions and a lot of time is spent trying to convey the meaning of these to the design team and to clients. Acousticians specify products designed to control the reverberation time, but what does a reverberation time of 0.8 s actually sound like? When a contractor value engineers a design and noise levels increase by 5 dB, how will that change the sound? VAR links a powerful 3D graphics programme with the CATT Acoustic software to enable clients and the design team to fully immerse themselves within a virtual world and be able to walk around the building, whilst listening to the audio signal change in real time. The judges recognised that this entry was slightly different from what they had expected but it was very relevant to building acoustics. It was a fantastic tool to engage the client very early in a project about the importance of the correct acoustics. It would also be useful for the design teams to try different solutions before committing to a particular design and it helps to demystify acoustics and raises the bar in client engagement and empowerment. For innovation and contribution to acoustics and public perception, this is the award winner.

P22 ▸

The Virtual Acoustic Reality (VAR) system

Christopher Biggs (second left) and Andy Parkin (second right) of Cundall with Helen Czerski and Thomas Murray of Armstrong (sponsor)

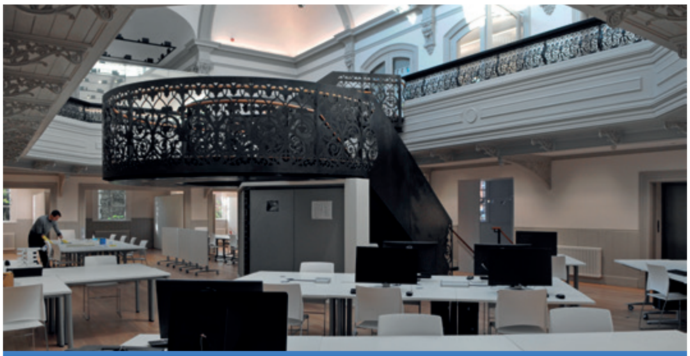
◀P20

Highly commended: Hoare Lea
United Kingdom Pavilion, World Expo 2015, Milan
The consultants undertook the design of acoustics, integrated audio-visual systems and a soundscape experience, with visitors following the dance of the honey bee through a series of landscapes and soundscapes. A 14-metre-cubed structure uses light and sound to connect the visitor to the activity of a real beehive, immersing the listener in an interwoven, meditative musical composition. Acoustic modelling was undertaken to understand the interactions during the design process. Designing an outdoor soundscape experience within a world expo site, wedged between motorways and the mainline railway, had the challenge of calibrating reproduced sound from the system on the listening planes against the ambient noise profile. The judges noted that although a temporary structure, this project was able to play with the senses using acoustical elements. The designers faced a unique challenge of creating a soundscape that is informed by movement of bees hundreds of miles away, as well as providing a conference space. Both of these objectives were met with the client saying "the result has surpassed my expectations. The experience is truly immersive".

Commended: BDP
Enterprise Centre, Norwich Research Park
Forming a gateway to the university, the building is a hub for joined-up low carbon thinking and acts as stimulation for the regional economy. The Enterprise Centre breaks new ground in sustainable design, reducing the carbon footprint through the supply chain and to the final material. The acousticians worked with architects to seek out low carbon materials that would perform the acoustic function whilst fulfilling key environmental criteria, all the while complementing the architectural aspirations. The building utilises passive ventilation via sound attenuating louvers, augmented by mechanical ventilation during the winter months. Internal acoustic finishes utilise natural materials including demountable woodwool acoustic tiles and a spray on acoustic finish containing 85% finishes, assisting in achieving the building's low embodied carbon. The judges noted this was a small project with sustainability at its centre which achieved both Passivhaus certification and BREEAM Outstanding. It showed that acoustics and sustainable design can go hand in hand and they were impressed to see that such a high finish and required performance was obtained using local materials.

Architectural acoustics: educational buildings

Winner: Adrian James Acoustics
Boardman House, Norwich University of the Arts
This project represents a successful and sensitive integration of acoustic and architectural design, which is unusual in a historic building. Often in the conversion of listed buildings, the conservation constraints lead to severe compromises to, or in some cases complete abandonment of, the acoustic design. The building has already won a RIBA East Award and the Norfolk Constructing Excellence Heritage Award but more to the point, the staff and students are very happy with it. Both the building and the brief were acoustically very challenging. Prior to the project, the basement housed a series of church meeting and function rooms, with the ground and first floors housing offices set around a large central two-storey meeting and worship space with a large glazed roof lantern, barrelled ceilings with stout cornices and a balcony with an ornate wrought iron balustrade. To provide good acoustics for study and teaching, while remaining sensitive to the historic building fabric, required extensive use of innovative finishes such as spray plaster, monolithic rendered mineral tile ceilings and slatted timber finishes. The design also required meticulous detailing of sound-insulating wall and floor constructions, particularly separating floors. The result is a building which achieves good acoustic conditions in a largely "invisible" manner. The judges felt this was a really excellent achievement particularly given the modest budget available. An open plan space had been made to work successfully so that it that fulfilled its purpose and achieved a good acoustic performance. The challenges of doing this within a listed building made this even more impressive and it is an excellent example of architectural acoustics at its best.



Boardman House, Norwich University of the Arts

Ian Rees (centre) of Adrian James Acoustics
with Helen Czerski and Shane Cryer of Ecophon (sponsor)

Highly commended: Arup (lead designer) and SRL
Swansea University Great Hall
The Sir Stanley Clarke Auditorium was conceived to occupy the existing Swansea University Great Hall building frame. Designing the auditorium to integrate concert hall acoustic requirements in line with the client's high aspirations and within a modest budget, was a challenge. The existing building frame implied significant constraints on the room geometry, and stringent limits on the building mass and imposed loads. A creative approach to the design of the acoustic finishes and substantial research into the design of successful precedent venues, delivered a great acoustic within the existing structural design. Yet the University's aspirations nearly went unrealised as the original design was well beyond their financial reach. There was a very exacting specification in place to create the acoustic conditions required. It contained a mixture of objective numerical criteria and specific construction methods. In many cases, mitigation methods were also recommended for meeting the objective criteria. Cost savings had to be found which wouldn't discernibly affect the acoustic performance of the building. The judges were presented with two entries for this project and invited the consultants to accept a joint award which would recognise their respective contributions to the successful delivery of this scheme. They were impressed by the emphasis throughout on the quality of the design and the emphasis on maintaining that.

Commended: Adrian James Acoustics
NMRB (now named the Bob Champion Building)
The consultants were appointed at Stage C of a design and build contract with the brief to ensure that the building would not only be acoustically fit for purpose, but acoustically excellent. The contractor had rightly identified that the acoustics would be critical to a successful overall result, but until this point acoustics had not been considered at all. The end result is an architecturally and acoustically excellent building that is unusual – perhaps unique – to achieve such high quality and innovation in a contractor-led design team. The project is an example of how a contractor, architect and acoustician can work together to develop and deliver an innovative and integrated acoustic design on a modest budget. This was a great project in respect of the collaboration P24▶

◄ P22

between the team and showed that a D&B framework can achieve results. The judges liked the way the acousticians had picked up the brief and set their own agenda convincing other parties of the importance of acoustic features that might otherwise have been value engineered out of the final building.

Environmental noise

Winner: Bureau Veritas with Crossrail and CSJV

Crossrail Bond Street: contract 412

Bond Street Station is one of the most sensitive sites on the entire Crossrail route in terms of noise and vibration. The Western Ticket Hall is surrounded by residents and a number of sensitive commercial properties, including an antique emporium housing valuable objects that are susceptible to vibration. In contrast, the eastern ticket hall is based in a predominantly commercial area. Despite these significant challenges, CSJV C412 were one of the first contractors to be awarded a "world class" score in noise and vibration performance. A detailed suite of objective performance measures were defined in order to measure contractor's performance in construction noise management, covering factors considered critical to success. These measures formed part of Crossrail's Performance Assurance tool (PAF) which sought to minimise impacts on people. This is quite different from controlling or minimising noise levels. Community response to noise is strongly influenced by people's attitudes towards the noise creator. In the context of construction noise people are more likely to tolerate the noise if they consider that the noise is necessary and that all reasonable steps are being taken to control and minimise noise impacts (ref BS 5228). The PAF places as much, if not more, emphasis on community engagement and communication as it does on the physical aspects of controlling and minimising noise emission from the works. The judges scored this highly in terms of complexity and managing the project. The application of established best practice to the control and mitigation of noise was critical in this sensitive location and the performance measures could be a real step forward in this field of work.

Part of the Crossrail project at Bond Street

Melissa Wellings (second left) of CSJV, Andrew Bird (centre) of Crossrail and Nigel Burton (second right) of Bureau Veritas with Helen Czerski (far left) and Jenny Krailing of ANV Measurement Systems (sponsor)

Highly commended: Arup

A14 Cambridge to Huntingdon (C2H) improvement scheme

The proposed A14 highways scheme represents substantive innovation that has secured development consent quickly and will deliver significant improvements in the health and quality of life of many thousands of people and materially improve the noise environment around the social infrastructure (e.g. schools, public open space) in several communities. It is the first highways scheme under National Policy Statement for National Networks (NPSNN) and the Government decision letter advises that the assessment method is robust. The project represents the "new" excellence for Highways England. The judges noted this project had taken acoustics forward and established new methods that would lead to a change in DMRB and possibly might ultimately result in a change in government policy. As the project is not yet complete it was not possible to see how effective it had been in practice and this influenced the decision to give it highly commended status.

Commended: Bureau Veritas with National Grid

Hinkley Point C connection project

The consultants worked closely with noise specialists and engineers within National Grid on their largest overhead line NSIP project subjected to the DCO regime to date. A bespoke assessment methodology was developed to assess operation noise associated with the new high voltage conductors, which only generate noise (corona discharge) under certain meteorological conditions and is wholly dependent upon the respective tower/conductor arrangement. Using sound power data calculated by National Grid, the consultants produced noise propagation models of the overhead line route, and developed an assessment methodology that followed the principles of BS 4142, but accounted for potential impacts during wet conditions when higher noise emissions typically occur. The assessment methodology also had to be clear and understandable to lay readers, with feedback sought at six consultation stages and at Issue Specific Hearings. In evaluating this project, the judges noted that it was highly specific and whilst the new assessment method made a valuable contribution to acoustics, it was perhaps not widely transferable. They however recognised that it deserves commended status for its work in developing the analysis of corona discharge into practical graphical methods that assist in public engagement and system optimisation.

Sound insulation

Winner: Mach Acoustics

Steiner Academy, Frome

The project posed a number of challenges, namely a material with inherently poor sound insulation performance (cross laminated timber) and a design with a strong aesthetic that exposes the CLT as much as possible. The consultants were required to improve the accuracy of their sound insulation models so to determine where CLT could be exposed and where it needed to be dry-lined. This required detailed reviews of construction data as well as calibration of modelling to on-site testing of similar CLT structures. The result is a project that meets all the proposed sound insulation targets with a minimal impact on the architectural vision. The CLT elements of Steiner Academy, Frome proved to be a challenging aspect of the acoustic design. In order to achieve the high sound insulation targets required for the various teaching spaces, on-site test data of other CLT projects was used to calibrate Bastian models. Input was provided to CLT thicknesses, slab breaks and minimal wall linings to allow the CLT structure to be as exposed. To determine the amount of flanking each CLT slab would provide the varying stiffness qualities of the CLT structure P26 ►

Work gets under way at the Steiner Academy, Frome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◄ P24

was assessed so as to gain a more accurate understanding of the buildings acoustic behaviour. This information was entered into a spread sheet model using the guidance given in BS 12354 and semi mirrored with the results provided by Bastian. The judges considered this to be the most innovative entry and were impressed by the performance obtained using CLT, especially as the brief had required this to be kept exposed. Acoustic designs such as these and use of natural materials demonstrates how consultants can work with low carbon materials to enhance the public profile of the acoustics.

Josh Childs of Mach Acoustics and Helen Czerski

Highly commended: Apex Acoustics
Vermont ApartHotel, Newcastle
This project is an example of consultancy work spawning research that inspires entirely novel solutions. It involved refurbishment of listed buildings, formerly comprising commercial and residential accommodation, into a luxury aparthotel comprising two penthouse suites and 11 double apartments. The pioneering and innovative work concerned the development of a suitable floor detail for this project. This has extensive potential applications in new-build timber flats as well as refurbishment projects; it is proven to offer the highest Class of impact sound insulation under the ISO Acoustic Classification System currently under development. This represents a significant advance on current lightweight timber frame floating floor technology, which cannot achieve this performance. The judges noted that the project has delivered significant sound insulation in a complex site exceeding the clients' brief and providing an isolated screed floor solution in a refurbishment project. Given the number of low frequency impact noise complaints that are made, this is an area that deserves more research and the adoption of novel solutions such as these. The judges also applauded the use of academic literature as part of the work undertaken by the consultants.

Commended: Peninsular Acoustics
Kingsway Music Rooms, University of Chester
The brief was to prepare specifications for three "soundproofed" rooms to enable rock bands to practise and perform at the same time as other "noise-sensitive" activities in adjacent spaces. An initial survey of the 1960s building revealed that the area planned for the main 'performance space' was a suite of classrooms which were to be knocked into one room able to accommodate performers and audience totalling 100 people, adjacent to the lecture theatre. The project had very challenging sound insulation requirements, a critical and demanding client, limitations imposed by the construction having to be built on a suspended beam and block floor at first floor level, the novel floating floor, the very short build time and the limited budget. The judges agreed that the performance achieved was impressive and although it looked a conventional project it had an interesting twist to it. They welcomed the significant client input and noted that projects such as these which deliver substantial sound insulation, with a restricted budget and in a complex site demonstrate the important contribution by acousticians. Finally the judges were pleased to see an entry from a sole practitioner that showed all sizes of consultancies can produce award-winning projects.

Vibration

Winner: RBA Acoustics
Queen Street, London
The scheme involved the conversion of two adjacent existing office buildings within an exclusive area of Mayfair within central London into a series of high value apartments. The site is located above the London Underground (Jubilee Line) and, consequently, was affected by high levels of groundborne noise and vibration due to underground train movements. The solution developed involved a mixture of various techniques for reduction of building vibration and despite the significant restrictions to the building, achieved reductions of 15dBA to the previously existing groundborne noise levels. The building was listed, severely restricting the available options. Furthermore, the site lay directly above one of the tunnels and so there were major concerns about the potential for excessive additional loading associated with any works being transferred to the ►

The new apartments at Queen Street, Mayfair tunnels themselves. The high value nature of the proposed properties also meant that it was essential to maximise floor area as far as possible. In the words of the main contractor: “The Queen Street scheme was an extremely challenging project and our original acoustic consultant left us fearing the worst. However, RBA Acoustics took a very positive approach to the various problems and delivered a solution which exceeded our expectations.” The judges were impressed by the innovative and practical solution which was intriguing in its approach. The consultants had worked closely with the other members of the project team and in particular the structural engineer and had the nerve to remove what they could, leaving only the exterior wall in contact with the ground. It scored highly on originality and a clear design concept that was followed through and for these reasons it is the 2016 winner.

Torben Anderson (centre) of RBA Acoustics with Helen Czerski and Mark Dowie of Brüel & Kjær (sponsor)

Highly commended: Bickerdike Allen Partners
British Museum – World Conservation and Exhibition Centre
The World Conservation and Exhibition Centre (WCEC) is a recently constructed research and exhibition centre extension at the British Museum. The consultants assisted on the design of the new building and protection of existing objects from adverse effects of construction vibration. Significant acoustic challenges were present at all stages of the project. The new, state-of-the-art laboratory facilities required extremely low background vibration levels. The control of vibration from daily activities such as footfalls, vehicular activity and mechanical plant was of paramount importance. Comprehensive FEA analysis was undertaken to ensure this objective was achieved. One of the most unique and difficult challenges was the close proximity of heavy demolition and construction work to irreplaceable objects and artefacts. The consultants developed vibration criteria to ensure object protection while minimising construction disruption. A pioneering set of object protection vibration criteria were developed that have since been used successfully on numerous similar construction projects. The numerous challenges required innovative, out-of- the box thinking and problem solving throughout. Not a single object was damaged during the project and the laboratories function without vibration issues. The judges agreed this was an impressive piece of work which had to take into account a large number of factors. It was an unusual brief, a complex project and an “operational” site. It was carried out with thoroughness over a long period and achieved the desired outcome. There was an original approach to establishing appropriate vibration limits and effective use of measurement, monitoring and prediction, plus it demonstrated that such works are possible without damaging collections and disrupting museum operation. It was very highly commended.

Focus on low-frequency noise, offices and the role of the expert witness at ANC annual conference

By Miles Woolley

Andrew Parkin, outgoing Chairman of the Association of Noise Consultants, in welcoming members to its annual conference at the Crowne Plaza, Birmingham, congratulated ex- President Sue Bird on her MBE awarded for her contribution to engineering, which was greeted with rapturous applause.

Low frequency noise

Dave Clarke (SRL Technical Services) opened proceedings with a discussion on low frequency noise. He discussed investigative work done in the 14th century of the relationship between the presence of low frequency sound within spaces and the reported sightings of apparitions. He also commented about the military use of low frequency noise.

Jack Harvie-Clark (Apex Acoustics) discussed the most applicable impact sound insulation parameter to consider low frequency noise for floors, such as the $L_{nT,W50}$ metric, and concluded it was not sufficiently robust to assess low frequency noise at a low enough frequency. Jack also examined the research done by LoVerde and W Dong and suggested that this had more merit.

Ian Critchley (Peninsular Acoustics) gave a fascinating evidence-based account of residents' responses to impact noise from apartments constructed with lightweight timber floors. He demonstrated that even though on-site measured impact sound insulation performance met the requirements of the Building Regulations 2010: Approved Document E *Resistance to the Passage of Sound 2003* (amended 2004), often residents were unhappy with the level of impact sound from apartments above. In most cases this was attributed to low frequency sound.

Roger Kelly (CDM-UK) played "Skillrex" (a dub-step music genre for those not in the know) and even had a little dance. It was evident from the spellbound audience that the music had plenty of low frequency content. Roger then replayed the same music as if were being heard on the other side of a concrete floor construction where, subjectively, it was evident that the music level was significantly reduced across the low to high frequencies. For dramatic effect, the IOA Building Acoustics Group Chairman played the same music track a third and final time but this time as if we were the listener on the other side of a Robust Detail type timber floor. It was apparent to everyone in the room that the level of low frequency sound was much higher as a result of the floor type. After a review of various sound insulation parameters, questions came from the floor to the panel of speakers from Richard Mackenzie (RMP) Nigel Burton (Bureau Veritas) and Andrew Parkin (Cundall).

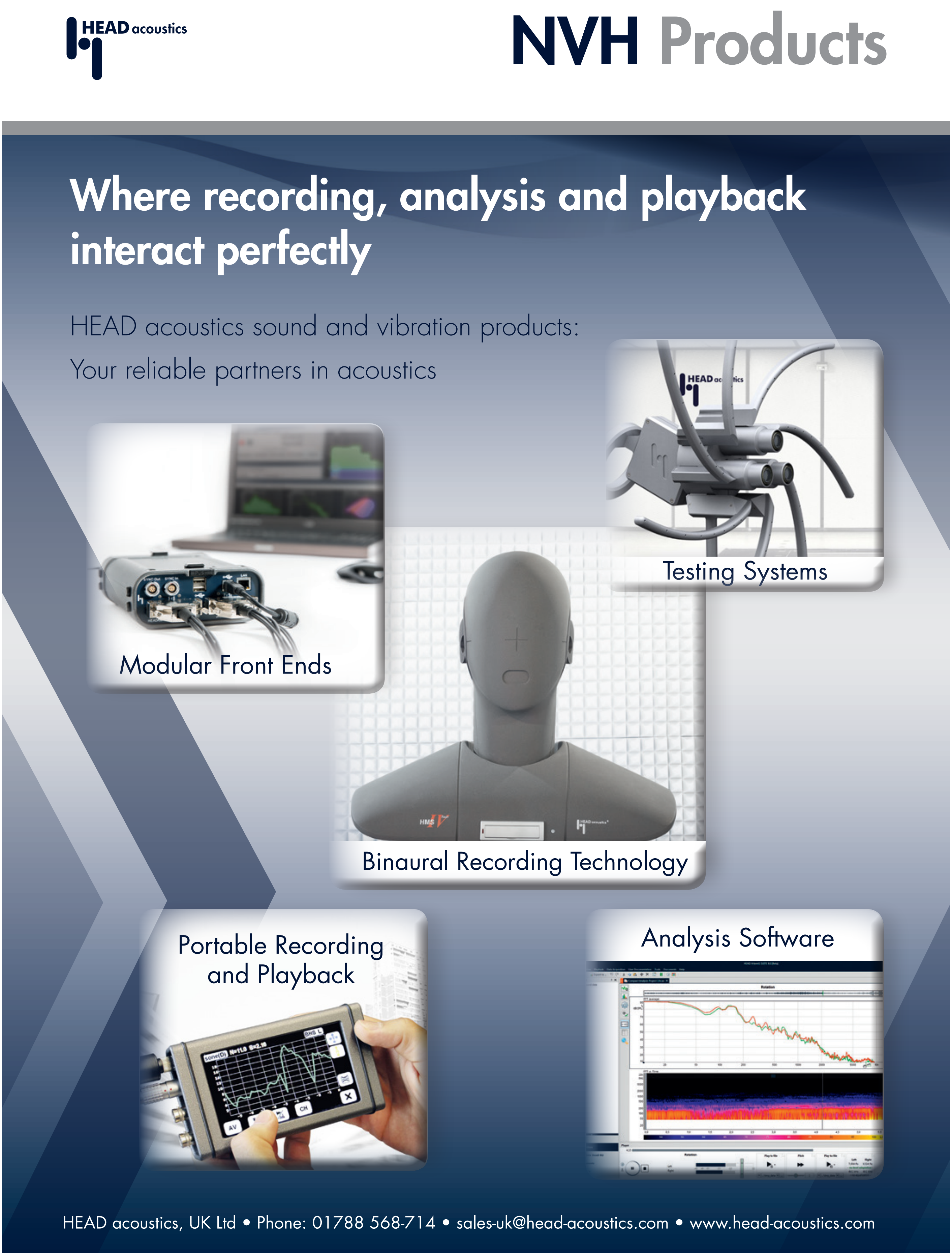
Offices

After a coffee break, Jack Harvie-Clark introduced ISO 3382 part 3: 2012; French and German standards. He started by looking at spatial decay within an open-plan office, Speech Transmission Index (STI) and stated that if the STI is less than 0.5, it is considered less distracting. He then looked at Hongisto's Design Guidance and how acousticians used specialist software to model noise within open-plan spaces, but Hongisto has proposed a formula based on measurements done in 16 offices which is quicker and easier compared with the desk-top modelling option. French guidance gave D_n and ambient noise targets for different types of spaces e.g. typically, a call centre has a higher target compared with collaborative working office. The draft German standard VDI 2569 *Sound protection and acoustical design in offices* was also reviewed. This avoids using STI but focuses on D_2,s. He concluded that the ISO standard does define standards but there is no consensus and suggested we needed a dedicated room acoustics group.

Nigel Oseland (Workplace Unlimited) introduced psycho-acoustics and stated that noise was one of the biggest problems in offices today and perhaps second to issues with room temperature. He went back to basics saying that noise is "unwanted sound" and cleverly linked this to our personal perception of noise. Psychological and physiological sound was the area which fascinated him in his two-year journey with Ecophon. His research concluded that around 65% of people said that noise affected their productivity, including the fact that we don't like to tell colleagues to be quiet. The psychologist then explored personality types from neurotic to stable and introvert to extrovert. For example, sales people (typically extroverts) versus research people (typically introverts) should be situated apart within the same office. He concluded by discussing what can be done practically to affect the way users use a space and experience its space. For example, the use of screening, quiet pods, properly design meeting P30

Jack Harvie-Clark

Nigel Oseland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◀ P28

rooms and book cases can simulate a library- like atmosphere. He finished with reference to two of his areas of research, which include Oseland & Hodsman (2015).

Anthony Chilton (Max Fordham) looked at Keynsham civic offices where exposed concrete panels were used in a passive design strategy and there was a requirement for ventilation units within the façade. He discussed issues with controlling noise ingress through façade. The design included a louvred façade which had an integral acoustic element, resulting in a level of 40dBA with all louvres open. A post-occupancy evaluation was also done for several offices.

Andrew Parkin showed his office with exposed soffits, canopies and upstands, which was modelled using CATT where spacial decay was predicted across the office. He then showed his other southern office which had a metal perforated ceiling where free-standing furniture was used to assist with "grazing". In comparison, the level of decay was better with the full ceiling. Andrew introduced the American 'WELL' building standard, which focuses more on the well-being of workers. He suggested that auralisation was a better way to explain internal acoustics to clients rather than giving parameters which may be meaningless to them. He also played some WAV files to effectively make his point.

Next followed questions from the floor including Miles Woolley (Environoise Consulting) who asked Nigel Oseland about the personality type of a typical acoustician and the type of working acoustic environment which would suit him or her. Nigel replied that (generally) there was a type of person who was an acoustician and this was, typically, someone who needed to focus in quiet conditions. Rory Sullivan (Sharps Redmore) asked the panel about guidance documents and suggested movement of people within the office could have been explored too. Andrew Parkin asked Nigel Oseland if personality types change due to their working environment. Nigel answered be saying we have a natural state but also a "survival mode" so can change to a small degree. Paul Shields (AECOM) asked what Post Occupancy Evaluation (POE) meant and suggested that jargon needed to be clarified within presentations.

Expert witness

Graham Parry (ACCON UK) introduced the next speakers: Toby Lewis (WSP), who has worked both in local authority and now consultancy, Phil Dunbavin (PDA) and Michael Stephens, an arbitrator, mediator and part-time judge, from Kings Chambers and who is also a member of the Academy of Experts.

Graham talked about *Why and how?* In mentioning that he is on IOA Council, he admitted that, even with 30 years' experience, he was always learning. He mentioned a tribunal about the impact of a new road scheme which lasted eight hours, and highlighted how interpretation of assessment methodology can result in very different conclusions. In this case, the assessment by an acoustic consultant on behalf of one party concluded that the change in noise level as a result of the scheme was "major" whereas the opposing party's acoustic consultant had concluded it was "minor". Graham recommended that evidence must be robust for cross-examinations and that listening to and understanding the questions being asked were key. Answers to any questions should also be directed to the decision maker. He also stated that it should be kept in mind that counsel was there to do a job and things said should not be taken personally. Graham suggested personal techniques he adopts which others may wish to use.

Toby Lewis discussed *Expert witness roles and realities*. Most scenarios were planning appeals rather than a formal public inquiry, and he also discussed abatement notice appeals. He suggested that local authority staff cuts meant there was a greater chance that acoustics consultants would be employed to represent councils in future. He discussed the preparation of written evidence, including various approaches to rebuttal. He concluded with "top tips for the novice", such as breathing exercises; ignoring theatrical mannerisms of advocates and not "waffling!" As an expert, he strongly recommended being dispassionate regardless of the circumstances.

Phil Dunbavin, who has been giving evidence for around 30 years, sought to define what an expert witness was and suggested that we can define him or her through what they do, which he then outlined. He emphasised that experts should give an independent view regardless of by whom they were instructed. He discussed a case about the effect of disco noise on sharks where a marine biologist was used to answer in areas outside his expertise. He outlined what should be included, for example reports should include the scope of the instruction given, the relevant experience of the author as well as recognition of witnesses' duty to the court. He stated an interesting case where a local authority used instrumentation out of calibration, resulting in him being awarded costs. Phil strongly recommended that all work which can disrupt the flow of report should be included in an appendix. He concluded that everyone involved in providing expert witness services should get formal training.

Michael Stephens, in looking at cases in civil court, pointed out that an expert witness should first consider whether there was a case to be presented. He then explored some "courtroom basics" for the expert witness, such as be early, know who is who, try to get some "inside knowledge" regarding the various people involved, and know the "bundles" and associated report format. For cross-examination he suggested "do your homework" and keep your temper even when counsel provoke you and repeat the same question. He then suggested that re-examination gave the expert witness the opportunity to clarify any questions put by counsel. Lastly, Michael discussed post-trial and what to do as this could be useful to the client of an expert witness and offered the opportunity to appeal a decision if required.

A question was posed by Richard Grove (BDP) who, in recalling a case where an expert witness was summoned back as he was considered to be providing false or unsubstantiated information, wanted to check if the story was true. Michael confirmed that could happen, particularly if that expert had misrepresented the oath.

Derek Nash (Acoustics Central) suggested that it may be difficult to support a case when approached to provide expert witness part way through the case. Toby suggested a proper review should be done before choosing whether to fully engage.

The conference was concluded with the usual applause for an ANC conference, being judged by members to be as interesting as it was diverse. ◘

ANC elects new officers and board members

The ANC AGM, held at the annual conference, elected Jack Harvie-Clark (Apex Acoustics) as Chairman and Dan Saunders (Clarke Saunders) as Vice Chairman. Joining the board are Dave Clarke from SRL, Paul Shields from AECOM and David Charles from Bickerdike Allen Partners.

Jack takes over from Andrew Parkin who remains on the board as Immediate Past Chairman. Martin Raisborough (WSP) and Miles Woolley (Environoise Consulting) are the others who continue in their roles. Board members serve two year terms and are eligible for re-election up to a maximum of six years.

One major area of activity over the next two years is expected to be the development of good practice guidance publications in several areas. Working parties are currently preparing documents covering:

- Acoustics, ventilation and overheating
- BS 4142 – additional guidance
- Construction noise
- Low frequency impact sound insulation
- Measurement of noise in buildings.

The guidance documents are being written by ANC members and will be available through the website **www.theanc.co.uk** when published.

Naval scientists study the future of sonar in warmer oceans

Scientists are studying how climate change will affect the speed of sound under water to help prepare the US Navy for operating in progressively warmer oceans.

Dr Glen Gawarkiewicz, an oceanographer at Woods Hole Oceanographic Institution in Massachusetts, said in explaining that the speed of underwater sound depended on a combination of temperature, salinity and pressure, temperature was the biggest factor.

Understanding sound speed is crucial for transmitting messages, detecting enemy submarines and avoiding marine animals. As climate change elevates temperatures, understanding underwater sound speed will become increasingly important.

"We haven't had to deal with this issue of climate change until the last 15 years, but the temperature changes are significant enough that it really is having an impact on how sound travels in the ocean," said Dr Gawarkiewicz. He and his colleagues presented their research on the effect of climate change on sonar at the 171st meeting of the Acoustical Society of America, held in Salt Lake City in May.

Dr Gawarkiewicz and his team use a torpedo-like autonomous underwater vehicle to study temperature's influence on sound speed. The vehicle emits sounds that are picked up by a receiver. Sound travels faster through warmer water and slower through colder water. By measuring the exact speed of different temperatures, scientists can help create better communication and detection tools.

This is important because submarines have become more challenging to detect. As technology has improved even more over the past few decades, it's become even more difficult to discover underwater craft. Climate change will only make detection more challenging.

"It's getting harder and harder to detect these subs, and the ocean is getting noisier and noisier with commercial shipping," Dr Gawarkiewicz said.

"You have snappy shrimp making noise and fish making noise, and you might be hearing oil platforms," he added. "It's a huge challenge to try and detect underwater sources."

Experts use underwater sound research to locate missing planes. The black boxes on airplanes have signals on them that send out bursts of sound. If the water is significantly warmer or cooler than normal, this could throw off any hope of finding the plane wreckage and figuring out what happened.

Sound speed is also important for the health of wildlife. Major shipping routes and oil platform construction often take wildlife into consideration. By mapping the speed of sound, scientists can prevent harmful noises from traveling far enough to mess up an animal's migratory patterns or mating grounds.

"If you know that whales hang out in a certain area and you're thinking of putting in an oil platform you'd want to know how close you can be without affecting the whales," said Dr Gawarkiewicz.

One-third of Europe's countryside 'affected by noise pollution'

One-third of Europe's countryside is potentially affected by noise pollution caused by human activity, according to a new report published by the European Environment Agency (EEA).

In noting that "environmental noise is one of the most pervasive pollutants in Europe", it states: "Tackling it (noise) is imperative, but so too is the need to focus on protecting areas that remain unaffected by noise pollution. Quiet areas are havens of natural soundscape that should be protected from any increase in background noise. This will involve ensuring that urban development is properly controlled, transport corridors are appropriately located and industrial sites are adequately regulated."

Entitled *Quiet areas in Europe: the environment unaffected by noise pollution*, the 80-page report delivers 10 key messages:

- Noise pollution has a major impact on human health and the environment in Europe
- Protecting areas that are not yet affected by noise can bring significant environmental health benefits
- Outside cities, approximately 18 % of Europe can be considered quiet, but 33 % remains potentially adversely affected by noise pollution
- The distribution of quiet areas in Europe is strongly related to population density and transport
- Other factors such as elevation, distance from the coast and land use greatly influence the presence of human activity and, therefore, noise
- For protecting wildlife and human health, accessibility to quiet areas is important
- Accessibility to potential quiet areas varies across Europe and reflects different settlement patterns
- Almost 27 % of Europe's protected Natura 2000 sites are havens of quiet
- Conversely, nearly 20 % of protected areas are potentially adversely affected by noise pollution
- Although some actions have been taken to protect quiet areas in open country, there remains much that could be done to reduce noise pollution and help to protect human health and biodiversity.

The report is a first mapping assessment of potential quiet areas in Europe's rural regions. Approximately 18% of Europe's area can be considered quiet, but 33% is potentially affected by noise pollution, the report finds.

Within the European Union, the Environmental Noise Directive (END; 2002/49/EC) defines quiet areas outside cities as those areas delimited by national authorities that are undisturbed by noise from traffic, industry or recreational activities.

The distribution of quiet areas is strongly related to population density and transport. Other factors such as elevation, distance from coastlines and land use also greatly influence the presence of human activity and noise.

Countries with relatively low population densities, such as Finland, Iceland, Norway, and Sweden, have the highest proportion of quiet areas. The noisiest areas tend to be found in areas with higher population densities, such as Belgium, Luxembourg, and the Netherlands. Remote areas such as the Alpine region or near the Mediterranean coast also have a high proportion of quiet areas.

Around 27% of Europe's protected Natura 2,000 sites have large areas of quiet, although one fifth of protected sites are exposed to high levels of noise. Although some actions have been taken to protect quiet areas in the countryside, the report says more could be done to reduce noise pollution in these areas to protect human health and biodiversity. Such measures may include for example, the introduction of national or local legislation that restricts certain business or recreational activities in quiet areas.

An EEA 2014 assessment estimated that at least one in four European citizens are exposed to noise from road traffic above EU thresholds, or a total of more than 125 million people. Harmful effects of noise pollution on humans include annoyance and sleep disturbance which can in turn result in more serious problems like hypertension or heart disease.

There is also increasing scientific evidence regarding the harmful effects of anthropogenic noise on wildlife. In nature, many species rely on acoustic communication for important aspects of life, such as finding food or locating a mate. Noise pollution can potentially interfere with these functions.

The report builds on the *Good practice guide on quiet areas* published by the EEA in 2014. That report proposed a method, the Quietness Suitability Index (QSI), allowing potential quiet areas to be identified in regions outside of cities and towns.

The present report further develops and applies the QSI methodology to put together a quietness index map for Europe as a whole and for individual EEA member countries. Such noise maps can help identify areas where action is needed to reduce noise, and to identify potential quiet areas which should be protected.

In danger: Europe's countryside

Traffic noise exposure can increase heart attack risk, researchers warn

Exposure to traffic noise increases the risk of suffering from a heart attack, researchers have found.

The noise from main roads and railway lines can lead to cardiovascular diseases such as myocardial infarction (MI), a German study has shown.

Researchers examined information from state health insurers of over a million Germans over 40 living in Rhine-Main region of Germany.

Where they lived was matched to road, rail, and traffic noise exposure measurements for 2005.

When the analysis was restricted to patients who died of heart attack up to 2014/2015, a statistically significant association was found between noise exposure and the risk of heart disease.

Professor Dr Andreas Seidler of the Technical University Dresden said: "Traffic noise can trigger complex psychological and physiological stress reactions.

"In terms of the effects of traffic noise on the cardiovascular system, activation of the sympathetic nervous system is regarded as the chief mechanism, along with activation of the hypothalamus-pituitary-adrenal axis

"The World Health Organisation estimates that in the western part of Europe at least one million disability-adjusted life years (DALYs) are lost due to diseases induced by traffic noise."

Rail noise can also be a problem.

The results show only an association between noise from road, rail and air traffic, and heart attack.

He added: "The comparably high estimated risks for all three modes of traffic noise in the subgroup of those who died-well above the respective estimated risks in the study population as a whole-suggest that traffic noise may affect not just the onset, but also the course of a MI.

"A large proportion of the population is exposed to levels of traffic noise that our case-control study indicates to be associated with increased-if only slightly increased-risks of MI.

"For this reason, effective control of traffic noise is a matter of great importance."

The study was published in journal *Deutsches Ärzteblatt International.*

Rail noise increases heart attack risk

Vibrating qualities of spiders' silk exploited in prototype violin

A violin made from a composite material that includes spiders' silk, which enables its acoustics to be customised, has been developed at Imperial College London.

Spiders' silk is strong and elastic. When a creature is caught in a web and is struggling to get free the web resonates or vibrates, sending the spider a message that it needs to swiftly scuttle across the web and make a meal out of its prey.

Now, Luca Alessandrini, a postgraduate from the Dyson School of Design Engineering at Imperial, has developed a composite material and made a prototype violin, which exploits the resonating properties of spiders' silk. He impregnated the violin's top side with three strands of golden silk, spun by an Australian Golden Orb Spider.

When played, the spiders' silk vibrates the violin's composite casing, which is emitted as sound. In the musical world this phenomenon is called propagation velocity. Instrument makers spend their entire lives experimenting with different types of wood and alternative materials such as carbon fibre to exploit this phenomenon in order to improve or vary the acoustic properties of instruments.

The composite material also consists of silk and a binding agent. The different fibres combined with the method of mixing them together enables Mr Alessandrini to engineer the propagation velocity in his composite material. The advantage of this is that the acoustics of any musical instruments could be customised, depending on the sound that is required.

This approach to making composite material with customisable acoustics could also be applied to the manufacturing process of other products such as speakers, amplifiers and headphones.

Mr Alessandrini said: "The amazing properties of spiders' silk mean that it serves many purposes. It's a home, a net for catching food and a means of communicating – via vibrations – when prey is ready to be pounced on and devoured. Spiders' silk has only previously been exploited as string in bows for instruments, but I've discovered that the amazing resonating property of spiders' silk has massive potential uses in instruments themselves."

Peter Sheppard Skaerved, a Grammy nominated violinist and Viotti Lecturer at the Royal Academy of Music in London, said: "My encounter with the prototype instrument developed by Luca has filled me with excitement. This approach offers a tremendous opportunity to move forward instrument making, using new materials in a way I have long hoped."

Luca Alessandrini
and his composite violin

Scientists amplify light using sound on a silicon chip

Scientists at Yale University in the US have found a way to greatly boost the intensity of light waves on a silicon microchip using the power of sound.

Writing in the journal *Nature Photonics*, a team led by Peter Rakich describes a new waveguide system that harnesses the ability to precisely control the interaction of light and sound waves. This work solves a long-standing problem of how to utilize this interaction in a robust manner on a silicon chip as the basis for powerful new signal-processing technologies.

The prevalence of silicon chips in today's technology makes the new system particularly advantageous, the researchers note. "Silicon is the basis for practically all microchip technologies," said Professor Rakich, who is an assistant professor of applied physics and physics at Yale. "The ability to combine both light and sound in silicon permits us to control and process information in new ways that weren't otherwise possible."

Professor Rakich said combining the two capabilities "is like giving a UPS driver an amphibious vehicle – you can find a much more efficient route for delivery when travelling by land or water".

These opportunities have motivated numerous groups around the world to explore such hybrid technologies on a silicon chip. However, progress was stifled because those devices were not efficient enough for practical applications. The Yale group lifted this roadblock using new device designs that prevent light and sound from escaping the circuits.

"Figuring out how to shape this interaction without losing amplification was the real challenge," said Eric Kittlaus, a graduate student in Professor Rakich's lab and the study's first author. "With precise control over the light-sound interaction, we will be able to create devices with immediate practical uses, including new types of lasers."

The researchers said there are commercial applications for the technology in a number of areas, including fibre-optic communications and signal processing. The system is part of a larger body of research the Rakich lab has conducted for the past five years, focused on designing new microchip technologies for light.

Heedeuk Shin, a former member of the Rakich lab who is now a professor at the Pohang University of Science and Technology in Korea, is the study's other co-author. "We're glad to help advance these new technologies, and are very excited to see what the future holds," he said.

Study finds we can hear the difference between standard and high-res audio

Listeners can hear a difference between standard audio and better than CD quality, known as high resolution audio, according to a new study from Queen Mary University of London (QMUL).

The study compared data from more than 12,000 different trials from 18 studies where participants were asked to discriminate between samples of music in different formats.

Dr Joshua Reiss from QMUL's Centre for Digital Music in the School of Electronic Engineering and Computer Science said: "Audio purists and industry should welcome these findings – our study finds high resolution audio has a small but important advantage in its quality of reproduction over standard audio content."

Many in the music industry have been split as to whether people can really hear a difference between CD quality music and high resolution audio – even celebrity musicians have entered the fray with new music streaming services: Tidal launched by Jay-Z and Pono players and music service spearheaded by Neil Young and crowd funded through a Kickstarter campaign.

Both streaming services launched in the last two years have been met with scepticism. However, this new study found that listeners can tell the difference between low and high resolution audio formats, and the effect is dramatically increased with training: trained test subjects could distinguish between the formats around sixty per cent of the time.

Writing in the *Journal of the Audio Engineering Society*, the research suggested that careful selection of stimuli, such as using long samples of more than 30 seconds, may play an important role in the ability to discriminate between the formats.

Dr Reiss explained: "One motivation for this research was that people in the audio community endlessly discuss whether the use of high resolution formats and equipment really make a difference. Conventional wisdom states that CD quality should be sufficient to capture everything we hear, yet anecdotes abound where individuals claim that hi-res content sounds crisper, or more intense. And people often cherry-pick their favourite study to support whichever side they're on.

"Our study is the first attempt to have a thorough and impartial look at whether high res audio can be heard. We gathered 80 publications, and analysed all available data, even asking authors of earlier studies for their original reports from old filing cabinets. We subjected the data to many forms of analysis. The effect was clear, and there were some indicators as to what conditions demonstrate it most effectively. Hopefully, we can now move forward towards identifying how and why we perceive these differences."

The samples analysed were mainly classical and jazz music, though it's not clear for which type of music high resolution recording and playback made the biggest difference.

Listen up: telling the difference in audio quality

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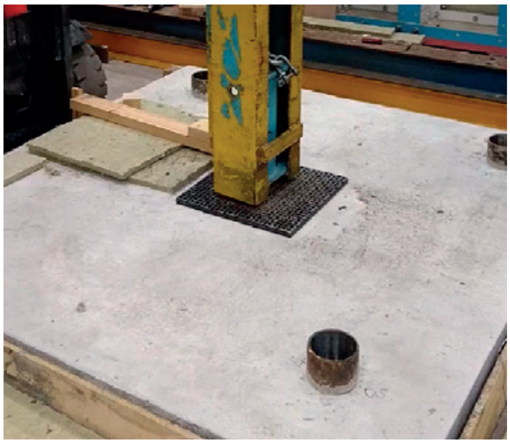


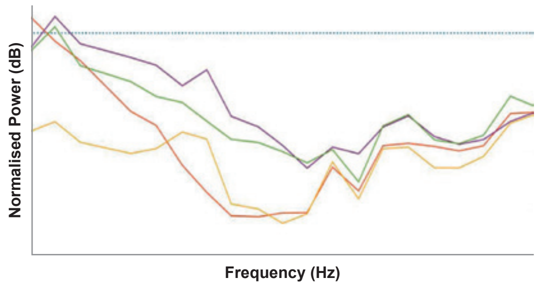
Specifying and designing an isolation system subject to heavy impact is difficult. Most commonly a problem for free weights zones and high energy activities such as CrossFit, the impact energy can be high and easily capable of causing significant disturbance.

We have long experience of installing effective floating floor systems for a wide range of applications but there are a number of design variables which can be utilised for customers with limited space or budgets.

There is no suitable test standard or good quality test data for consultants to specify against. To rectify this, Mason UK tasked Salford University Heavy Structures Laboratory to carry out a range of tests on a specially designed test floor (above right).

The results increase our understanding of how impact energy is absorbed by a floating floor and how it is best controlled across the spectrum by varying the design (below right).

The type of impact, the floating floor and the structure are all part of the same complex system but as with all types of projects Mason UK strives to support industry and produce the best possible solutions.



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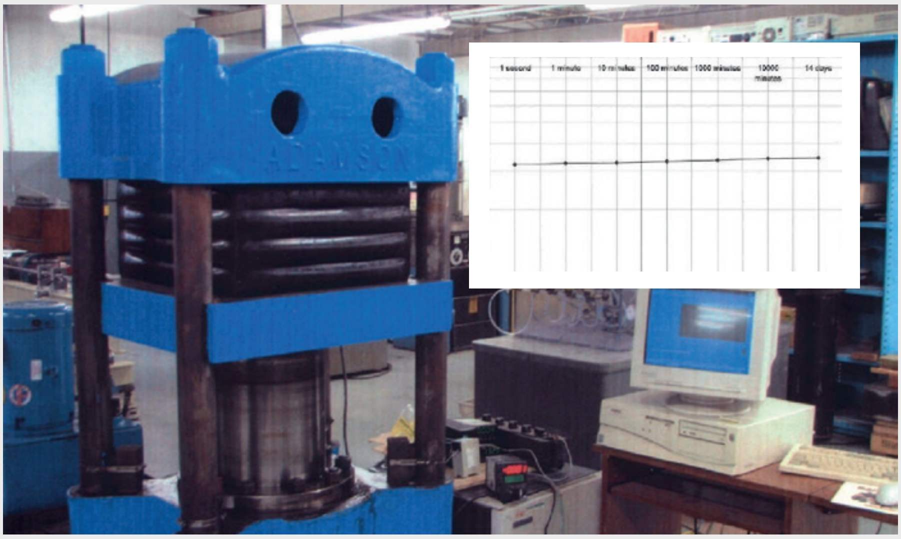

Bearing creep testing and results chart

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Acoustic waves used to determine softness of brain matter

A team of researchers have measured how soft brain matter really is. By recording how fast an acoustic wave travels in the intact brain of a pig, the researchers were able to determine that brain matter is extremely soft, even softer than common gelatine.

The study by researchers from Tsenghua University in Bejing and Professor Michel Destrade, School of Mathematics, Statistics and Applied Mathematics at NUI Galway, Ireland appears in *Biomechanics and Modelling in Mechanobiology*.

The experiment was carried out by generating “acoustic beams” on the surface of the brain, and focusing the beams to interact at a location inside the brain. The interaction amplified the magnitude of the beams and eventually a sound wave was launched in the bulk of a brain.

The sound wave was then observed in an ultrafast image through an ultrasound scanner, similar to those used in obstetrics. The speed of the wave was measured, and then related to stiffness of the brain matter through mathematical equations, like the pitch of a plucked string can be related to its tension. The connection between wave speed and stiffness was made through advanced modelling and simulations, which were mainly carried out at NUI Galway.

Professor Destrade said: “Previously I had compared the brain to glue by testing cubic samples of the brain. During this study the brain was fully intact and compared to a very, very soft gelatine gel, basically a wobbly liquid.”

Results from the experiments showed that brain matter is at least three times softer than a gelatine gel. This extreme softness helps explain why brain matter is so susceptible to impacts and rapid accelerations of the head, such as those occurring in violent sports, car accidents or following a bomb blast.

The research has promising results for neurosurgery, if it can be used to measure the stiffness of healthy tissue compared to that of brain tumours. At the moment neurosurgeons have to rely on crude estimates to determine the extent of a brain tumour, as it is visually undistinguishable from the surrounding healthy tissue.

First they remove a part of the skull to access to the brain. Then they use finger palpation to estimate how soft or hard a region is, before deciding which part to remove, a procedure which has barely improved in the last 100 years.

Infrasound detection can improve early warning of tornadoes

A new tornado early warning system based on infrasound detection could result from research at the University of Alabama (UAH) being conducted with the help of General Atomics Electromagnetic Systems (GA-EMS).

Dale Strong, Chairman of Madison County Commission which is supporting the project with $50,000 in funding, said: “Any early prediction or warning to residents is critical in saving lives and property.

“It's not about if we're going to have another natural disaster – it's when.”

The seed funding will be used to develop the necessary infrastructure and start the research on the relationships between infrasound and tornadoes and other severe storms, said UAH atmospheric scientist Dr Kevin Knupp.

Infrasound is generally defined as sound waves with a frequency less than 20 Hz – the lowest range of human hearing. Unlike higher frequency sound in the audible range (20-20,000 Hz), infrasound with a frequency around 1 Hz can travel hundreds of miles under typical atmospheric conditions without significant atmospheric attenuation.

Natural sources of infrasound include volcanoes, earthquakes, avalanches, large ocean waves, meteors, and meteorological sources such as turbulence, thunderstorms and tornadoes.

“I have had a long-standing interest in infrasound, and that interest was heightened after I was contacted by Hank Rinehart of GA-EMS, who leads an infrasound group at the company,” said Dr Knupp. “They had some infrasound detectors operational during the April 27, 2011 super tornado outbreak, which accurately detected and tracked the Hackleburg (EF-5) and Cullman (EF-4) tornadoes.”

Mr Rinehart, GA-EMS business area director of Sensors and Surveillance Systems, said an internally funded analysis of GA-EMS infrasound sensors that were operational on April 27, 2011 demonstrated further evidence of persistent and high-coherence infrasound emissions during the lifecycle of multiple tornadoes.

Dr Knupp said: “Infrasound detection offers a capability to economically fill in gaps in radar coverage. If the public understands that direct detection has a very high level of accuracy, then we believe that complacency can be reduced through public education.”

A relationship between infrasound and tornadoes was suggested in the 1960s and 1970s, and further established by National Oceanic and Atmospheric Administration (NOAA) scientists who conducted research that has correlated infrasound sources with verified tornadoes. However, the manner in which infrasound is generated by tornadoes is not completely understood.

Infrasound sensors may help in tornado detection

Studying acoustic waves in diamonds brings scientists one step closer to new microsensors

Russian physicists from the Technological Institute for Superhard and Novel Carbon Materials, the Moscow Institute of Physics and Technology(MIPT) and the Siberian Federal University have mathematically modelled diamond-based microstructures for producing compact high sensitivity sensors,

The scientists proposed a mathematical model and experimentally studied acoustic waves in the piezoelectric layered structure (aluminium nitride AlN thin film on the diamond substrate) and found a number of ways of decreasing the effects of spurious peaks. "In the future, diamond crystal based structures may be able to be used as high sensitivity sensors to detect pressure, acceleration, temperature, the thickness of ultrathin films, etc," MIPT said.

A piezoelectric layered structure is a "sandwich" of various different materials with a piezoelectric effect. This term means that under compression or tension an electric field occurs around the material – and when an electrical voltage is applied, the material itself changes shape. Non-scientists will have seen the piezoelectric effect in lighters (pressing the button compresses the piezoelectric, which provides enough voltage for a spark). However, aside from lighters, the effect is used in microphones, precise micromanipulators, and many kinds of sensors for pressure, humidity, temperature etc.

The effect of an electric field on a piezoelectric, in this case a thin film of aluminum nitride AlN, leads to deformation and causes elastic waves, which pass to the substrate in the same way that an elastic wave falling on the piezoelectric film causes an electric field. When it reaches the edge of the substrate, the wave is reflected and within the layers of several materials a number of oscillations occur at the same time – this effect resembles an echo that can be heard when you shout in a tunnel or into a wide tube.

Frequencies and other characteristics of these oscillations depend on the properties of the materials, as well as the geometry of the structure. This means that detectors can be made that are able to detect even individual bacteria that have become attached to their surface – the bacteria slightly increase the mass of the entire system and shift the resonant frequency.

Using mathematical modelling, scientists studied in detail the spectrum of various acoustic modes occurring within the diamond structure. Researchers succeeded in selecting and identifying different types of waves and forming dispersion laws for them. The results obtained will be useful in the development of microwave acousto-electronic devices.

The paper has been published in *Applied Physics Letters*.

Sound therapy 'could help Alzheimer sufferers'

A new therapy could be music to the ears of people suffering from Alzheimer's disease.

A recent study found that sitting down patients in a chair with built-in speakers and subjecting them to sound stimulation at 40 hertz had "promising" results in terms of increasing their cognition, clarity and alertness.

The research, which was undertaken by researchers from the University of Toronto, Wilfrid Laurier University and the Baycrest Centre hospital in Toronto, studied the effects on 18 participants with different stages of the disease (six mild, six moderate and six severe) after six sessions of treatment.

They also received a second round of treatment through visual stimulation on DVDs, also across six sessions.

Researchers then tested the participants on their mental, emotional and behavioural states.

They found that the 40 Hz stimulation had the strongest impact on patients with mild or moderate Alzheimer's disease.

While the study's sample size is small, Lee Bartel, one of the authors of the study says the findings are encouraging.

"I was absolutely delighted and elated because ... you go from theory, and this study had not been done before," said Mr Bartel, associate director of the Music and Health Research Collaboratory at the University of Toronto.

Mr Bartel said the study saw some of the participants with mild Alzheimer's return to being "normal again," and those in moderate condition see their symptoms be downgraded to mild.

"They became more engaged with their present space and the people around them," he said.

"They seemed to be more alert and more interested in life and the goings on, and, in fact there was evidence of some memory from two or three days before ," he added.

Acoustic field identifies cancer cells in blood

Researchers at Lund University in Sweden and the Massachusetts Institute of Technology (MIT) in the United States have developed a method to analyze and separate cells from the blood. Ultimately, the method, which goes under the name iso-acoustic focusing, can become significant to measure the efficiency of cancer treatments for individuals.

The new method involves exposing cells to ultrasound when they flow through a so-called micro-channel inside a chip. The individual cells are separated in the acoustic field and by studying the cells' lateral movement at the end of the channel it is possible to identify the acoustic properties of the cells. Conversely, if you know the cells' acoustic characteristics, you can detect which type of cell that passes through.

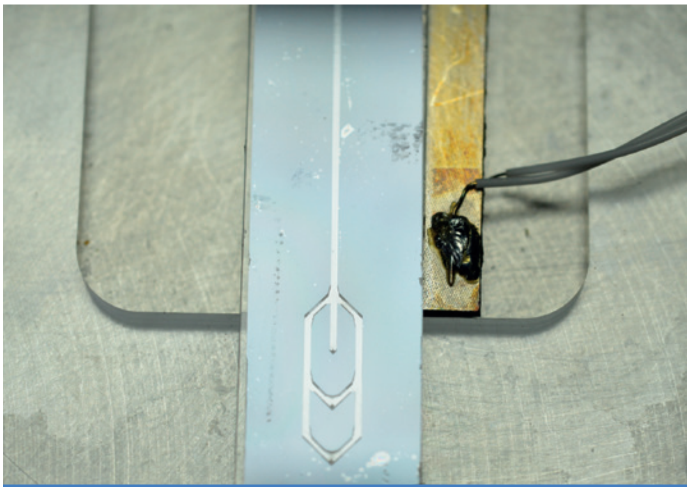
"The vision is that our innovation will eventually be used in healthcare facilities, for example, to count and distinguish different types of cells in patients' blood," said Per Augustsson, researcher at the Department of Biomedical Engineering at Lund University who developed the method together with researchers at the Technical University of Denmark during his time as postdoc in the lab of Professor Joel Voldman at the MIT.

The researchers have applied the method to measure the acoustic properties of white blood cells and discovered that there are differences between different subgroups. Furthermore, the researchers have observed that cancer cells that are cultured in a laboratory have significantly different acoustic properties in comparison with blood cells from healthy donors.

"It may seem odd that we are interested in the acoustic properties of blood cells and cancer cells. But we have been searching for new methods to separate cells in order to study them in more detail," said Per Augustsson.

The blood contains extremely rare cells and it can be of interest to gain access to them. One example is the so-called circulating tumour cells found in the blood of patients with cancer, which play a major part in the spread of cancer inside the body.

The ability to measure how the number of tumour cells varies from one occasion to another can help determine whether medication in the context of a treatment will have the desired effect. But this is technically very challenging and research groups worldwide are currently developing methods to achieve this.



A new cell-sorting device of a microfluidic channel that vibrates at a very low frequency. As cell flow through the channel, they are pushed to a certain position depending on how they interact with the acoustic forces generated by the vibration. Pictured is an example the device.
Picture courtesy of the researchers

One strategy is to employ acoustic fields. In previous studies in acoustic separation of cells it has only been possible to separate the cells based on their size. However, measuring the size of cells is in itself not enough to determine the cell type in question.

"Since we are looking for individual cells in a blood sample which contains billions of cells, the smallest overlap in size between the cancer cell and other blood cells will lead to thousands of blood cells 'contaminating' the cancer cells extracted through the separation. This is why we have now developed iso-acoustic focusing," said Per Augustsson.

The new method provides a way to count and measure the acoustic-mechanic properties of the cells, and the hope is that in the future this will create a better understanding of, for example, how cancer spreads in the body. With the help of this method, researchers hope to shed light on issues such as: What causes metastasis, and which mechanisms control how tumour cells spread in the body? Are there differences in physical characteristics between tumour cells and circulating tumour cells?

"We are currently also working on two follow-up projects to describe the physics behind iso-acoustic focusing in greater detail. This is a very exciting project. We expect that the work will lead to meaningful results within acoustofluidics," added Per Augustsson.

Artificial intelligence fools humans with realistic sounds

Researchers at Massachusetts Institute of Technology (MIT) in the US have demonstrated an algorithm that has effectively learned how to predict sound.

When shown a silent video clip of an object being hit, the algorithm can produce a sound for the hit that is realistic enough to fool human viewers.

This "Turing Test for sound" represents much more than just a clever computer trick: Researchers envision future versions of similar algorithms being used to automatically produce sound effects for movies and TV shows, as well as to help robots better understand objects' properties.

"When you run your finger across a wine glass, the sound it makes reflects how much liquid is in it," said PhD student Andrew Owens, who was lead author on an upcoming paper describing the work. "An algorithm that simulates such sounds can reveal key information about objects' shapes and material types, as well as the force and motion of their interactions with the world."

The team used techniques from the field of "deep learning," which involves teaching computers to sift through huge amounts of data to find patterns on their own. Deep learning approaches are especially useful because they free computer scientists from having to hand-design algorithms and supervise their progress.

The research may help robots understand objects' properties

The first step to training a sound-producing algorithm is to give it sounds to study. Over several months, the researchers recorded roughly 1,000 videos of an estimated 46,000 sounds that represent various objects being hit, scraped, and prodded with a drumstick. (They used a drumstick because it provided a consistent way to produce a sound.)

Next, the team fed those videos to a deep-learning algorithm that deconstructed the sounds and analysed their pitch, loudness and other features.

"To then predict the sound of a new video, the algorithm looks at the sound properties of each frame of that video, and matches them to the most similar sounds in the database," said Mr Owens. "Once the system has those bits of audio, it stitches them together to create one coherent sound."

The result is that the algorithm can accurately simulate the subtleties of different hits, from the staccato taps of a rock to the longer waveforms of rustling ivy. Pitch is no problem either, as it can synthesize hit-sounds ranging from the low-pitched "thuds" of a soft couch to the high-pitched "clicks" of a hard wood railing.

To test how realistic the fake sounds were, the team conducted an online study in which subjects saw two videos of collisions – one with the actual recorded sound, and one with the algorithm's – and were asked which one was real.

The result: Subjects picked the fake sound over the real one twice as often as a baseline algorithm. They were particularly fooled by materials like leaves and dirt that tend to have less "clean" sounds than, say, wood or metal.

On top of that, the team found that the materials' sounds revealed key aspects of their physical properties: An algorithm they developed could tell the difference between hard and soft materials 67 per cent of the time.

The team believe that future work in this area could improve robots' abilities to interact with their surroundings.

"A robot could look at a sidewalk and instinctively know that the cement is hard and the grass is soft, and therefore know what would happen if they stepped on either of them," said Mr Owens. "Being able to predict sound is an important first step toward being able to predict the consequences of physical interactions with the world."

Charity campaigns to take noise off the menu in restaurants

Eight out of 10 people have left a restaurant, café or pub early because of the noise according to a new survey from Action on Hearing Loss which has launched a nationwide campaign for "a quieter dining experience".

The charity's Speak Easy campaign is calling on the catering industry to take action on background noise.

The online poll that surveyed both people with and without hearing loss showed that 81% of respondents had difficulty holding a conversation because of the high level of environmental noise. They were also united (91%) in saying that they will not make a return visit to a place where the noise levels were too high.

The high level of background noise, which includes noise made by other diners, noise from the kitchen and background music was also responsible for more than a quarter (27%) of all respondents receiving the wrong order during a meal out.

The problem is exacerbated by recent interior design trends that have seen venues employ industrial, minimalist aesthetics with lots of hard surfaces and high ceilings, which have led to increased noise levels due to a lack of furnishings that absorb sound.

Paul Breckell, Chief Executive of Action on Hearing Loss, said: "Through our campaign we want to help the restaurant, café and pub industry to create a more welcoming dining experience for all customers.

"Whether you're out for a meal with friends, or if you're on a date you should be able to enjoy it without having to repeat yourself, raise your voice or receive the wrong order due to high levels of background noise.

"There are 11 million of people in the UK with hearing loss so, financially, it's a no-brainer for the industry to help make dining out even more enjoyable and accessible.

"Three-quarters of people believe that restaurants, cafés and pubs have become louder in the last five years and we look forward to working with the catering industry to help take noise off the menu."

Volume control: diners say restaurants must be quieter

Scientists call for noise management plan to protect marine life

A long-term plan for managing noise in shallow parts of the ocean is needed to protect the environment, say scientists.

Man-made noise in the marine environment can increase stress in animals, alter their behaviour, and displace them from habitats important to their daily lives.

There has so far been limited scientific research on methods to assess long-term trends in marine noise in coastal regions, but engineers and biologists from the Universities of Exeter and Bath, have been investigating how best to monitor this increasing human influence in our seas.

They used underwater sound recorders in Falmouth Bay for 14 months at a marine renewable energy test site and have found managing noise in shallow coastal environments will likely require a very different strategy to other, deeper ocean environments.

Lead author of the research, Dr Joanne Garrett, from the University of Exeter, said: "We found considerable variation in noise throughout the year. As well as anthropogenic noise sources such as shipping, we found that natural environmental conditions, such as waves and tide, also affect the sound levels.

"Both of these factors highlight the need for tailored and long-term monitoring to develop a robust understanding of our effects on the marine environment."

Dr Matthew Witt, from the University of Exeter's Environment and Sustainability Institute, said: "This work underlines the need for continued and focused research in the area of human noise, both on techniques to collect, analyse and interpret data, and on the biological implications of noise on marine species and consequences for marine ecosystems upon which we are so very much dependent."

Dr Philippe Blondel, from the University of Bath's Centre for Space, Atmosphere and Oceanic Science, said: "This work provides much-needed data to inform the debate about the impacts of human activities on marine environments, by providing measurements over several years in a sensitive and important area of the British Isles.

"This data will be extremely useful to both European regulators, who lead the way in terms of environmental monitoring, and standardisation bodies like British Standards and the International Standards Organization."

At risk: scientists say marine life must be better protected

Crossrail – how do you solve a problem like TCR?

By Dave Clarke

Nearly five years ago, SRL was appointed by Dragados Sisk Joint Venture (DSJV) as its acoustician on C305 Eastern Tunnels, the longest of the Crossrail tunnels. Following lessons learned on the Channel Tunnel Rail Link (or HS1) project, where residents raised issues about noise from the Temporary Construction Railway (TCR), an assurance was imposed on the tunnelling contractors which related specifically to the noise and vibration impact from this source.

The TCR is the track laid down by the Tunnel Boring Machine (TBM) in its wake along which a small freight train runs carrying people and materials to and from the TBM. As the name suggests, this is only a temporary structure which is removed at the end of the tunnel works and replaced with the operational railway. It therefore needs to be basic (i.e. cheap) and easily removable.

Arup Atkins JV had done an initial appraisal of the TCR and provided all contractors with a "Reference Design" showing the likely extent of mitigation (i.e. they identified the sections of track which would probably need isolating). However, the contract required the contractors to develop their own design for the TCR. And simply isolating the entire length of track was not an option due to the very large additional costs involved (well in excess of £1 million). This meant that as DSJV's acoustician we would need to predict the levels due to this as yet non-existent railway.

This was the type of challenge which reminded me exactly why I became a consultant all those years ago. A truly interesting technical problem to get me really fired up!

So where to start?

Well, I have found over the years that almost every acoustic problem can be boiled down to the following simple formula (can you think of any that cannot be expressed this way?):

$$\mathbf{R} = \mathbf{S} - \mathbf{T}$$

where: **R** is the level at the Receiver of Receptor. **S** is the Source level. **T** is the Transmission Loss (or, more generally, the Transfer Function).

We knew what **R** was, as this was defined in the project criteria (as it so often is). So we just needed to establish **S** and **T** to find out if there were any problems.

SRL already had a great deal of experience in assessing railway vibration to buildings in situations where the ***source existed but the building did not***. However, projects like this (which are the other way round) are much rarer.

Our approach to solving the "source but no building" problem tended to follow the same format:

a) measure the existing vibration at locations representing the proposed building(s)
b) predict transfer functions into the foundations[1]
c) predict the response of the building to establish the vibration on each floor1
d) predict ground-borne noise from these vibration levels[2]

So we decided to use this as our starting point on this project. Arup Atkins JV had already surveyed every building along the proposed route of the tunnel and created a database containing all the key factors we needed (e.g. the building's function – and P44

◄ P43

therefore criterion, its location in relation to the tunnel, foundation type, etc). By using this comprehensive data set, we were able to establish the part of **T** from the point where the vibration entered the building foundations – i.e. steps b) to d) from the list above.

All we needed to know now to complete our assessment was the vibration level due to the TCR at the base of each building. But this is where our tried and tested method came up short, which meant we needed to expand our capabilities.

Through investigations and literature searches we found a prediction method developed by Ungar and Bender[3] which enabled you to predict the surface vibration using knowledge of the tunnel construction, properties of the ground between tunnel and surface as well as the tunnel wall vibration level. The only problem with this was that we didn't have any reliable source data for this particular train and track type inside a tunnel, so we looked for tunnel wall vibration data, which we felt could be adapted to this particular situation and could be used as the Source data for our model.

Unfortunately, there was very limited information, particularly for what is effectively an underground freight train on jointed track. This meant that there was a significant degree of uncertainty about our answers from this approach, so we felt we should look for an alternative.

The acoustic consultants for the contractor delivering the Crossrail Western Tunnels (BFK) had found a relatively novel approach called "Pipe-in-Pipe"[4]. This is a modelling software package which could predict the surface vibration level "from scratch". You needed no source level, just the details of the train (unsprung mass, speed, etc), track (e.g. material properties of the rail and distance between sleepers) and tunnel (diameter, wall thickness and track bed – assumed to be a floating slab)

As collaboration is a key value of the Crossrail project, we both agreed to use this software so there was a common approach on the two longest stretches of tunnel. The main aspects of uncertainty surrounding Pipe in Pipe were that:

1. It was originally intended to be a comparative prediction tool (i.e. it would give you differences in vibration level when you changed any given parameter). There was no validation in the field to see how accurate the absolute predictions were.
2. It was intended for continuous welded rail, so having no specific way to include track joints in the model was a real issue as the Crossrail criterion was in terms of L_{max}.
3. It assumed the track was supported on a floating slab, unlike the temporary track.

This is akin to predicting the noise outside a room which contains a speaker when all you know is:

a) The components list of the loudspeaker (i.e. what it is made from)
b) The "volume" level it will be set at
c) The size of the room and some idea of the surface finishes
d) A very rough idea of what the wall construction is.

Even the programme writers state that the "prediction accuracy can't be better than 10dB", so we decided to adopt a "dual approach" to ascertain the surface level:

- The Ungar and Bender method with uncertain source levels and
- The Pipe in Pipe method based purely on theory with no validation.

As required by the Crossrail contract, we made sure our assessment methods were compliant with BS ISO 14837:1 *Mechanical Vibration – Ground-borne noise and vibration arising from rail systems. Part 1: General Guidance.*

We worked closely with BFK's acoustic consultants and the creator of Pipe in Pipe (Dr Mohammed Hussein) for advice to come up with the most suitable input parameters. We predicted the surface level for a number of different locations using both methods and the results we got were broadly similar which gave us a degree of confidence in our work.

Another Crossrail requirement was that, once the train was up and running, we had to validate our prediction model(s) through measurement in order to assess the degree of accuracy. Obviously, this was a terrific opportunity for us to gain a better understanding of how accurate each of these methods were – and also to gain some invaluable source data inside a tunnel.

The main drawback, however, was that the design needed to be in place long before we could start measuring.

DSJV sought advice from Voest Apline regarding the sleepers ►

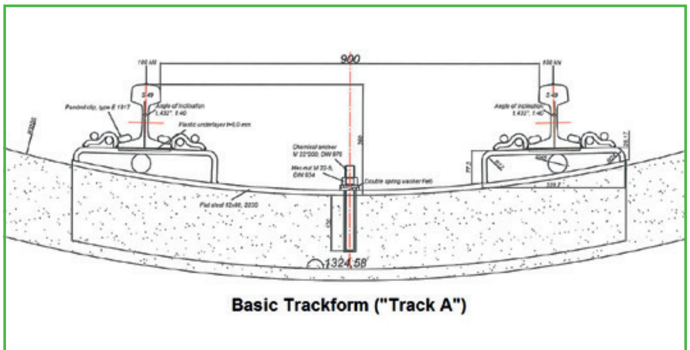


Figure 1. Basic Trackform

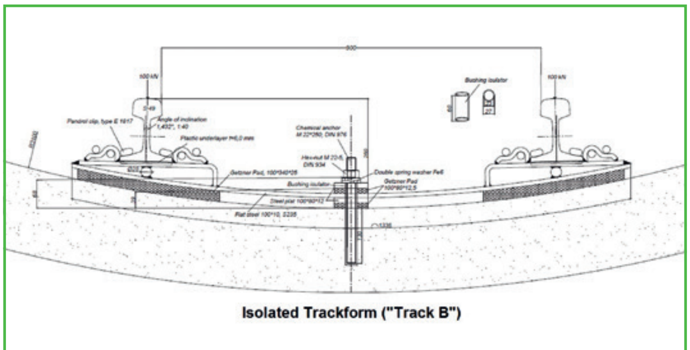
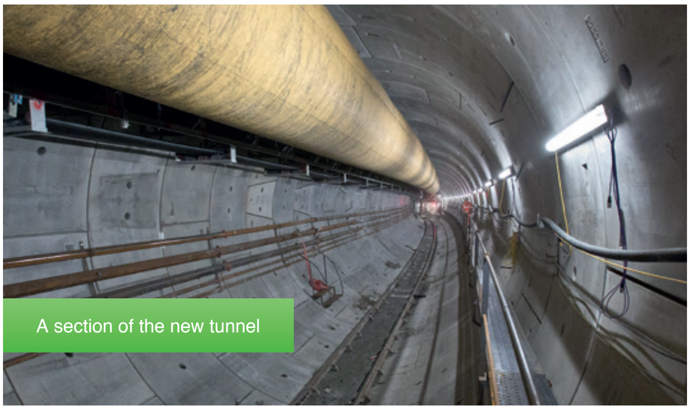


Figure 2. Isolated Trackform

A Tunnel Boring Machine (TBM) is lowered into the main shaft



A section of the new tunnel

and we assessed the range of isolation pads they proposed. We predicted that the pads needed to be 25mm thick based on the material properties and from this, DSJV's tunnelling team were able to develop a solution for the rails which:

a) used basic (and relatively cheap) pads and
b) resulted in two types of sleeper (basic and isolated) which were the same height (see Figures 1 & 2).

This latter point was critical as it meant the sleepers were completely interchangeable ... just in case any unexpected problems were encountered with the basic (un-isolated) track anywhere. These two track types or trackforms were imaginatively called Track A (basic) and Track B (isolated).

By inputting the predicted ground level into our acoustic model for a sample of buildings along the route, we were able to advise our client which sections of track needed to be isolated. DSJV launched their first TBM from Limmo, which almost immediately went under a housing estate (on the opposite side of the river). Our predictions indicated that the track needed to be isolated under parts of this estate, which meant that we had an early opportunity to measure both the "standard" track and the isolated track.

For the basic track we measured on the tunnel wall and on the surface above. As the level at the surface was only just measureable, we realised that it was highly unlikely that we would record anything on the surface with trains running on the isolated track, so we took all our measurements inside the tunnel instead. We placed one accelerometer on the wall at the mid-point of the section of isolated track and another around 50m from the start of this section. This enabled us to measure the tunnel wall vibration due to each train pass-by on both basic and isolated trackforms. From this we could calculate how effective the isolators were (i.e. the insertion gain/loss).

Our surface measurements indicated that the Ungar and Bender method (see Figure 3) was more accurate than Pipe in Pipe (see Figure 4) so we used this method for the remainder of the assessment. This was very positive as Ungar and Bender predicted lower levels between 100 - 200 HZ – the all-important frequency range for ground-borne noise.

This enabled us to run our model for every building within 50m of the tunnel route to refine the Reference Design and our initial predictions. As part of this process, we modified the Reference Design, recommending isolation to a few un-isolated sections and removing it from several others. The net result was that our more accurate proposal had less isolated track than the Reference Design, thus saving a significant amount of money.

Fortunately, the most critical key location for us came close to the end of the Eastern Tunnel route – the Barbican Estate. This contained many sensitive uses and, as a result, very exacting criteria.

Rather unusually, a specific solution was written into an undertaking that had been given to the City of London which took the form of "ballast on ballast mat" (called, yes, you guessed P46

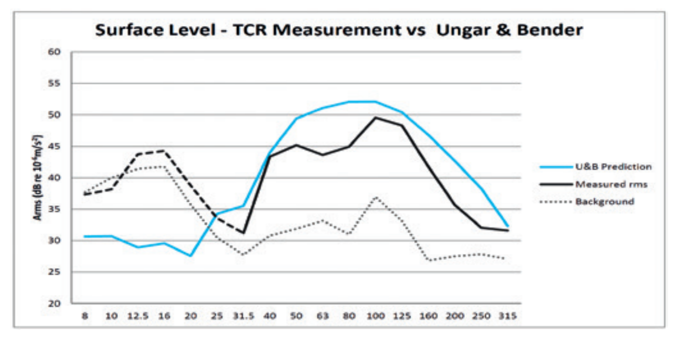


Figure 3. Measurement vs Ungar Bender

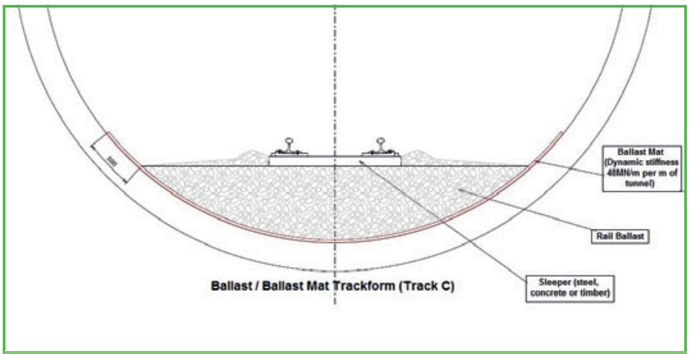


Figure 5. Ballast Track for Barbican

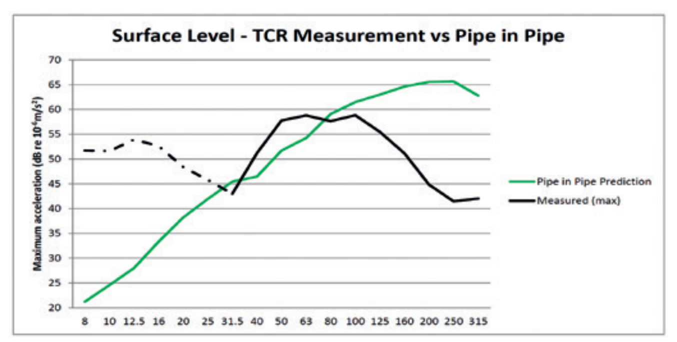


Figure 4. Measurement vs PiP

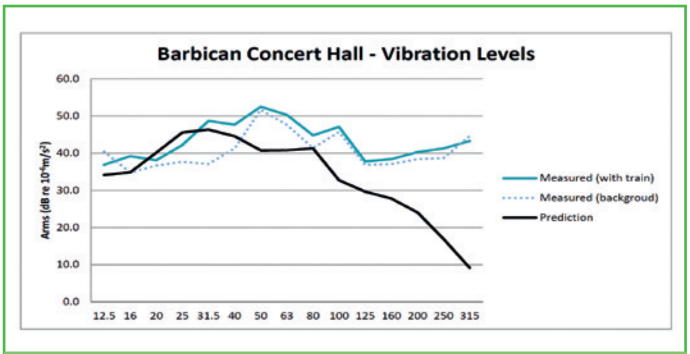


Figure 6. Barbican Vibration Levels

◂P45 it, "Track C" – see Figure 5). According to DSJV, the main problem with this solution (apart from very considerable cost) was the time it would take to deliver all materials to this location and then remove them again, not to mention the environmental impact as all that rubber matting would have to be disposed of. After all, this was just a temporary railway!

Furthermore, the estate was very close (<800m) to the end of our tunnel (meaning that the TCR train would only run beneath the estate for a few weeks at the very most). And add to that the very real possibility that the construction and removal of all the ballast might actually have been noisier than the train movements themselves.

So we attended a meeting with the City of London at the Barbican, and thankfully their consultants (Cole Jarman) were pragmatic and agreed that the actual solution was not as important as achieving the numerical values set out in the undertaking.

From our predictions, using our validated model, it looked like the original isolated trackform (Track B) would be sufficient, which represented a huge saving both financially and in terms of timescales.

During nearly 18 months of tunnelling, the Crossrail helpdesk only received a handful of calls from residents regarding noises they could hear which they automatically assumed were due to tunnelling. Each were investigated initially by DSJV and most found to be nothing to do with Crossrail (though on one occasion a TBM hit an unexpected pile which did cause significant short term disturbance!).

The only valid complaint happened close to the Pudding Mill Lane site where a small number of residents complained they could hear the train running "every hour 24 hours a day". DSJV duly sent a representative to the houses and found that the TCR was clearly audible, but was unable to confirm whether the project criterion (40dBA $L_{Amax)}$ was being exceeded, or not.

Regardless of this, DSJV immediately implemented the back-up plan (to replace the standard sleepers with isolated ones), a task that they completed within 72 hours from receiving the original complaint.

This was great for both the residents and the project in that the problem was swiftly resolved, but rather a disappointment to us, as we did not get the opportunity to do any checks or validations at this location.

So the day finally arrived when the TBM had passed under the Barbican and we got the opportunity to measure the TCR travelling beneath the most sensitive part of our route, the main concert hall.

We turned up as all good acousticians do – in the middle of the night. We duly set up our noise and vibration measuring equipment inside the concert hall and also an accelerometer on the wall of the tunnel where it passed closest to the hall. Then we waited ...and we waited ...and, well if it hadn't been for our chap in the tunnel, we wouldn't have known that the TCR was even running.

So it had worked! The TCR train pass-by was completely inaudible despite a typical background noise of 20-25dBA.

For good measure, we ran our model one last time to compare the predicted vibration level in the Concert Hall (using the actual tunnel wall measurements we'd taken that night). Although vibration levels measured in the concert hall during the train pass-by was very close to background, Figure 6 shows one event where we may have picked up something. The vibration between 25-40 Hz is noticeably above the background level and this coincides with our predicted level so it is very likely that this is due to the TCR.

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Revision of the CIBSE Guides – An acoustician's view of the evolution

By Alex Krasnic and Bob Peters

Introduction

Following CIBSE's (Chartered Institute of Building Services Engineers) announcement that it had completed publication of a complete revision of all parts of its omnipresent CIBSE Guides, this discussion looks back at the origins of the guides and provides a subjective view of what we can expect from the latest editions. Taking around four years to conclude all the revisions, CIBSE Guides are still heralded today by building services designers and engineers of all denominations (mechanical, electrical, public health, thermal, lighting and acoustics), as offering comprehensive technical guidance in key areas of building services engineering.

Under this backdrop, these revisions now allow practitioners to adopt the latest developments and techniques in building services design within the context of recent UK and EU regulatory reforms (including the *European Energy Performance of Buildings Directive*), which are seen as some of the principal drivers for CIBSE's knowledge update. Not since the introduction of the latest *Building Regulations - Approved Documents: Part L* (Thermal performance) and *Part F* (Ventilation) and developments with sustainability certification schemes (BREEAM, LEED, WELL amongst others), leading to the advent of industry-defining practices such as the Building Information Modelling (*BIM*) movement, has there been a greater need for a comprehensive overhaul of the entire gamut of CIBSE's knowledge base.

So where does noise and vibration control of building services fit in with all these developments and what can we expect of the latest CIBSE Guides, particularly in the context of acoustics? Most practitioners of CIBSE guidance documents should be familiar with Guide B5 *Noise and vibration control for HVAC* (February 2002) which was preceded by section B12, as well as Sections 1.9 (Acoustic environment) and 1.10 (Vibration) of Guide A1 *Environmental Design* (January 2006). Where traditionally Guide B would be the preserve of design guidance for HVAC systems, Guide A would contain the environmental performance criteria by service application or room type for each specialist discipline.

The evolution of Guide B

Section B12 of Guide B *Installation and equipment data* was originally published until 1986 and contained 31 pages of guidance relating to "Sound Control". One could infer from the limited connotation of the title and the relatively short page count that this area of expertise was yet to emerge from its commercial origins in the field of HVAC systems design. This can also be noted by the publication dates of the references going back to the 1960s and 1970s and written by notable luminaries in the field such as; *Beranek, L. L., Kosten, C. W. & Van Os, G. J.* overseas and *Allaway, P. H.* (Allaway Acoustics/GAA) and *Fry, A. T.* (Sound Attenuators Ltd/Salex) in the UK, to name but a few. Indeed, much of the technical expertise in this field, whilst having partly filtered through to section B12 of CIBSE Guide B, was still regarded as commercially-sensitive by the individuals and organisations who had pioneered the technical guidance we see in today's guides.

Following a brief introduction containing a list of acoustic terminology, section B12 introduced the concept of noise from building services (both airborne and structure-borne). Here, Fig. B12.2 is first presented which is by now considered a well-accepted illustration of HVAC noise transmission paths (Figure 1). P48

◀ P47

Due to the evolving nature of mechanical services components at the time, only seven initial types of noise-generating equipment were given discrete attention in this edition, these being; fans, cooling towers, refrigeration plant, boilers, motors, pumps and water movement equipment (e.g. pipework and valves). For the most part, empirical equations were available at the time allowing the services designer to make elementary predictions of sound pressure level and sound power level of a given type of equipment usually based on the rated power output of the equipment being assessed. In addition, representative 1/1-Octave Band Centre Frequency spectra for various equipment types would also follow.

Perhaps where section B12 would come into its own, thereby leaving a lasting legacy on all future editions would be the section on predicting noise in air flow systems and resulting room sound pressure levels. For the first time, practitioners would be provided with the hands-on knowledge to predicting noise in airflow systems due to numerous HVAC components such as; shape of ductwork, introduction of bends, branches and the ubiquitous end reflection losses (then based on single duct dimension alone). Additionally, in the absence of manufacturers' test data, empirical formulae for predicting flow-generated noise over grilles and diffusers would also be presented. With these guides in hand and by adoption of well-versed room acoustic theory, resultant room sound pressure levels starting from a known source sound power level upstream of an HVAC system, could now be predicted with relative ease. Corrections for room acoustic characteristics would also be presented as a means of simplifying the usually elaborated method of room reverberant SPL prediction and reproduced in Figure 2.

Further technical inclusions would refer to control of cross-talk between spaces via ductwork terminals and advice provided on the sound reduction and sound absorption properties of common building materials, some of which are still applicable today. These would all be punctuated by comprehensive examples demonstrating procedures to adopt when predicting the flow of sound energy from source to receiver (i.e. inside a receiver room). This would then allow the practitioner to compare design performances with room acoustic criteria and make informed recommendations to modify the HVAC system or introduce any noise control measures. On this note, section B12 does introduce the concept of an in-duct (passive) attenuator and plenum accompanied by empirical equations for predicting the attenuation due to lined plenum chambers and lined ducts, including radiused bends.

In amongst this HVAC noise prediction information, a full section on "Vibration and structural noise control" is presented which presents an engineering guide to the theory of vibration isolation and practical means of controlling vibration from building services equipment. Figs. B12.14 and B12.15 present now well-accepted graphs showing the theoretical resonance curves for differing degrees of damping for both floor motion and machine motion and reproduced in Figure 3.

In short, the guidance contained in section B12 sought to provide the services designer with an introductory set of noise and vibration design principles, reinforced by known empirical relationships of the day, such that informed decisions as to the progress of an HVAC system could be implemented at the design stage, whilst at the same time introducing several hitherto unpublished noise and vibration prediction methods.

Following this initial design guidance now well documented, much ▶

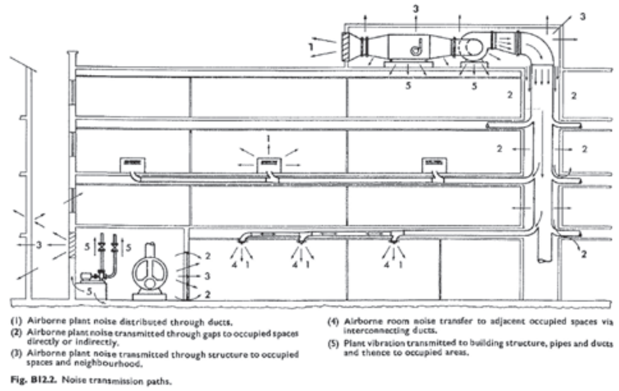


Figure 1: HVAC noise transmission paths, excerpted from CIBSE section B12 (1986) (by kind permission of CIBSE)

Table B12.7. Corrections for room acoustic characteristics.

Description of room acoustic characteristics	Corrections (dB) Octave band centre frequency (Hz)						
	125	250	500	1000	2000	4000	8000
Live	+16	+15	+14	+12	+13	+15	+16
Medium live	+11	+11	+ 9	+ 7	+ 6	+ 6	+ 6
Average	+11	+ 9	+ 7	+ 5	+ 4	+ 3	+ 3
Medium dead	+ 9	+ 6	+ 5	+ 3	+ 2	+ 1	+ 1
Dead	+ 6	+ 4	+ 2	0	− 1	− 1	− 1

Live
Rooms with hard and heavy surfaces, with no soft furnishings and without any acoustical treatment or fittings of absorbing material.

Medium Live
Rooms with hard surfaces e.g. panel construction with no special acoustical treatment but with some absorbent content e.g. people, covered chairs, or limited soft furnishings.

Average
Rooms which have acoustical ceilings or appreciable soft furnishings e.g. carpeted or upholstered and furniture and soft drapes.

Medium Dead
Rooms which have both acoustical ceilings and appreciable soft furnishings.

Dead
Rooms which have been specially treated to absorb sound.

Figure 2: Original corrections for room acoustic characteristic, excerpted from CIBSE section B12 (1986) (by kind permission of CIBSE)

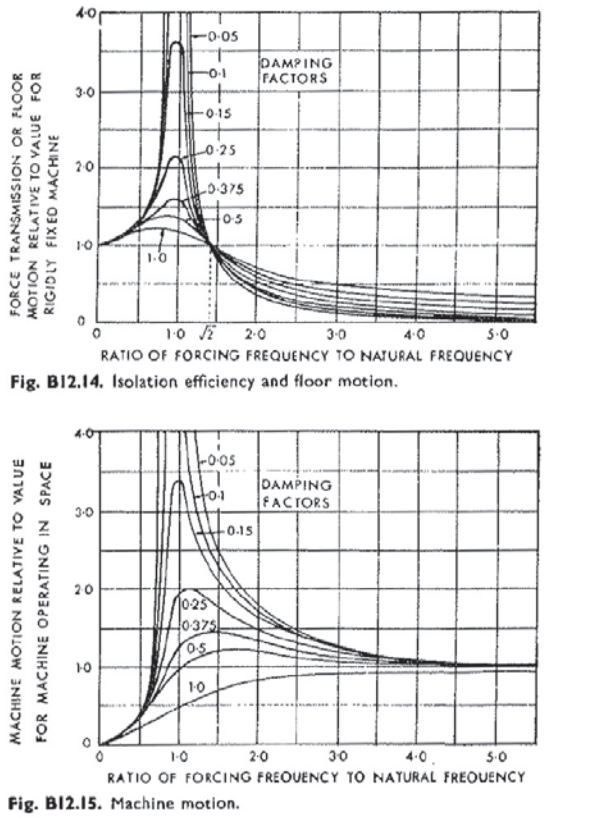


Figure 3: Theoretical vibration resonance curves for differing degrees of damping for (above) floor motion and (below) machine motion, excerpted from CIBSE section B12 (1986) (by kind permission of CIBSE)

later in 2002 CIBSE would commission all parts of its guides to be re-written under a new knowledge direction. Under this initiative, the well-received Guide B5 would be conceived. Whilst the steering committee for its predecessor would be chaired by P. G. T. Owens, this edition's steering committee would be chaired by Dr Geoff Leventhall (HonFIOA). The latter steering committee would comprise only three remaining IOA members to reprise their roles on the latest guide, these being: Richard Galbraith (MIOA), Peter Hensen (MIOA) and the late Peter Tucker (MIOA) to whom the current steering committee is most indebted for his invaluable vibration prediction and control expertise, without which the recent guides would not be what they are today.

The introduction of CIBSE Guide B5 "*Noise and vibration control for HVAC*" ushered in a new era in the prediction and control of noise and vibration from HVAC systems. With the proliferation of this specialist knowledge base spreading across the globe, acoustic engineers now had a wider array of acoustic prediction tools at their disposal. What was once considered the commercially-sensitive preserve of a select group building services acousticians, would now filter its way into the mainstream and Guide B5 would be at the forefront of this knowledge revolution.

At face value however, Guide B5 may not have appeared any more cutting-edge than its predecessor but, as always, the "devil would be in the detail". That said, Guide B5 would not only expand upon the initial guidance contained in section B12 but also introduce new services equipment types such as; vertical transportation equipment (i.e. lifts and escalators), chillers, standby generators, compressors and the now-ubiquitous air-conditioning condenser.

In addition, new techniques for the prediction of ductborne noise transmission would be introduced such as; a more detailed examination of attenuation due to ducts of both rectangular and circular shape and of varying dimensions, end reflection loss by area of termination, different types of bends (i.e. square and round elbows) with and without turning vanes and the phenomenon of regenerated noise due to air flow obstructions, e.g. dampers. Noise recommendations inside plant rooms would also be updated with the advent of the *Control of Noise at Work Regulations* (1989). Advancements in the measurement of the insertion loss performance of passive silencers would also be updated in this edition, as would the first appearance of the practical uses for active silencers which had up to then been considered somewhat of an unproven acoustic technology. Another notable addition from Section B12 would the introduction of a method for predicting noise breakout of ducts which, in the UK, has its origins in the so-called "Allen formula". With further technical additions with regards to acoustic privacy, crosstalk and room acoustic prediction, as well as an entirely new section devoted to the "Transmission of noise to and from the outside", would firmly place Guide B5 on top of most building services designers' desks for the next 11 years.

A brief commentary on Guide A - Section 1

Moving on to CIBSE Guide A, this criteria-based document has seen several revisions since its 1999 edition. The most notable period was between 1999 and 2007 which contained expert technical contributions courtesy of Les Fothergill and, complementing his chairmanship of Guide B5, Dr Geoff Leventhall. The last of year of publication in this period has seen the most popular usage since the current full revision. From this 2007 edition, practitioners of all denominations have consistently made reference to the well-adopted Table 1.15 in Section 1.9 "Acoustic environment". This is shown in Figure 4.

The convenience and popularity of Table 1.15 would be due to the presentation of acoustic acceptability in terms of the *Noise Rating* (NR) metric. An early variant of which first pioneered by *Rosenblith & Stevens* and *Parrack* would later be championed by *Kosten & Van Os* in their 1962 paper. Whilst NR metrics had seen extensive adoption by acousticians in the intervening years between 1962 and the first edition of Guide A, by the time Table 1.15 of Guide A1 (2006) would be published, the Noise Rating had cemented its place as one of the standard acoustic acceptability metrics for building services amongst engineers across the World.

However, whilst the simplicity of the NR metric had reinforced the use of Table 1.15 by both the UK and International building services design communities, this would also be its limitation in the wider context. This may have been due to the insistence of other international building services engineers referencing other universally agreed metrics (such as noise criteria (NC), dBA and even dBC). The former metric; the NC, originates from Beranek and was used by the P50

◀ P49

early heating, ventilation and refrigeration industries in North America, later forming ASHRAE (*American Society of Heating, Refrigerating and Air-Conditioning Engineers*) in 1959. Notwithstanding, Table 1.15 would recommend the well-versed relationship; "dBA ≈ NR + 6" at the base of the table for simple correlation to the well-adopted dBA metric. Whilst Table 1.15 comprised 36 discrete sets of room criteria, there was nonetheless a general desire amongst the building service design community to increase that number to incorporate NR criteria for a wider range of room/building types.

On the other hand, Section 1.10 of Guide A would instead focus attention on the response of both the human body and of structures due to vibration from building services equipment. In the former context, Section 1.10 would make reference to *BS6472:1992* by reproducing the multiplying factors used to specify satisfactory magnitudes of building vibration. The latter context of Section 1.10 would instead cite a lack of available technical documentation (at the time), to propose any suitable criteria for the identification of the onset of cosmetic damage to buildings due to building services vibrations.

Revising a pair of classics

Now approaching late 2010/early 2011, the current chair of CIBSE Guides B5 and A1(S.9 & S.10); Dr Bob Peters (FIOA) would be charged with assembling a steering committee to take up the mantle of revising a pair of already well-established guidance documents, in both Guides B5 and A1. By initially inviting Peter Tucker (MIOA), Richard Galbraith (MIOA), Peter Hensen (MIOA), John Shelton (MIOA), Alan Fry (FIOA) and John Lloyd (MIOA) and later, Alex Krasnic (MIOA), CIBSE would now have at their disposal a commensurate team of well-versed acousticians to steer the revision of these two "crowd favourites".

This then led to an appearance at the Institute of Acoustics' annual conference in 2011 held in Glasgow, of a paper entitled; *Revision of CIBSE Guides on noise and vibration*. The paper effectively provided some early background into the origins of the CIBSE guides (not unlike this discussion) and sought to motivate delegates in responding to a set of ten consultation points. Chief amongst these would focus on Guide A and, in particular, return to the question of suitable acceptability criteria for building services noise. The question of adopting NC, dBA and dBC would all be deliberated upon (again), as would how to penalise tonality and impulsivity. With the emergence of green buildings, further points focusing on naturally-ventilated buildings (another topic for which CIBSE has been active in recent years) would also be consulted on. The paper would also propose a comprehensive reworking of the popular Table 1.15, by inclusion of many more room types from ice rinks to squash courts. The feedback ensuing from the consultation of this paper would then precipitate the revisions of both Guides B5 and A1 respectively.

New kids on the (CIBSE) block

Fast-forward to March 2016 and CIBSE are pleased to announce the completion of four years' worth of work, culminating in a new set of CIBSE Guides which are now available but not without a few (un) expected twists. Guide A would retain the same designation, indeed a new Guide A: Part 0 entitled *Quality in environmental design* would now appear, dedicated to identifying the quality of the environmental design of building services by consideration of an holistic approach to the design process, as well as proposing a system to assure the quality of the design calculations and decisions.

However, the big change would occur to Guide B5, now no longer. Designated Guide B4, the document now sports a new title *Noise and vibration control for building services systems*. Recognising the evolution of smart building systems, energy-efficient building services and renewable technologies, the previous title of Guide B5 now reimagined to encompass all contemporary building services systems. Whilst a title change alone may not elicit an impressed reaction, the updated contents of the document certainly would.

Turning attentions to Guide A1 (now with 01/06/2016 corrections) firstly and contributed by Dr Bob Peters and John Shelton under the auspices of Professor Fergus Nicol, Noise has been renumbered Section 1.10 and Vibration Section 1.11. One of the biggest changes in Guide A is the amalgamation of all building service performance indicators into one holistic, criterion-based table (Table 1.5 "Recommended comfort criteria for all specific applications"). Whereas the previous edition of Guide A1 would contain all the applicable comfort criteria in separate specialist sections, these now all feature in Table 1.5 including the noise criteria metrics in the final columns. The ubiquitous NR is still present and correct but now supplemented by the addition of dBA and dBC columns (in response to the consultation of the IOA 2011 paper). The latter useful for specifying criteria for building services noise with particular low-frequency content within noise-sensitive spaces. Figure 5 presents an excerpt of Table 1.5 identifying some new building/room types to expect, thereby demonstrating CIBSE's overall holistic approach to environmental criteria.

Section 1.10 itself contains several useful updates, particularly regarding the use (and measurement) of Lmax vs. Lpeak and the use of statistical (percentile) noise metrics. The relationship between the sound power level of a building services noise source and the resulting sound pressure level in a room, is also revisited for the benefit of all acoustic levels of interest. The subjects of speech privacy and speech intelligibility are also expanded in this edition, as is a comprehensive rundown of emerging acoustic guidance documents published outside of CIBSE. These relate to revisions to *BS 8233 (2014 edition)*, cross-correlation with BREEAM technical manuals, the *British Council of Offices (BCO): Guide to Specification* and a previously unpublished introduction to (the then) *Technical Design Manual* (TDM) criteria (for healthcare buildings, now superseded by the *Health Technical Memorandum, HTM 08.01*). The distinction between building services noise and external noise ingress is also elaborated, as is the spectral shape P52 ▶

Table 1.15 Suggested maximum permissible background noise levels generated by building services installations[100]

Situation	Noise rating (NR)
Studios and auditoria:	
— sound broadcasting (drama)	15
— sound broadcasting (general), television (general), sound recording	20
— television (audience studio)	25
— concert hall, theatre	20–25
— lecture theatre, cinema	25–30
Hospitals:	
— audiometric room	20–25
— operating theatre, single bed ward	30–35
— multi-bed ward, waiting room	35
— corridor, laboratory	35–40
— wash room, toilet, kitchen	35–40
— staff room, recreation room	30–40
Hotels:	
— individual room, suite	20–30
— ballroom, banquet room	30–35
— corridor, lobby	35–40
— kitchen, laundry	40–45
Restaurants, shops and stores:	
— restaurant, department store (upper floors)	35–40
— night club, public house, cafeteria, canteen, department store (main floors)	40–45
Offices:	
— boardroom, large conference room	25–30
— small conference room, executive office, reception room	30–35
— open plan office	35
— drawing office, computer suite	35–45
Public buildings:	
— law court	25–30
— assembly hall	25–35
— library, bank, museum	30–35
— washroom, toilet	35–45
— swimming pool, sports arena	40–50
— garage, car park	55
Ecclesiastical and academic buildings:	
— church	25–30
— classroom, lecture theatre	25–35
— laboratory, workshop	35–40
— corridor, gymnasium	35–45
Industrial:	
— warehouse, garage	45–50
— light engineering workshop	45–55
— heavy engineering workshop	50–65
Dwellings (urban):	
— bedroom	25
— living room	30

Note: dBA ≈ NR + 6

Figure 4: Table 1.15 of CIBSE Guide A1 (2007) (by kind permission of CIBSE)

◀ P50

of building services sound sources with particular attention to the control of low-frequencies. Occupational risks of noise-induced hearing loss in high sound level spaces are again elaborated by way of reference to the *Control of Noise at Work Regulations* (CNWR, 2005).

Section 1.11 (Vibration) too has undergone some notable revisions, particularly with regards to the human response to vibration wherein a set of recommended guide limits originating from BS 6841 and ISO 2631-1 are presented. With the advent of the *Control of Vibration at Work Regulations* (CVWR, 2005), further guidance on limiting vibration exposure levels are provided. The current version of BS6472-1 is also introduced with regards to building services vibration, also elaborating on appropriate survey and assessment procedures to adopt. Finally, Section 8.8 of Guide A also presents some useful noise and vibration health considerations to take into account during the services design process.

Next, we have Guide B4 (2016) which receives a raft of updates compared to its predecessor. Firstly, to note are the updated *Foreword and Structure of CIBSE Guide B*, which detail the drivers behind CIBSE's initiative to revise its knowledge base. The Introduction now replaces the iterative outline process chart with a simplified diagram illustrating the flow of sound energy in a HVAC system and expands on the classic Figure B12.2 with a more detailed illustration of services transmission paths and possible means of attenuation (see Figure 6).

Advice relating to all equipment types too has been greatly expanded, from the humble HVAC fan which enjoys numerous upgrades to empirical relationships, including casing breakout noise prediction, through to high velocity/pressure terminal units (including VAV systems), induction units, Fan Coil Units (FCUs), Fan Assisted Terminals (FATs), pumps, boilers (including tested sound pressure levels courtesy of *Hoval*), chilled ceilings (active and passive), electric motors, vertical transportation and water flow systems. Indeed, a great deal of previously unpublished commercial data relating to the acoustic performance of many of these services types are presented relating to; grilles and diffusers, FAT units, acoustic louvres, boilers, cooling towers (including tested sound power data and previously unpublished directivity indices for various types of cooling tower) and electric motors of various speeds (rpm) and power rating (kW). In addition, a full set of typical plant room sound pressure levels in 1/1-Octave Band Centre Frequency between 63 Hz and 8 kHz by dominant equipment type is also provided (courtesy of *Peabody*).

The next section, *Airflow noise – regeneration of noise in ducts*, also sees some major changes. Whilst the previous Table 5.1 (effectively insertion loss data pertaining to various duct configurations) from CIBSE B5 is retained, previously unpublished typical self-generated sound power levels inside attenuators is now provided. This is supplemented by a greatly updated table of suggested limiting duct velocities inside ducts and at terminal devices, which is provided by Table 4.15 (courtesy of Sound Research Laboratories Ltd) and effectively amalgamates the previous Tables 5.2 and 5.3 of Guide B5 (2002). In addition, the comprehensive Table 4.17 now provides a full dataset of previously unpublished typical damper flow-generated noise inside ducts for various configurations (courtesy of *Farex/Swegon*, see Figure 7). The section is completed by a step-by-step guide to predicting grille and diffuser flow-generated noise, adopting a useful nomogram and table of corrections.

Section 6 retains the heading *Control of transmission in ducts* and begins with a fully comprehensive set of tested insertion loss data for lined ducts which is previously unpublished. This is followed up by a full rewrite on typical insertion loss test data for passive attenuators, with accompanying text distinguishing between static and dynamic tests (with forward and reverse flow conditions) and associated indicative test data. Circular (and flexible) attenuators in particular, enjoy a greater degree of explanation, including a full dataset of typical dynamic insertion loss performances.

The universal issue of duct breakout is revisited, this time taking a more engineering approach to predicting this phenomenon. By effectively foregoing previously published methods of prediction, which treated the duct as a long room and adopted the random incidence-derived sound reduction of duct material, as opposed to adopting a grazing incidence approach to the sound reduction. In addition, the previous flaw of not assuming a constant reduction of the in-duct sound power is now addressed in the new prediction method, by introducing a level decay term in the equation. The newly introduced latter term (the "Length Effect") is detailed in Figure 4.42 and reproduced in Figure 8.

Following on, additional empirical relationships for breakout from circular ducts is now provided, as is test data for various lagging/cladding materials including a new sub-section relating to the reverse phenomenon of noise break-in. The latter content being particularly useful for predicting additional flow-generated noise where ducts (and attenuators) are sited inside high noise level plant spaces. Interspersed amongst this is a large quantity of previously unseen test performances relating to break-in and breakout transmission losses for P54 ▶

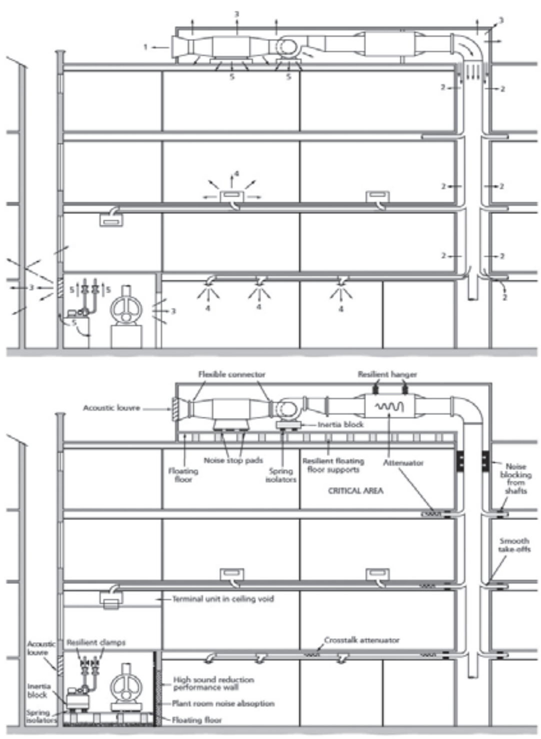


Figure 4.3 Noise from rooftop and ground level plant; (above) transmission paths, (below) possible means of attenuation

Figure 6: Excerpt of Figure 4.3 of Guide B4 (2016) (by kind permission of CIBSE)

Table 1.5 Recommended comfort criteria for specific applications

Building/room type	Customary winter operative temperatures for stated activity and clothing levels*			Customary summer operative temperatures (air conditioned buildings†) for stated activity and clothing levels*			Suggested air supply rate / (L·s⁻¹ per person unless stated otherwise)	Filtration grade‡	Maintained illuminance¶ / lux	Noise criterion§		
	Temp. / °C	Activity / met	Clothing / clo	Temp. / °C	Activity / met	Clothing / clo				NR	dBA§	dBC§
Airport terminals:												
— baggage reclaim	12–19[1]	1.8	1.2	21–25	1.3	0.6	10[2]	F6–F7	200	45	50	75
— check–in areas[3]	18–20	1.4	1.2	21–25	1.3	0.6	10[2]	F6–F7	500[4]	45	50	75
— concourse (no seats)	19–24[1]	1.8	1.2	21–25	1.3	0.6	10[2]	F6–F7	200	45	50	75
— customs area	18–20	1.4	1.2	21–25	1.3	0.6	10[2]	F6–F7	500	45	50	75
— departure lounge	19–21	1.3	1.2	22–25	1.2	0.6	10[2]	F6–F7	200	40	45	70
Art galleries — see Museums and art galleries												
Banks, building societies, post offices:												
— counters	19–21	1.4	1.0	21–25	1.3	0.6	10[2]	F6–F7	500	35–40	40–45	65–70
— public areas	19–21	1.4	1.0	21–25	1.3	0.6	10[2]	F5–F7	300	35–45	40–45	65–70

Figure 5: Excerpt from Table 1.5 of Guide A1 (2016) (by kind permission of CIBSE)

Advertising Feature

The business case for wellbeing buildings

John Spicer, technical sales manager for Armstrong Ceilings, discusses the market drivers and impact of building design and construction on occupant health, wellbeing and productivity.

The economics of the built environment have become as complex as building design. While they provide shelter, act as communication and data terminals, and are centres of healing, education, justice and community, buildings are expensive to build and difficult to maintain effectively over their life cycle.

Yet the business case for getting it wrong, in terms of a building being designed or performing so badly that it impacts on the health of the people who work in it, is obvious.

Some 90% of a typical business' running costs are staff so it makes sense to look after the health and wellbeing of employees but a study by the World Green Building Council into health, wellbeing and productivity in offices shows the impact of not looking after employees' health and wellbeing.

For instance, poor mental health costs UK employers £30 billion a year through lost production, recruitment and absence.

A 2014 study by the BCO (British Council of Offices), "Making the Business Case for Wellbeing", identified nine bugbears from office workers about their workplace conditions, and acoustics (too noisy in open plan) was one, if not the major, element. The repercussions of a noisy indoor environment were poor concentration/lower productivity. Certainly a study by Office Wars 2015 Orangebox found that when noise is over 85 dB ALL work suffers.

In areas requiring collaboration, ceiling canopies and vertical baffles are appropriate solutions to complement low/high furniture systems within and between areas while in areas requiring focus, mid to high sound absorption and attenuation-rated ceilings to complement moderate to high furniture panels can be considered. In areas requiring privacy, high attenuation and moderate absorption rated ceilings complemented by high attenuation rated walls are appropriate.

Here is where we need to make the case for user-centred design where individual team members consider the project holistically and how people will interact with it. The integrated approach is designed by the whole team at the same time so all options can be considered and improved upon.

Axiom Knife Edge Canopy with Axal Vector at 85 Gracechurch Street, London

Black Metal V-P500 Baffles at Ernst & Young's offices, Warsaw

◂ P52

various duct shapes and configurations, which would no doubt form a valuable arsenal of data for any building services designer.

Section 7 again reprises some already well-developed room acoustic principles, relating to building services noise prediction. The room acoustic characteristics presented in Figure 2 previously are once again revisited in this section but supplemented by an expanded set of source directivity corrections for terminal devices inside rooms of various configurations and receiver directivities at an angle away from normal incidence to the source.

Section 8 also sees some significant changes in the shape of predicting plant noise transmission to and from the outside, including that occurring for naturally-ventilated buildings. The advice given in this section is supplemented by outline advice given in other standards such as the revised *BS 8233* (2014 edition).

Section 9 *Criteria from noise from building services* too sees a few additions, notably in the form of advice on assessing the "noise quality" of building services and a timely revisit of oft-adopted metrics (such as statistical levels, dBA, dBC, NR and NC). Section 10 greatly enhances the noise prediction guidance by providing a step-by-step guide to the room noise calculation process. Here the well-versed "Shultz" method is given a revisiting, which effectively takes the classic room acoustic prediction method and reverses it, by starting with the target criterion and finishing with a maximum permissible sound power spectrum due to the sound source. By presenting both the classic and Shultz methods, the practitioner has the choice of adopting the method which suits best. The following subsection expands on Section 8, by further detailing building services noise transmission to the outside environment complemented by another useful step-by-step process illustrated by a worked example.

One of the main features of the guide, Section 11 on Vibration, gains several pages of additional data and information and sits nicely within the context of the updated guide. Whilst the fundamentals of building services vibration, and its control are well covered, the existing subsections on the rating of vibration emissions and associated limits, are now supplemented with the addition of a vibration isolation chart in Table 4.56, which greatly adds to the value of this section. Now the practitioner is able to identify in one comprehensive table, the various isolator minimum static deflections required by equipment type and mounting configuration, across several floor spans (in metres). This is in turn supplemented by a well-laid out image (Figure 4.57, courtesy of *Eurovib Acoustic Products Ltd*) presenting a number of typical vibration control solutions, updated from that provided in Guide B5 (2002) and reproduced in Figure 9.

The subsection on determination of loads for a mounted system is also given a remake with the addition of Figure 4.63 which provides a visual reference for determining the distribution of load for building services equipment, to four support points for a known centre of gravity location via percentages. Finally, the subsection on floating floors neatly tails the section off with a clean, visual representation of a typical "box in a box" floating floor solution.

However, the changes inherent in Guide B4 do not end there. Indeed, the appendices are where many aspects of the guide's innovations lie with regards to use by practitioners of all acoustic levels. Starting with Appendix 4.A1, a greater explanation is afforded to tonality of building services noise, how to treat duct-borne sound power and sound pressure levels, distinguishing between the intrinsic and positional directivities of sources and dealing with unweighted and A-weighted levels. Furthermore, Appendix 4.A3 expands on the previous advice given to the interpretation of manufacturers' noise data and supplemented by some up-to-date industry literature references and standards. The following appendices; Appendix 4.A4 "*Noise instrumentation*" and Appendix 4.A5 *Vibration instrumentation* are also vastly updated and present a plethora of invaluable measurement advice spanning; weighting networks, statistical levels, frequency and tonal analysis, calibration procedures, use of accelerometers and appropriate mounting techniques, amongst other related topic. ▸

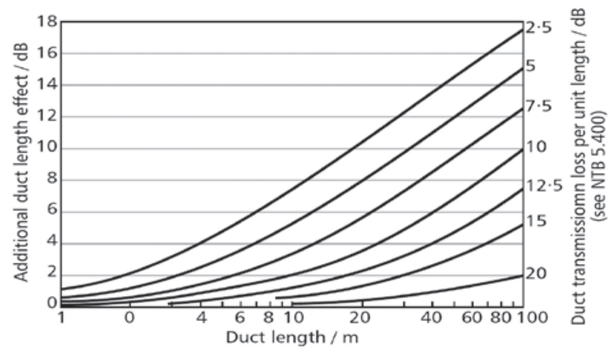


Figure 4.42 Additional duct length effect

Figure 8: Excerpt of Figure 4.42 of Guide B4 (2016) (by kind permission of CIBSE)

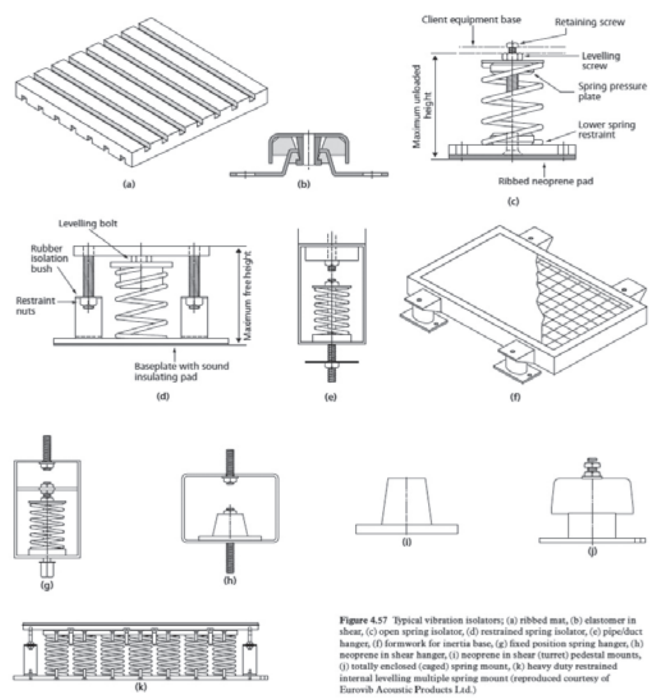


Figure 4.57 Typical vibration isolators; (a) ribbed mat, (b) elastomer in shear, (c) open spring isolator, (d) restrained spring isolator, (e) pipe/duct hanger, (f) formwork for inertia base, (g) fixed position spring hanger, (h) neoprene in shear hanger, (i) neoprene in shear (turret) pedestal mounts, (j) totally enclosed (caged) spring mount, (k) heavy duty restrained internal levelling multiple spring mount (reproduced courtesy of Eurovib Acoustic Products Ltd.)

Figure 9: Typical building services vibration isolators excerpted from Figure 4.57 of Guide B4 (2016) (by kind permission of CIBSE)

Table 4.17 Damper flow generated noise in duct (reproduced courtesy of Farex); to find the airflow generated SWL from single and double opposed blade dampers, first find the volume flow rate correction from column 2 and add this (or subtract if negative) to each octave band value found from appropriate centre or right hand columns

Volume flow rate / (m^3/s)	Correction / dB	Pressure across damper / (N/m^2)	Single opposed blade dampers: Damper flow generated SWL / dB for stated octave frequency band / Hz							Double opposed blade dampers: Damper flow generated SWL / dB for stated octave frequency band / Hz						
			63	125	250	500	1000	2000	4000	63	125	250	500	1000	2000	4000
0.03	–10.0	981	75	76	73	75	75	71	67	79	80	80	79	78	74	68
0.03	–9.5	932	75	76	73	75	75	71	67	78	79	79	78	77	73	67
0.03	–9.0	883	74	75	72	74	74	70	66	78	79	79	78	77	73	67
0.04	–8.5	834	73	74	71	73	73	69	65	77	78	78	77	76	72	66
0.04	–8.0	785	73	74	71	73	73	69	65	77	78	76	77	76	72	66

Figure 7: Excerpt of Table 4.17 of Guide B4 (2016) (by kind permission of CIBSE)

The final two appendices are new additions to the guide and relate to *The uncertainty in measurement and prediction of sound levels and sound power levels* (Appendix 4.A6) and "*The application of noise prediction software and integrated building design process*" (Appendix 4.A7). The former of which applies existing methodologies for quantifying the uncertainty in any prediction method (eg. the *ISO/IEC* Guide 98-3:2008 aka the "GUM") by emphasising the importance of applying such uncertainty methods when calculating any building services noise transmission processes. This is substantiated by numerous references to guidance documents and standards which would greatly assist the practitioner in this regard.

The last of the new appendices is devoted to both the emergence of prediction software which have risen in popularity since the publication of Guide B5 (2002) and, in reference to the origins of Guide B4, advancements of the integrated design process as championed by the BIM movement witnessed in recent years. The first subsection in particular, presents advice on how to approach building service noise prediction and modelling software, in terms of assessing the degree of accuracy of prediction methods which, whether part of a commercially-available package or conceived by a practitioner, would most likely be based on the same empirical guidance presented in Guide B4 and other sources. The final subsection, as alluded to, aims to thread the building acoustics discipline with the growing demand for an integrated approach to services design. Whilst many existing source of information exist on this topic, including well-documented standards (such as the *BS EN 12354* family of standards), a view on how existing acoustic practices might segue into newly-adopted design processes such as BIM are also presented, including some useful web-based resources to assist the practitioner's further learning.

Conclusions

In all, the valuable information presented in the latest CIBSE Guides B4 and A1 should be seen as a significant step up compared with their immediate predecessors, particularly where previously unearthed building service noise and vibration test data and guidance, has now been made available for the first time which includes a vastly updated set of references. It is worth noting at the conclusion that, based on previous experience, CIBSE Guides are not revised on a "regular" basis (ie. typically every 10 to 11 years). Therefore, the intention stands that the current offerings should remain as widely adopted by all building services designers, both in the UK and overseas, for many years to come just as their predecessors did once before. All CIBSE Guides and knowledge documents can be obtained by visiting; http://cibse.org.uk/knowledge/cibse-publications.

***Alex Krasnic MIOA**, an Acoustics Consultant at Vanguardia, specialises in architectural acoustic design, planning and licensing acoustics and noise and vibration control of building services and renewables for all built environment projects. He sits on the IOA Building Acoustics Group and Education Committee and chairs the IOA working group for the Good Practice Guide on the Control of noise from Places of Entertainment.*

***Dr Bob Peters FIOA** is Principal Acoustics Consultant for Applied Acoustic Design, and is Senior Research Fellow at London South Bank University. He is also the Distance Learning Tutor for the Institute of Acoustics Diploma course at St Albans.*

Soldata acoustic division wins £2.5 million 'super sewer' contract

Soldata's acoustic division has been appointed as the noise, vibration and air quality specialist for the east section of Thames Tideway Tunnel, London's new "super sewer".

Soldata will provide a comprehensive environmental consultancy service including a range of technical documentation to support the construction of the project, a joint venture between Costain, VINCI Construction Grands Projets and Bachy Soletanche.

It will also implement and manage an extensive programme of noise, vibration and dust monitoring at each of the six main work sites throughout the seven-year construction period.

The Tideway east contract involves construction of two sections of tunnel and five large shafts which intercept the existing overflows of untreated sewage that currently enters the River Thames. Overall, the £4.2 billion project has 25 kilometres of tunnel through central London and requires 24 work sites.

Soldata will be assisted by ACCON-UK to execute the £2.5 million contract, a partnership designed to manage the joint venture's project noise, vibration and air quality requirements.

Frederic Delafosse, Soldata Acoustic's General Manager, said: "We are extremely proud to be a part of this prestigious project and build on our previous successes in the tunnelling sector including Crossrail, Grand Paris and Rennes Metro.

"This contract is one more step towards the achievement of our growth strategy launched six years ago, with the creation of our acoustic division in London."

One of the Thames Tideway tunnels

Gary Wickens, Soldata's UK Environmental Division Manager, added: "We look forward to assisting Tideway in overcoming the challenges associated with delivering an ambitious construction programme within central London."

Brüel & Kjær noise system flies high for Dassault Aviation

Dassault Aviation has performed noise certification tests on its new Falcon 8X business jet, using an acoustic data acquisition and analysis system from Brüel & Kjær.

Exterior aircraft noise certification tests are required by aviation regulators. The tests establish certified aircraft Effective Perceived Noise Levels (EPNLs) for each of the flight conditions: approach, flyover and sideline.

The Brüel & Kjær system uses three GPS-synchronized data acquisition stations that are distributed around the test area. They communicate via WiFi, and are controlled from a central monitoring station.

Each remote location measures and records noise and has a webcam, and one station monitors weather data. The central monitoring station controls the data acquisition, uploads data, interfaces to flight-track data and layered weather data, and calculates results.

The system is based on the modular Brüel & Kjær PULSE LAN-XI data acquisition hardware, which provides the measurement data for the official calculation of EPNL levels. This data is corrected, 1/3rd octave noise measurements compliant with the requirements for aircraft noise certification measurements in accordance with ICAO Annex 16, Volume I, amendment 9.

Brüel & Kjær's system can also compute EPNL values including background noise, flight track and weather corrections for test validation and management of the tests. While these calculations are not usable for ICAO compliant certification like the 1/3rd octave noise measurement data is, they help testers ascertain their data is valid before ending the test.

The system can also calculate intermediate results such as OAL, PNL, PNL Tmax, PNLT curve and 10 dB down points, which are used during aircraft development testing to ensure designs are on target to meet their requirements.

For more information go to **www.bksv.com/Markets/Aerospace/Airframes/NoiseLegislation**

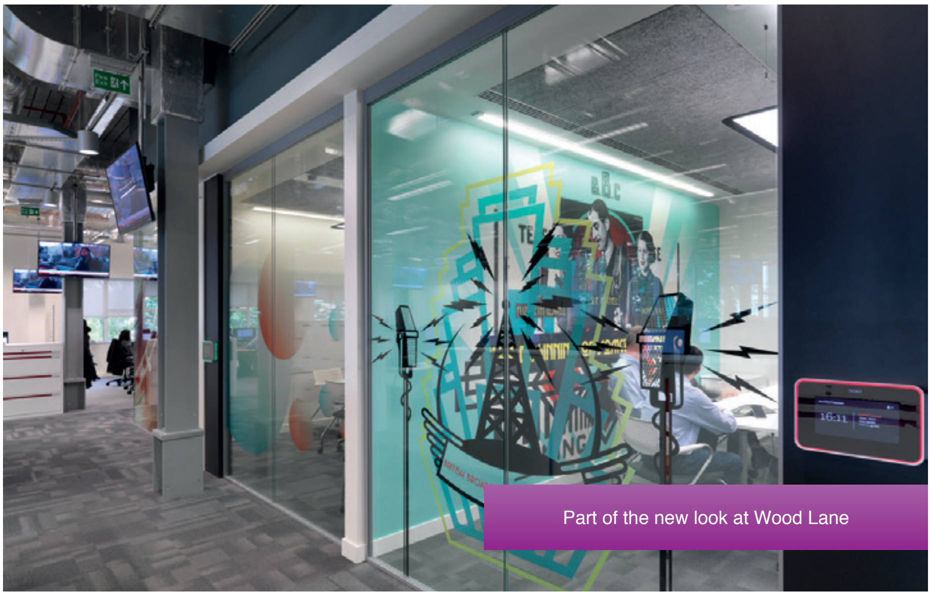
The Falcon 8X business jet

Troldtekt panels specified for new look BBC TV Centre

Troldtekt acoustic panels were specified to refurbish the interior of the BBC TV Centre at Wood Lane, London.

The panels were used to line all the ceilings and the soffit around the circular atrium. They were fitted to wood battens fixed to the concrete ceiling as ceiling panels. Prior to fixing, the fine structure panels were factory painted by Troldtekt in a light grey finish.

Troldtekt acoustic tiles can be delivered as either FSC or PEFC certified panels.



Part of the new look at Wood Lane

They are manufactured using 100% natural wood. Available in various sizes and in three grades from ultrafine to coarse, they can be left unpainted or painted in virtually any RAL colour.

For more information ring **01978 664255** or visit **www@troldtekt.co.uk**

Sound & Vibration Technology and Discom join Brüel & Kjær stable

Brüel & Kjær Sound & Vibration Measurement A/S has acquired long-term UK partner Sound & Vibration Technology.

And in another move, it has bought Discom, the German-based producer of automotive transmission sound and vibration test systems for acoustic quality analysis at the end of production lines.

Sound and Vibration Technology is based at the Millbrook proving ground in Bedfordshire where its sound and vibration engineers provide engineering services for automotive and aerospace customers.

Staff will continue to be based at Millbrook which has facilities to support service projects such as numerous test tracks, secure vehicle workshops and a semi anechoic test chamber facility.

The acquisition includes all its assets, which means the team is equipped to support a diverse range of data acquisition, analysis and Noise Vibration Harshness (NVH) Full Vehicle Simulation projects.

Richard Johnson of Sound & Vibration Technology said: "Since we founded the company in 2003, we have enjoyed solid growth with a core group of customers throughout Europe and Asia, many of whom are already utilising Brüel & Kjær test equipment.

"Being an integral part of Brüel & Kjær now allows us to better serve global customers, whilst ensuring that the experiences gained from services are leveraged in future product developments to deliver better NVH solutions."

The acquisition is in line with Brüel & Kjær's policy to strengthen its engineering service capabilities to better serve both original equipment manufacturers (OEM) and suppliers.

Alan Humphrey, Brüel & Kjær Sound & Vibration Measurement A/S's Vice President, Automotive, said: "Our customers want to make more informed and rapid NVH decisions, whether it's in concept development, design development or production management.

"The acquisition is another step change in our capability to deliver high end engineering services, building upon the 2015 acquisition of Sound Answers Inc."

Referring to Discom, he added: "This acquisition is a key step in implementing our strategy to enhance our solutions for automotive customers across both R&D and production testing, leveraging our unique sound and vibration expertise to help customers further optimize their vehicles."

Millbrook proving ground

Echo Barrier clinches huge US distribution agreement

Echo Barrier has secured a distribution deal with US-based United Rentals, the world's largest equipment rental provider, which will see its acoustic barriers made available across the globe.

Echo Barrier products are used by some of the world's biggest construction companies, at sites such as World Trade Centre in New York and on the London Underground.

Peter Wilson, Technical Director, said the agreement was a "monumental landmark" in the company's growth. "United Rentals can get our products in front of huge markets across the world with relative ease, which will significantly grow our business," he said.

"We have been working with the team in the States for a long time to try to get the deal right to benefit both parties and we are thrilled to have finally signed on the dotted line."

Echo Barrier launched its first barrier in 2010 and since then two improved versions have been produced, while a generator acoustic enclosure, H20 Acoustic tent, the zero-rated barrier and the transparent barrier have also been added to its portfolio.

Echo barriers in use in London

Acoustical Sensing and Imaging

By Hua Lee

Review by John Shelton

Acoustical imaging is currently a burgeoning area in the field of sound and vibration R&D as well as trouble-shooting noise sources. A variety of techniques has been brought to bear over the years, such as sound intensity mapping, using two-microphone probes, but the method has always been time-consuming and assumed stationarity, as well controlled field reactivity.

More recent developments, such as direct measurement of particle velocity, have reduced the need for a controlled environment, and have found a niche in trouble-shooting applications such as automotive squeak and rattle.

Whilst transducer arrays have normally been only affordable by the huge aerospace and automotive companies, and to a large extent the military, particularly underwater, the availability of lower cost, yet stable, sensors, as well as huge advances in digital signal processing have brought array techniques into the mainstream.

The first "acoustic cameras" appeared in commercial form around 10 years ago, and since then, almost every major acoustic instrumentation manufacturer has something to offer in beam-forming and holography applications. Over that time, the issues have been the same; spatial resolution, time resolution, frequency resolution, field dependency, Doppler shift, and so on.

Professor Hua Lee, of the University of California, Santa Barbara, is well-placed to discuss these issues, with a long background in imaging system optimisation, image formation algorithms in applications ranging from tomographic radar imaging to acoustic microscopy. He has already published widely with books dating back to 1986, but this new book is targeted at engineers who need a concise review of the technical elements, and it can also serve as an undergraduate textbook.

The 115-page book kicks off by using an underwater acoustics application for exploring bearing-angle estimation, either by using a single source and multiple receivers or vice-versa. Using a high performance signal processing technique (Hilbert transform pairs), the efficiency of the calculation can be greatly improved, while reducing the hardware requirement.

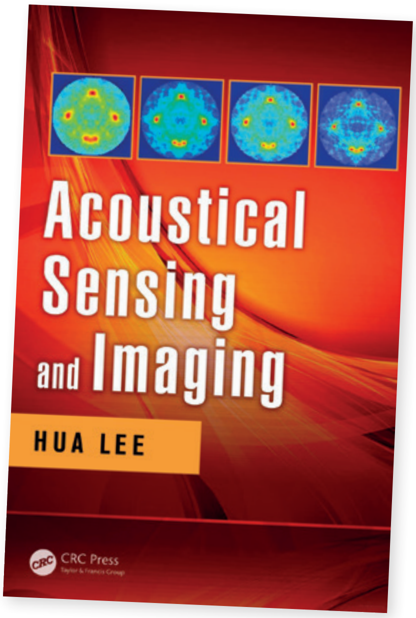
This discussion serves to move the reader into the theoretical meat of the book, by modelling the wave propagation and scattering, and leading to the classical backward-propagation method which forms the backbone of many systems. Warning – the core of this involves a lot of mathematics, but complex ideas such as Fresnel and Fraunhofer approximations are dealt with clearly, although additional graphics could help with some of the concepts.

Once the basics are covered (perhaps the word 'basics' is understating it!), the book moves on to acoustical imaging applications, such as acoustic microscopy and pulse-echo imaging, with a direct example given of sonar imaging, for sea-bed image reconstruction. A medical ultrasound example is also given.

The last part of the book is concerned with image enhancement, once the image has been reconstructed, and covers subjects such as removal of phase errors, statistical methods and motion estimation, each illustrated with graphical examples.

Although angled towards ultrasound and underwater applications, much of the theory and enhancement is appropriate to classical acoustics, and developers, rather than users, will find this useful.

In summary, this is a useful and well-written book, which will prove a handy reference for those working in the field of imaging, regardless of bandwidth.



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MBE for Sue Bird in Queen's Birthday Honours


Sue Bird

Long-serving IOA member Sue Bird was made an MBE in the Queen's Birthday Honours for "services to engineering and to women in engineering both in the UK and abroad".

She has twice been President of the Women's Engineering Society (WES) and is a former Chairman and President of the Association of Noise Consultants. A member of the Institute since its formation in 1974, she played a leading role in setting up its first CPD scheme.

"The MBE was a complete surprise, and I am very honoured to receive the award," she said. "The reaction from friends and colleagues has been wonderful, especially as I have only done what I have enjoyed doing, with people I like. Hopefully it will be another small step in raising the profile of engineering, and women in engineering."

Sue started her career in acoustics in 1970 at the British Aircraft Corporation, after gaining a BSc in Applied Physics at Coventry Polytechnic. There she worked on flyover noise from BAC 1-11s, VC10s and Concorde. After four years she moved on to join the Greater London Council (GLC) in its Scientific Branch, doing general consultancy work involving any noise issues which impacted on the capital, but finally worked mainly in architectural acoustics, specialising in acoustics in educational buildings.

After the demise of the GLC she formed her own consultancy, where she was joined by her husband, Peter, after a few years. There she specialised in noise for planning purposes, architectural acoustics, transportation noise, noise nuisance and expert witness work on noise induced hearing loss. She retired in 2008.

She said she has always felt that there were too few women in engineering, and that an increase would not only benefit women themselves but also the engineering profession, commerce and society. In addition to her WES involvement, in 2002 she was instrumental in setting up the International Network of Women Engineers and Scientists (INWES) and was its President from 2008 – 2011.

Martin Rawlins to spearhead BASWA's UK sales drive


Martin Rawlins

Martin Rawlins has been appointed as head of UK sales by Swiss-based BASWA acoustic AG.

The appointment means the acoustics products specialist now has a direct presence in the UK, where it sees "huge potential for growth".

Martin, previously sales and marketing manager at Acoustic GRG, will support the existing installer network and focus on building sales for BASWA's range of acoustic surfaces, including new products such as the thermal-acoustic offering BASWA Cool.

BASWA, founded in 1991, is based in Baldegg, Switzerland. Its markets include government, education, leisure, airports, museums and galleries, commercial and high end residential.

The products are used in projects such as the Elbphilharmonie in Hamburg and the Rolex Learning Centre in Lausanne, as well as others by Zaha Hadid, Herzog & DeMeuron, Jean Nouvel and Norman Foster.

Scientist wins award for work in bio-acoustic inspired technology


Dr Rob Malkin
Image courtesy of the British Science Association

Dr Rob Malkin has been awarded this year's British Science Association Isambard Kingdom Brunel Award Lecture 2016 for his work in bio-acoustic inspired technology.

By studying insects with fascinating hearing organs, he suggests improvements to the design of microphones found in smart phones, hearing aids and many other technological devices used regularly today.

He said: "Microphones are really common but their designs still show serious drawbacks. By looking to the natural world for inspiration, we can design and build bio-inspired acoustic devices beyond our own imaginings."

Dr Malkin, from the Department of Mechanical Engineering at the University of Bristol, will be delivering his lecture on 8 September at the British Science Festival at the University of Swansea.

He completed his PhD in Engineering at Bristol in 2012 working on bio-inspired materials, followed by a three-year post-doctoral research project looking into bioacoustics and modelling of biological materials. Today he works collaboratively with biologists across the world looking for more solutions to engineering challenges.

Obituary

Laurence Gerald Haslam (1954-2016): Esteemed acoustician and retired partner of Sandy Brown Associates

By Stephen Stringer

Laurence Gerald Haslam (1954-2016)

Born on 18 July 1954, Laurence Haslam was educated at Maidenhead Grammar School, achieving 13 O levels and 3 A levels. He went on to graduate from the University of Exeter in 1976 with a 2:1 Honours BSc in physics before studying for a PhD in acoustics at Chelsea College.

Whilst completing his PhD, he heard of a vacancy at Sandy Brown Associates. He applied in 1979 and was granted an interview, which obviously went well as he was then invited to an office party where and I quote from his subsequent offer letter that "it would give you the opportunity to see the firm with its hair down". The letter went on to say "we work you hard but we also have the opportunity to relax occasionally". Needless to say, Laurence accepted a position as Senior Acoustic Engineer and never lost this mantra.

Within two years of joining, Laurence's ability and value to the firm even at so early a stage in his career was apparent. In autumn 1981, it was noted that "Laurence, in his capacity as Senior Acoustic Engineer, is extremely valuable to the firm and even if our workload showed signs of severe decline we would still retain him, as he has qualities very difficult to find".

In 1987, Laurence relocated to Edinburgh in order to run the South Queensferry office and was made a Partner in 1993. It was here that I first met him. At the time, he was advising on the acoustic design of the proposed new Waterfront concert hall in Belfast and I was fortunate enough to be taken under his wing to assist in the development of the design. As a result, I made regular trips to the Edinburgh office and to Belfast with Laurence, benefitting substantially from his immense knowledge of architectural acoustics whilst applying my rather limited knowledge of building services design under his watchful eye.

During his 35 years with the firm, Laurence advised on many other high profile projects including Edinburgh International Conference Centre, Edinburgh Festival Theatre, Scottish Ballet, the Scottish Parliament and the award-winning Theatre Royal, Glasgow. He also published and presented numerous papers at IOA conferences.

Laurence was a quiet, modest and unassuming man who never sought the limelight, even often appearing embarrassed when praised. When he had something to say, however, everyone listened.

He was highly respected by clients, colleagues and industry peers alike. No matter how busy, he was always willing to help and provide guidance to less experienced staff. Indeed, it was a known fact that any internal technical requests via round robin e-mails would often be answered by Laurence who would inevitably come up with some gem of information from his vast knowledge, wide experience and extensive library.

Away from the office, his interests included classical music, playing the organ, hill walking and maintenance of his beloved MG which he continued to enjoy following his retirement.

Laurence was one of the nicest, kindest and most considerate people you could ever hope to meet both professionally and personally. I had the fortune to do both.

All of us at Sandy Brown Associates are deeply saddened by his passing yet extremely grateful at having had the opportunity to work (and occasionally party) with such a special person.

Sreenivas Narayanan to spearhead Siderise Middle East sales growth

Sreenivas Narayanan

Siderise has appointed Sreenivas Narayanan as Sales and Business Development Officer for the Middle East and India.

Based in Dubai, Sreenivas, or "Sreeni" as he is known, joins Siderise from partner General International where he was product manager. With over a decade of industry experience and a deep knowledge of Siderise products and the Middle Eastern market, he will be responsible for growing the company's customer base in the region.

Chris Hall, Commercial Development Officer at Siderise, said: "As we continue to build on our presence in the region, Sreeni's expertise, talent and enthusiasm will be invaluable in taking us forward and to meet the needs of our customers."

Rik Lewis joins Merford as account manager for Midlands and the North

Rik Lewis

Industrial noise control specialist Merford has appointed Rik Lewis as account manager for the Midlands and the North. He joins Gary Dawson, Account Manager for London and the South.

Previously working at Industrial Acoustics Company, Rik Lewis was responsible for sales of acoustic products and solutions to the industrial and power and transmission market segments, including acoustic enclosures, barriers and doors.

Olivier Wallien, Merford Business Unit Manager, said: "We've identified two prevalent trends making noise control an urgent need: the 'merging' of commercial and industrial spaces with residential areas, and the fact that the public is no longer willing to 'put up' with excessive noise."

Campbell Associates clinch exclusive UK rights for EM2010

Campbell Associates have secured the sole UK distributor rights for Sonitus Systems' EM2010 automated noise monitoring system.

Campbell say the device, which allows users to remotely access data anywhere from any device, is particularly useful on construction and demolition sites.

Features include:

- IEC 61672 Class 1 measurements
- Add users and manage rights access data online
- Can be integrated with dust monitoring solution
- SMS and email alerts
- Real time automatic upload and display of data
- Weather data from logged automatically with sound level data
- Audio recordings allow for noise source identification
- Plug and play – once power has been connected the system is running.

The web-based platform also allows consultants to brand their website giving customers a secure and reliable platform to monitor noise data whilst engaging with the brand.

For more details email **hotline@campbell-associates.co.uk**

The EM2010

New version of doseBadge from Cirrus Research

The Mark V doseBadge

Cirrus Research has unveiled a new version of the doseBadge noise monitor, the Mark V.

The latest model has a wide range of new USPs including: increased wireless technology so the doseBadge can be connected via a mobile phone or App on a IOS or Android controlled device; with information being downloaded using this Bluetooth type of technology.

The reader unit has detailed data-logging facilities that can be specified down to the second, rather than the previous one-minute window.

The Mark V also now has intelligent charging with the device controlling its own charger to combat overcharging so it can prolong battery life to more than 12 hours and now includes an anti-tamper and vibration device to cut down on anomalies.

New opportunities available to join us in...

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5
offices are currently recruiting

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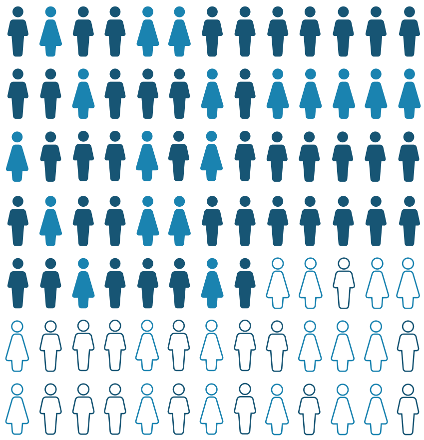

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year average length of employment

46
countries providing extensive opportunities for you

10,000
of the best ongoing global projects to work on

10%+
profit, reinvested in business, employees and R&D

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Committee meetings 2016/17

DAY	DATE	TIME	MEETING
Tuesday	**13 September**	**10.30**	**Council**
Monday	26 September	11.00	Research Co-ordination
Wednesday	12 October (TBC)	10.30	Engineering Division
Thursday	13 October	11.30	Meetings
Thursday	20 October	11.00	Publications
Thursday	27 October	10.30	Membership
Tuesday	1 November	10.30	Diploma Tutors and Examiners
Tuesday	1 November	1.30	Education
Wednesday	2 November	10.30	CCENM Examiners
Wednesday	2 November	1.30	CCENM Committee
Wednesday	2 November	10.30	CCBAM Examiners
Thursday	3 November	10.30	CCWPNA Examiners
Thursday	3 November	1.30	CCWPNA Committee
Tuesday	8 November	10.30	ASBA Examiners (Edinburgh)
Tuesday	8 November	1.30	ASBA Committee (Edinburgh)
Tuesday	15 November	10.30	Executive
Tuesday	**6 December**	**10.30**	**Council**
Thursday	12 January	11.30	Meetings
Thursday	19 January	10.30	Membership
Thursday	02 February	11.00	Publications
Thursday	02 March	10.30	Diploma Tutors and Examiners
Thursday	02 March	1.30	Education
Tuesday	07 March	10.30	Diploma Examiners (London)
Wednesday	09 March	10.30	Medals & Awards
Wednesday	09 March	10.30	Executive
Wednesday	**22 March**	**10.30**	**Council**
Tuesday	28 March	11.30	Meetings
Wednesday	05 April	11.00	Research Co-ordination
Tuesday	11 April	10.30	CCWPNA Examiners
Tuesday	11 April	1.30	CCWPNA Committee
Thursday	27 April	10.30	Membership
Thursday	11 May	11.00	Publications
Thursday	18 May	10.30	CCHAV Examiners
Thursday	18 May	1.30	CCHAV Committee
Wednesday	24 May	10.30	Executive
Wednesday	**14 June**	**10.30**	**Council**
Tuesday	20 June	10.30	CCENM Examiners
Tuesday	20 June	1.30	CCENM Committee
Tuesday	20 June	10.30	CCBAM
Wednesday	21 June	10.30	Distance Learning Tutors WG
Wednesday	21 June	1.30	Education
Tuesday	27 June	10.30	ASBA (Edinburgh)
Thursday	06 July	11.30	Meetings
Thursday	03 August	10.30	Diploma Moderators Meeting
Thursday	10 August	10.30	Membership

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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