Volume 50 No 1 January/February 2024

ACOUSTICS BULLETIN

1974–2024

Institute of Acoustics
Sound • Noise • Vibration

ACOUSTICS BULLETIN

Acoustics Bulletin Volume 50 No 1 January/February 2024

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Institute affairs

Features

Technical articles review procedure

All technical contributions are reviewed by an expert identified by the IOA Publications Committee. This review picks up key points that may need clarifying before publication, and is not an in-depth peer review.

Regular

Cover image: This year, we celebrate the 50th anniversary of the Institute of Acoustics. So in each issue of Acoustics Bulletin during 2024, we will travel back in time to see where we started and how we progressed over the decades to become the highly topical, balanced, impartial, and respected institution we are proud to be members of today. Page 37

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, electroacoustic, engineering dynamics, noise and vibration, hearing, speech, physical acoustics, underwater acoustics, together with a variety of environmental aspects. The Institute is a Registered Charity no. 267026

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Dear Member

Firstly, I would like to wish you all a very happy New Year! A time for reflecting on the year past and looking forward to the year ahead. Perhaps some past disappointments may come to mind, but also many achievements, and now is the time to reset, and launch into 2024, our 50th anniversary year. It is planned to offer many and varied 50th anniversary activities throughout the year, so you should keep an eye out for opportunities to take part and get involved.

As we start this anniversary year, we reflect on the past by taking a look at the IOA in the 1970s! You will find this in the archive section (page 37). Over the next few issues of Acoustics Bulletin we will continue to present archive material from past decades, which I hope will give you a taste of what it was like to be involved in acoustics during the formative years of our Institute. I'm sure you will find this informative, surprising and, at times, probably amusing!

Conferences

It was a great finish to 2023, with conferences in both October and November. **Acoustics 2023** took place in October and it was our first fully 'live' annual conference since 2019! I had the privilege of welcoming a capacity attendance to the wonderfully historic venue of The Guildhall in Winchester (thank you to the Meetings Committee for your venue planning). Later in this issue (page 16) you will see that we delivered a programme with 66 papers, over a huge range of topics: ecology, beer gardens, honeybee hives, musical therapy, machine learning, sustainability and net zero, artificial intelligence, sleep and health, construction management, mental wellbeing, lifts design, road, rail and air transport, and school design. My observation at the time was that anyone presented with this list, would seriously struggle to come up with what on earth such a conference was about! The giveaway, I suppose, were the inevitable BS 4142 papers! A big thank you to Linda Canty, Martin Lester and those assisting them from the Specialist Groups who put the programme together.

The conference in November was another classic **Reproduced Sound event (RS23)**, with its inimitable brand mix of relaxed informality and robust academic technical presentations. I was particularly pleased and privileged to present the Peter Barnett Memorial Award to Angelo Farina, University of Parma, Italy, and an Honorary Fellowship to Jamie Angus-Whiteoak. Jamie then carried on to 'kick-start' the conference with her presentation, which was a personal refection, titled '*A life in electro-acoustics.*' All interested in this field should note that this year's **RS24** will be a celebration of their 40th anniversary!

I started off by saying this was a time for reflecting on the year past and looking forward to the year ahead. We held our final 2023 Council meeting in December and I was delighted to welcome on board two entirely new Council Members. They are Matthew Torjussen (ANV Measurement Systems) and Jim McIntyre (Scottish Environmental Protection Agency). At this meeting we reviewed our progress in delivering our 2023-24 strategic aims, and also considered papers on the future direction of our Institute with respect to governance, educational services, and international engagement. We have achieved much, but there is much still to do.

Challenges and opportunities

In closing, I would like to acknowledge that none of what we achieve is possible without the commitment and hard work of our staff and members who give so much of their personal time in service to our Institute. It is clear that the coming year will not only be a celebration of past achievements, but I believe it will be the beginning of an exciting new chapter for our Institute. One with significant challenges, but also huge opportunities to develop and grow. Watch this space, get onboard and enjoy the ride!

Warm regards,

Alistair Somerville, IOA President

Engineering Division

The IOA Engineering Division will support you through the process to help you become one of almost 229,000 registrants that hold international professional recognition.

By Blane Judd BEng FCGI CEng FIET FCIBSE, Engineering Manager

When you first approach us about becoming registered, we send you the guidance document, together with the new additional support report examples.

We are always ready to comment on the content of your professional review report prior to submitting the final draft and will always comment on submissions and ask for re-drafted versions where necessary, but to avoid an iterative process, try to include evidence that shows you have the underpinning knowledge related to the projects you have submitted. For example, if you have selected a particular software to conduct modelling, explain why you chose it, what the shortfalls are, what results you were expecting and how you validated the outputs.

It is vitally important for candidates to look at UK SPEC 4 when drafting reports. The steps you need to take are clearly indicated in the guidance document we send so please take the time to study it as it will tell you exactly what documents are needed, and which items need to be endorsed by your sponsors. It also explains what to do if you cannot find IOA members to act as your sponsors. You can check the copy of UK SPEC 4, here: **https://www.engc.org.uk/ukspec**

You can check if your qualifications meet the required specification by visiting the Engineering Council website (**http://www.engc.org.uk/courses**).

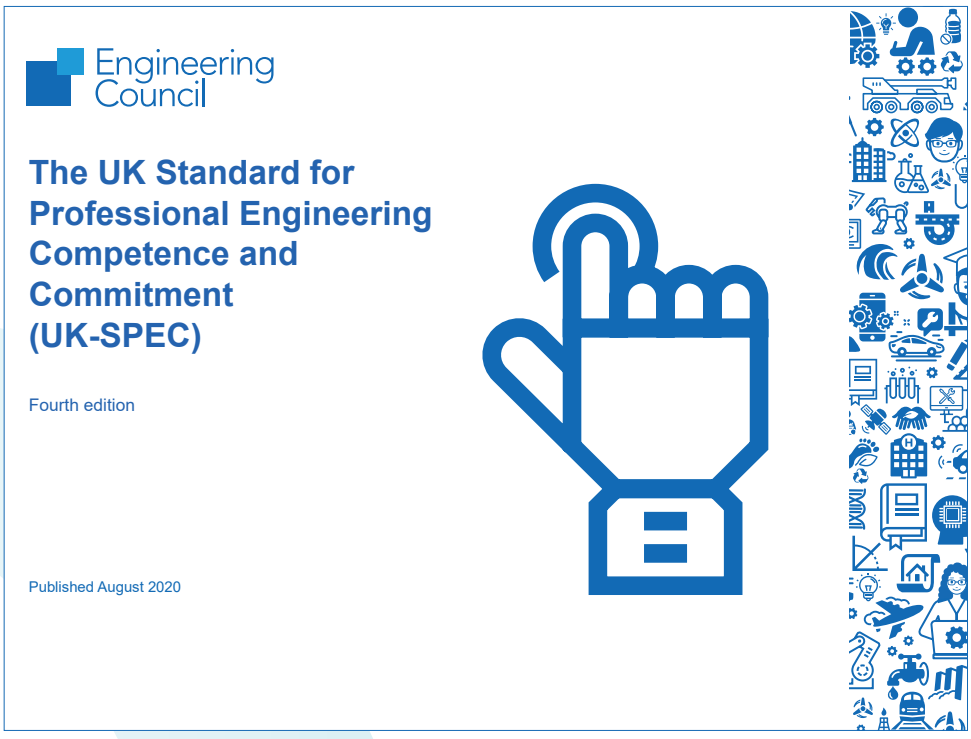
Below:
We are now interviewing using the Engineering Council UK SPEC version 4

But please don't panic if your specific qualification is not listed, as we can still help you through the process using individual assessment (see later in the article). For those seeking chartered status, the IOA Diploma is a way of demonstrating that you have attained the master's level (M level) learning if you do not have the academic qualifications to M level and you graduated after 1999. Please also see the table on page 7 for Incorporated Engineer recognised qualifications. It is a requirement that you have three merits one of which must be General Principles of Acoustics to be able to meet the M level requirements.

There are other routes such as experiential learning in the workplace, but we will deal with those on a case-by-case basis.

Interviews

We hold several interview events through the year, depending on the number of candidates we have coming forward for registration. If you are interested in taking the next step to becoming a professionally registered engineer, email us at **acousticsengineering@ioa.org.uk** sending a copy of your CV and copies of certificates and transcripts of your qualifications. It is important that we have all your further and



higher education certificates (not A-Levels) and not just your highest attainment, training courses are not relevant at this point.

There are two routes to registration:

The **recognised qualification** route, if you have achieved the required learning outcomes through recognised qualifications in acoustics. Qualifications which provide the required level of knowledge and understanding are for IEng and accredited Bachelor's degree and for CEng an accredited integrated Master's degree or a combination of accredited Bachelor's and Master's degrees (see table right).

The **individual assessment** route, for applicants who do not have the recognised qualifications and who will have an individual assessment of their qualifications and any other relevant learning such as: formal academic programmes, in-employment training and experiential learning self-directed learning. In many instances, it is likely to be a combination of some or all these options.

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

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

The Institute recognises the IOA Diploma course and the several Master's courses linked to it as providing evidence if you are looking to gain CEng registration. You could also offer a PhD qualification, depending upon the content of the associated taught element. We can also offer support for registration via a 'technical report' route, if you do not have the relevant qualifications to help you demonstrate you are working as a professional engineer in acoustics. If you need to follow the technical route, we will discuss this with you before you embark on that process.

Recognised qualifications

Incorporated Engineer (IEng) One of the following:	Chartered Engineer (CEng) One of the following:
An accredited Bachelor's or honours degree in engineering or technology	An accredited Bachelor's degree with honours in engineering or technology, plus either an appropriate Master's degree or engineering doctorate accredited by a licensee, or appropriate further learning to Master's level*
An accredited Higher National Certificate (HNC) or Higher National Diploma (HND) in engineering or technology started before September 1999	An accredited integrated MEng degree
An HNC or HND started after September 1999 (but before September 2010 in the case of the HNC) or a foundation degree in engineering or technology, plus appropriate further learning to degree level	An accredited Bachelor's degree with honours in engineering or technology started before September 1999
A National Vocational Qualification (NVQ) or Scottish Vocational Qualification (SVQ) at level 4 that has been approved by a licensee, plus appropriate further learning to degree level*	Equivalent qualifications or apprenticeships accredited or approved by a licensee, or at an equivalent level in a relevant national or international qualifications framework†
Equivalent qualifications or apprenticeships accredited or approved by a Licensee, or at an equivalent level in a relevant national or international qualifications framework†	

* See: **www.engc.org.uk/ukspec4th** for qualification levels and HE reference points.

† For example, UNESCO's International Standard Classification of Education (ISCED) framework.

Election process

The election process is overseen by the Institute's Engineering Division Committee, which is made up of volunteers from the membership. They represent the ever-growing number of members holding EC registration and provide the essential peer review process that affirms that you are at the appropriate level for recognition as an Engineering Council Registered Professional Engineer.

Turn to page 8 to read about the most recently qualified professionally registered engineers.

Our video explains how members can gain professional recognition and Engineering Council registration through the IOA.
https://www.ioa.org.uk/video/recognising-your-professionalism-0

Engineering Division

Engineering Council

Left:
Cesar Bustos CEng

Below:
Philip Hainsworth CEng

Cesar Bustos

Cesar graduated from the Universidad de San Buenaventura in Bogotá, Colombia, in 2012 with a BEng in Sound Engineering.
He then continued his academic journey by pursuing an MSc in Acoustics with Environmental Applications at the University of Salford in 2013. Subsequently, he started his career as an acoustics consultant at Arup in 2014. At Arup, he has primarily focused on large-scale infrastructure projects, such as the A66 Northern Trans-Pennine Project, high speed train modelling where he provided support to the team by engaging in numerical techniques and, more recently, Cesar has been involved in a remarkable project dedicated to rebuilding schools in Perú.

He initiated the CEng certification process in 2021, a decision driven by his growing experience at Arup and his ability to demonstrate the required CEng competencies. He said: "Achieving CEng status marks a significant milestone in my career, as it is highly respected within the industry and reflects my commitment to the profession. This process also offered me an invaluable opportunity for self-reflection, allowing me to assess my achievements since joining Arup and consider my future career aspirations.

"I strongly recommend that fellow acoustics consultants pursue the CEng qualification — it is a great achievement and IOA provides all necessary support throughout the journey.

"Although I was a bit nervous during the interview, it ultimately turned into a fruitful conversation with other experts in the field, offering a unique opportunity for constructive cross-examination without the usual project-related pressures."

Philip Hainsworth

Phil is a chartered engineer and Associate at AtkinsRéalis, with around 12 years' experience in acoustics, noise, and vibration engineering consultancy. He is Chair of the IOA Midlands Branch and an industrial mentor at Birmingham City University. Throughout his career, he has had experience of working with multi-disciplinary engineering design teams on significant infrastructure projects in the UK, North America, and Middle East.

Prior to attending university, Phil worked in live events as a sound engineer, this experience of sound and electronics, plus an interest in mathematics and science, lead to him enrolling on a Bachelor of Science degree in sound, P10

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light and live event technology at the University of Derby in 2007. It was as a student that Phil attended 'The Art of Being a Consultant' IOA conference, which captured his imagination and encouraged him to pursue the career as an acoustic consultant. From this point, Phil tailored his undergraduate studies to maximise the acoustics and electroacoustics content and decided to continue further academic study with the IOA Post-Graduate Diploma in Acoustics and Noise Control, and Master of Science in Applied Acoustics at the University of Derby.

In 2012, Phil started as a graduate acoustician at Atkins in Birmingham. Over the following years, Phil worked on a range of building acoustics and environmental noise and vibration projects supporting Atkins' global design teams. This work has, at times, required working abroad in other countries (including Saudi Arabia, Qatar, and UAE). Phil is now the team lead for the Birmingham AtkinsRéalis acoustics team and manages noise and vibration inputs to projects, particularly within transportation, energy, and industrial sectors. Project highlights include managing the acoustics and noise assessments for the Trillium Line Extension railway in Ottawa (Canada), the investigation and abatement of road traffic noise on TS-1 highway in Jubail (Saudi Arabia), and numerous client-side support roles on High Speed 2 in the UK.

On professional registration, Phil said: "Chartership for acousticians can be daunting, however, engineering competencies, including the application of engineering principles, research and innovation are routinely undertaken on our inputs to infrastructure design projects. Other competencies around leadership, interpersonal skills and professional commitment can also readily be demonstrated by the additional volunteering roles many of us take on, such as being on IOA/ANC committees or being a STEM ambassador. The IOA and volunteers on the Engineering Committee are there to help and have been invaluable at encouraging me to get my professional registration over the line."

Right:
Adam Woolley
BEng(Hons)
CEng MIOA

Adam Woolley

Adam is a sonar engineer at Thales, developing underwater systems for anti-submarine warfare and mine countermeasures. He joined Thales straight after graduating from the University of Salford with a BEng(Hons) in Audio Acoustics in 2018. Now, alongside his day job, Adam is studying part-time for a PhD in ocean acoustics at the University of Southampton.

Adam said: "Going through the process of IEng registration last year was good preparation for my CEng application this year. The process was identical (just with a tougher marking scheme!) I was even prepared for the interview question about codes of conduct, which caught me completely off guard the first time around.

"My application consisted of documents signed by both myself and my mentor (who needed to be a Chartered Engineer themselves). These documents included my CV, CPD record, development action plan, organisation chart (a flow chart showing my place in the company hierarchy), degree certificate and transcript, an initial professional development (IPD) report, which was used in place of an MEng degree to demonstrate that I had a baseline level of knowledge that would be expected of an applicant (I was able to use the same IPD report from my IEng application) and finally, a professional review interview (PRI) report, which detailed my work on engineering projects where I demonstrated the required competencies of a Chartered Engineer.

"The final step was to defend my PRI report over a Zoom interview, where a panel of engineers challenged me – in rather relaxed and informal tones – to provide further details which backed up my claims of competence.

"To invoke what I wrote in an Acoustics Bulletin article last year – the qualification of CEng is a mark of professional credibility that I am proud to display after my name. I am most grateful to the IOA and to Thales for their support in achieving this career milestone."

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IOA EVENTS FOR 2024

Organised by the Measurement and Instrumentation Group
MEASUREMENT IN BUILDING ACOUSTICS
27 February 2024
BCTA, Loudwater

Organised by the Early Careers Group and UKAN+
THE ART OF BEING A CONSULTANT
21 March 2024
National Oceanography Centre, Southampton

Organised by the Early Careers Group and UKAN+
THE ART OF BEING AN ACOUSTICIAN
22 March 2024
National Oceanography Centre, Southampton

Organised by London Branch
ARTIFICIAL INTELLIGENCE FOR ACOUSTICS
22 May 2024
London South Bank University, London

Organised by the Underwater Acoustics Group
ICUA2024
International Conference on Underwater Acoustics
17-20 June 2024
University of Bath

ACOUSTICS 2024 - 50TH ANNIVERSARY CONFERENCE
12-13 September 2024
Manchester Metropolitan University

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

Approved Membership Applications

The Membership Committee reviewed 44 application forms on 23 November 2023 at their last Committee meeting of the year, held at AECOM offices in London. 24 corporate applications have recently been approved by the Council following the recommendations of the Membership Committee. The Committee saw 18 new candidates joining the IOA, the remaining applications came from members upgrading. The Membership Committee also welcomed a new sponsor.

FIOA

Ryan Arbabi	Angela Lamacraft
Ben Dymock	Tim Ward

MIOA

Ben Baddour	Stefan Marshall
Maxim Billingham	Laurence Nickolls
Filippo Ciarla	Beatriz Nogueira
Laura de Azcarate Rodriguez	Mostafa Ranjbar
Rob Eadon	Michael Ridley
Jason Gallimore	Seena Sajeev
Stuart Griffith	Daniel Shaw
Samantha Griffith	Baldeep Rai Sohal
Daniel Hagan	Ben West
Bailey Hoare	Oliver Wright

AMIOA

Aondokaa Angir	Kevin Lynch
Lucus Antippa	Robert Murray
George Baker	Mihindukulasuriya Perera
Andrew Brooks	Becky Pidsley
Grady Cook	Luc Retour Rose
Ecaterina Delendrea	Nicklaus Oon Xin Tan
Abigail Ehrlich	Kalyani Tendulkar
Anantha Girijavallabhan	Jose Vasquez
Cian Grunfeld	Rowe Will
Jackson Vui Kee Ho	Fook Yee Nicole Yeung
Robert Kirkwood	Jihui (Aimee) Zhang

TechIOA

Philip Campbell	Luke Lloyd
Donogh Casey	Mark Pimlett
Miguel Cartuyvels	Stuart Ross
Andrew Hunt	

Affiliate

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Chuen Yoong Max Kuah	Diana Rogers
Stephen McDonagh	Annamarie Schooling
Caroline McKinlay	Laura Warren

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SCAN ME

A social media STEM campaign — Lottie's acoustics work experience

The IOA joined in with the Women's Engineering Society (WES) Lottie Doll campaign, as part of Tomorrow's Engineers Week (TEWeek) in early November 2023.

By Vicky Wills

On the lead up to Tomorrow's Engineers Week the IOA STEM Committee arranged for Lottie dolls to carry out work experience at acoustics-related companies, including consultancies, universities, and loudspeaker manufacturers.

They collected as many pictures of Lottie's work experiences as possible and, in advance of TEWeek, created montage videos using the pictures, as well as volunteer profiles and banners for the campaign. In addition a blog and an article for the November/December IOA Bulletin was written as the tour progressed (**https://www.ioa.org.uk/ioas-wes-lottie-tour-tomorrows-engineers-week**)

Social media support

Behind the scenes STEM Committee members rallied support and enthusiasm for the campaign amongst the 30 organisations that had taken part, to encourage them to post their own pictures – as companies or individuals. There were no strict rules on what could be created for the campaign on social media, and it was brilliant to see videos, blogs and creative photographs uploaded on all platforms throughout the week.

The campaign went live on 6 November 2023, and here are some of the statistics from the campaign:

There were around 100 posts about the WES Lottie Tour in total, and 25% were from acoustics professionals using #AcousticianonaMission, and many were reposted by WES, EngineeringUK or the company that make Lottie dolls, as well as other acousticians. Nine accounts posted about acoustics at least once, in addition to the IOA, and most of these posts were seen by around 100 to 700 accounts, with one being seen by almost 4,000 (thanks Edinburgh Airport). In total the posts by the IOA account had 5,888 impressions and 252 interactions.

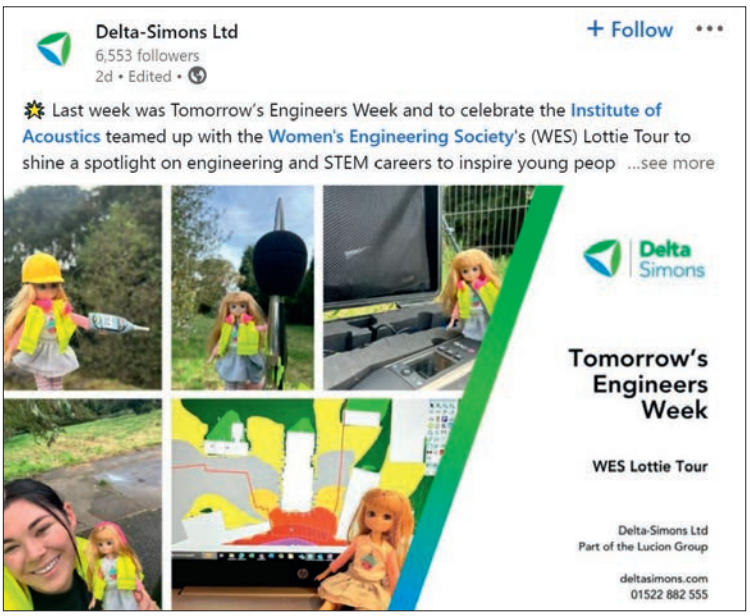
Three accounts posted on Instagram, with eight posts in total – three reel videos and five photos on the grid. The IOA posted four reels on Instagram, including one from Careers Hive and the three montage videos, and these were viewed between 100 and 500 times each.

Although the IOA TikTok account is quite new, each of the montage videos was viewed between 200 and 250 times. On Facebook the IOA posts reached almost 3,000 people in total.

The most popular social media platform for this campaign was LinkedIn, for both content from acousticians and reach. The posts from the IOA page were seen by almost 8,500 people, with 224 interactions, leading to a spike in visitors and views on the IOA page. In addition there were 49 posts throughout the week about the campaign from 18 different organisations.

In summary this has been a really successful campaign for STEM, as well bringing the industry together and showing a huge range of careers that are available in acoustics-related fields. It is wonderful to see what we do when we all work together for our industry, so do get in touch if there are other campaigns that we should get involved with (like noise awareness day), as well as letting us know if you would like a doll for the 2024 campaign, at **stem@ioa.org.uk**

Below:
Lottie at Delta-Simons Ltd

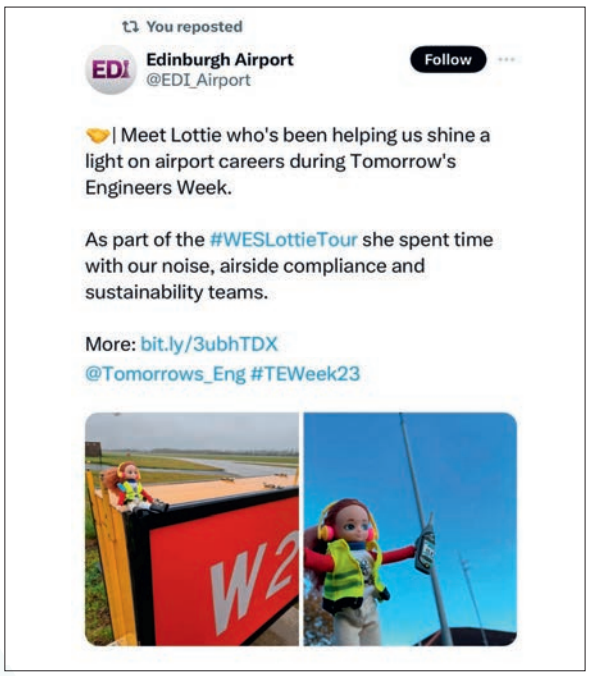


Above:
Busy at BSRIA

Huge thanks go to all the amazing organisations that took part: AECOM, Aercoustics Engineering Limited in Canada, ANV Measurement Solutions, Apex, Arup, AtkinsRéalis, BSRIA, Clarke Saunders, Create Consulting Engineers, CDM Stravitec, Delta Simons, Dyson, Edinburgh Airport, Kings College London, KP Acoustics, Loughborough University, Marshall Day in Australia, Masimo (Bowers and Wilkins), NDY in New Zealand, New Acoustics, Ramboll, RBA Acoustics, RPS Group, Sandy Brown, SRL Technical Services, Stantec, Sustainable Acoustics, Thales, Tymphany, University of Sussex, Vanguardia (A Buro Happold Company) and WSP, as well as all the individuals that got involved in the campaign, and the ANC and UKAN+ for promoting it.

Below:
RBA Acoustics welcomed Lottie

Below:
Lottie at Loughborough



Above:
Lottie flying high

Acoustics 2023

The IOA annual conference was held on 16 and 17 October 2023 at Winchester Guildhall, a venue with enough space and split of rooms, along with the character of an older building giving a presence to the events held in the different spaces.

Report compiled by Martin Lester, Chair of the IOA annual conference

Last year's annual conference was the first in-person conference that the IOA had held since the 2019 conference at Milton Keynes' Stadium MK venue.

The very good attendance of just over 200 delegates on each day, shows that IOA members are up for meeting again in-person. We also had a remote hub in Edinburgh (with six delegates) who had a live stream of the 'Room 1' presentations, and who were able to ask questions via the session chair.

The conference was opened on the first morning by Alistair Somerville, IOA President, who also chaired the award lectures.

Above: IOA members gathering for Acoustics 2023

With the conference being a bit of a catch-up event, delegates were treated to two Rayleigh Medal lectures: *Environmental Noise, Health and Cognition* by Stephen Stansfeld of Queen Mary University, London (2023 recipient) on day one; and *From Sound Propagation to Sound Perception* by Jian Kang of University College, London (2022 recipient) on day two. Both these are available to view by all via the IOA website.

For the rest of the conference there were four parallel sessions, with all the usual IOA Specialist Groups having at least a session each. My thanks go to the Specialist Group Chairs and Session Chairs (and committees) for their time in helping to make the conference happen in the first place and helping it progress smoothly:

- *Environmental Sound Group* – Steve Mitchell;
- *Measurement and Instrumentation Group* – John Shelton;
- *Speech and Hearing Group* – Gordon Hunter;
- *Physical Acoustics Group* – Keith Attenborough and Shahram Taherzadeh;
- *Musical Acoustics Group* – Stephen Dance and David Sharp;
- *Building Acoustics Group* – James Healey and Adrian Popplewell;

P18

Sound Masking

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- *Noise and Vibration Engineering Group* – Naomi Tansey and Matt Torjussen;
- *Sound, Noise and Health Group* – Benjamin Fenech; and
- *Early Careers Group* – Josie Nixon.

Apologies to anyone that I have missed in this list, it certainly isn't intentional. In addition to the above, it was a pleasure to have pupils and staff from St Oscar Romero Catholic School (the IOA Secondary School Competition Winners for 2021 and 2022) presenting a paper on *The IOA Schools' Competition on Soundscapes: Student Learning and STEM Engagement.* Thanks go to Angela Lamacraft who has headed up the IOA School Competition since its conception in 2020.

As always at the IOA annual conference, there were a good number of exhibitors (20 in all). These were split between the Bapsy Hall (where refreshments were served and the conference dinner held) and the rear of the King Charles Hall. The exhibitors this year (by table number) were:

- AcSoft
- Cirrus
- Mason UK
- Sound Reduction Systems
- Aecom
- SEPA/Environment Agency/ Natural Resources Wales
- PSI Audio
- AMC Mecanocaucho
- CDM Stravitec
- Acoustic Camera UK
- Getzner
- HEAD Acoustics
- Campbell Associates
- Hottinger Brüel & Kjær
- Christie & Grey
- CMS Danskin
- ANV Measurement Systems
- Castle Group Ltd
- GERB UK, and
- NTi Audio.

The IOA AGM was held at the end of the technical sessions on the first day.

The conference dinner was held on the Monday evening with just over 150 attendees, and although it was a sit down dinner, it was less formal than previous years as there were no awards presentations. This was because the IOA held a separate awards lunch (which took place at the Kennington Oval Cricket Ground on the 19 April 2023). However, at the end of the conference dinner Alistair Somerville (IOA President) gave a short speech to thank all those involved in organising the conference.

Four of the IOA Specialist Groups held their AGMs during the conference:

- Environmental Sound Group;
- Musical Acoustics Group;
- Measurement and Instrumentation Group; and
- Sound Noise and Health Group.

The IOA Engineering Committee also held a lunchtime drop-in Chartered Engineer workshop on both days.

On the more 'social' side of the conference, there was a get together on the evening prior to the first day at the Bishop on the Bridge public house organised by the Early Careers Group, and sponsored by Getzner, so that buddies and mentors (within the buddy scheme coordinated by Josie Nixon) could meet up before the conference opened. Other delegates and members of local acoustic consultancies also joined this event.

A summary of each IOA Specialist Groups presentation, written by the Session Chair(s) is given below.

Environmental Sound Group – Steve Mitchell

What makes a noise limit acceptable?

By S W Turner (Stephen Turner Acoustics Limited) (ST Acoustics)

Stephen Turner opened the conference proceedings with a fascinating insight into the challenges in setting noise limits. He reminded us that policy refers to preventing unacceptable effects, but does not refer to what is acceptable. 'Acceptability' varies greatly between individuals so is not a good term to use. Limits are only useful if they are enforceable, and quite likely noise effects would arise below the limit anyway. Overall, great care is required in considering numerical noise limits and the consequences of setting them.

Environment Agency noise regulation

By J Tofts (Environment Agency)

Jon's presentation explained the standard Environment Agency (EA) condition for noise emission that applies to permits on regulated activities: *'Emissions from the activities shall be free from noise and vibration at levels likely to cause pollution outside the site, as perceived by an authorised officer of the Environment Agency, unless the operator has used appropriate measures, including, but not limited to, those specified in any approved noise and vibration management plan to prevent or where that is not practicable to minimise the noise and vibration.'*

He explained that the noise had to be judged as perceived, and that the EA regulates pollution on a sliding scale from major, significant, minor, and no impact. Unlike planning there is no acceptable limit but the requirements to use best available techniques, so EA requirements could be different those of the planning authority.

Method Implementation Document for BS 4142

By J Smyrnowa, G Brown, T Clayton, and J Tofts

The second presentation from the Environment Agency was given by Julia Smyrnowa. The agency receives about 2,000 noise assessments that use BS 4142 each year and an analysis showed that 60% were extremely poor, and only 5% were adequate. Hence, the Agency has produced a Method Implementation Document to help those carrying out assessments for EA-regulated facilities. The guidance covers aspects of the BS most commonly misused such as:

- measuring the specific sound level;
- the fact existing site noise must not be included;
- a rating level must be audible;
- observations should take priority over calculations; and
- assessing the context is crucial.

Predicting BS 4142

By Matt Torjussen (ANV Measurement Systems), Patrick Hoyle (WSP), Jo Webb, Antonio J Torija-Martinez, and David C Waddington, (University of Salford)

Matt Torjussen's presentation summarised a research project for Defra into modelling acoustic features at remote assessment locations, and whether this would result in improved reliability in the numerical 'initial estimate' element P20

of BS 4142 assessments for planned developments. He described the Auralization Lite tool that they had developed to synthesise samples of background noise, new noise with various characteristics, and the results of a survey of 44 participants judging the character corrections from what they heard compared to the character corrections calculated using the BS 4142 reference method. Some, including those with experience, judged correction to be lower than calculated.

Lessons learned monitoring noise during construction of the HS2 Colne Valley Viaduct and Chiltern Tunnels, being delivered by ALIGN JV.
By A Bird, G Hales (ALIGN JV, UK), and Q Arnaud (Sixense, UK)

Andy, Graham, and Quentin shared some of the lessons learned while monitoring noise during the construction of the Colne Valley Viaduct and Chiltern Tunnels being undertaken by the ALIGN Joint Venture (ALIGN JV), including the south portal site, HS2's largest construction site, which is the size of 80 football pitches. More than 90% of noise monitoring with 22 monitors was registering above the trigger limits set in the Section 61 prior consent, but when listened to, this was usually due to noise other than construction noise. Listening to such a mass of triggered samples was not feasible, so a noise recognition algorithm (NORA) was developed to analyse the triggered noise samples.
The software was successful in identifying 85% of the triggered samples as **not** construction noise, allowing the team to focus on the important noise samples that may be construction noise that could require further noise control.

The science of soundscape – summary of the evidence base from the UK acoustics community
By Peter Rogers (Sustainable Acoustics), F Aletta (UCL), K Attenborough (Open University), C Bentley (Sharps Acoustics), J Harvie-Clark (Apex Acoustics), J Kang (UCL), L Lavia (Noise Abatement Society & Heriot Watt University), A J T Martinez (University of Salford), S R Payne (University of Surrey), and G Waters (Tranquil City)

Peter explained how he had been involved in providing evidence to the House of Lords Science and Technology Committee on *The effects of artificial light and noise on human health*. As well as noise effects evidence that has been presented to the committee, he and a learned group of IOA members had compiled a paper summarising knowledge about the effects of soundscapes, but this had not appeared in the committee report. The UN Frontiers 2022 Report recognises soundscape assessment as one of the forward-looking aims for the acoustic industry to be focusing on. Peter gave some diverse examples of where a soundscape assessment can be valuable including:

- designing noise barrier and water features;
- fair and equitable dispersion of aircraft flight paths;
- bus routes in Brighton;
- road traffic movements around Trafalgar Square;
- a park restoration; and
- tranquillity in urban Bristol.

Questions and discussions suggested that the soundscape standards, including those referred to in the Welsh Government guidance, are now available, and training and application are the next steps.

Below: Alistair Somerville, IOA President, opening Acoustics 2023

Habitats: Developments in managing the ecological impacts of noise on wildlife habitats for sustainable development
By David C Waddington, Michael D Wood, William J Davies, Robert J Young, and Margret Engel (University of Salford, UK)

David summarised the outcomes of a workshop at the University of Salford in December 2022, which focused on the development of a UK network on anthropogenic noise impact assessment on wildlife in the context of sustainable development. Research using the feedback from the workshop had identified 46 knowledge gaps, the most pressing of which included:

- developing assessment methods;
- classifying groups; and
- developing indicators for acoustic diversity etc.

Without filling the considerable gaps in our knowledge, we will not be able to fully develop acoustic mitigation measures to assist in sustainable development. David suggested nonetheless we should develop a good practice guide based on what we do know, to help us contribute to development projects in the meantime.

Acoustic benefits of green infrastructure in urban areas – a rapid evidence review

By G L Waters (Tranquil City, UK), C Wood, D Mohith, J Nauman (Anderson Acoustics, UK), B Piper (Acoustic Sensor Networks, UK), A Murdock (Maploom, UK), H Notley, and L Marazzi (Defra, UK)

Grant presented a comprehensive report of the main findings of another Defra-funded project, that had rapidly reviewed over 250 papers on the various acoustic and non-acoustic benefits of green infrastructure. The evidence of positive benefits is substantial, but so far has not been compiled in such a way as to allow policy and guidance on acoustic design to develop. The presentation gave ample examples of the types of green infrastructure giving benefits to soundscape and, importantly, not just sound levels but how sound is perceived, including:

- strategic planning of green infrastructure in towns/cities;
- green and natural spaces;
- vegetation and tree belts;
- vertical greenery systems;
- green roofs; and
- blue spaces.

Key findings included the importance of considering perceptual benefits to sound and noise exposure (e.g. phsycological benefits equivalent to around 10dB noise benefit), the need to optimise designs to maximise their acoustic potential, but also the need for further in-situ studies to understand how contextual and built-environment design considerations are important in ensuring acoustic performance.

Integrating acoustics engineering and soundscape design for an urban park: A case study

By Jack Harvie-Clark, Rebecca Romeo Pitone, and Luis Pereira, of Apex Acoustics Ltd, Gateshead, UK, and Andrew Mitchell, Institute for Environmental Design & Engineering, UCL.

Jack described an urban park design project in Stockton-on-Tees, where a soundscape assessment had been undertaken to inform acoustic mitigation design measures in addition to a conventional noise assessment. Surveys had been conducted at two locations using a questionnaire based on soundscape standard ISO 12913 and psychoacoustic measurements. The results showed similar noise levels at the two sites, but the soundscape was perceived as chaotic and loud near the city centre but calm near the riverside. Road traffic noise barriers were designed to improve pleasantness ratings and speech intelligibility in the amphitheatre near the waterfront. The study demonstrated the value of integrating soundscape assessments with standard acoustic analyses to optimise sonic environments. It also highlighted limitations around predicting soundscape perception and collecting sufficient survey data, and that further work is needed to standardise methods.

Measurement and Instrumentation Group

By John Shelton

The Measurement and Instrumentation Group held an 'Ask the Instrumentation Expert' panel session at Acoustics 2023. The session brought specialists from the world of sound and vibration instrumentation and measurement together to answer questions from conference delegates.
The panel consisted of M&I Committee members:

- **Simon Bull** (Session Chair), MD of Castle Group Ltd;
- **John Shelton** (M&I Group Chair), MD of AcSoft Ltd;
- **Charles Greene** (co-opted member), NTi Audio Ltd;
- **John Campbell** (M&I Committee member), Campbell Associates Limited; and
- **Mike Breslin** (co-opted member), ANV Measurement Systems.

In true 'Question Time' tradition, Simon Bull opened with a brief biography of each panel member followed by an introduction by M&I Chairman, John Shelton.
The session then moved straight on to questions starting with a pre-submitted one from Richard O'Sullivan of Acoustic Camera UK Ltd on the relative benefits and limitations of modern acoustic cameras. The panel members were quick to hail the visualisation of noise as having huge benefits in many applications although it was stressed that low frequencies still pose a problem due to the size of array required to resolve at the lower end. There was some discussion about the possible standardisation of this technology and it was agreed that cameras were an engineering tool for determining relative levels rather than establishing absolute sound pressure or power values.

The next question from Professor Andrew Hugill, PhD, PFHEA, NTF, the Deputy Director, Institute for Digital Culture, School of Computing and Mathematical Sciences at the University of Leicester, asked how instrumentation takes account of the difference in perception of a profoundly deaf person, a cochlear implant wearer, someone who has tinnitus and an autistic person with hyperacusis. The initial thought from panel members was that instrumentation was capable of producing measurements to any number of criteria, but that these have not been clearly defined in terms of people with such differences.

It was noted that the capabilities of instruments are dictated by the requirements of practitioners rather than the other way round and that, even when considering ontologically normal listeners, the industry standard is still A-weighted sound pressure level despite more sophisticated metrics that have been available for many years.

Follow up questions and comments from the audience then led to the thought that more research is needed into the difference in perception for many groups in society, be this driven by age, gender, disability, or any other category of interest.

Dr Mostafa Ranjbar of Cranfield University asked if it might be possible to dynamically determine the surface conditions of airport runways by acoustic means. The panel discussed the use of an impedance tube or looking to the research carried out by the Transport Research Laboratory with a special trailer that could measure surface acoustic properties whilst moving. After a little discussion, the possibility of using sound cameras and AI to 'learn' what signals constituted a potential problem for aircraft wanting to take off or land was raised. It was suggested that this was another potential area for research. P22

The last pre-submitted question came from Mark Kubis of Acoustica, who asked if noise dosimeters are capable of capturing peaks properly without missing any of the signal, perhaps even by mechanical inertia in the microphone. The panel discussed the fact that electrically, so long as an instrument fully complies with IEC 61252, then there is no reason to think that it would miss any of the waveform. It was pointed out, however, that much of the testing for this standard does not include the microphone, so diaphragm inertia could possibly be an area for further consideration.

There was a supplemental question on whether modern, 'cheap' imported sound meters or phone apps were any good these days. The panel pointed to work carried out by the M&I Group, which tested six 'catalogue type' meters claiming IEC 61672, none of which passed all the tests conducted, especially for tone-burst testing. They were still, however, better than most phone app combinations, which can be more than 30dB out. John Shelton came to the defence of his iPhone app, which he said gave good frequency determination and did at least allow users to compare one sound to another.

The foregoing text covers the main topics discussed. The final part of the session involved open questions from the floor which led to a wide-ranging discussion.

Papers

Three papers were offered for the Measurement and Instrumentation session, the first being a paper from Feargus Flanagan of Dragonfly Acoustics on comparing methods of predicting beer garden noise from measured data. Feargus was helped out by colleague, Chris Chittock, and although the practical side of measuring in beer gardens initially sounds attractive, many measurements were made over an extended period at antisocial hours!

Existing guidance was reviewed and measurements made in 18 gardens and two terraces of $L_{Aeq,5min}$.

A broadly linear relationship was established between sound power/square metre/hour, and people/square metre. Values L_w of 67dBA (lunch) and 74dBA(evening) were established, although it was implied that additional data has been derived subject to commercial confidence.

The second paper was presented by Daniel Lurcock of ISVR Consulting, covering input terms for use in strategic noise models of railway noise. After a review of prediction standards and methods, Daniel described the various noise generation mechanisms on trains, such as rolling noise, and aerodynamic noise from e.g. pantographs, and how this can become more important with noise barriers.

The rolling noise is obviously dependant on rail roughness and needs to be taken into account in the prediction terms. The measurement of these elements was described using a microphone array trackside at different heights.

Finally, Richard O'Sullivan of Soundcam UK, presented some case studies of acoustic camera measurements in different applications to illustrate how this technology has 'come of age'. Barely short of being a commercial presentation, there were no comparisons with other techniques such as holography or optical methods, so it was unclear how the technique had matured while being around for nearly 30 years.

Some useful examples were shown for thermal cracking, air leaks, and air lines in factories, implying that high frequency sources are preferred for the beamforming technique.

As is often the case, the terminology often confuses, with 'dynamic range' bearing no relation to our normal idea, but merely a colourscale range for display purposes. The method does, however, provide fast qualitative results without providing anything more useful, such as sound power, with any accuracy.

The session was recorded and is available to members of the IOA. Anyone interested in reviewing this event can find it on the IOA website at **https://www.ioa.org.uk/**

If anyone is particularly interested in any of the topics mentioned in this report, then please contact the IOA for one of the panel members to answer your question directly.

Speech and Hearing Group – Gordon Hunter

This session featured three talks on topics related to speech and hearing although, this time, two of those related primarily to non-human hearing!

Professor Stephen Dance of London South Bank University (LSBU) presented work largely carried out by a group of LBSU MSc students, but supervised by him and his colleagues on investigating the effect of direction of the sound source relative to the direction the listener was facing, on the intelligibility of human speech in both quiet and noisy rooms of various reverberation properties, using listeners from both first and second language English-speaking communities.

Stenford Ruvinga and Gordon Hunter (Kingston University) gave a talk about work they undertook in collaboration with Agsenze Ltd, NGO Nature Development Ghana and Kwame Nkrumah University of Technology (also in Ghana) on investigating whether computational methods developed and optimised for the processing of human speech were suitable for processing and analysing the sounds made by honeybees in situations of interest, such as the queen bee dying or the bees preparing to swarm. Their study included a comparison of the sounds made by various types of African honeybees with those made by European honeybees.

Finally, Professor David Waddington (Salford University) gave a comprehensive review and meta-analysis of research on the impact of noise on birds. He noted what had been identified as 'best experimental practice' for eco-acoustic monitoring by experts, but also that there was great variation in the experimental procedures employed by researchers in the field, with very few studies coming close to complying with that 'best experimental practice' standard! Such variation between the methods used makes direct comparison between the results of different studies very difficult.

Physical Acoustics Group – Keith Attenborough and Shahram Taherzadeh

The first presentation in the morning session by Chris Feuillade concerned a novel time domain investigation of the validity of Babinet's principle for a system of two half planes, by applying and

adapting the Biot-Tolstoy theory for the acoustic impulse response of a wedge. Babinet's principle predicts that the diffraction amplitude from a half plane is cancelled exactly by diffraction from a complementary half plane. It was demonstrated theoretically that, while the principle holds if the planes have opposite reflectivity, it does not hold, and there is a small residual field, if the half planes have the same reflectivity.

The second presentation by Haydar Aygun was a preliminary investigation of a Spatial Fourier Transform method for deducing the reflection coefficient of a finite sample of porous material as a function of angle using the Johnson-Allard-Champoux (JCA) model. A novel feature was to include an angle dependent tortuosity. It is planned to use the method to investigate the acoustical performance of a composite 'sandwich' material.

The last presentation of the morning session by O. Loa Aranda was a review of the likelihood of damage to flood defences from vibratory impact piling. The review encompassed the importance of geotechnical conditions and ground settlement.

The afternoon session started with a pair of presentations from the Open University on acoustic surface waves above rough periodic surfaces. The first by Shahram Taherzadeh was on modelling of the speeds of audio-frequency surface waves. He presented methods of deducing phase and group velocities and compared them with data.

The second paper was presented by Keith Attenborough and was on the study of spectra of sound pressure above a periodic rough surface and the features attributed to surface waves. Several models such as Boundary Element Method and Modal models developed to predict surface waves above such a surface were explored.

There was a lively discussion about the physics of surface waves during the Q&A and Keith A gave a brief history of measurements observing acoustic surface waves.

Next paper, given by Dr Mostafa Ranjbar of Cranfield University, was on modelling a dragonfly wing and the noise generated by the wing. It was It was shown that the vein and wing structure changes stiffness along its length which, in turn, affects sound generation. Structures have been fabricated to mimic this variable stiffness, and sensitivity analyses using FEA software were shown and discussed.

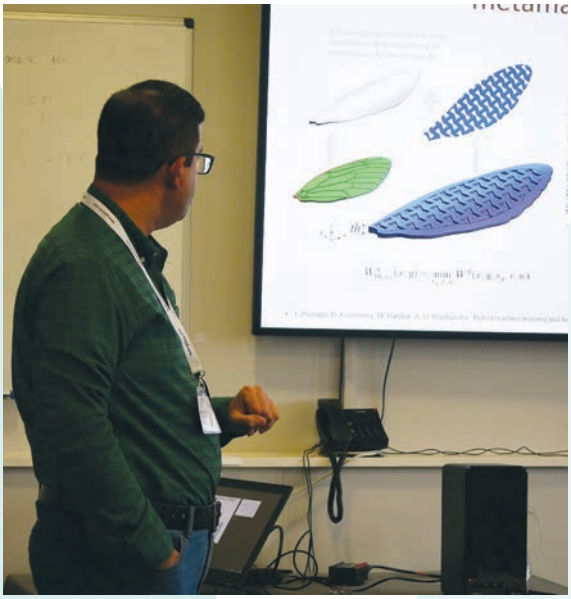
The next paper was presented by Jah Shamas, a PhD student from University of Sheffield about using Baysian inference approach for inverse problems. Their experiments on mechanical vibration of thin structures showed that uncertainties exist for which engineering-based models are not adequate. Hence a novel Approximate Baysian Sequence — sequential Monte Carlo method is proposed for parameter estimation.

The final talk in this session was by Jamie Scanlan, a PhD student from Salford University on modelling tibia bones in humans to determine strength.
This can be used in the diagnosis of bone diseases such as osteoporosis in elderly populations. The aim was to understand response of tibia to impact and its link to bone strength. He showed several Finite Element models of a tibia and discussed the complexities of vibration modes of the bone due to its varying cross-section and size of the bone ends. So far, they have modelled the bone as a simple elastic material. Their next step is to model it as a porous-elastic medium.

Musical Acoustics – Stephen Dance and David Sharp

The first two sessions organised by the IOA Musical Acoustics Group were chaired by Stephen Dance, and the final session of the day was chaired by David Sharp.

The room was overflowing for the first presentation by Peter Wheeler of the Open University, on mitigating the low frequency sound from festivals. The technology, a mixing desk plugin (currently patent pending) would reduce environmental noise overspill by 3dB while maintaining the audience visceral experience. The second paper of the morning was presented by Thea Strother, based on her University of Salford graduate dissertation on a psychoacoustical experiment involving 80 students (45 of whom were musically trained). The experiment explored whether their perception of pitch was fundamental-based or harmonics-based, and whether it was affected by different reverberant conditions. The final paper was given by Patrick Gaydecki, University of Manchester, on behalf of Erdem Atbas, on converting video to sound using a texture based-algorithm. This sonification was intended as an aid for the visually impaired. The data reduction – demonstrated on a test video of a stag running through P24



Above:
Dr Mostafa Ranjbar of Cranfield University

Below:
(L-R) Session Chair, Stephen Dance with Patrick Gaydecki, University of Manchester

water and forest – was of the order of 1:1000, but it did sound like an old-fashioned 1980s modem!

After lunch the IOA Musical Acoustics Group AGM was held, with David Sharp taking the minutes. Several attendees asked to be added to the mailing list, indicating a strong interest in the activities of the Group.

The afternoon session started with a presentation by Andrew Morgan, a music therapist, who provided anecdotal evidence of the medicinal benefits of music and followed this with a demonstration of the soothing sounds of bronze Tibetan bowls. Jonathan Kemp of the University of St Andrews then talked about windings of metal strings, particularly for bass guitars, and how the bridge permanently deforms the string. He explained that the string needed to be non-linear in shape to account for this deformation, in order to uniformly produce the necessary harmonics. The final paper of the session was by Patrick Gaydecki on his freshly-launched pedal that provides real-time convolution for acoustic instrument emulation for string instruments. One of the key selling points is the low latency, with the processing delay being just 1.3 milliseconds.

The final session of the day kicked off with a presentation by Sebastian Duran of the University of Bologna, who described work to improve the numerical modelling of thin plates. This involves making experimental measurements to determine properties such as the damping ratio and rigidity of the plate material, and then using these to fine-tune the numerical model. The overall aim is to create more accurate numerical models to explore how ancient musical instruments may have sounded, as well as to help with the design of new musical instruments.

The next talk was given by Ludovico (Ludo) Ausiello of the University of Portsmouth, who described work on tuning the soundboard of a guitar in a systematic fashion, through thinning down the wood by using a drum sander and by varying the angle of the bracing. Ludo passed around a guitar soundboard on which the bracing was secured by strong magnets, thereby enabling the bracing angle to be easily altered and the subsequent change in the soundboard resonances measured dynamically.

Concluding the session, Jiaxi You presented preliminary findings of her PhD research at the University of Manchester, where she is investigating the use of machine learning and signal processing techniques for restoring old audio recordings. She described various algorithms and then played different audio clips to demonstrate their effectiveness in reducing hiss and removing pops and crackles.

Building Acoustics Group – James Healey and Adrian Popplewell

In the first building acoustics session of the day, Neil Bodsworth and Colin O'Connor (Cundall, UK) gave delegates a glimpse into a future zero carbon world. Drawing on real life examples they advocated for early engagement, setting acoustics targets, and strategic material selection to align with sustainability goals.

The case studies presented exemplified how acoustics design can be integrated into zero carbon pathways, emphasising the importance of environmental product declarations. Neil and Colin also recognised suppliers' roles in driving sustainability, and encouraging the promotion of lower carbon options by acoustic consultants to spur innovation. Ending by showcasing a positive shift toward sustainable materials by highlighting emerging eco-friendly products.

Presenting a review of current sources of sustainably material and product information, Neha Sharma, and Barry Jobling (Hoare Lea) continued the session by underscoring the challenges faced by acousticians in selecting sustainable materials, with numerous databases lacking a focus on sustainable acoustic products.

Existing databases often lack Environmental Product Declarations (EPDs), and established products with EPDs may unexpectedly have higher carbon content than ostensibly less sustainable alternatives. The presenters argued that the absence of a central resource potentially hinders practitioners from exploring novel materials and impedes their ability to advise clients and design teams. To address inaction and to contribute to the industry's response to the climate emergency, they suggested the creation of a common product reference platform, potentially developed through commissioning or adapting existing databases, or creating a general platform. Such a resource could enhance knowledge, foster innovation, and expedite the adoption of sustainable materials in acoustic design.

Jack Harvie-Clarke (Apex Acoustics) and James Healey (Peninsular Acoustics) brought the morning session to a close with an in-depth and well-informed presentation about the challenges in aligning acoustic and thermal models referenced in Approved Document O and CIBSE TM59 (Design methodology for the assessment of overheating risk in homes).

They acknowledged the uncertainty in predicting façade sound insulation for partially open windows, emphasising the need for advancements in acoustic measurement and modelling in the future. In conclusion, the authors proposed a pragmatic, practical approach to be adopted in the meantime.

During the afternoon sessions chaired by James Healy, the following papers were presented:

Acoustic classification scheme for configurable pods Ben Southgate, Sandy Brown; Andrew Parkin, Cundall.

The use of adaptive sound masking systems in open plan offices: how they work, and the relative improvements for speech privacy and acoustic comfort André L'Espérance, Alex Boudreau, Vincent Le Man, François Gariépy, Roderick Mackenzie, Soft dB, Canada.

Designing for acoustic satisfaction in open plan offices Jack Harvie-Clark, Nick Dobinson, Richard Hinton, Richard King, Emily Foster, Apex Acoustics.

Decolonising museum soundscapes: a practice-based case study Rebecca Romeo Pitone, Jack Harvie-Clark, Apex Acoustics.

Inclusive acoustic design for mainstream schools: an evidence based approach Jack Harvie-Clark, Apex Acoustics, Emma Greenland, Anderson Acoustics, Adrian James, Adrian James Acoustics.

The Synergistic power of ChatGPT and Grasshopper for 3D analysis in room acoustic design Shenzhi Su, Cundall. P26

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Noise and Vibration Engineering Group – Naomi Tansey and Matt Torjussen

The Noise and Vibration Engineering Group had a full day of presentations on the second day of Acoustics 2023 featuring presentations showcasing the breadth of interests and expertise of our members.

Base-isolated buildings

The first presentation of the day was by James Talbot from the University of Cambridge, on the modelling of the performance of base-isolated buildings. He asked the question; how simple can we get? and talked delegates through various simulation studies to answer just that.

There is no standard approach to predicting the vibration isolation performance of a building and significant questions remain concerning how the isolation may be optimised. Theoretical models were developed at Cambridge to investigate the effectiveness of base-isolation and to establish which aspects of the building, such as its foundation and the isolation design, govern the overall performance. The aim being to develop sufficient simplified models fit-for-purpose.

James described a theoretical study of a typical multi-storey building founded on piles adjacent to an underground railway, along with four different building models and a tunnel-foundation model that incorporated various states of soil-structure interaction. Mean vibration power entering the building was analysed and the following concluded:

- soil-structure interaction (SSI) is essential for the understanding of vibration transmission into the building;
- viscous dashpot models are good at approximating axial and flexural transmission behaviour of columns;
- the most significant component of SSI for reducing error is soil-pile interaction; and finally
- more complex foundation models may be formulated to account for differing behaviour at higher frequencies but the benefits may not outweigh the computational cost.

Low Frequency Noise Control – HS2 Construction

Andrew Bird, from ALIGN, talked about managing low frequency noise during the production of precast concrete segments required for the construction of HS2's Colne Valley Viaduct. A case study contained details of complaints received, on and off-site investigations, and then implemented solutions. The project's commitments in relation to construction noise effects are outlined in HS2 Information Paper E23: Control of Construction Noise and Vibration (IP E23).

Construction was required to be operative on a 24hr basis, where intermittent use of vibration packs (the key noise source here) were used to help compact concrete. The works led to 30 complaints being received over a 30-day period, from locations up to 5km away from the site. Noise surveys were conducted at two surrounding complainant locations. At both locations the results highlighted that the casting noise from the factory only had influence in the 160Hz 1/3 octave band, the overall A-weighted level was unaffected. In isolation, the 160Hz 1/3 octave band fell below the LOAEL in both locations. Given the number of complaints, alternative assessment criteria were considered in the form of BS 4142:2014. While not intended for construction noise application, it was used to provide some context into the character of the sound.

Mitigation measures covered kit setup/condition, improved operating cycles and usage, also increasing community engagement. Since implementation, complaints have significantly reduced.

Rail-induced ground-borne vibration

The last presentation of the first session was by Zijiang Yang and Jorge De Avillez from WSP. They discussed the influence of piles on the building foundation response relative to local geotechnical conditions, focusing on a rail-induced ground-borne vibration assessment.

A 3D finite-difference time-domain (FDTD) numerical model was used to model a simple scenario to assess the influence of both the piles and local geotechnical conditions on a buildings's foundation response. The model consisted of a tunnel at 10m depth, with a foundation slab (0.5 x 22 x 32m) adjacent to the tunnel. Three pile depths were considered, 3m, 12m and 17m, where all pile scenarios also considered both soft and hard ground. The maximum simulation frequency for the hard and soft ground scenarios was 300Hz and 100Hz respectively.

The study revealed that the introduction of piles at the foundations of a building will not increase the ground-to-foundation transfer of vibration, where there's a minor improvement of 1dB at prominent frequencies for hard ground and 8dB for soft ground. Other findings were that vibration transfer may be decreased with increasing pile depth, distance to tunnel does, however, impact effectiveness. Finally, vibration levels in the local soil may be significantly reduced by the pile grid, thereby reducing vibration transmission into a buildings' foundations.

Noise and vibration isolation for CLT

Reinhilde Lanoye, from CDM Stravitec, opened the second session discussing the development and testing of noise and vibration isolation solutions for cross laminated timber (CLT) constructions. Whilst CLT is increasing in popularity and provides a sustainable building material option, there stems an acoustic challenge due to its orthotropic character and low mass density. Different national acoustic requirements were shown for required airborne and impact sound insulation, however most regulatory requirements state that $D_{nT,w} \geq 55$dB and $L'_{nT,w} < 52$dB are to be achieved.

Airborne and impact sound insulation results from tests completed in the laboratory of Buildwise, Belgium, were presented. The paper contains results for many different constructions, some key conclusions shown are as follows:

(i) a suspended ceiling may provide ~14dB improvement to both airborne and impact sound insulation, below 80Hz there is however a negative effect but this may be simply mitigated;

(ii) when comparing setups using discrete bearings vs mats as resilient supports, improvements of up to 10dB to airborne sound insulation and 5-7dB to impact

sound insulation were achieved across the complete frequency spectrum; and

(iii) above 50Hz, there is no benefit to varying channel spacing between bearings (in one orientation only). The study showed that by combining discrete pads with selected panels, very high performance can be achieved for airborne and impact sound insulation, even using a CLT structural floor.

Flanking transmission tests from a construction site were also presented, demonstrating the influence of elastic interlayers and acoustic brackets. Measurements of Kij and results from the empirical formula in Annex F of ISO 12354 are provided in the paper. Experimental results from a study to improve flanking sound transmission in CLT modular construction were also shown, where it was concluded that high-quality acoustic connectors have an important contribution to achieving sound insulation requirements.

Lift noise and vibration

The next presentation was on lift noise and vibration from Adam Fox, Mason UK. The noise and vibration from lifts is a common issue, originating from the movement of the car and cables through rails and hardware connected to structure.

Typical lift layout and a detailed discussion on noise a vibration sources were discussed. A lift system may be simplified to a mass, spring, damper model to enable the derivation of the principal natural frequency of the system. Key variables are K (stiffness of the tension ropes), C (damping applied by inertial action of the counterweight) and Mc (mass of lift car). The natural frequency varies with the number of people in the car (Mc) and the position of the car (effective rope length, impacting K). The following factors were however raised, which aren't captured and may impact the theoretical prediction: (i) rail straightness; (ii) rail imperfections; and (iii) wheel-rail interaction causing rumbling.

Adam showed a case study of a problem lift, to which the theoretical model was applied. Baseline vibration readings were taken, where they exceeded the VC-A criteria, which was required due to a nearby scientific facility. The predicted natural frequency was shown to align with on-site measurements, helping to inform the design of isolation systems. Vibration measurements were taken following the installation of tailored isolator pads for rail brackets at pit floor and shaft wall, demonstrating the application of an effective isolation solution.

Noise from air source heat pumps

Matt Torjussen, ANV Measurement Systems, and Jack Harvie-Clark, Apex Acoustics, ended the session with a presentation on the noise from air source heat pumps (ASHPs). ASHPs are a hot topic (literally) given the UK Government's push to adopt low carbon alternatives for domestic heating. There are concerns on the noise emissions from ASHPs, where Matt and Jack covered recent research and provided recommendations to improve noise assessments.

An overview of the components of an ASHP was provided. The fan (to draw in ambient air over the heat exchanger) and compressor (to increase the temperature of the refrigerant) were raised as the main noise sources. Both airborne and structure borne transmission paths need to be considered to minimise emitted noise. (See the paper for a detailed diagram.) To improve the source noise, the operating point of the fan may be changed. The energy and acoustic optimum lie at different points, however a small deviation (1.22% reduction) from the energy optimum can yield 5dB acoustic improvement.

The measurement and evaluation of ASHPs was discussed in the form of BS EN 12102-1:2022, alongside supporting assessment and measurement standards. The issue surrounding the reporting and correct application of manufacturers' data was raised. P28

An overview of the 10 steps of the Microgeneration Certification Scheme (MCS) noise assessment was provided, where a limit of 42dB $L_{Aeq,5mins}$ is stated. This is however no industry standard or characterising non-standard conditions.

Some of the key recommendations are as follows: (i) sound power level measurement conditions should be clarified; (ii) removing the arbitrary 'background' noise level from the MSC assessment; (iii) allowing ASHPs on front facades; and (iv) publishing good practice installation guides. Critically ASHPs need to adopt quieter designs.

Gound-borne Noise and Vibration – HS2 Construction

Opening the final session were Alex Champion, Southdowns Environmental, and Andrew Bird, ALIGN JV, presenting on managing the effects from gound-borne noise and vibration during construction of the HS2 Chiltern tunnels. The tunnels, each approximately 16km in length and 8.8m in diameter, pass beneath several residential communities. Two tunnel boring machines (TBMs) were required to operate on a 24hr basis, around 20-90m beneath overlying buildings.

The two main sources of vibration were discussed; TBM and hydraulic breakers. The rotating disc cutters of the TBM generally create vibration of a continuous nature but the magnitude can vary with speed. The excavation process consists of a continual cycle, whereby the TBM is paused for ~30mins while segment concrete rings are installed to form the primary lining. To create cross passages every 500m along the tunnel, hydraulic breakers were used as part of the sprayed concrete lining technique.

HS2's Code of Construction Practice (CoCP) and Information Paper E23 Control of construction noise and vibration (IP E23) were used as assessment criteria. Following initial GBN&V predictions using BS 5228-2, a finite difference time-domain numerical model was used, the results of which predicted a reduction in the number of exceedances of the ground-borne vibration LOAEL and SOAEL thresholds vs initial predictions. The ground-borne noise levels were however up to 2dB higher than the BS 5228-2 empirical predictor and therefore the primary concern. This work enabled several risk management activities to commence, including booking temporary respite accommodation.

Data captured in vacant properties above the construction works was discussed. The measured ground-borne noise level due to TBM operation was typically 8-10dB below the predicted level (which included a +5dB allowance for model uncertainty). Measured free-field PPV was comparable to the model, however measured VDV was significantly below prediction. Refinement of the model following the surveys resulted in a reduction of GBN&V effects for receptors yet to be exposed, with no SOAEL exceedances.

Low frequency active absorption

The final presentation of the session and conference was from Roger Roschnik from PSI Audio, on low frequency active acoustics absorption. Low frequency room modes in small to medium-sized rooms can cause acoustic issues if untreated. This case was used for demonstrating the benefits of their active absorber design, which operate in the range of 15-160Hz. The absorbers are portable and can be used to reduce any low frequency noise, regardless of the noise source.

Roger discussed the design of the absorber, showing the differences and benefits vs alternative acoustic resonators. A passive membrane resonator may be tuned to a specific frequency, whereby the membrane moves back and forth. An active absorber works similarly, however the membrane is driven actively, via a microphone, so that any frequency may be absorbed, not just its own resonant frequency. The active absorber lowers the acoustic impedance of the air in front of it to therefore act like a low frequency pressure sink. They also have a significantly smaller form factor than passive designs. The excursion can be far greater than a passive absorber, thereby offering improved performance. Some additional benefits raised, where that no calibration or setup is required, the absorber may just be placed in a room in a position of your choosing (typically corners) and easily moved if needed.

Sound, Noise and Health Group – Benjamin Fenech

Acoustics 2023 was the first annual IOA conference with a parallel session dedicated to the health effects of sound and noise, following the establishment of the IOA Sound Noise and Health Group in 2022. The number of abstracts submitted for the session exceeded the available slots, and on the day a lot of the talks saw a packed room with some delegates having to watch from the doorway. This was a very encouraging start for the Group, and a clear indication of the growing interest in this field amongst acoustics researchers and practitioners.

Charlotte Clark (St George's) started the session with *The effects of night-time aviation noise exposure on sleep disturbance and annoyance*. This is an ongoing research project sponsored by the Department for Transport (DfT) which is being delivered by a consortium consisting of St George's University of London, National Centre for Social Research, University of Pennsylvania, and Noise Consultants Limited. The study involves a cross-sectional survey of 4,000 participants living near eight UK airports to assess associations of aircraft noise exposure at night and subjective sleep disturbance and annoyance, as well as an objective sleep disturbance study of 200 participants. In the latter study, state-of-the-art physiological assessments of sleep disturbance will be linked to aircraft noise exposure at the participant's home. The study will deliver exposure-response functions showing how time-averaged metrics and noise above metrics relate to subjective and objective sleep disturbance and annoyance. This evidence is likely to inform updates to the DfT's Transport Analysis Guidance (TAG) and future changes to aviation night-noise policy in the UK.

Benjamin Fenech (UK Health Security Agency) presented *Estimates of the burden of disease due to transportation noise in England*. The first half of the talk gave an overview of the first spatial assessment of the attributable burden of disease due to transportation noise in England, which was published earlier in 2023 by a team from UKHSA, University

Above: Charlotte Clarke

Below: Benjamin Fenech, UK Health Security Agency

of Leicester, and Extrium. The publication received considerable attention by national and local media, and by the House of Lords Inquiry. In the second half of the talk, three sensitivity analyses were presented to demonstrate how burden of disease estimates vary according to input parameters. The first was to test the impact of modelling all roads (as opposed to only the strategic road network) and down to levels of 40dB L_{den} and 35 L_{night} (as opposed to 50dB $L_{den,}$ 50dB L). The second was to test the influence of different exposure response relationships (ERRs). A useful result of these two sensitivity analyses was that an estimated 7% of the adult population in England was estimated to be highly annoyed by road traffic, which is not too dissimilar from the 8% reported by the 2012 National Noise Attitudes Survey. The third sensitivity analyses showed the complexity of analysing data from socio-acoustic surveys, such as the 2014 Survey of Noise Attitudes to derive ERRs.

Next Benjamin also presented *Monitoring noise complaints — the Public Health Outcomes Framework indicator B14a.* A brief poll at the beginning of the talk showed that very few attendees were aware of the Public Health Outcome Framework (PHOF), and therefore there is little knowledge amongst acoustics practitioners that there are three noise indicators in the PHOF – two for transport noise, and one (B14a) for neighbour and neighbourhood noise. The data source for this indicator is the CIEH noise survey of noise complaints to local authority. One of the main challenges is the low return rate to this survey (~40%). The acoustics community was encouraged to raise awareness of the PHOF indicators to ensure their long-term survival, which in turn helps remind the public health community of the importance of noise as a determinant to health.

The session after lunch was opened by Jamie Scanlon (University of Salford) on *Aural diversity and acoustic assessment*. This project, sponsored by Defra, questions a fundamental assumption in most acoustics assessments, i.e. that the A-weighting is representative of the general population. The presentation looked at the relevance of A-weighting to three diverse groups:

- people with age-related hearing loss;
- neurodivergent people; and
- noise sensitive people.

The project found situations for each group where A-weighted noise levels and other common acoustic assessments may not work well. It also found significant research gaps, both in basic hearing research and in translating that hearing research into alternative assessment methods which might work better for an aurally diverse population. The talk sparked an interesting debate amongst the audience on the lived experience of aurally diverse people.

Next Charlotte Clark (St George's) gave an overview of *Developing a noise and soundscape conceptual framework for fair and equitable distribution of aircraft*, a project in collaboration with Heriot Watt University and University of Salford. Fair and Equitable Distribution (FED) of aircraft was introduced in 2015 as an aspirational objective by communities affected by aircraft noise from Gatwick Airport. The aim was to develop a clear definition of FED that would enable airspace managers and aircraft operators to design solutions in the context of the UK's Airspace Modernisation Strategy (AMS). A transdisciplinary soundscape conceptual framework for operationalising the development of an agreed definition of FED was presented, incorporating acoustics, psychoacoustics, non-acoustic factors, air traffic management technology options, health, psychology and other contextually-specific community and stakeholder engagement disciplines. While the aims of the project were ambitious, it is hoped that such an approach could be applicable to noise management across all transportation modes to reduce annoyance and improve health and wellbeing.

David Waddington (University of Salford) stood in for Balshaw's Church of England High School to present their entry for the *Institute of Acoustics Secondary Schools' Competition 2023: The connection between acoustics and ecology*. P30

Above:
Jian Kang, University College London

The talk summarised the experience and findings of pupils and staff from Balshaw's High School investigating the acoustic ecology of bird song in three acoustically different areas in their local area of Leyland, UK. The areas investigated were a park, a trunk road, and a residential area.

The pupils used the BirdNET app to identify birds in the three areas, and they also used ISO/TS 12913-3:2019 to assess the quality of the soundscape from a human perspective. The pupils developed skills in critical thinking, problem-solving, and collaboration. The project was well-received by the pupils, and their enthusiasm showed clearly from the presentation. From a teacher's perspective, the IOA Secondary Schools' Competition 2023 provided a valuable model for other projects that aim to engage pupils in learning about STEM. The pedagogy of the project was designed to be inquiry-based and collaborative. Delegates attending this talk were impressed by the enthusiasm shown by the students, the mixed methods approach to investigate this topic, and the rationale for decisions made throughout the project. They got a well-deserved extended applause (which David promised he would convey back).

Charlotte Clark (St George's), Angela Lamacraft (Sustainable Acoustics) and Jian Kang (University College London) presented an *Evidence review of effects of soundproofing on residents' mental wellbeing and alternative designs*, on behalf of the SIENA Consortium. The project was commissioned by Defra based on an idea from the Welsh Government. In the context of publications that specify targets for maximum recommended sound levels inside dwellings from external sound sources, and the drive to improve thermal efficiency and airtightness, the project sought to determine if there is a minimum audibility of external sound within dwellings for optimal health and wellbeing.

The project was split into several work packages. One focused on examining how the concept of 'good acoustic design' can achieve an optimal balance of minimising noise exposure while preserving the outdoor sounds that people might wish to remain audible inside buildings.

A second work package carried out a systematic review to investigate the impact of indoor sound environments on mental health, wellbeing, quality of life, annoyance, and sleep. The review focused on exploring the health consequences of the internal soundscape, particularly for vulnerable individuals who may spend a high proportion of their time indoors.

A third work package examined soundscapes and non-acoustic factors (NAFs). The concept of salutogenesis was applied to consider which NAFs are critical to accurately interpret acoustics and soundscape data to inform design and planning options.

Benjamin West (Birmingham City University) presented *An in-situ investigation of office soundscape perceptual evaluation methodologies*, a project carried out in collaboration with Arup. The aim was to investigate the suitability of affective quality evaluations of open-plan office acoustic environments. Perceptual assessments were completed by occupants of five open-plan office floorplates, using the affective dimensions outlined in PD ISO/TS 12913-3:2019 and recent indoor soundscape studies. Participant demographic, contextual and work-related data was collected, and psychological wellbeing was measured using the WHO-5 Wellbeing Index. Workstation noise levels were also measured on each floorplate.

Results indicate the suitability of the 12913-3 two-dimensional model to the open-plan office environment. Pleasant scores were found to be positively correlated with overall office soundscape assessment and appropriateness. The perceived presence of sounds from human beings was negatively correlated with Pleasant scores, yet positively correlated with Eventful scores. Participant task type, gender and self-reported aural diversity were shown to mediate Pleasant scores. Psychological wellbeing, overall work-related satisfaction and perceived productivity were positively correlated with Pleasant scores. No correlation was evident between averaged acoustical indicators and perceptual scores, suggesting that alternative acoustical indicators may be needed for objective quantification of office soundscape perception.

Reuben Peckham (Intelligent Instruments Ltd) closed the session with a talk on *The use of proprietary noise camera systems to manage excess noise from motor vehicles in residential areas*. Road traffic noise is associated with several adverse health outcomes, and significant effort and resource is allocated for its management. However one aspect of this noise, arising from aggressive driving, over-revving and from unlawful modifications, is entirely avoidable and is deemed unwelcome and unnecessary by the general public. In recent years there has been growing interest in using advanced measurement techniques the facilitate the

management of such noise, such as the ongoing research commissioned by the Department for Transport. This talk presented an alternative system, developed by Intelligent Instruments using a noise camera system to detect excess noise from motor vehicles at the roadside and capture the relevant evidence to enable enforcement authorities to issue cautions or penalty notices according to local legislation.

It was argued that this system is currently the only type in use to fine offending motorists, with multiple systems in operation both in London and several cities in the USA. The system consists of a class 1 sound measurement system with ANPR cameras and a microphone array to detect and quantify the sound. In the discussion it was clarified that penalties are not issued due to exceedances of a specific numeric noise limit, but following the professional judgement of the regulatory officer having reviewed the evidence. There was also a discussion on the various types of calibrations and type approval that would be required depending on the enforcement criteria. (See page 65 of this issue for more detail on Reuben's project).

Early Careers Group – Josie Nixon and Diogo Pereira

On the Sunday evening, the Early Careers Group held a fantastic social event at The Bishop on the Bridge, hosted by Getzner. A huge thank you must go to Getzner for sponsoring the event and to Taylor Cooper, the IOA Southern Branch ECG representative, for helping to organise the event. It was great to meet the Getzner representatives, Ben van Breda, Johannes Hagspiel, and Reinhard Haemmerle, who made sure everyone was made welcome, especially those attending their first conference. Towards the end of the event, that some acousticians who've been in the business slightly longer joined the group to chat to the new members. The buddy scheme was run again at this conference and the Sunday evening allowed for buddies and mentors to meet before conference began the following day.

Diogo and Josie had the privilege of hosting a room for the ECG on the second day of the event. The morning began with a wonderful talk from pupils from St Oscar Romero Catholic School, who won last year's IOA school's competition, four talented students, Ashton Billett, Emmeline Turner, Shay Wheeler, and Peter Clarke, gave a very comprehensive and interesting talk on their project, which centred around the noise problems of school bells. If they continue within the discipline, they may become brilliant acousticians in the years to come.

Martin Mcvay followed on from the school with a talk on *Noise and Soundscape Policy Development in Wales* and it was interesting to hear about how soundscapes are embedded in the Welsh policies. Charles-Etienne Lamort then looked at a couple of case studies to explore environmental pollution management initiatives on construction sites that are bordered by existing development, and looking at options to determine if noise was coming from your construction site, or a nearby one. Stephen Jay, then gave a talk on the Environment Agency's position between planning and pollution regime control.

The afternoon session was hosted by Diogo Pereira and kick-started by more representatives of the Environment Agency, where Tony Clayton gave a talk on *The UK Best Available Techniques (BAT)*. Ian Holmes followed with a talk on *The National Highways Environmental Sustainability Strategy* and Simon Kahn finished the afternoon first session with a review on BS8233. The final speakers were grouped to engage in a panel discussion from the Environment Agency (EA), by Stephen Jay, Paul Doyle, and Jon Tofts. This led to a lively debate around the role of the EA, the difference between reports for permitting or planning applications along with the issues of building houses close to protected zones and the restrictions it can then place on existing businesses. It was great to see plenty of people in the room for this and the discussion.

Watch again

All the above presentations were recorded, and are available to IOA members via the IOA website. (**https://www.ioa.org.uk/**) So, if you didn't attend, or you wanted to be in two places at the same time, you can watch the presentation that you missed. Special thanks are due to Chris Barlow who assisted with the initial discussions with the AV provider, and who has collated/edited the recordings.

Overall it is considered that the conference was a great success, with all the feedback generally being very positive of the venue, AV, catering, and the organisation of the event, which (as has been the case for many years now) was arranged and managed by Linda Canty at the IOA head office (with the assistance of Emma Lilliman at the IOA, IOA CEO Allan Chesney who was Secretary for the IOA AGM, and photographs by Alex Shaida (IOA Marketing)).

We look forward to seeing as many as possible at Acoustics 2024 during the IOA's 50th Anniversary year. It will be held at the Manchester Metropolitan University on 12th and 13th September 2024.

Below: Stephen Jay, Environment Agency

The Guildhall staff provided excellent site support throughout the conference. AV was provided by Whitwam Winchester, and the refreshments/catering by The Little Kitchen Co.

The Institute of Acoustics Diploma results 2022-23

By Professor K Attenborough, HonFIOA (IOA Education Manager)

Candidates for the IOA Diploma in Acoustics and Noise Control in 2022/2023 were based at two accredited Centres (KP Acoustics Research Labs, and London South Bank University), and at four Centres for tutored Distance Learning (Bristol, Edinburgh Napier University, Milton Keynes, and Trinity College Dublin).

Given the absence of pandemic restrictions, written examinations at centres were held on 8 and 9 June 2023. There were 92 candidates (including 11 resits) for the General Principles of Acoustics (GPA) Module examination, 17 (including four resits) for Regulation and Assessment of Noise (RAN), 54 (including eight resits) for Noise and Vibration Control Engineering (NVCE), 65 (including nine resits) for Building Acoustics (BA) and 57 (including eight resits) for Environmental Noise Measurement, Prediction and Control (EN). 97 candidates registered for the Project Module. Although 24 are listed as having failed the project in the table of results, 13 of these 24 have deferred their project to 2024.

As in previous years, a merit threshold of 70% was applied to the written GPA paper and the conflated GPA mark. The examination scripts of candidates satisfying the conflated mark threshold but gaining between 68% and 72% on the written paper were examined at moderation, re-marked where appropriate and judged individually as 'pass' or 'merit'. However, even if these criteria were satisfied, a merit was not awarded if a coursework assignment mark was carried over from a previous year.

Criteria based on the means and standard deviations from the previous 10 years were used to decide whether to moderate examination marks for the Specialist Modules. To obtain a merit grade on the Specialist Modules, candidates were required to have a conflated mark of at least 70% and a written examination mark of at least 70%.

The first GPA coursework assignment was about rocket sound propagation and resulted in a mean mark of 67%. The second GPA assignment was on noise in restaurants and resulted in a mean mark of 72%.

The Specialist Module coursework topics this year included: Design of low vibration buildings (NVCE), Acoustical considerations in concert hall design (BA), Road traffic noise (EN) and Onshore wind farm noise (RAN). For the third time, candidates were required to produce and record a video presentation for the NVCE coursework. The mean mark gained this year for the video presentation was lower than last year. An online presentation associated with the project proposal part of the project was included for the second time this year. As a result of the experience in 2022 and 2023, advice on creating such presentations has been added to the handbook, the project guide and issued when needed.

The numbers of candidates who gained merits (M), passes (P), or fails (F) in each module are shown for each Centre in the following table of results. The 'fails' include those who were absent from the written examinations.

Six exceptional candidates have obtained five merits. The prize for best overall Diploma performance, based on not only gaining five merits but also achieving the highest aggregate mark overall (GPA, Labs, BA, EN and Project), is to be awarded to Nicolas Assiotis (DL Milton Keynes).

The other candidates who are to be congratulated on achieving five merits are Jack Collins (DL Dublin); Deirdre Doran (DL Dublin); Christopher Burn (DL Milton Keynes); Emily Forster (DL Milton Keynes) and Harry Johnson (DL Milton Keynes).

Candidates to be commended on achieving four merits are Liam McAleavey (DL Dublin); Shauna Livingstone (DL Dublin); Cameron Mc Auley (DL Edinburgh); Divyamaan Sahoo (DL Milton Keynes); Harry Coles (KP Acoustics Research Labs); Wayne Eastwood (KP Acoustics Research Labs); Edward Hand (KP Acoustics Research Labs) and Rebecca Page (London South Bank University).

Deirdre Doran will be receiving the prize for the best overall Diploma performance by an Irish student.

Joe Oxenham has been awarded the 2021-22 ANC Prize for the project: '*Predicting the sound reduction index of a natural ventilation unit using finite element analysis*.'

I am grateful to all examiners and tutors for their cooperation and contributions and thanks again to Helen Davies, Fiona Pizzey, and Katharyn Holmes for their administrative contributions during the 2022/2023 presentation year of the Diploma.

IOA Diploma Results Chart for 2022/23

Centre Name		GPA	Labs	BA	NVCE	RAN	EN	Project
Distance Learning (Bristol)	Merit	1	1	0	3	1	0	2
	Pass	6	7	3	0	1	6	7
	Fail	0	0	0	0	0	0	0
Distance Learning (Dublin)	Merit	4	4	2	2	4	3	7
	Pass	6	4	6	2	1	4	4
	Fail	1	1	1	0	0	3	2
Distance Learning (Edinburgh)	Merit	4	3	3	3	3	1	1
	Pass	6	7	3	0	0	5	5
	Fail	1	0	1	1	1	1	6
Distance Learning (Milton Keynes)	Merit	10	6	10	7	3	4	10
	Pass	9	19	7	7	0	11	17
	Fail	23	11	12	10	0	15	16
KP Acoustics Research Labs	Merit	3	3	1	2	1	2	3
	Pass	3	4	3	2	2	2	4
	Fail	1	0	0	0	0	0	0
London South Bank University	Merit	0	4	3	7	0	0	2
	Pass	14	9	7	7	0	0	11
	Fail	0	0	3	1	0	0	0
Totals	**Merit**	**22**	**21**	**19**	**24**	**12**	**10**	**25**
	Pass	**44**	**50**	**29**	**18**	**4**	**28**	**48**
	Fail	**26**	**12**	**17**	**12**	**1**	**19**	**24**

Project titles 2022/2023

Distance Learning (Bristol)

- Investigation of the suitability of BS 4142 for noise impact assessment at a small-scale artificial grass football pitch at Meadowbank Football Ground
- Measurement and acoustic treatment for audiophilic listening room
- Noise exposure and risk perception of sound levels in spin classes
- The effect of military vehicle noise emission on local wildlife
- An investigation into low frequency noise generated from air source heat pumps
- Façade design for soundscapes: an investigation into the influence of façade design on the acoustic characteristics and auditory perception of for an urban campus
- Investigating methods of reducing noise from a working museum exhibit with a view to preserving the authenticity of the display and to protect and improve the noise environment for members of staff and the public
- Investigation into battery energy storage systems (BESS), comparing the noise output of a complete containerised system and non-containerised system, with special attention to low frequencies
- Understanding synergy and differences in matrices for noise and air pollution from traffic sources

Distance Learning (Dublin)

- An investigation into the reduction of noise nuisance from room to room in music rehearsal spaces
- The influence of vertical wind shear on the measurement and propagation of wind farm noise
- Acoustic planning assessment for proposed new bungalow development, Tang Co. Longford
- Noise pollution effects over marine life: a study on Dublin Bay
- What mapping environmental noise to WHO levels would mean for Ireland
- An investigation into the attenuation effect of open windows on internal sound levels
- An investigation into the psycho-acoustic response to wind turbine noise
- An investigation into the methods used to assess noise from air source heat pumps
- How do the levels of noise protection towards a receptor vary depending on the environmental noise assessment methodology
- Designing and building a curved column loudspeaker
- Reverberation time (RT) of TCD lecture hall computer model vs field measurements

Distance Learning (Edinburgh)

- Investigation of methods to visualise flanking paths
- Impulse noise exposure from occupational firearms use and assessment of the adequacy of commonly used hearing protection
- Investigating the acoustics of a multi-use community hall
- The investigation of the noise propagation from vessels in ports and its noise impact P34

- 'Good PR is worth 10 dB': investigation of the coexistence of a music venue with neighbouring residents
- The determination of sound power level by measurement for 'in-situ' applications

Distance Learning (Milton Keynes)
- Sound power level and sound frequency spectra determination of an EV charging system with variable commutation frequencies — efficiency vs noise
- Sound masking in the modern workplace
- Do local authorities use the POP Code and can it be modernised for use in the future
- Investigating air leakage with an acoustic camera
- Health and equality in indoor pools – a study of acoustic standards and guidelines
- A review of the implications of the acoustic criteria contained in Approved Document O
- Improving acoustic conditions in open plan offices using a soundscape approach
- A study of the magnitude and frequency content of flutter echoes
- Investigating the mitigation required for the installation of bowling alley leisure facility in a former commercial unit to protect neighbouring residents
- Examining and investigating the efficacy of low frequency absorbers 1. panel absorber and 2. Helmholtz resonator (cavity absorber)
- Acoustic assessment for generator room airborne noise and vibration control
- Predicted Vs measured reverberation time with recommendation of acoustic treatment in office meeting room
- An assessment of the noise impact of battery energy storage facilities and a limited comparison with the noise impact associated with other types of renewable energy generation
- An investigation of the effect of randomness in trunk size and location on the attenuation of sound through forests generated by L-systems
- Acoustics in schools – South Africa: field measurements and subjective outlook of classroom acoustics in South Africa
- Exploring the sound of Dubai: an environmental noise study
- Investigating the reduction of urban night-time noise maxima (Lmax) from road traffic events through open windows and their effect on sleep
- Investigation into noise fingerprints of facilities within the waste industry
- Investigation of an old sound attenuator to quantify its acoustic and aerodynamic performance and re-design to improve performance
- An investigation into the acoustic properties of horse skulls

KP Acoustics Research Labs
- Workplace local exhaust ventilation (LEV) – seen and not heard?
- A review of the noise council's code of practice of environmental noise control at concerts
- An evaluation of the correlation between assessment of impact under BS:4142 methodology and determination of statutory nuisance
- Analysing impact noise for proposed gymnasiums
- Design of a new sustainable acoustic absorber for small meeting and video conferencing rooms
- Rapid prediction of construction underwater noise in coastal shallow water

London South Bank University
- The effect of separation distance on silencers in sequence in relation to insertion loss and pressure loss
- Improving the acoustical environment of an existing heritage school building
- Acoustic assessment of a spiritualist church
- An experimental investigation into the effectiveness of movable gym matting upon the acoustic comfort in an atrium
- Evaluating the transfer function between vibration and reradiated noise within a room
- Environmental noise from outdoor cinema and impacts on surrounding residential area
- An investigation into the effects of noise and vibration arising from the Jubilee Line
- Investigating aircraft type responsible for maximum noise events to residents surrounding London Heathrow Airport
- The impact of alternating runways at Heathrow Airport on a residential noise environment
- Investigating noise and vibration induced by deadlifting within a gym environment

Diploma awarded December 2023

Distance Learning Bristol
Brasher-Jones J
Brown A
Chakravartty A
Mackworth G
Malam B
Mileusnic T
Murray S
Thomas O
Winter I

Distance Learning Dublin
Breslin C
Coady C
Collins J
Doran D
Gnagni L
Hand M
Isaac L
Livingstone S
Lynch K
McAleavey L
Ryan G
Scheele A

Distance Learning Edinburgh
Anderson R
Hay W
Matthews H
Mc Auley C
Ramesh P
Venus G

Distance Learning Milton Keynes
Alves E
Assiotis N
Burn C
Campbell G
Dalwai R
Forster E
Johnson H
Joubert R
Kavazi P
Kharade K
Lilley D
Lovell A
McCoach K
O'Brien C
Redding J
Sahoo D
Shajan Johnson A
Singh J
Stones A
Welsh M

KP Acoustics Research Labs
Coles H
Eastwood W
Gregory I
Hand E
Hucklesby J
Sartori I
Tanner C

London South Bank University
Anderson L
Angir A
Baines M
Baylis A
Evans H
Hawkins R
Humphris J
Moore G
Page R
Quarless-Oates M
Samuel M
Smith J

The Institute of Acoustics Certificate results 2023

Centres unable to deliver certificate courses during the pandemic years in 2020-2022 were able to deliver them in 2023. During the year, there were re-accreditations for The Institute of Naval Medicine for CCMOEHAV. Although CCBAM and CCENM continue to be the most popular, there is an increasing interest in CCWNRA. The list of successful candidates below includes several resits.

List of successful candidates

Certificate of competence in workplace noise risk assessment

Exam date: 3 March 2023

Blue Tree Acoustics
Matthews M
Paterson B
Talbot A

Make UK
Lilliott T
Plage J
Smith A
Speer P
Ward P
Wassell D
Young G

Shorcontrol
Power G

Exam date: 29 September 2023

Blue Tree Acoustics
Hewett D

KP Acoustics Research Labs
Bunting T
Lindsay K
Pateman A

Make UK
Booth D
Salpekar S

Shorcontrol
Burke S
Everard T
Horgan L
Murphy P

Certificate of competence in Irish building acoustics measurements

Exam date: 10 March 2023

KP Acoustics Research Labs
Boyle B
Cullen J
Lynch N
McDonagh S
Richardson W
Scheele A
Traynor N

Certificate of competence in building acoustics measurements

Exam date: 21 April 2023

KP Acoustics Research Labs
Ahmadi S
Cotterill T
Dickinson J
Grigorieva E
Highton W
Leung D
Lo H
Whelan G
Whipp J

Exam date: 3 November 2023

Bateman W
Brown R
Burrows R
Chang YM
Cooper S
Favill G
Heald B
Porteus C
Vulcan M

Certificate of management of occupational exposure to hand-arm vibration

Exam date: 21 April 2023

Institute of Naval Medicine
Clinning M
Davis G
Forsyth A
Ingram I
Ladds T
Mulhall I
Sinclair A
White J
Yeboah E

Certificate of competence in environmental noise measurement

Exam date: 19 May 2023

Bel Noise
Dickson C
Henderson J
Kelly S
Logan D
MacLeod M
McFarlane L
McMurray L
Quinn L
Robertson M
Seaman L
Venner K P36

Blue Tree Acoustics
Brian J
Campbell P
Gilmour D
Healy J
Hewitt J

Colchester Institute
Alabi KO
Byrne J
Flack K
Hardes J
Haviland F
Hunter M
Jackson G
Kitchener O
Mountstevens A
O'Halloran L
Pethers B
Reed R
Rubidge D

KP Acoustics Research Labs
Archer J
Bryan S
Cook S
Fox B
Greatorex T
Higgins M
Howe G
Maxfield J
Milligan C
Page S
Sampson J
Stuart W
Waidson D

London South Bank University
Bingham S
Corr J
Craig S
Holmes D
Lewis N
Phillips S
Priestman J
Richardson M
Yozgyur N
Zhang A

Shorcontrol
Clarke A
Clarke S
Corrigan K
Farrington S
Green J
Hamilton K
Kelliher E
Lee A
Lyons A
Nelson P
O'Brien L
Ormsby A
Reck C
Stokes R
Sullivan E

Ulster Environmental
Johnston Z
Kinnear A
Mayes KA
O'Brien R

University of Derby
Blackford T
Bunting T
Codd S
Findley S
Haider K
Smith B
Spaczynska A

University of Liverpool
Adkins M
Bennett K
Cifuentes P
Cogle I
Dunsmore A
Grima A
Klarecki D
McCarthy H
Taylor R
Willett D

Exam date: 6 October 2023

Colchester Institute
Bourgeois J
Davies K
Fern C
Gurung M
King-Phillips S
Kirk G
Lloyd L
Mostert N
Shurmur D
Stewart K
Stokes S
Warren R
Yem-James S

KP Acoustic Research Labs
Chapman K
Cullen R
Jones D
Lewis L
Marsh C
McKeown G
Melvin S
Pritchard A
Rigby J
Salmond C
Speed A
Tsekana MD

Leeds Beckett University
Semple J

London South Bank University
Kuah CYM
Ryan B

Shorcontrol
Barrett M
Commane M
Coyne B
Finn L
Kehely S
McDevitt D
O'Neill U

Ulster Environmental
Anderson R
Beavis D
Burke M
Casey G
Contrell S
Falls A
Hughes R
McComb R
Nicholas L
Spears L

University of Derby
Clarke L
Crawley J
Drinkwater E
Fedyszyn M
Hart F
Mills S
Mountford T
Reed N
Wilkes T

University of Liverpool
Kelly S

Certificate of proficiency in anti-social behaviour (Scotland) Act 2004 – noise measurements

Exam date: 30 June 2023

Bel Noise
Brown R
Cardoo S
Hadden C
Hamilton G
Garner M
Lamond N
Lawlor R
McComb K
McLaughlin G
Paterson A
Sim R
Summers A
Waterfield V
Wood J

In the beginning – the 1970s

This year, we celebrate the 50th anniversary of the Institute of Acoustics. So in each issue of Acoustics Bulletin during 2024, we will travel back in time to see where we started and how we progressed over the decades to become the highly topical, balanced, impartial, and respected institution we are proud to be members of today.

Starting with the 1970s, the then IOA President, William Allen, wrote an introduction to the April 1976 issue of Acoustics Bulletin, which included a potted history of how the IOA came to be. He wrote:

'The Institute of Acoustics is now in its third year of existence but it is built upon two previos generations. At a time when the Institute is entering a period of intensive development, in which the present and future must command full attention, it is appropriate to slip a brief reminder of the past in to the record.

'The first move was initiated by A T Pickles and myself. He had directed underwater defence research during the war and had come to the Building Research Station (now the BRE) as Head of Architectural Physics while I was his deputy, justifying the 'architectural' part of the Division's title. We convened a group which included radio technology, musical acoustics, audiology, and other major subject areas and, in 1947, the Acoustics Group of the Physical Society was born. In due course the Physical Society merged with the Institute of Physics and the Acoustics Group went with it.

'During the 1960s the social and technological importance of acoustics rapidly expanded and the British Acoustical Society (BAS) was formed. For several years the Acoustics Group and the BAS co-existed but it became apparent that the division was hampering the growth of acoustics in the UK, eventually a marriage was arranged and on 1 January 1974 our Institute was formed, and here we stand, approaching now 1,000 members and growing steadily in size and influence.' (Editor's note: In fact, the IOA was formally incorporated on 16 January 1974).

Much later, in the introduction to the IOA's 40th anniversary book (where more information about the IOA's history can be found) on page 7, the then President, William Egan, wrote:

'With the increasing recognition of the impacts that acoustics, noise, and vibration issues have on all our daily lives, it can be strongly argued that the role of the Institute, and with it the work of its members, has never been more important. The challenge for us all, therefore, is to build on the work of our founding fathers so that, through a steadfast commitment to the advancement of acoustics, we can continue our mission.'

Member memories

In a way, nothing has changed since these words were written – in that the ethos and the purpose of the IOA are still the same, but recent years have seen our industry embrace unprecedented change and progress, some of which stemmed from the pandemic. Science generally continues to evolve, discover, and develop at pace, so industry must be permanently on the starting blocks to adapt and invent to make the most of scientific advances. This is what makes our industry endlessly fascinating and why it is attracting more public engagement.

In this, the first issue of our 50th anniversary year, we re-visit the 1970s, where it all began, by reproducing excerpts from IOA archives, including issues of Acoustics Bulletin and contributions from IOA Specialist Groups. For some members it will bring back memories, for others it will be a history lesson. For all of us though, it will show how the disciplines of acoustics, noise, sound, and vibration have increasingly influenced other industries such as construction, medicine, research, entertainment, and environmental sustainability, and which, we hope, will continue to do so for at least the next 50 years.

If you have any IOA memories or photos you'd like to share in future 2024 issues, contact the editor, Nicky Rogers at **nickyr@warnersgroup.co.uk**

Recollections of acoustic development within Scotland from 1974

By Robin K Mackenzie FIOA, former member of the IOA Council, Emeritus Professor of Acoustics, and former Vice-Principal of Edinburgh Napier University, and founding partner of RMP Acoustic.

I joined the IOA at its inauguration in 1974, having previously been a member of British Acoustical Society, the forerunner to the IOA. Behind the initiative in 1966 to establish the British Acoustical Society, was a Scot, Sir Gordon Sutherland (1907-1980), who was Director of the National Physical Laboratory, later becoming Master of Emmanuel College, Cambridge.

I was encouraged to join the Society in 1968 as a student member by my MSc co-supervisor, Dr Marion Ross, Reader in Acoustics in the Department of Physics and Natural Philosophy at Edinburgh University. She was the pre-eminent authority on acoustics P38

in Scotland at that time and was a contemporary of Sir Gordon Sutherland. Her own PhD supervisor at the University of Edinburgh was the Nobel laureate, Professor Charles Barkla. In the years leading up to World War ll, she worked on sound ranging at the University of Manchester under Sir Laurence Bragg, another Nobel laureate. The programme on sound ranging was discontinued by the War Office and Dr Ross joined Sir Robert Watson-Watt, yet another famous Scot, at the National Physical Laboratory, helping to develop radar. At the outbreak of the World War ll, Dr Ross was appointed Head of Research in Underwater Acoustics at the Admiralty Research Laboratory at Rosyth.

In 1969, there were only two students taking Dr Ross's diploma course in acoustics at Edinburgh University; myself and Paul Newman, a lecturer in acoustics at the Edinburgh College of Art, who later became a partner in my consulting practice. At the end of my course, Dr Ross retired, following which, there would be a gap of 10 years before another university course in acoustics, became available in Scotland.

Around this time, the emphasis in Scotland had moved from theoretical acoustics to applied noise and vibration, with strong groups set up at the University of Glasgow under Professor John Robson in the Department of Mechanical Engineering, and Douglas Gordon in the Department of Aeronautics and Fluid Mechanics.

Also active at Glasgow University was Professor Ian Donald, another member of Watson-Watt's radar group, and considered widely, as the pioneer of medical ultrasound.

Other people involved in the development of acoustics or in the formation of the Scottish Branch of the IOA, or both, included Bill Kennedy and Ruben McLean at Strathclyde University, and Bill Laurie, Les Mair, Ronnie McLaughlan, and David Barbour at Glasgow Caledonian University.

At Dundee University, Bill Taylor who was Professor of Occupational Medicine, was very active in studying noise-induced hearing loss and vibration white finger, while in Aberdeen, Ivor Lockie was involved in environmental noise.

The introduction of the Building Regulations in the mid-1960s was a considerable stimulus to building acoustics research in Scotland, and in the Department of Building Engineering at Heriot-Watt University, John Williamson built the first sound insulation suite in Scotland, which allowed me, as a postgraduate student, to carry out full scale tests on lightweight timber walls as part of my Master's degree.

There were only a few acoustic consulting practices in Scotland in 1974 and around at this time, a senior environmental health officer, Alex Turner, (who later became Director of Environmental Health) was developing a particular interest in noise nuisance. He would prove very influential along with his junior colleagues, John Stirling, and Alistair Somerville, (current President of the IOA) in establishing Edinburgh City Council as a major policy-maker in the control of noise from neighbours and music premises.

Back at the University of Edinburgh, Dr Murray Campbell was appointed as a lecturer in Physics in 1972 leading to the re-introduction of acoustics as a formal course in the BSc Physics programme. Later in 2006, as Professor of Musical Acoustics, Murray developed a Masters' programme in Acoustics and Music Technology, which continues today.

Research

Around the same time, I had left Edinburgh for the USA to study for my PhD under IOA Rayleigh Medallist, Professor Richard Lyon at MIT, marking the start of research work in statistical energy analysis. This would be carried on for a further 30 years at Heriot-Watt and would be significantly expanded under Bob Craik, who was my post-doctoral research assistant for four years, before becoming a lecturer in 1984 and, ultimately, Vice-Principal of Heriot-Watt University.

In 1972, Heriot-Watt University was awarded a contract from the Department of the Environment (DoE) to monitor the effect upon buildings of noise and vibration from the sonic boom produced by the Concorde aircraft. 20 supersonic flights were carried out up and down the west coast of Scotland, and measurements were made using strain gauges and accelerometers on walls and windows in dwellings around Oban, Argyll & Bute. There were no adverse effects from the sonic boom, but the measurements were invaluable in providing information on the diurnal movement, due to thermal expansion, between the inner and outer leaves of external brick cavity walls.

The following year we were awarded a further contract from the DoE to measure the performance of different types of double glazing against traffic noise, the results of which formed the basis of the 1975 Noise Insulation Regulations and put Heriot-Watt University firmly on the map as a significant research centre in building acoustics.

Edinburgh boost

In 1974, acoustics in Edinburgh was given a further boost following a decision to build an opera house. Sir Robert Matthew, who had designed the Royal Festival Hall in London, was appointed architect and Dr Vilhelm Jordan, acoustic consultant for the Sydney Opera House was appointed as acoustic advisor.

He advised that two acoustic contracts should be awarded, one for the acoustic design and one for the acoustic modelling. Sandy Brown, an Edinburgh-born architect turned acoustician, who had established a practice in London, was appointed acoustic consultant and Heriot-Watt University was given the contract to build and test a 1/8th scale model of the opera house.

Sandy Brown Associates opened an office at South Queensferry, near Edinburgh, to handle the design work with Sandy Brown as design lead supported by Dick Bowdler, Neil Spring and Alex Burd, the latter becoming President of the IOA in 1994.

The acoustic modelling work was led by myself and supported by Dr Richard Guy, who later became Professor of Acoustics at Concordia University in Canada and Dr Mike Barron, IOA Rayleigh Medallist and one of Europe's leading authorities on auditorium acoustics.

Conferences

In 1974, the IOA hosted the first of four major conferences to be held in Edinburgh, during the past 50 years. The conference on Auditorium Acoustics attracted P40

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200 delegates, including some of the finest acousticians of their time such as Professor Lothar Cremer, who was consultant for the Berlin Philharmonie Hall, Professor Peter Parkin, Rayleigh Medallist and consultant for the Royal Festival Hall, Dr Wilhelm Jordan, consultant for the Sydney Opera House, Lawrence Kirkegaard, consultant for the Barbican, and Professor Richard Bolt of Bolt Beranek and Newman, who were consultants for the New York Philharmonic Hall.

At this point I was joined in my work on various EPSRC contracts in sound insulation by two outstanding young research students, Bob Craik, and David Mackenzie, both of whom had just graduated. I supervised both for their postgraduate degrees in building acoustics — Bob joined me as a research assistant and would later be awarded the Rayleigh Medal by the IOA.

After his initial work in sound insulation, David Mackenzie started to develop his own research in school acoustics, the results from which would greatly influence the *Building Bulletin 93 on the Acoustic Design of Schools*. David would later go on to become Chairman of the Scottish Branch of the IOA.

Building Regulations

Around this time, in the late 1970s, the Building Research Establishment had been busy carrying out sound insulation measurements in new dwellings in England and Wales and had established that around 60% of all walls and floors had failed to meet the Building Regulations performance standard. However, this failure rate was not replicated in Scotland. It became obvious to us, that this was, in large part, because pre-completion testing was carried out by several local authorities north of the border, but not in England and Wales, although it took the best part of 20 years before this was addressed in the regulations south of the border. The fact that pre-completion testing was carried out in Scotland gave Scottish consultants and academics a much clearer understanding of the causes of inadequate sound insulation, particularly the problems caused by poor workmanship.

There was increasing activity and demand for acoustic consultants, during the late 1970s, due, in part, to the Control of Pollution Act 1974 and the Code of Practice for reducing the exposure of employed persons to noise 1972, but also because of the rapid growth in the offshore oil and gas industry. Indeed, I found myself making frequent visits by helicopter to oil drilling rigs in the North Sea to deal with a variety of acoustic problems.

Education

I mentioned this increased demand for acoustic engineers to the Education Committee of the IOA and they agreed for the Institute diploma course to be launched in 1979 at Heriot-Watt University. At that time, it was particularly convenient to deal with the IOA, since it had moved its HQ from the Institute of Physics in London to the Heriot-Watt University, with Cathy Mackenzie appointed as Chief Executive.

The following year, an MSc in acoustics, vibration and noise control was established, being the first postgraduate course in acoustics in Scotland for 10 years, since the discontinuation of the diploma course in acoustics at Edinburgh University.

In 1982 the MSc course was launched in the far-east, but not before having to deal with concerns expressed by the University Senate. They were concerned by the possibility that our UK students could contact our Hong Kong students to find out what was in the exam paper, sat nine hours earlier. Their concerns were only resolved once arrangements were made for the Hong Kong students and the UK students to sit the exams simultaneously at 5.00pm (HK time) and 9.00am (UK time).

During the early years of the MSc, it became clear that the overwhelming demand for this course was for part-time tuition. One problem however, was the remoteness of many candidates throughout Scotland. As Course Director, I explored the possibility of providing this course via the recently introduced medium of video cassette recording and in 1983, the MSc course was offered by distance learning video instruction, the first such course of its type, in any discipline, at a British university.

1983 was a particularly busy and important year for acoustics in Scotland, not only for the launch of the MSc course by video instruction, but also because of the hosting of the Inter-Noise conference, which was held in the Edinburgh International Conference Centre. This was a massive undertaking for the IOA secretariat with over 600 acousticians from all over the world attending.

The same year saw the launch of the Scottish Branch of the IOA, under its first chairman, Dr Howard Latham, one of my former PhD students. Former MSc acoustics graduates, Bill McTaggart, and Andy Watson, were Branch Secretary and Treasurer respectively for around 50 members.

Building acoustics

In the area of building acoustics, new regulations were introduced in 1985 and although research had identified a clear link between post-construction testing, or the absence thereof, and failure due to poor workmanship, there remained a significant resistance to the inclusion of mandatory post-completion testing largely due to the cost and time involved in carrying out sound insulation tests. So, our attention at Heriot-Watt University turned to developing rapid and cheaper test methods, which resulted subsequently in an International Standard, *ISO 10052 — Field measurements of airborne and impact sound insulation — Survey Method*, being published in 1993.

1987 brought about a flurry of new consulting practices in Scotland. Dick Bowdler left Sandy Brown Associates and joined Colin Frier, one of my former MSc students, to form New Acoustics in Glasgow, where they were later joined by Anne Budd. In the same year, Andy and Fiona Watson formed Acoustic Consultancy Services in Glasgow. Also in the same year, Nick Charlton Smith established his consulting practice in Dundee.

Around this time a new directive from the EU, the Construction Products Directive, gave a stimulus to acoustic product manufacturers and I formed a close association with the Proctor Group, based in Perthshire, which lasted over 30 years and during which time we were awarded 12 patents, covering a range of new acoustic products, all manufactured in Scotland.

In 1993, I left Heriot-Watt University to take up a professorial position in Sheffield and Bob Craik took over my role as Director of the MSc course. Professor Craik carried P42

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on his work in flanking transmission and, with Alistair Somerville, started to look at inaudibility as a criterion for noise control from pubs and music venues.

Four new PhD students joined Bob in his research group, Mike Stewart, Ian Steel, Robin Wilson, and Sean Smith. They undertook some very influential research on flanking transmission and have since developed their own distinguished careers, Mike as a principal researcher at the UK Health & Safety Laboratory, Iain as Professor and Head of School of Engineering at Robert Gordons University, Robin as an Associate Professor at the University of Nottingham, and Sean as Professor of Future Construction and Director of the Centre for Future Infrastructure at the University of Edinburgh.

In 1996, one of my former PhD students, Dr Bernadette McKell took over as Chair of the Scottish Branch and during her period in office the membership rose to 130. She handed over the Scottish Branch chair in 2003 to David Mackenzie, with the Secretary's role being taken over by Lilianne Lauder, who served in that post until her untimely death in 2021.

Back at the University of Edinburgh, in 1997, Professor Campbell hosted an International Symposium on Musical Acoustics, which was attended by 150 delegates, the largest conference in musical acoustics to be held in Scotland.

Neighbour noise

Towards the end of the 1990s the English House Condition Survey showed that the problem of noise from neighbours in England and Wales had not significantly improved from the situation identified 20 years earlier by the BRE.

It was now clear that changing social patterns, with louder TVs and music systems were creating a situation whereby neighbours were becoming less tolerant to noise and were demanding higher standards of sound insulation. Consequently, in 2001, a decision was finally taken to include pre-completion testing as a means of demonstrating compliance in the amendments to Part E of the Building Regulations in England and Wales.

In July 2002, after lobbying from the industry, a Green Paper was introduced in Parliament, allowing the use of *Robust Standard Details* (RSDs) as an alternative to pre-completion testing, provided that the industry could develop such designs before the planned date of publication of the revised Regulations in August 2003.

This challenge led to the largest sound transmission project ever undertaken, involving 1,300 dwellings being tested throughout the UK with 13 RSDs being designed all within six months by the Building Performance Centre at Edinburgh Napier University. This project was led by Sean Smith, who had joined RMP Acoustics two years prior, and Richard Mackenzie, who had taken over as Principal Consultant of RMP Acoustics. The designs were incorporated in a UK Government's White Paper published by the Office of the Deputy Prime Minister in August 2003. The new regulations included the most comprehensive set of amendments to the provisions for sound insulation since the introduction of the Building Regulations in the 1960s.

Between 2003 and 2008, important research contracts dealing with societal issues were carried out by the Building Performance Centre at Edinburgh Napier for Defra involving noise control from laminated floors, and sound insulation of open windows. A research contract awarded by the Scottish Government also led to the publication of an important document co-authored by John Wood, Sean Smith, and Richard Mackenzie, entitled *Good Practice Design Guide for Sound Insulation*. Around this time, Dr Bernadette McKell, who had become a Vice President of the IOA, was also undertaking important contract work for Scottish Government in the area of noise mapping.

To assess the impact of pre-completion testing and RSDs after 10 years in operation, the NHBC investigated the pattern of noise problems reported by occupiers of new homes since the introduction of these measures in 2004. The findings from that work, reported in *Sound Progress*, indicated a 57% drop in complaints in relation to problems from transmitted noise in new attached homes. It is clear that pre-completion testing has significantly reduced the rate of failure due to poor workmanship and that RSDs have provided a level of sound insulation for the UK which is now amongst the highest in the World. The impact of RSDs and their benefit to society was recognised by the award of the Queen's Anniversary Prize in 2009 to the Building Performance Centre at Edinburgh Napier University for their pioneering work in this area. This is only the second time that the Queen has recognised a British university for its research in acoustics, the other being the Institute of Sound and Vibration Research at Southampton University.

In 2009, Edinburgh hosted *Euronoise*, with over 800 delegates present and in 2022, Glasgow held *Inter-Noise*, attracting 1,000 participants from 60 countries, the largest conference to be organised by the IOA in Scotland in its 50-year history.

During its 40 years of existence, the Scottish Branch has managed to hold at least two technical meetings or visits each year covering most of the disciplines in acoustics. The Branch has also frequently responded to both Scottish and UK Government consultation documents. Indeed, over the 50 years since the IOA was formed, our Branch members have exerted major influence in UK policy and regulations covering diverse areas ranging from building acoustics, noise mapping, medical ultrasonics, speech technology, underwater acoustics, and motor sports. Since 1974, six members from the IOA Scottish Branch have served on the governing Council of the IOA including myself, Ann Budd, Bob Craik, Richard Mackenzie, Bernadette McKell, and Alistair Somerville. The provision of staff trained in acoustics is well demonstrated by the fact that the number of acoustic consulting practices in Scotland has grown from two, back in 1974, to around 36 today.

In conclusion, I would observe that the Scottish Branch has performed extremely well and has gone from strength-to-strength over the 40 years since its formation. Its members remain well positioned to advise and carry out research on future acoustic issues affecting society, including noise from offshore engineering, wind turbines, road traffic or in the areas of building

acoustics, or in the development of new music technologies for our recreational enjoyment.

Memories of a founder member

By Rupert Thornely-Taylor FIOA

The 1960s and early 1970s were an eventful time in acoustics. Small though the discipline was, there had long been institutions devoted to acoustics; the Acoustical Society of America was founded in 1929 and Brüel and Kjær was formed in 1942. Study of the science of sound has a much longer history with its origins in classical Greece, having been developed by Galileo in the 17th century. My beautiful half calf-bound volume of the first edition of *Sound*, John Tyndall's course of eight lectures at the Royal Institution was published in 1867, and Lord Rayleigh's monumental work *The Theory of Sound* was first published in 1877. They are both commemorated in the IOA's Tyndall and Rayleigh Medals (the latter of which I was awarded in 2016). The Institute of Physics formed an acoustics group in 1947, to become the *Acoustics Group of the Institute of Physics and the Physical Society* after those two organisations merged in 1958. It was the only acoustics organisation in the UK until the *Society of Acoustic Technology* was formed in 1962. These two groups were merged under the auspices of the Royal Society to create the British Acoustical Society in 1965 (the first meeting was held in 1966). The British Acoustical Society was administered as a daughter society of the Institution of Mechanical Engineers with its headquarters in Birdcage Walk near Parliament Square in London. I was elected a junior member of the Council on 1968, the year I started my consultancy practice.

In the USA the Institute of Noise Control Engineering was founded in 1971 by Bill Lang and Leo Beranek, and I was pleased to attend Inter-Noise 72 (whose General Chairman was Malcolm Crocker, who went on to found the International Institute of Acoustics and Vibration), thanks to a grant from the Churchill Fellowship that took me to all the centres of acoustics in the USA.

Internationally, the International Commission for Acoustics was instituted in 1951 as a subcommittee of the International Union of Pure and Applied Physics and it held its first congress in 1953 in Delft. In 1963 it was decided that the 8th International Congress on Acoustics would be held in London. The organisational issues that arose are well described in *IOA the first 40 years* and, as a result, the IOA was formed from the British Acoustical Society and the Acoustics Group of the Institute of Physics and the Physical Society. It was created as a daughter society of the Institute of Physics (renamed thus in 1970). The 8th ICA took place at Imperial College in 1974.

The problem of noise

One of the topic areas within acoustics, noise, grew in prominence in the 1960s with the publication of the report of the *Committee on the Problem of Noise chaired* by Sir Alan Wilson in 1963[1]. The Noise Advisory Council was formed by Anthony Crosland, Secretary of State for Local Government and Regional Planning in Harold Wilson's Government. After the 1970 General Election and the advent of Edward Heath's Conservative Government, Peter Walker created the Department of the Environment and took the chair of the Noise Advisory Council, which in due course published some important reports including *Neighbourhood Noise*, containing a draft of what was to become the noise parts of the Control of Pollution Act 1974. One of the leading figures in the gestation of the IOA, Professor Elfyn Richards, stated at a conference that noise was the "new pollution", and frequently spoke on the topic, referring to us as "acousticians".

The predecessors of the IOA had memberships composed primarily of physicists, and in its early years the IOA was housed within the Institute of Physics (IoP) in Belgrave Square. As its first Honorary Treasurer, I had to work with the IoP's financial management system which was a service provided to us commercially by the IoP. We had both an Honorary Secretary (Dr A E Brown) and a Secretary, John Byrne, who was very active and contributed to starting the publication of Acoustics Bulletin.

Academia

In the academic world, the Institute of Sound and Vibration Research was founded in 1963 at Southampton University, and leading academic institutions specialising in acoustics included Chelsea College, Imperial College, Salford University, Liverpool University, and Heriot-Watt University. Prominent names from those times, in addition to Elfyn Richards who went from Southampton to become Vice-Chancellor of Loughborough University, were Brian Clarkson (Southampton) RWB Stephens and Geoff Leventhall (Chelsea College), Peter Grootenhuis (Imperial College), and Peter Lord (Salford University). However, some giants in acoustics, such as Sir James Lighthill (Imperial College) and Professor Geoffrey Lilley (Southampton and a member of the Noise Advisory Council) were seldom to be seen at conferences. The BBC Engineering Research Department was the original home of many acousticians who went on to build careers in acoustics including Sandy Brown, Alex Burd, Frank Ward, and Chris Gilford

The IOA began to have a wider appeal and membership began to include practitioners in noise control, employees of companies making acoustical products, consultants, and what were then called Public Health Inspectors. Hearing conservation was in its infancy with realisation of the magnitude of the hearing damage risk in the workplace only beginning to emerge with enactment of the Health and Safety at Work Act in 1974.

Prominent public sector organisations (as they were then) included the National Physical Laboratory, Building Research Station, and the Road Research Laboratory. In the private sector, Acoustical Investigation and Research Organisation (founded in 1958), and Sound Research Laboratories founded in 1967 were the most senior laboratories. The Association of Noise Consultants was formed in 1973 on the initiative of Professor John Large of Southampton University, and Bill Allen of Bickerdike Allen Partners, along with Roy Waller and me.

Strains within the management structure of the IoP led to the departure of the IOA from Belgrave Square and the IoP in 1979 to move to Heriot-Watt University and be so ably managed by Cathy Mackenzie.

The IOA has grown to achieve its remarkable stature thanks to P44

the selfless, time-consuming work of many acousticians. There is a groundswell of young workers in acoustics, some of whom will see the IOA celebrate its centenary. May they have careers as fulfilling as mine has been.

Education and the IOA Diploma origins

By Dr Brian Smith FIOA

During the 1970s I was a lecturer at Ewell Technical College teaching building science and maths to students aiming to become construction managers or structural engineers. At that time we ran short courses and invited sixth formers to attend from local schools so that they could get an idea of science applications in construction. These courses came to include acoustics and noise control and it was to one of those courses that Alec Burd visited in 12 July 1971 to listen to the acoustics input. After that I was invited to join the British Acoustical Society (BAS) Education Committee. I think the first meeting was held on Tuesday 7 September 1971 followed by the Council on Tuesday 25 October at the Institute of Mechanical Engineering (IMechE). I remained on the Education Committee and Council of the BAS and IOA until 1984.

I started a part-time PhD at UCL in 1968, which was related to structure-borne noise. During this time I was asked by Longmans to write a book on acoustics for students, so *Acoustics and Noise Control* was published in 1971, its content based on expertise gained from the short courses we had been asked to run for environmental health officers and others as consultancy work became quite extensive.

Acoustics and Noise Control covered basic principles and, to my surprise, became a recommended book for architectural and building degrees etc. It has since been developed further with appropriate additions by other people.

The BAS in 1971 was fairly informal but did include some notable academics in the field of acoustics including Peter Lord, Ray Stevens, and Alec Burd. I seem to remember that there were a couple of vice chancellors on the committee. The diploma format was developed because of the nature of the need for acoustics and noise control knowledge by a wide range of people with different expertise and backgrounds – for example, EHOs, architects, engineers etc.

Comprehensive acoustics training

The initial ideas for what became the Diploma in Acoustics started in 1972/3, I became the Chair of the Diploma Advisory Board in 1975 and the courses started in September 1977. Many colleges had already been running short courses, most of which formed a brief introduction to acoustics and although most were good on theory, they were light on instrumentation. Students realised that more comprehensive courses were needed to meet their needs particularly as legislation continued to impose greater demands on them.

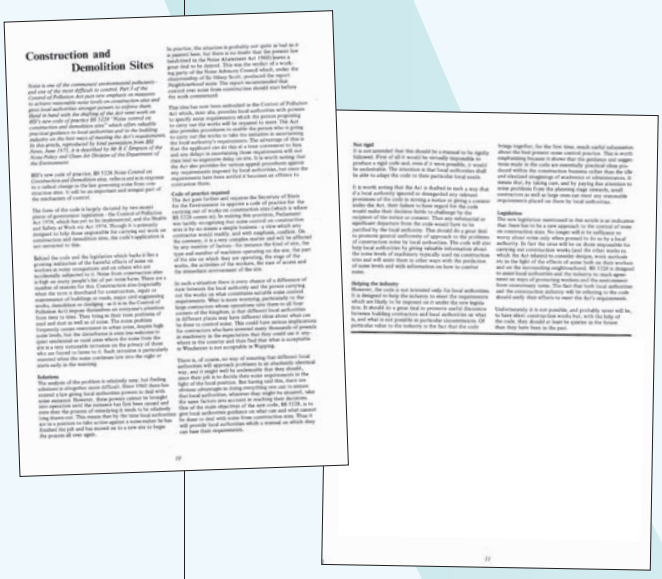
In 1975, The IOA set up a working group (chaired by Alex Burd) to consider training in acoustics and sought representation from various significant bodies including the Association of Noise Consultants, the British Society of Audiology, HSE, the Noise Advisory Council and the Society of Environmental Engineers. During its first meeting, working group members identified the groups with the greatest need for more working knowledge of acoustics, for example, graduates mainly in science and engineering, those with professional backgrounds such as EHOs, and higher technicians with HNCs or HNDs.

In consequence, the working group aimed to develop a course which would be the equivalent of just one day a week for one year, which would be enough to give delegates a good background to acoustics and noise control – the standard in acoustics being far higher than that of any standard physics or engineering degree and it would become a measure of the academic standard needed for corporate membership of the IOA. In June 1978, 56 candidates sat the Diploma exam; 82% of whom were EHOs.

I should like to emphasise that while I was very much involved with the development of the Diploma, much of the credit must go to others who were developing courses. The wisdom and practical knowledge of people like Peter Lord, Ray Stevens, and Alec Burd, combined with their drive and encouragement was undoubtedly the most important factor.

Article from the archives – April 1976, *Construction and demolition sites*

This article shows the growing realisation of the harmful effects of noise on workers in noisy occupations as well as others who would be incidentally subjected to it – this led to the onus being put on to those responsible for carrying out the works, to protect workers and the environment from unnecessary noise from construction sites.


Construction and Demolition Sites

Article from the archives – April 1976, *Acoustics in Parliament*

Concorde

On 23rd June 1975 Mr Hayhoe asked the Secretary of State for Trade (Mr Clinton Davis) if he will arrange a series of Concorde landings and take-offs at Heathrow so that those living near the airport may assess the noise nuisance this aircraft will cause under normal airline service conditions.

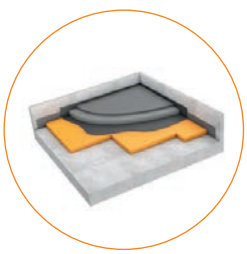
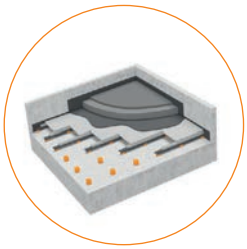
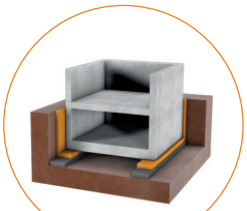
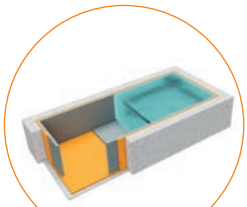
Mr Clinton Davis: No.

A substantial number of Concorde flights to and from Heathrow are, however, planned to take place between July and September as part of the endurance flying programme. These flights will be monitored for noise purposes.

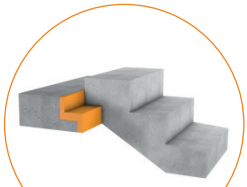
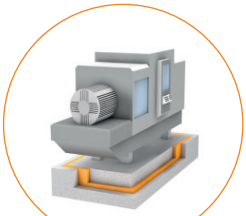
Mr Hayhoe asked the Secretary of State for Trade what are the latest figures for the landing and take-off noise of Concorde; and how these compare with the current generation of large jets in airline service.

Mr Kaufman: I have been asked to reply.

The manufacturers' latest estimate remains as quoted in the reply which my hon. Friend gave to P46

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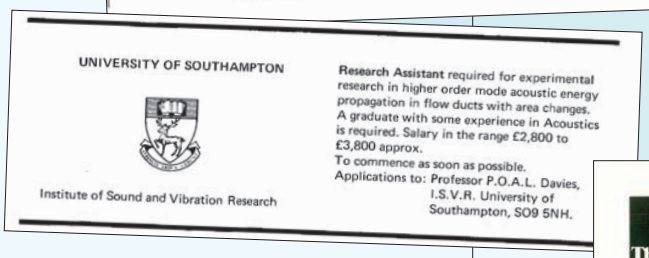
the hon. Member on 17th December last. This is that Concorde's noise levels on certification at the increased weight of 400,001b. will be 118 EPNdB on take-off and 115 EPNdB on landing. These compare with large jets currently in airline service as follows:

	Take-off	Landing
VC10	110	112
Boeing 707-320C	114	120
DC8-61	115	116
Boeing 747-200 B/F	108	107
Lockheed 10-11	97	103
DC 10-30	104	107

Advertisements from the archives – April 1976

It seems that this half page, (below), went unsold in the April 1976, so this 'house ad' was placed to encourage potential advertisers to buy space in future issues.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Institute of Sound and Vibration Research

However, this job advert, (above), for a research assistant promises an attractive salary, when the average salary was £1,981 — for men anyway. For women, it was £1,024.

This advert for a portable tape recorder, (right), took the inside front cover prime position in the April 1976 issue. Anyone interested in buying one had to cut out the coupon and post it to the manufacturer, and the code in the bottom left hand corner of the coupon was to enable to manufacturer to tell exactly where and when the advertisement had been placed so they could monitor response.

Specialist Groups

As the IOA celebrates its 50th anniversary, its specialist groups have been looking back at key developments in their sectors over the past five decades and looking ahead to what the future might hold. In this first series of reviews, we look at the work within buildings acoustics and early careers.

Buildings Acoustics Group

By James Healey

It seems like yesterday when we attended the NEC, Birmingham to celebrate the IOA's 40th anniversary. In the decade since, the Building Acoustics Group has supported many one-day events and the annual conferences. There have been a few themes developing through the years, most notably sustainability, office acoustics and hybrid meetings.

Committee members have steered most new building acoustics standards in the past 10 years, including BS 8233, ISO 10848, ISO 16283, ISO 2295, CIBSE Guide A, the ANC Gym Acoustics Guidance and the Acoustics, Ventilation and Overheating: Residential Design Guide.

When in our control, we have voted and awarded on several Peter Lord awards for innovative projects, including Jian Kang's plenum window design, Arup for their work on the Royal Academy of Music and RES for their resonant string shell. These projects have demonstrated the creativity and excellence of building acoustics practitioners and researchers, and have inspired many others to follow their footsteps. For example, the plenum window design has been adopted by several schools and hospitals to provide natural ventilation and noise control, while the resonant string shell has been used to create unique musical experiences for audiences and performers.

In 2019 we provided the last one-day conference before the pandemic, on open plan office acoustics. The theory and practice tabled at the meeting went on to influence the new ISO 22955 used today. This standard provides guidance on how to design and manage open plan offices to achieve optimal acoustic conditions for workers, especially in the context of hybrid working models and flexible workspaces.

What's clear on reflection, as a group we have responded well to whatever is current at the time. Whilst some of our members (me included) have been part of the group since (and before) the 40th anniversary, we have new faces bringing refreshing ideas. We have also maintained a strong network and collaboration with other groups and organisations, both within and outside the IOA.

In 2021, I took over as Chair, moving from the role as Secretary which I held since 2013 (joining as Young Member in 2008). Prior to this, Roger Kelly steered our committee

with great leadership and enthusiasm. Since 2021 we have attempted to continue this enthusiasm, and recognising that our committee comprises some brilliant minds, we embarked on the sharing of our knowledge and using it to advance the thinking of our membership.

The first output of this new approach is the Building Acoustics Sustainably document, now out for consultation. Authored by one of our committee members, Ben Burgess of Buro Happold, with the help of the committee, it seeks to influence the way we approach our building acoustic designs, aiming to enable easy, reachable methods to implement sustainable practices into our design. As a group, we see this as the first of a few documents, continuing the responsibility we believe we have, to give back to our members.

The next decade

Looking forward to the next 10 years, we anticipate new influences shaping our response to building acoustics. We envisage artificial intelligence becoming a major part of our daily lives. The benefits are obvious – we can automate optimisation of a room acoustic design, delivering the best solution in a short timeframe. We can use AI to develop smart soundscapes, actively learning from usage patterns of building occupants and even who may be occupying the building, to cater occupant-specific sound masking. We can use AI to optimise site layout and building positioning, with the noise exposure and façade design constraints being an influence in the process.

We also envisage a further and more increased focus on sustainable methods in the way we design and construct our buildings. New material development and methods of construction are likely to affect our approach, and indeed climatic influences and responses to these are expected to become even more important.

We will continue to recognise what the next influence is and will seek to mirror and amplify these thoughts in the events and publications to which we contribute.

Presently, we look forward to a year of celebration in us all being part of this fantastic community we have the pleasure to be part of, and we can't wait to celebrate 50 years of the Institute of Acoustics.

Early Careers Group

By Josie Nixon

Looking back...

The Early Careers Group (ECG), formerly known as the Young Members' Group became a formal group in 2009 (having run informally since 2007), as such, we are relatively new compared to many of the other Specialist Groups and Branches. Ours was the first group formed to engage young members of the IOA, and one of the only two to feature representatives from each Specialist Group and Branch, and Louise Beamish was the first ECG Chair.

Louise said: "I set up the Young Members Group (now the ECG) to provide a voice and a network for the next generation of acoustics engineers. It's important that the IOA provides a network for its early careers members so that peer-to-peer relationships can be built and the IOA can evolve considering the opinions of all its members. I'm very proud to see the way that the group has continued to grow and establish itself."

The ECG aims to bring together a diverse network of acoustic professionals in the early stages of their career by promoting peer knowledge sharing and support, providing a link to the knowledge of established acousticians, and a platform for the continuing development of new and existing skills.

Louise was followed by Angela Lamacraft (who is now Chair of the IOA EDI Group). Angela said: "I became Chair of the Young Members Group, as it was then, because I remembered what it was like to start in acoustics and not know anyone, and I wanted to help people early in their career meet people at a similar stage, as well as more experience acousticians.

"I think it's important that experienced and less experienced people are connected so that they can learn from each other. My ambition for the ECG was to organise events that facilitated this aim within the IOA, but also beyond so that early careers people in different professions could meet each other, share their experiences, discuss their specialism and ultimately grow their network of trusted professionals to work with as their careers progress."

Ellen Harrison took on the role of Chair after Angela, and I was lucky enough to be the ECG rep for the IOA Eastern Branch under her for a short time, before Tomasz Galikowski took over. Ellen encouraged the social aspects of the ECG and arranged interdisciplinary events. The core aims of the ECG have remained and grown with time and a focus on social acoustic networking events, along with interdisciplinary and informative webinars have also become part of the programme, to enable those early in their careers to grow a professional network and discuss their specialist interests.

When the pandemic hit in 2020, the ECG saw a change in its aims, under the guidance of Tomasz Galikowski, who said: "I became the ECG Chair shortly after the start of the pandemic. In the early days there were concerns about the employment and prospects of the ECG members so the key task then was to galvanise the ECG Steering Committee and the members, which we achieved by forming a Covid-19 response group to support the ECG members during and post-pandemic. We engaged with the IOA ECG members by surveying them to understand the impact of the pandemic and their needs. We were vocal about making advertisements for jobs free on the IOA website to improve opportunities and we put together a regular programme of webinars focused on career-related topics. We created space for networking and emphasised openness of the ESG, which included sessions during the annual IOA conferences and – for the first time – fully virtual sessions of 'The Art of Being a Consultant'."

The end of the pandemic saw a return to social events with an evening at The Charlotte in Southwark and The Hatch in Manchester in 2021 sponsored by Mason.

At Inter-Noise 2022, the ECG organised a dedicated session of presentations and launched a 'buddy scheme' along with the IOA EDI Committee. As part of this we held a breakfast event where mentors and buddies could meet. We also organised an evening social event with the IOA Scottish Branch. The buddy scheme has since been used at other IOA-led conferences, such as Acoustics 2023, where we also had a networking social evening supported by Getnzer and hosted a room for a day. P48

The 'Art of Being a Consultant' conference was first held in 2004, and since the formation of the ECG, has been organised by the committee. This event is now run annually, changing locations predominantly between London, Manchester, and Southampton. During the pandemic, it was held as a virtual event, with a mini-series of panel discussions. Last year (2023) saw the start of hopefully many joint initiatives between UKAN++, SIG and IOA ECG as we hosted 'Art of Being A Consultant' and 'Art of Being an Acoustician', a two-day event at The Little Ship Club in London.

In 2012 the ECG had 116 members, by 2014 this had grown to 229 members and at time of writing the Group now has 526 members, with an ECG representative sitting on most IOA Branches and Specialist Groups.

The future of the ECG

As can be seen by looking back over our Group's history, the ECG has evolved to encompass a range of objectives and support the needs of its members in many ways. I hope this continues and that the Group continues to adapt to the changes in society as well as the needs of its members.

It would be lovely to see an ECG representative in every Branch and Specialist Group, and we hope to achieve this with more volunteers. We continue to strive to bring together a diverse network of acoustic professionals in the early stages of their career, introducing them to the IOA through a variety of webinars, conferences, networking events, and social interactions. Hopefully, our membership will continue to grow and the ECG will continue to be instrumental in shaping the future landscape of acoustics and the IOA.

Some 1970 significant world events

- Britain's monetary system saw its biggest change for more than 1,000 years on Decimal Day (15 February 1971)
- 'The Godfather' had its world premiere (14 March 1972)
- The 'Battle of the Sexes' tennis match was played between Billie-Jean King and Bobby Riggs (20 September 1973)
- The Yom Kippur War began as Egypt and Syria attacked Israel (6 October 1973)
- Facing likely impeachment and conviction over the Watergate scandal, Richard Nixon became the first US president to resign (9 August 1974)
- Microsoft was founded by Bill Gates and Paul Allen (4 April 1975)
- The first mass-produced practical home computer, the Apple II, went on sale (June, 1977)
- Elvis Presley died (16 August 1977)
- Louise Brown, the first human conceived through in vitro fertilization, was born (25 July 1978)
- Margaret Thatcher became the UK's first female Prime Minister (4 May 1979)

You can read *IOA, The First 40 Years* here: https://bit.ly/IOAfirst40

Memories differ

All our contributors to this section will remember events differently and as we feature *their* memories, and they might not be exactly how others remember them!

Technical terms

In this archive section, we use technical terms 'of the day.' These terms may not be what we use now.

1 Editor's note: This seminal report contained the first airport noise contours for the UK and also at Annex 15, the pre-cursor to the 1967 version of BS 4142. The committee comprised members from industry, academia, and the public sector, but also included '*Mrs E I Webley, JP (Housewife)*'. The Institute held a one-day conference at the Royal Society in 2013 to mark the 50th anniversary of the Wilson Report.

IOA Bursary Fund update:

The Bursary Fund was very popular in 2023. It opened for applications four times, and nine applications were received throughout the year.

By Reena Mahtani, Chair of the Bursary Fund

From those nine applications, three were successful in obtaining funding to study the IOA Diploma and to attend different conferences outside the UK. The lucky applicants will be sharing their experiences with the IOA membership soon.

In most of the unsuccessful applications the request for funding was made for an activity related to the applicant's field of employment. Completing the personal statement section of the application correctly is incredibly important for the review panel to understand the applicant's background and the reason why the proposed activity should be funded. Sadly, we cannot provide funding for activities we believe to be related to the applicant's employment, and applicants should make this clear in their applications.

IOA members can apply now

Finally, there were no successful applications in the Autumn 2023 round of funding. The first point in the rules is that this programme is open to IOA members, no matter what grade they are, and we cannot unfortunately accept applications from non-members.

The Winter round of funding is currently open until the end of February. If you or someone you know could benefit from financial assistance from the Institute, please consider applying. There is more information on the website, and if you have any questions, please feel free to send us an email to **ioa@ioa.org.uk**

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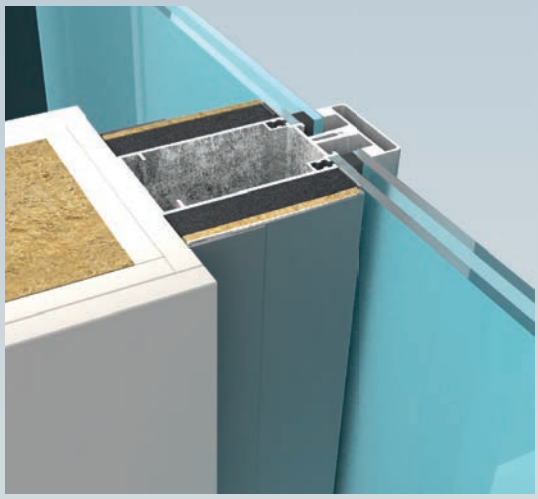

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2023 Secondary School Competition winner, Clementine Bristow, from Stamford Endowed Schools

2023 was the third year that the IOA has run the secondary school competition, and the second year it has run one for primary schools too. The aim of the competitions is to raise awareness in children of the importance of sound and its place in our environment — we want to encourage children to think consciously about the soundscapes around them and the influence they have.

By Angela Lamacraft, Sustainable Acoustics Ltd, and IOA Schools Competition Lead

Above: (L-R): Angela Lamacraft (Sustainable Acoustics Ltd, and IOA Schools Competition Lead); award winner, Clementine Bristow from Stamford Endowed Schools; Trudy Harrison MP (Parliamentary Under Secretary of State for the Department for Environment, Food and Rural Affairs (Defra)); and Alistair Somerville (IOA)

The effects of sound on wildlife are often overlooked, therefore the 2023 IOA Secondary School Competition was especially exciting as we asked children to explore the connection between acoustics and ecology, specifically birds.

The first step for students was to install the BirdNET app and familiarise themselves with the hardware and software they would be using. Next, students were asked to identify three areas that sound different and describe the soundscape of each area in a way that makes the differences clear. Finally, students had to identify any birds that were present in each area and discuss the differences between the three areas.

The judges of the competition were:

- Gloria Elliott, Chief Executive of the Noise Abatement Society and Chair and Co-Founder of Quiet Mark;
- Fiona Rogerson, Senior Consultant, Acoustics at ARUP; and
- Matthew Muirhead, Associate Director, Acoustics at AECOM.

Winner, Clementine Bristow from Stamford Endowed Schools

The judges said the entries were as innovative and diverse as ever, making judging extremely hard. However, after much deliberation, Clementine Bristow from Stamford Endowed Schools was selected as the winner, with the team from Balshaw's Church of England High School Highly Commended and St Oscar Romero Catholic School Commended.

Clementine was awarded her prize at the Noise Abatement Society's (NAS's) John Connell Awards at the Palace of Westminster on the evening of 25th October 2023. Now in their 22nd year, these awards acknowledge the importance of the quality of sound in our lives, and champion vital advances in reducing the negative impact of unnecessary noise for the public benefit. Over 390 recipients from local authorities, industry, organisations, and individuals have now been honoured for the significant impact they have made to improve the aural environment. **(See the full report of the NAS awards on page 30 of this issue).**

The IOA Secondary School Competition judges remarked that: '*Overall, we were really impressed with the entries, and it was very close. Clementine's entry was*

well written, precise, and logical. The different soundscapes were described well and the results were clearly presented. Clementine clearly enjoyed the knowledge gathering and got a lot out of the exercise.'

Gloria Elliott OBE, NAS CEO and co-judge of the competition said: "Congratulations to Clementine Bristow for her highly impressive submission which demonstrated real depth of investigation as well as practical problem solving skills, and all beautifully produced."

Alistair Somerville, IOA President said: "The IOA School Competition is now an annual event which encourages young people to explore the wonderful world of acoustics! This year's winning entry by Clementine was extremely well written, clearly showing us a precise and logical approach to exploring the different soundscapes under investigation. Her results were beautifully presented, and she clearly enjoyed and benefited from the knowledge gathering exercise."

2024 IOA Secondary School Competition

The 2024 IOA Secondary School Competition is continuing with the same task and is live now! The competition is for a small team of up to three students between 11 and 16 years of age to use the BirdNET app to identify the birds present in three acoustically different areas. A brief report describing what was done for familiarisation of the app, and the methodology, results and findings from the measurements is required. The electronic format for the report can be one that best suits each entry. The criteria for assessment are:

- age of the entrants (this will be considered when assessing the quality of the report);
- number of students in the group (this will also be considered when assessing the quality of the report);
- suitability and ingenuity of the format of the entry deliverable;
- presentation of the entry, including any photographs or audio;
- content, including
  - description of the methodology;
  - description of soundscapes;
  - description of bird species;
  - scientific conclusions; and
- development of acoustic ideas introduced by the competition.

We want to encourage children to think consciously about the soundscapes around them and the influence they have.

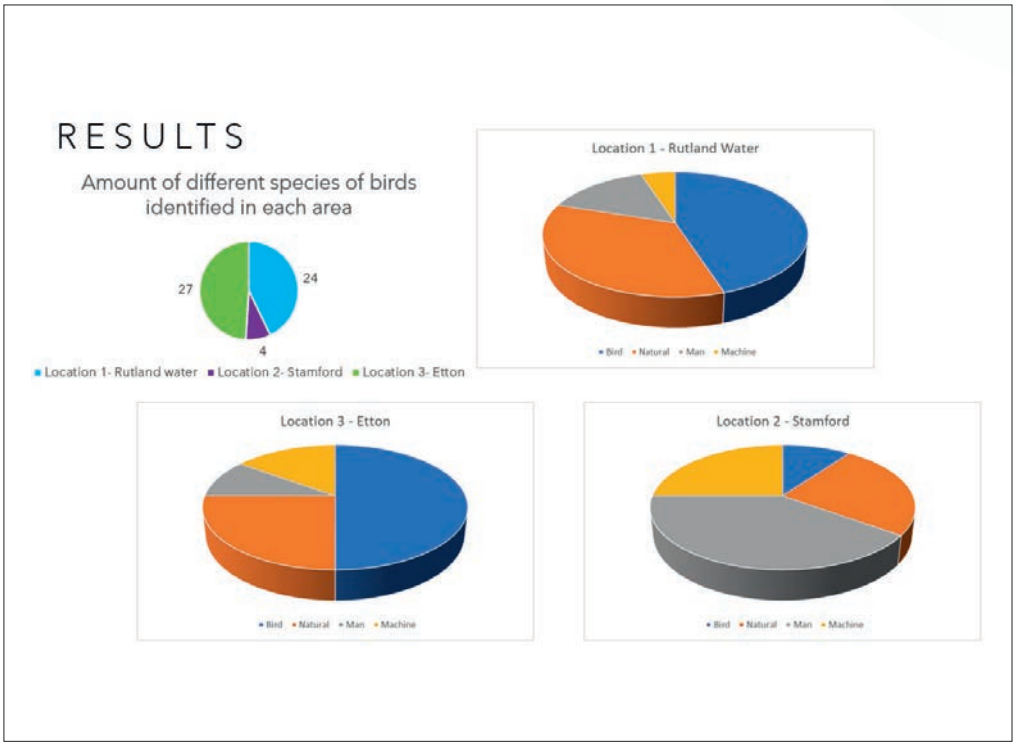
The prize is £25 for each winning entrant, plus £500 and an engraved crystal trophy for their school. The winning school will be invited to send up to three students who have participated in the submission, plus one parent per pupil and one teacher, to collect the winning prize in person at the 2024 Noise Abatement Society's John Connell Awards ceremony at the Houses of Parliament (reasonable travel and subsistence expenses will be available).

This is a great way for young people to investigate the connection between acoustics and ecology and think about the value of positive soundscapes.

Head to **https://www.ioa.org.uk/video/ioa-secondary-schools-competition-2024-connection-between-acoustics-and-ecology** for more information.

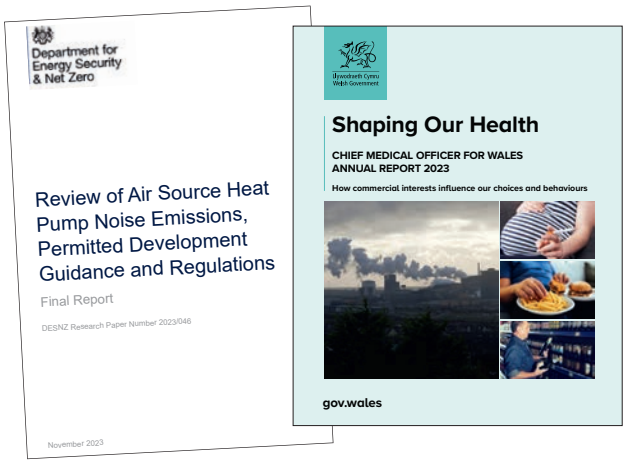
Above: Part of Clementine's winning competition entry

Below: Clementine's observations at three different areas



Current parliamentary and policy news

The end of 2023 was a busy time for announcements linked to noise and acoustics issues, with plenty for the IOA Parliamentary and Public Liaison Group (PPLG) to consider, and more noise-related consultations pending.



The UK Government response to the House of Lords report covering environmental noise and health details current work covering acoustics issues. In Wales, we welcome the recognition of soundscapes in law for the first time in the UK. We look forward to supporting the development of new and existing policies and research in 2024 – and continuing to raise the profile of acoustics with policy makers.

Government responds to House of Lords report on noise

The Government response to the House of Lords Science and Technology Committee report investigating noise and human health was published on 1 December 2023. While the Government response recognises noise as second only to poor air quality as an environmental cause of ill health in Europe, it does not agree with the report recommendation that an expert advisory group on noise should be established. The response states that noise covers a very wide spectrum of expertise given the many possible areas of interaction between noise and our human experience – in addition to the interactions with other species, and that flexibility must be maintained to draw in the most appropriate expertise to individual areas of research. They point to the existing network of collaborations, and state they will consider whether the remit of existing bodies should be extended to cover noise. The response also signposts ongoing work programmes to identify potential noise issues and their solutions related to air source heat pumps and onshore wind, which are integral to the Department for Energy Security and Net Zero (DESNZ) net zero programme. In addition, it notes that DfT is funding two domestic cross-sectional studies – an Aviation Night Noise Effects Study and an Aviation Noise Attitudes Study. It also states the intention to make Defra's noise modelling system available to all public bodies, which will support noise assessments in the early stages of planning any new development, as well as identifying interventions appropriate to individual situations where they exist.

Read the full report at: **https://committees.parliament.uk/publications/42401/documents/210714/default/**

Review of air source heat pump noise

A review of air source heat pump (ASHP), noise emissions permitted development regulations (PDR) and guidance was commissioned by DENSZ to assess whether current guidance is fit-for-purpose for the larger scale deployment of ASHPs in England, which is part of Government proposals to meet net zero targets. The report, of the work undertaken by engineering consultancy WSP, construction engineering company BSRIA, University of Salford Acoustics Research Centre University of Salford Acoustics Research Centre, and Stephen Turner Acoustics was published at the end of November. Key findings were that ASHP noise appears to be a problem for a minority, and that where there were noise complaints these were a result of poor quality installation – solved by use of rubber matting or acoustic enclosures – and location in relation to neighbouring properties – which could be solved by moving or replacing the ASHP. The research carries the caveat that it is based on householder survey respondents mostly in detached and semi-detached housing, and interviews with installers willing to participate in the review.

The review recommends potential updates to PDR guidance and regulations include:

- providing clear guidance on best practice installation, including specific location and minimising reflecting surfaces rather than relying on a specific distance from the boundary;
- consider removing the requirement that all parts of the ASHP must be at least one metre from the property boundary;
- provide clear guidance on what operating load and environmental test conditions of the sound power level should be used in the assessment; and
- including an assessment methodology that takes account of noise from ASHPs installed at multiple properties in a neighbourhood.

Read the full report at: **https://assets.publishing.service.gov.uk/media/6568b7b95936bb000d3167ef/ashp-planning-regulations-review-main-report.pdf**

Consultation on planning requirements for ASHP

The Microgeneration Certification Council (MCS) are consulting on the MCS 020 Planning Standard for Permitted Development

Installations of ASHPs, in line with the DESNZ ASHP noise review outcome. Planning is devolved so conditions differ across the four devolved administrations; however, all four require ASHP to comply with MCS 020. Since MCS 020 was first issued in 2011, and updated in 2019, improvements in heat pump technology have led contractors and consumers to raise concerns that current PDR are a barrier to installation. In Wales currently, domestic ASHPs are required to be at least three metres from the site boundary, and in England one metre. The Welsh Government is also looking to update PDR in Wales, with a report prepared by Sustainable Acoustics and Apex Acoustics (referenced in the DESNZ report) and due to be published shortly. IOA are preparing a response for submission by the deadline of 26 January 2024.
In November 2023 an article in the Daily Telegraph highlighted concerns about ASHP noise, demonstrating that it is a significant issue. It is likely to remain a key topic, important to the roll out of renewable energy, which may well play a part in political debates when we move towards a general election. Read the MCS 020 Consultation at **https://mcscertified.com/wp-content/uploads/2023/11/MCS-020-Consultation-FINAL-1.pdf**

IOA supports updates for vehicle type approval

The DfT has consulted on updating the type of approval for GB vehicles. The UK is signed up to comply with certain United Nations Commission for Europe (UNECE) regulations, ensuring UK-made vehicles comply with international standards. As international vehicle regulations evolve, the consultation is part of the process of considering whether these updates are incorporated in the GB scheme. The UNECE Regulation 138 on Quiet Road Transport Vehicles (QRTV) regulates the sound on electric vehicles incorporated for safety and is signed by the UK so needs to be accepted in the GB scheme. Other regulations covered include sound levels and replacement silencing systems. The IOA responded supporting the measures which will align GB vehicles with international standards.

Reduction in Northern Ireland noise complaints

The latest noise complaint statistics for Northern Ireland, published by the Department of Agriculture, Environment and Rural Affairs (DAERA), show a 14.5% drop in complaints for 2022-2023 compared to the previous year. Belfast City Council received the highest level of complaints — 16.54 complaints per 1,000 people, with Newry, Mourne and Down District Council receiving the fewest — 2.14 per 1,000 people. Most complaints were about domestic noise. There has also been a 34.6% decrease in the number of notices served compared to the previous year. See the Noise Complaint Statistics 2022-23 at **https://www.daera-ni.gov.uk/news/noise-complaint-statistics-2022-23-report-released**

Wales: Chief Medical Officer supports soundscapes

The annual report of the Chief Medical Officer for Wales recognises that mitigating noise and consideration of soundscapes are important for public health protection and improvement. He stated: "We need to work closely with commerce to ensure they clearly understand impacts of air and noise pollution, the steps needed to mitigate the sources of pollution and the speed in which solutions are required."

Read 'Shaping Our Health' the Chief Medical Officer for Wales annual report 2023 at **https://www.gov.wales/sites/default/files/publications/2023-11/chief-medical-officer-for-wales-annual-report-2023.pdf**

Wales: Senedd passes Soundscapes Bill

In November, the Senedd passed the Environment (Air Quality and Soundscapes) (Wales) Bill, which alongside measures to tackle air pollution, gives the Welsh Government powers to make policies that tackle unwanted noise and protect sounds that matter to people, like birdsong and "the welcoming hum of a vibrant town centre." Wales is the first Government in the UK to bring forward legislation requiring governmental consideration of soundscapes. The Bill places a duty on Welsh Ministers to promote awareness of air pollution alongside publishing a progressive national soundscapes strategy. The IOA was consulted during the drafting of the Bill, with PLG members contributing to the development of policies on soundscapes in written evidence and verbal evidence presented to the Climate Change, Environment, and Infrastructure Committee. IOA welcomes the passing of the Bill and recognition of soundscapes in law in Wales.

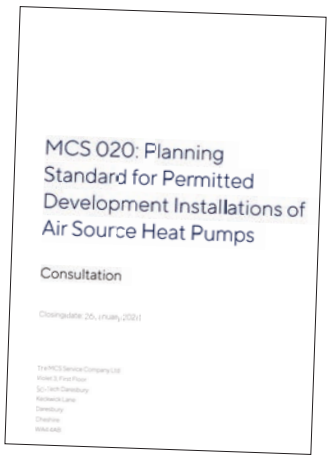
Read the Welsh Government Statement at: **https://www.gov.wales/bill-tackle-air-and-noise-pollution-passed-senedd-supporting-cleaner-healthier-and-greener-future**

New briefing: Reducing noise with green space

This latest in the IOA briefing series outlines how green space helps to reduce sound levels. With biodiversity net gain becoming a mandatory planning condition in England, and tree planting and rewilding being widely advocated to help to combat climate change, the briefing aims to explain to policy makers and the public how planting our open spaces can be an opportunity to lower noise levels and create healthier soundscapes. **https://www.ioa.org.uk/news/reducing-noise-green-space-new-briefing**

Planning changes proposed in autumn statement

In the Government's autumn statement, announcements on future planning included a new permitted development rights to end the blanket restriction on heat pumps one metre from a property boundary in England (see ASHP consultation above). In addition, a new Permitted Development Right to convert one house into two flats without changing the façade was proposed, to be implemented in 2024 following consultation early in the New Year.


MCS 020: Planning Standard for Permitted Development Installations of Air Source Heat Pumps

Consultation

About the author:
Mary Stevens supports the IOA to bring acoustics to the attention of policy-makers.

INSTRUMENTATION CORNER

Microphone selection for measuring in reverberant spaces, and electrical corrections networks for diffuse-field response in a sound level meter

The current Standards for sound level meters allow both free and diffuse field (random incidence) responses; however, the most common measurement requirements are for free field responses. As a result, most sound level meters in service are fitted with free field microphones.

By John Campbell, Campbell Associates Ltd

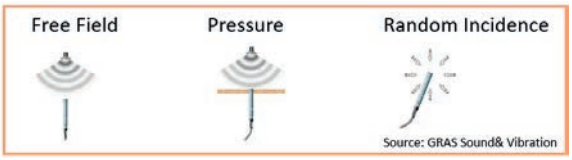
There are applications that require diffuse field levels to be measured, such as sound insulation measurements in buildings and sound power in reverberant rooms/spaces. To avoid the necessity of having a different microphone capsule for these measurements many sound level meter manufacturers fit electrical correction networks that will convert the acoustic free field response to an effective diffuse field response.

In the United Kingdom the accreditation authority, UKAS, are now requiring[1] these correction networks to be included in the standard accredited periodic verification procedure[2]. The objective of this technical note is to give an understanding of the basis of such correction networks and the impact they will have on the uncertainty of the result.

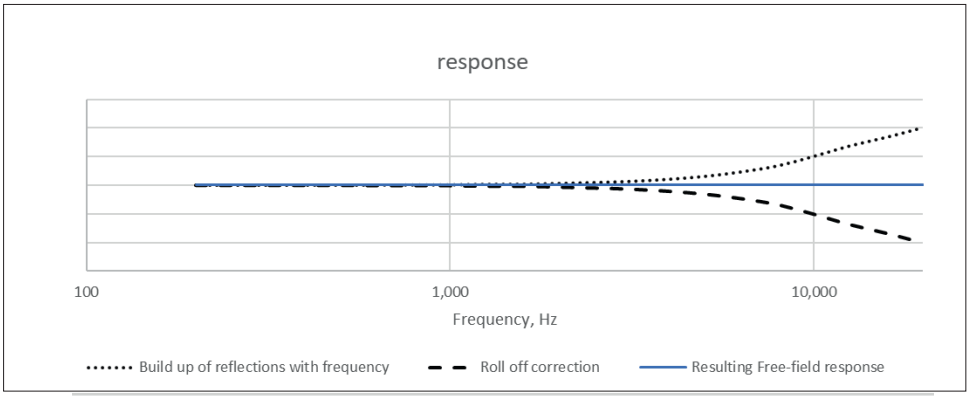
Firstly, a quick recap on microphone types:

- A **free field microphone** is designed essentially to measure the sound pressure as it was before the microphone was introduced into the sound field.
- A **pressure microphone** is for measuring the actual sound pressure on the surface of the microphone's diaphragm.
- A **random incidence microphone** is for measuring in sound fields, where the sound comes from many directions e.g. when measuring in a reverberation chamber or in other highly reflecting surroundings.

The basic WSM2F[3] microphone used in class 1 sound level meters is a pressure device that has been engineered to provide a free field response. So, starting with a flat pressure response there will be an increasing response with frequency as the wavelength approaches the diameter of the microphone capsule due to the reflections of the incident pressure wave from the microphone itself. As most meters have half-inch microphones these effects will start to be seen above 1k Hz and extend to around 10 dB at 20k Hz (Figure 2). By careful design changes to the diaphragm mass, compliance, tension and damping the basic pressure response may be attenuated in the exact opposite direction to this unwanted pressure build up, resulting in a flat free field response, namely the sound field that was present before the introduction of the measurement microphone to the sound field. P56



Above:
Figure 1:
Microphone types



Below:
Figure 2:
Pressure microphone engineered to have free field response

1 LAB23 Edition 3 January 2023
2 BS EN IEC 61672-3 Periodic verification of sound level meters for legal metrology applications
3 BS EN ISO 61094 Laboratory and Working Standard Microphones

NEW Sylomer® AFS Gym Dry Floor

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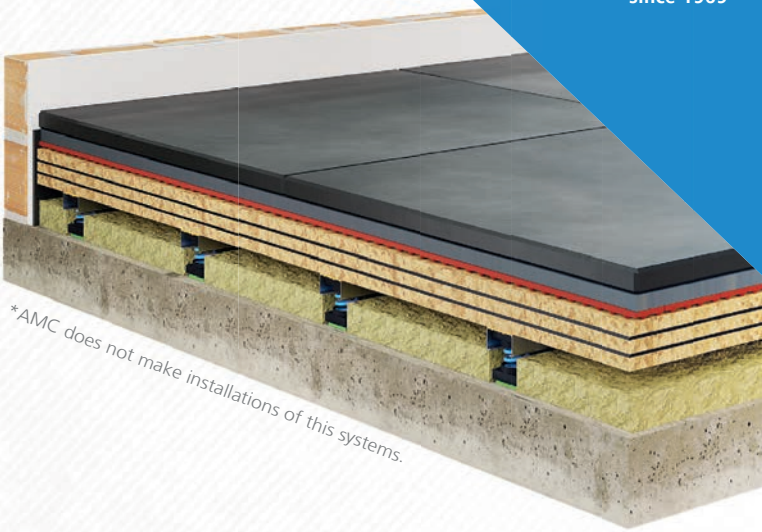
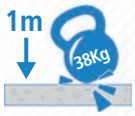
Manufacturing **solutions** for architectural acoustics and vibration problems **since 1969**

The **new Sylomer® AFS floor springs** have been specifically designed to provide high impact performance for gym applications where a dry construction solution is needed. Due to the low stiffness of the springs natural frequencies as low as 3.5 Hz can be achieved. Three systems have been designed and tested to suit the performance requirements of each project.

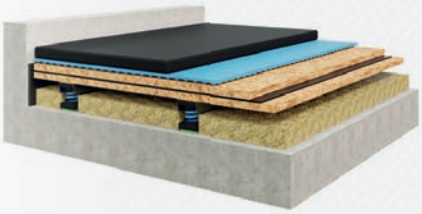




LAFmax Reduction

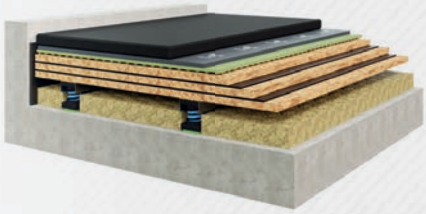
Noise reduction compared to concrete slab with sports flooring only:

BASE



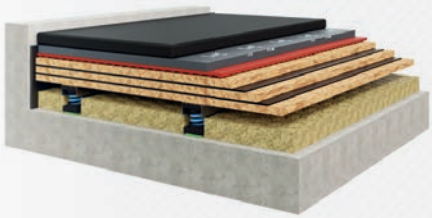
-41,7 dB

ADVANCE



-45,7 dB

PRO



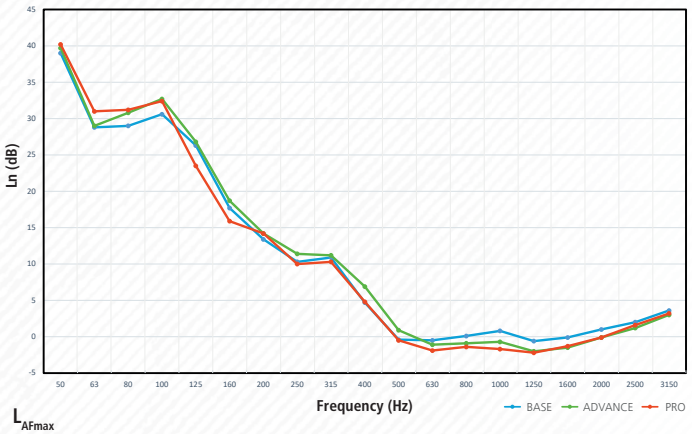
-48,6 dB

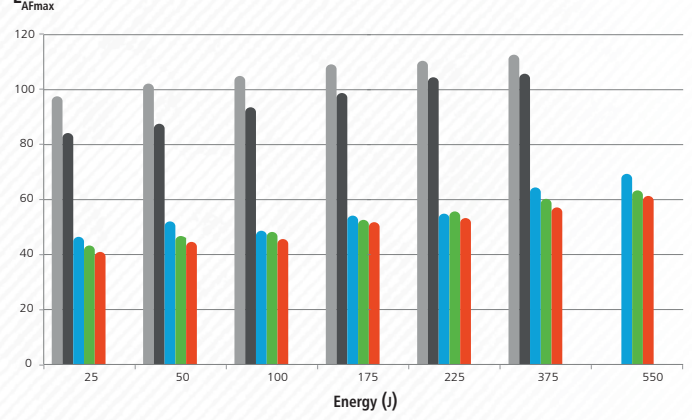
To avoid infringement of patent, apply full surface permanent and effective adhesive assuring no movement between panel and profile.

Normalized impact noise isolation

Tests carried out in Audiotec UNE EN ISO 10140-1:2016.

Impact noise results





AFS+SYLOMER

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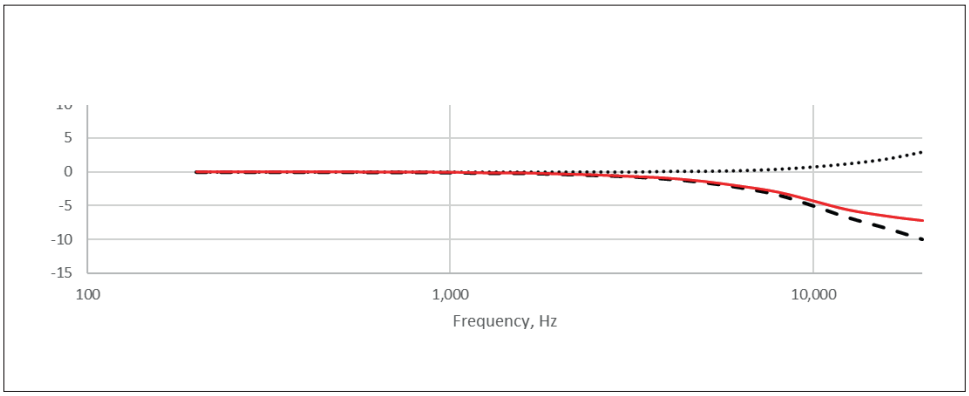
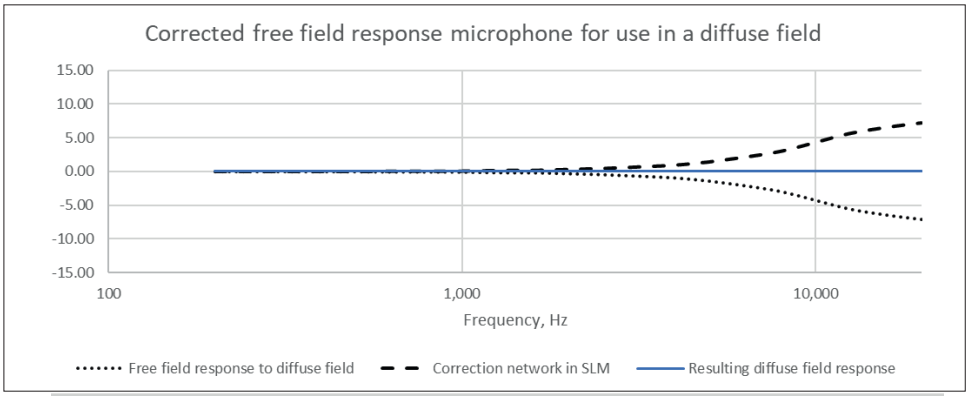
MORE LABORATORY AND FIELD TESTS

The build-up of the reflective and diffracted field around the microphone is effectively cancelled by the engineered roll off in the microphones pressure response.

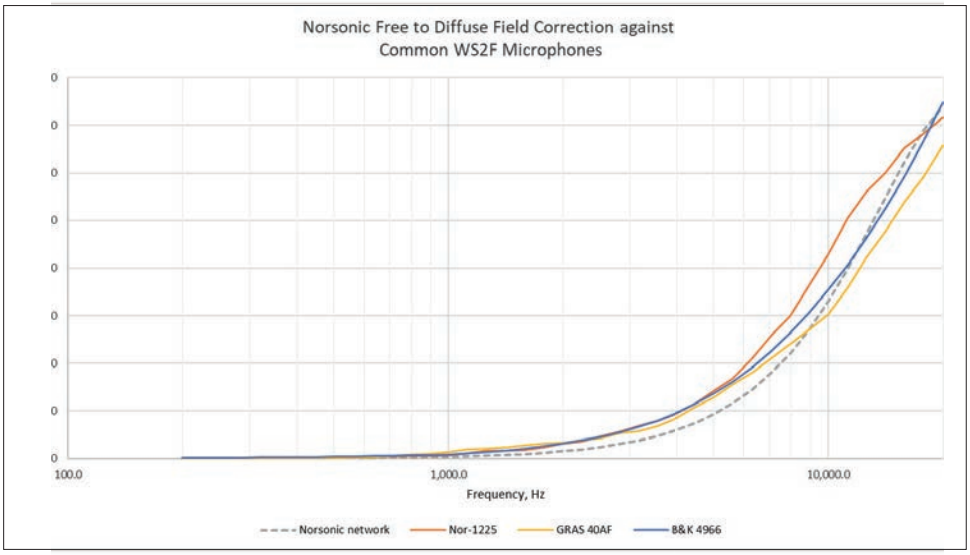
If the free field microphone is then used in a diffuse field there will then be a lower reflective build-up of sound field around the microphone diaphragm; and hence the engineered roll off will be too large to exactly cancel this out, resulting in a non-linear diffuse field response as can be seen in Figure 3. The resulting error at high frequencies will be in the order of 7 to 8 dB at 20k Hz. The engineered roll off that gave the free field response is inherent to the design of the microphone capsule and cannot be changed. The answer is therefore, to build a correction network into the electronic circuits of the sound level meter. This will have to be designed to compensate for the difference between the pressure to free field response of the microphone and the smaller amount of reflective build up in a diffuse field (Figure 4). The correction will therefore only be true for the model of microphone fitted to the sound level meter when it was new and, of course, it would be a nominal correction based on the production spread found in both the microphone capsule and the filter tolerances in the sound level meter.



Above:
Figure 3: Use of free field microphone in diffuse field results in errors



Above:
Figure



Above:
Figure 5: Comparison of actual correction network from nominated and equivalent WSM2F microphones

This is a simplified example to show the principle of the correction network, in practice there are other factors that the manufacturer needs to consider when designing the correction network. The build up in front of the microphone diaphragm is primarily due to the reflection from the microphone diaphragm as the incident sound wavelength becomes shorter than the size of the diaphragm it is incident upon. But there are other components such as diffraction around the microphone as well as reflections from the body of the sound level meter itself. There are other front-end accessories that also need to be considered such as windscreens and weather protection in the design of the filter response required.

Should you use an alternative microphone it is possible to look at the manufacturer's data for it to determine the nominal pressure to free and diffuse corrections and, from these, determine the correction that would be needed. We have done this for three different WSM2F microphones and shown the result in Figure 5 against the standard manufacturers (Norsonic) correction. The use of electrical correction networks is a compromise, and it will not be as good as a true diffuse field microphone. The addition of up to 10 dB of gain at some frequencies into the measurement chain will have the effect of moving the measurement nearer to the overload level and at the other P58

Whatever the reason, Penguin Recruitment are here to help!

Penguin Recruitment is a multi-disciplined Engineering and Environmental Recruitment Consultancy established in 2004. We offer nationwide and international job opportunities for anyone looking to kick start or develop their profession.

With extensive knowledge in the Acoustics and Air Quality Industry, we are proud to offer an energetic can-do approach whilst providing a friendly, professional and knowledgeable service at all times.

If you're a growing business looking to access a wider pool of candidates to help with your expansion plans, then please get in touch!

Penguin Recruitment advertise on more job boards than any other specialist recruitment agency within the acoustics industry, and have a well-established and expansive network of candidates accumulated over 16 years of service, allowing us to provide leading advice on the current candidate market.

For more information please contact Amir Gharaati or Charlotte Lavender on **01792 365000**, or email **amir.gharaati@penguinrecruitment.co.uk** and **charlotte.lavender@penguinrecruitment.co.uk**

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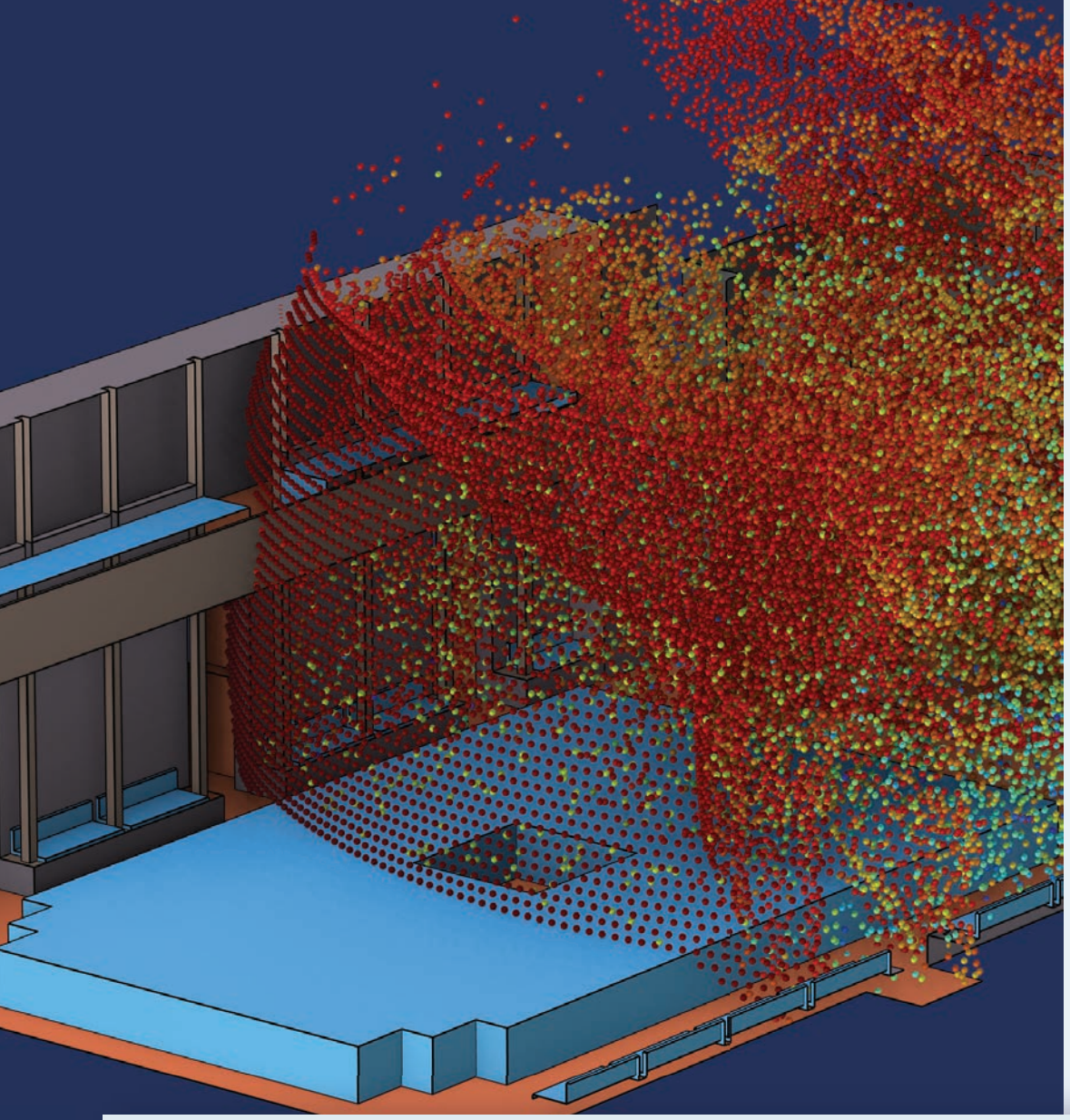
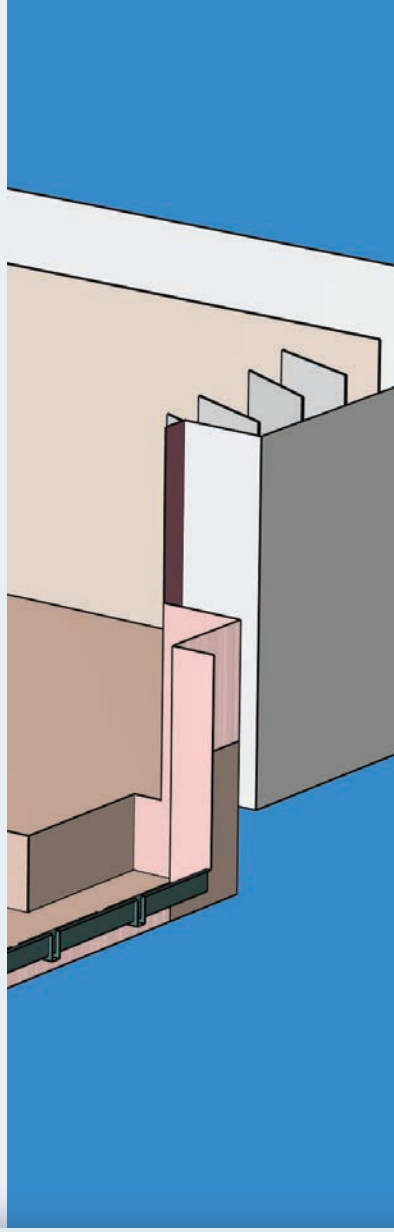
end of the dynamic range it will increase the self-noise. There will also be some additional components to consider in the uncertainty budget, these are mostly related to the normal spread of performance of the microphones in respect of their polar response that controls the magnitude of the diffuse and free field responses. Of the microphones we have looked at for this exercise, they were all around 0.1 dB at low frequencies going up to 0.5 to 0.9 dB at high frequencies.

One of the primary applications that is driving this investigation is building acoustics and it is worthwhile considering the wider aspects of such a measurement. In building acoustics, we compare the difference between the source and receiving room levels. So if the same measurement kit is used for both measurements, the difference between the two rooms would, in general, be the same with or without the diffuse field filter in circuit. This is not the case with impact measurements where only receiving room measurements are made. Sound insulation measurements are usually only taken up to 3,150Hz/5kHz where the effects are less significant. Other applications such as sound power testing in reverberant rooms under ISO347x series of standards should consider the type of microphones used and corrections.

All the considerations discussed here have related to steady test signal; with impulsive sources it would be necessary to consider the impulse response of the filter network, as this could significantly affect the results. Until more information is available it is best to use a diffuse field microphone until this has been investigated.





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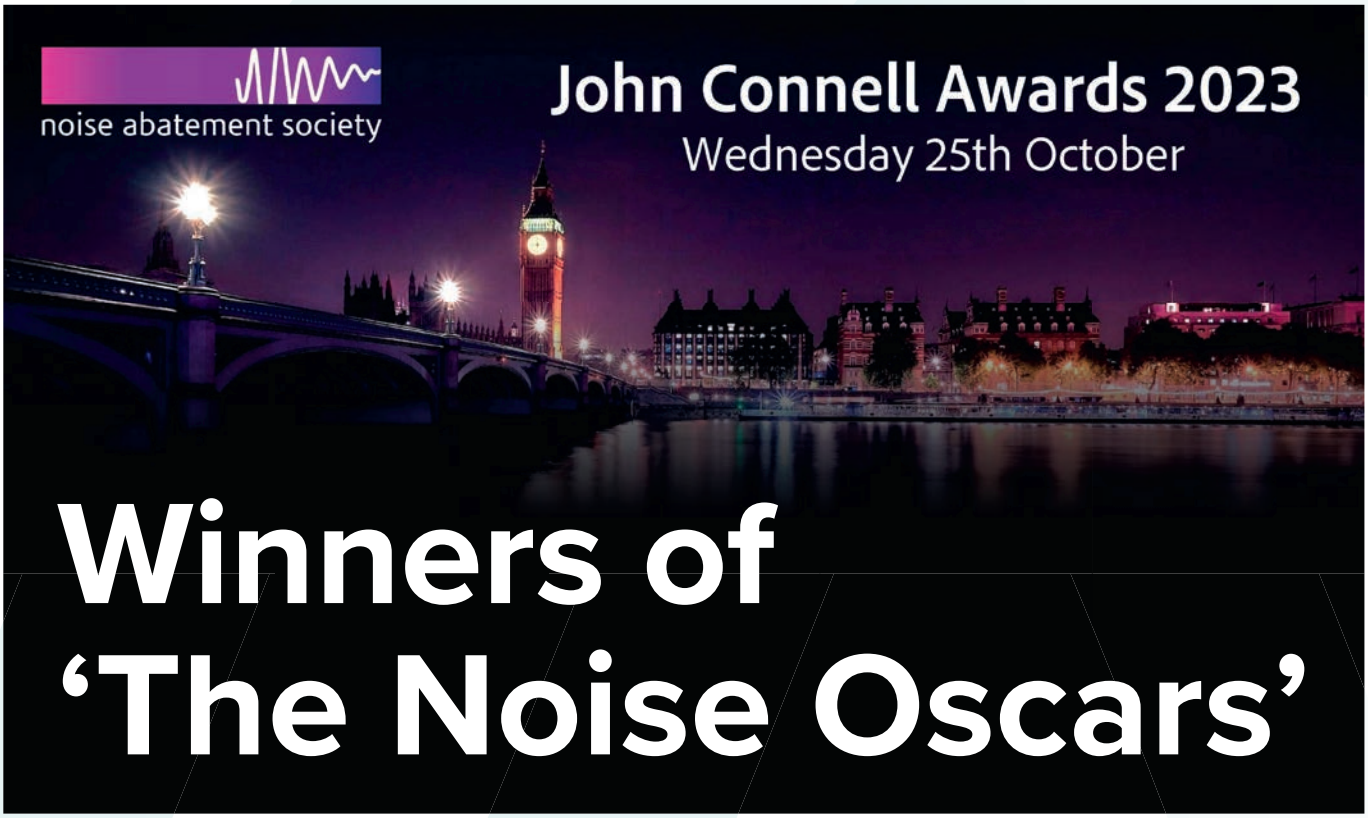


Winners of 'The Noise Oscars'

The Noise Abatement Society's (NAS) John Connell Awards 2023 took place at the Palace of Westminster on 25 October 2023 and were hosted by Sir Peter Bottomley, Member of Parliament for Worthing West. The awards were presented by Trudy Harrison MP, Under Secretary of State, Defra.

The awards are named after NAS's founder John Connell OBE, who lobbied the Noise Abatement Act through Parliament in 1960 when noise became a statutory nuisance in the UK for the first time.

These unique annual awards, known as the 'Noise Oscars', now in their 22nd year, acknowledge the importance of the quality of sound in our lives, and champion vital advances in reducing the negative impact of unnecessary noise for the public benefit.

The John Connell Innovation Award was sponsored by IOA, and the IOA Secondary Schools Competition is also marked at this event.

John Connell Award 2023 winners

JOHN CONNELL LOCAL AUTHORITY AWARD 2023 — sponsored by ROCKWOOL UK, winners: **Bristol City Council, Tranquil City and Go Jauntly collaboration** for enhanced green routes tranquil routing app to reduce exposure to pollution, increase wellbeing and progress towards sustainable development goals.

JOHN CONNELL INNOVATION AWARD 2023 — sponsored by the IOA, winner: **Defra Noise and Statutory Nuisance Team** and partners for developing the transformative, global first, Noise Modelling System (see more details on page 31).

Right:
John Connell Innovation Award 2023 winners. (L-R) Alistair Somerville (IOA); Bill Parish and Cerise Reynolds (Defra); Simon Shilton (Acustica Ltd); Hilary Notley and Rhian Thomas (Defra); George Gibbs (Noise Consultants Ltd); with Trudy Harrison MP, Parliamentary Under Secretary of State, Defra

THE IOA SECONDARY SCHOOLS COMPETITION 2023, winner: **Clemetine Bristow from Stamford Endowed Schools** (see page 50 for more information).

JOHN CONNELL SOUNDSCAPE AWARD 2023 — sponsored by Anderson Acoustics, winner: **Welsh Government** for the first UK Bill on soundscapes.

JOHN CONNELL NOISE APP AWARD 2023 — sponsored by RHE Global, winner: **ASB Help** for the most successful use of the Noise App technology, which facilitates the reporting and assessment of community noise complaints.

JOHN CONNELL RISING STAR AWARD 2023 — sponsored by the Association of Noise Consultants and ANV Measurement Systems, winner: **Alec Korchev from Clarke Saunders Acoustics** (see page 69 for more information).

JOHN CONNELL SILENT APPROACH AWARD 2023 — sponsored by Brigade Electronics, winner: **Philip Dunbavin Acoustics** for the new main Manchester Airport multi-storey car park security mesh noise mitigation project.

QUIET MARK LOGISTICS AWARD 2023 — sponsored by Rolltek International, winner: **Tarmac, Renault Trucks and TVS Interfleet** for pioneering sound reduction in heavy plant machinery.

QUIET MARK CAMPAIGN AWARD 2023 — sponsored by Quiet Mark Approval Ltd, winner: **BSH Home Appliances** for showing customer care by highlighting the important health benefits that quiet technology brings to homes.

QUIET MARK BUILT ENVIRONMENT AWARD 2023 — sponsored by Quiet Mark Approval Ltd, winner: **NBS** for showcasing noise reducing products and materials to support health and wellbeing within the built environment.

Left: The IOA Secondary Schools Competition 2023 winner. (L-R) Angela Lamacraft (Sustainable Acoustics); Clementine Bristow (from Stamford Endowed Schools); Trudy Harrison MP, Parliamentary Under Secretary of State, Defra; and Alistair Somerville (IOA)

Left: John Connell Rising Star Award winner. (L-R) Phil Dunbavin (ANC), Alec Korchev (Clarke Saunders Acoustics) with Trudy Harrison MP, Parliamentary Under Secretary of State, Defra and Mike Breslin (ANV Measurement Systems)

John Connell Innovation Award 2023, sponsored by IOA

This award was won by Defra Noise and Statutory Nuisance Team and partners for developing the transformative and global first, Noise Modelling System.

Good policy has the potential to improve the lives of all citizens free from inequality and bias. To provide a strong evidence-base, a new noise model was developed demonstrating innovation, robust technological advancement, and a sustained commitment to long-term noise exposure reduction. It transforms the way that government can understand the scale of impact from road and rail noise and provides enhanced capability for responsible authorities. It more accurately depicts the soundscape of the nation by mapping every public road and railway to 100% 10m resolution – this is thought to be the first time an entire country has been mapped to this level of detail in the world. It enables health and biodiversity impacts to be assessed; the potential for soundscape and tranquil areas evaluations and much more.

The groundbreaking model has been adopted across all UK governments – and it is modular, meaning it is resilient and future-proofed allowing the benefits to be reaped for many years to come in a sustainable and consistent manner.

The Noise Abatement Society is a UK charity whose aim is to share a better understanding of what sound is, how it affects us and how we can solve noise problems and improve soundscapes in a pragmatic and sustainable way. Its internationally respected work helps to relieve the physical and mental distress caused by excessive noise which profoundly affects health and wellbeing, learning, productivity, and social cohesion. **www.noiseabatementsociety.org**

IOA Innovation Award judges

Russell Richardson, Director, RBA Acoustics, and Chair of the Innovation Award judging panel, on behalf of IOA

Gloria Elliott OBE, Chief Executive, Noise Abatement Society

Professor Bridget Shield MBE, Professor Emerita, The School of the Built Environment and Architecture, London South Bank University

Daniel Goodhand, Director, Goodhand Acoustics, and IOA Council member

IOA Schools Competition judges

Gloria Elliott OBE, Chief Executive, Noise Abatement Society and Co-Founder and Chair, Quiet Mark

Fiona Rogerson, IOA Honorary Secretary/senior acoustic consultant, Arup

Matthew Muirhead, Associate Director, Acoustics UK&I, AECOM

Simulating dog spatial hearing

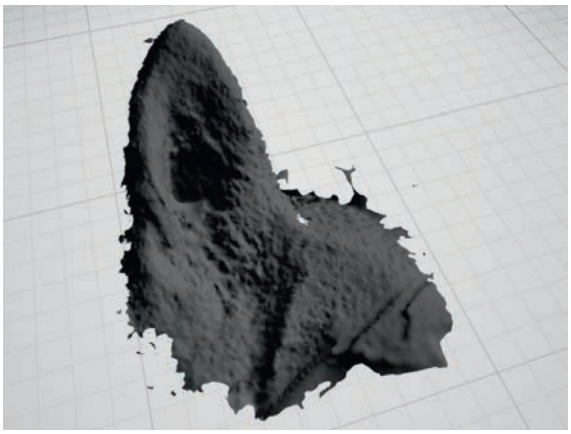
By Michael McLoughlin, Lauren Ward, Ben Tsui, and Gavin Kearney

Assistance dogs work with humans in a variety of roles including guiding, sensing medical problems, and alerting their handler to key sounds around them.

When training for and executing these roles, the dogs rely heavily on spoken word cues from their handlers as well as reacting to important sounds in their environment. However, beyond awareness of their extended hearing range, surprisingly little is understood about canine hearing.

How ear shape affects their hearing ability, their risk of noise-induced hearing loss and inter-breed differences in sound sensitivity are all unknown, despite the impact these factors have on working dogs' effectiveness and welfare. Comparatively, human hearing is well understood; particularly the relationship between the physical characteristics of our head and outer ear (pinna) and our ability to identify the direction of a sound source. The effect of these physical characteristics on an incoming sound can be captured as a head-related transfer function (HRTF). As technologies such as blue-light 3D modelling advance, increasingly accurate representations of human ears can be scanned and modelled all without needing in-ear microphones or listening to unpleasant noise bursts. However, there are several challenges in scanning that need to be overcome first in order to create accurate models.

Below:
Figure 1: An example of dog ear scan using blue-light scanning. Due to the interaction between the dog hair and the scanner, a detailed mesh for BEM simulation cannot be created



Challenges in scanning

We investigated the limitations of commercially available scanning methods for collecting meshes of canine heads and ears. First, we verified that we were able to scan a human head using the equipment available to our lab (Artec Spider 3D Scanner) and created the simulation using Mesh2HRTF[1]. After that, we brought in a colleague's dog in an effort to create a scan of their dog's head. However, due to the hair on the animal, and that we decided to not use any strobe on the scanner to avoid distressing the animal, we were not able to create a high enough resolution scan of the ear (see Figure 1). We also investigated photogrammetry methods as an alternative, but these also failed to produce a suitable mesh (see Figure 2).

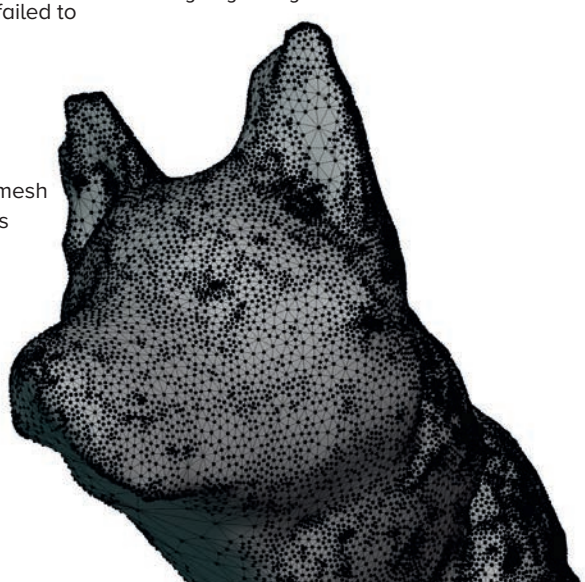
Solutions to scanning challenges

One of the advantages of mesh modelling is that it presents a non-invasive method to collecting HRTFs. For this reason, we believed that removing any hair from the animal in order to obtain a better scan was against the spirit of the project. Rather, we plan on continuing the project by investigating the application of human sculpted meshes that can be parameterised using landmarked study. The results from this parameterised model will then be compared to real HRTFs collected from the same animal. We are currently in the process of completing this process and will be presenting these results early this year.

Ethics

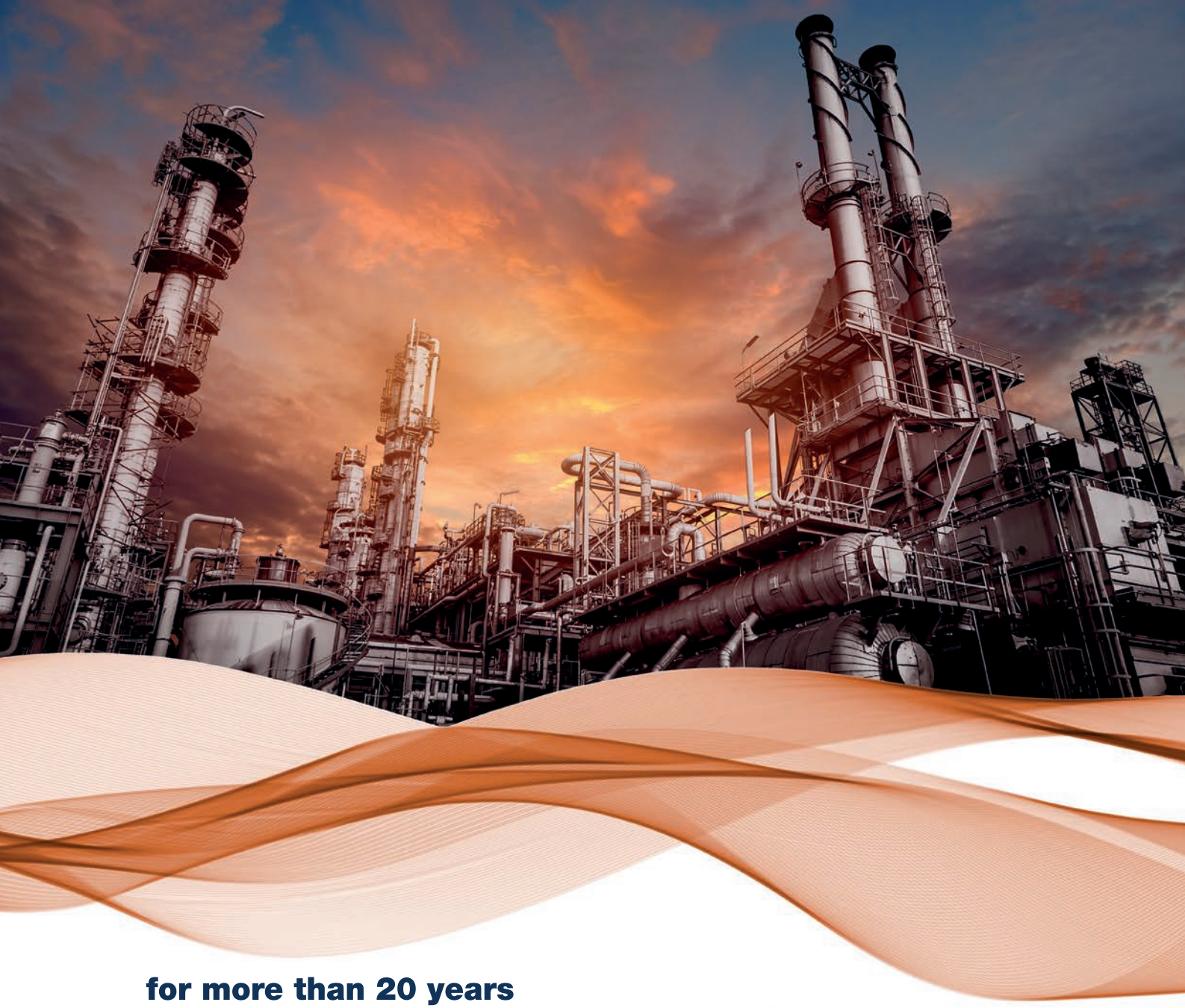
This study was approved by the Animal Welfare and Ethics Research Board at the University of York. We took significant measures to ensure our test subject did not experience any distress during the scanning process. The owner was present during all data collection, and we collected measurements only for short time bursts in to minimise any stress on the animal. The test subject received lots of treats and reassurance that she is, in fact, a good girl.

Below:
Figure 2: Photogrammetry methods are also not capable of creating a high resolution scan for BEM modelling. We are now investigating scaling human made



Reference

1 Ziegelwanger, H., and Kreuzer, W., Majdak, P. (2015). 'Mesh2HRTF: An open-source software package for the numerical calculation of head-related transfer functions, in *Proceedings of the 22nd International Congress on Sound and Vibration, Florence, Italy*.



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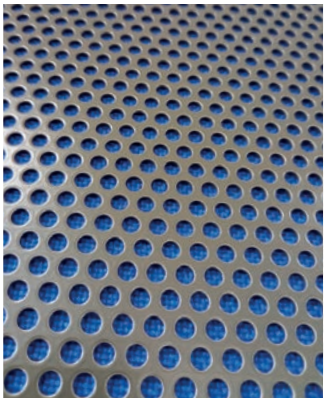


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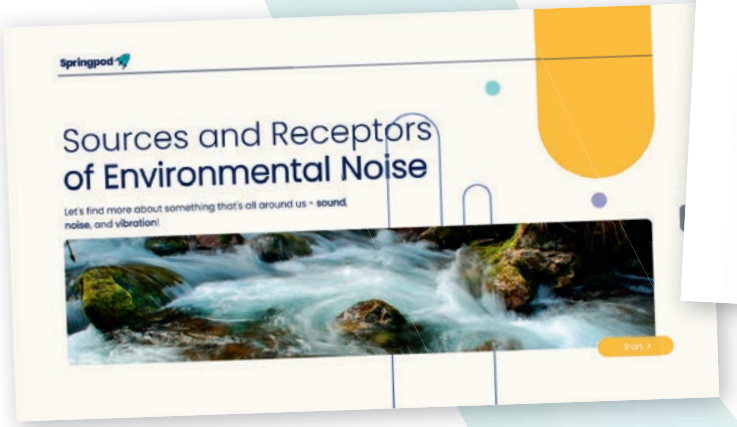
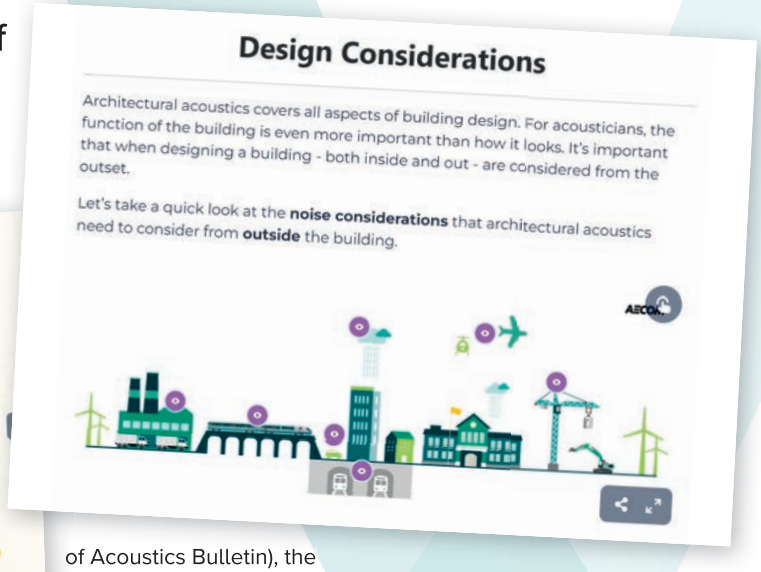
Virtual work experience – the Springpod relaunch

In this issue Matt Muirhead, Chair of the IOA STEM Committee, provides an update on the virtual work experience programme.





In 2022 the IOA launched its first virtual work experience programme for teenagers, created in partnership with Springpod (springpod.com). Rather than a traditional work experience placement, this is 10 hours of online content that introduces the world of acoustics through videos, text, webinars, activities, and quizzes. The course also highlights different routes into the industry, with links to apprenticeships and further education.

What has happened in 2023?

Following a successful first year, with 1,000 students signed up (see the January/February 2023 issue of Acoustics Bulletin), the IOA continued supporting the programme into 2023.

The first big change since 2022 was to make the material available throughout the year, rather than during specific periods. This on-demand model allows students to engage with the content at a time in the year that suits them but does put the onus on us to continually advertise the programme.

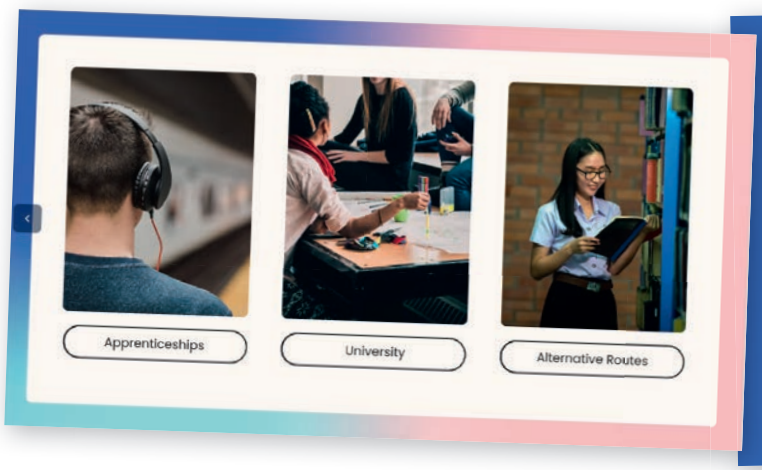
In recent months, the programme has been updated to be more inviting to engage with and easier to read. After feedback for more maths and more hands-on problem solving, two new activities have been included; one covering the benefit of noise barriers and the other, reverberation times. This has provided us with a focal point to remind everyone of the programme and advertise it further.

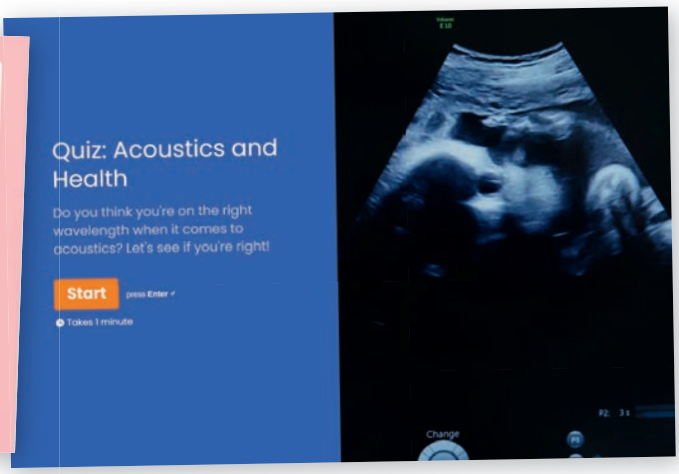
What next?

In the next few months, we are partnering with Springpod on some targeted advertising, and we will get the statistics and feedback on how the course was engaged with throughout 2023. This will allow us to make continual improvements to the programme as required throughout 2024.

What you can do

Please check out the course at **https://tinyurl.com/IOASpringpod** and contact the STEM Committee at **STEM@ioa.org.uk**. We are always looking for new content and ways to improve the existing offering. We would also encourage everyone to promote the course to any secondary school or college they are engaged with; the more well known the programme the better.





The use of proprietary noise camera systems to manage excess noise from motor vehicles in residential areas

In 2019 Intelligent Instruments (II) was approached by environmental health officers from the Royal Borough of Kensington and Chelsea to discuss the issues they were having with excessive noise from road vehicles, primarily because of excessive speed and aggressive driving. As a result of this, II developed a noise camera system. This detects excess noise from nuisance vehicles and is now widely used in the Borough and other cities worldwide. The system has been developed independently and is unrelated to the recent work undertaken by the Department for Transport.

By Reuben Peckham, Director, Intelligent Instruments Ltd, and Philip Richardson, Principal Environmental Health Officer, Royal Borough of Kensington & Chelsea

The health effects of excess exposure to noise are well documented. Non-auditory effects are well known to include:

- increased stress;
- cardiovascular function (hypertension, changes to blood pressure and/or heart rate);
- annoyance;
- sleep disturbance (with associated performance and safety-related issues); and
- mental health issues.

Noise can also affect speech intelligibility (the ability to understand spoken words) and cause performance effects through loss of concentration, distraction, and annoyance.

The World Health Organization[1] states that noise is one of the top environmental hazards to both physical and mental health and wellbeing. It estimates that at least one million healthy years of life are lost every year from traffic-related noise in Western Europe with sleep disturbance and annoyance from traffic noise constituting the bulk of this burden.

The WHO states:

'*Noise pollution in our towns and cities is increasing, blighting the lives of many European citizens. More than a nuisance, excessive noise is a health risk — contribution to cardiovascular diseases, for example.*'

'*Excessive noise seriously harms human health and interferes with people's daily activities at school, at work, at home, and during leisure time. It can disturb sleep, cause cardiovascular and psychophysical effects, reduce performance, and provoke annoyance responses and changes in social behaviour.*'

'*Traffic noise alone is harmful to the health of almost every third person in the WHO European region. One in five Europeans is regularly exposed to sound levels at night that could significantly damage health.*'

Noise from road traffic could be argued as an inevitable part of life. It is, by necessity, associated with a means of travelling from A to B and for those of us that live adjacent to busy roads and highways something that must be tolerated. Not all noise, however, is inevitable. Some aspects of traffic noise are avoidable. Excessive noise from vehicle exhausts, from aggressive driving, over-revving, and unlawful modifications is entirely avoidable and arguably the nature character of this sound may cause increased health effects (those associated with sleep disturbance and annoyance in particular).

The RBKC experience

The Noise and Nuisance Team at the Royal Borough of Kensington and Chelsea (RBKC) aims to maintain and improve the quality of life for residents in the borough. The overarching objective of the Noise and Nuisance Team is to ensure that the vibrant and eclectic lifestyle of RBKC does not hinder the residents of the borough's legal right to be protected against noise nuisance, statutory or not. A statutory nuisance is defined as *'an unlawful interference with a person's use or enjoyment of land or some right over, or in connection with it.*'

Residents and ward councillors at RBKC have suffered from noise nuisance because of modified cars and supercars from both the UK and abroad for years, particularly within the Brompton and Hans Town Wards.

In 2019 it was widely reported in the press that the Department for Transport (DfT) were considering the use of noise cameras for the enforcement of noise from nuisance vehicles. RBKC had sought to P66

1 World Health Organization, Environmental Noise Guidelines for the European Region, 2018

work with the DfT and use the borough as a pilot area, however, funding for the project was vastly reduced and the Covid pandemic reduced initial trials to two locations in Hampshire. Ward councillors, however, were keen to see noise cameras tested within the borough and discussions with Il led to the trial of two systems from 22 September 2020 for three months on Sloane Street and Pont Street.

RBKC issued fixed penalty notices (£100) for offences during the trial period. The Anti-social Behaviour, Crime and Policing Act 2014[2] provides local authorities with a range of flexible tools and powers that they can use to respond quickly and effectively to anti-social behaviour. As such, the borough has used the powers provided by Public Spaces Protection Orders (PSPO), in a bid to tackle antisocial behaviour and nuisance from noisy vehicles. These powers are intended to deal with a particular nuisance or problem in a specific area that is detrimental to the local community's quality of life by imposing conditions on the use of that area which apply to everyone. They are intended to help ensure that the law abiding majority can use and enjoy public spaces, safe from anti-social behaviour. RBKC's Nuisance Vehicle PSPO[3] is borough-wide and is in force between the hours of 12 noon and 6 am.

The three month trial resulted in the serving of 144 fixed-penalty notices and 69 warnings. It was deemed a success by officers and councillors and the two trial systems became permanent. Borough councillors, however, recognised that some residents in other areas of the borough also suffer from noise from nuisance vehicles and have installed further systems. There are now 12 in total in London across three Boroughs.

Right:
Figure 1:
First generation noise camera system in RBKC

Noise camera development and evolution

Il's noise camera system was originally conceived for use in RBKC. Their PSPO describes prohibited activities from the driver of a vehicle if 'causing a public nuisance.' This legislation therefore requires the operator to review the evidence and determine subjectively if the PSPO is breached.

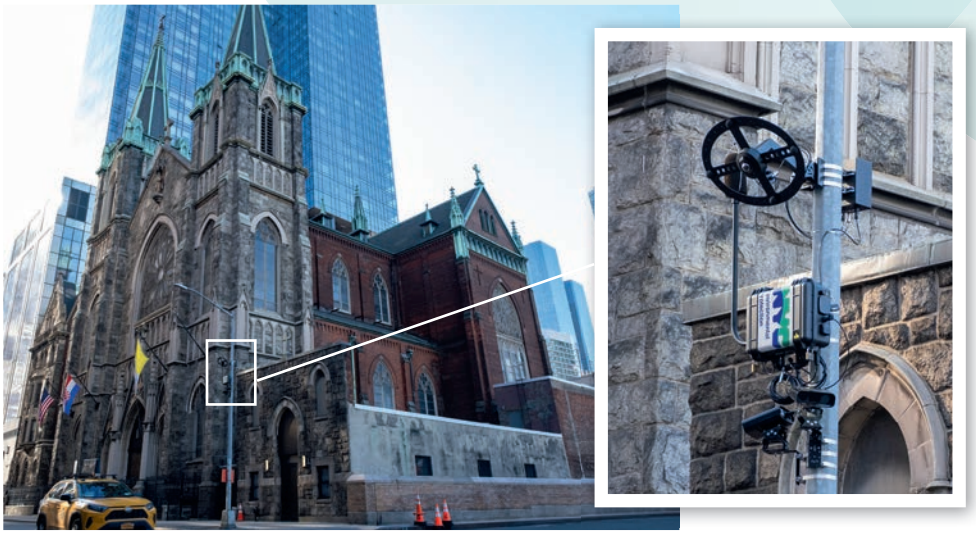
Il's first generation noise camera system comprised a Class 1 accuracy measurement system with two cameras, a processor and modem. The system was designed to identify noise from nuisance vehicles, trigger and upload the relevant data (noise level, audio, and video) to the cloud. The user then interrogated the data via a web interface to determine whether an offence had occurred by subjective means.

As news relating to the success of the systems in RBKC spread, Il started to receive enquiries from other parts of the world.

New York City authorities receive more than 45,000 noise complaints per year and many of these relate to noise from nuisance vehicles. As a result, Il began a noise camera trial in NYC in June 2021.

A different legal structure operates in NYC and across the USA. Most territories have fixed noise ordinances (a defined noise level at a defined distance from the side of the carriageway) and consequently the application of Il's cameras in NYC and the US in general needed to be modified.

Following further extended trials and testing Il launched its second generation noise camera system 'SoundVue™' in February 2023. Upgrades included new cameras with ANPR technology, an additional wide-angle camera, and a microphone array.



Below:
Figure 2:
Il second generation SoundVue™ noise camera in NYC

2 Her Majesty's Stationary Office, Anti-social Behaviour, Crime and Policing Act, 2014 Chapter 12
3 Royal Borough of Kensington & Chelsea, Antisocial Behaviour (ASB) Nuisance Vehicles Public Spaces Protection Order (PSPO), 2023

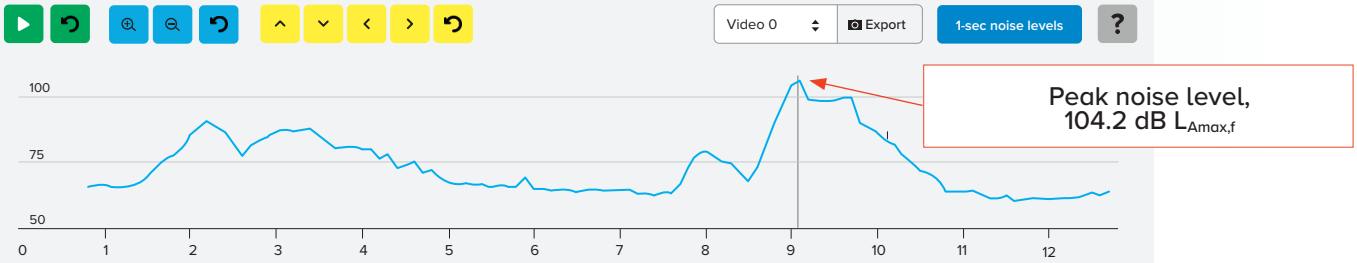
Below:
Figure 3: Screenshot showing SoundVue™ noise camera back end

The system's algorithms detect excess noise from nuisance vehicles — from exhausts, horns, or music. When it triggers, data is uploaded to the cloud. In addition, the microphone array identifies the dominant vehicle and directs the ANPR cameras to focus on and read the number plate of the offending vehicle.

The operator has sight of all data from the web-based front-end as illustrated below.

The system has been found to be a highly innovative and effective means of managing one aspect of environmental noise emission in our cities, to the benefit of those living, visiting, and working there.

Halo microphone array identifies dominant vehicle



Peak noise level, 104.2 dB $L_{Amax,f}$

Device name: INM-426

Location: NYC - 20th Ave Astoria

Date of exceedance: 15-Nov-23

Time of exceedance: 13:53:35 EST

Highest Leq: 99.5 dBA

Highest Lmax,f: 104.2 dBA

Number plate

- ☐ Foreign plate
- ☐ Seen this vehicle before
- ☐ Event actioned
- ☐ False positive
- ☐ Outside of PSPO times

NEWS

Refreshers and CPDs

IOA's Education Manager, Professor Keith Attenborough, has developed eight short online refresher videos for the IOA Diploma in Acoustics and Noise Control.

Available to IOA members only at **https://www.ioa.org.uk/members-can-access-new-acoustics-refresher-videos** the refresher topics cover:

1. Outdoor Sound Propagation
2. Transport Noise
3. Room Acoustics
4. Sound Transmission
5. Vibration Fundamentals
6. Building Vibrations
7. Human Response to Noise
8. Human Response to Vibration

For further information, please contact **education@ioa.org.uk**

Alec Korchev from Clarke Saunders Acoustics wins the John Connell Rising Star Award 2023

The Noise Abatement Society's (NAS) John Connell Awards 2023 took place at the Palace of Westminster on 25 October 2023 and its John Connell Rising Star Award 2023, won by IOA member, Alec Korchev, recognises self-motivated individuals who have made impressive progress or an outstanding contribution within the first five years of their career within acoustics. Speaking of his award, Alec said: "Throughout my career, I have been very fortunate to have had such a supportive network of acousticians around me. Their help and guidance continues to be invaluable and has shown me the importance of a strong network of mentors for early career acousticians. Supporting younger colleagues is therefore so important to me and I try to support greater engagement with the profession wherever I can.

"Winning the John Connell Rising Star 2023 Award has been a great honour, and I'd like to extend huge thanks to Clarke Saunders Acoustics for all of the support through the years and of course to the Noise Abatement Society for hosting the wonderful event."

(L-R) Phil Dunbavin (Association of Noise Consultants); Mike Breslin (ANV Measurement Systems; Alec Korchev (Clarke Saunders Acoustics) with Trudy Harrison MP, Parliamentary Under Secretary of State for the Department for Environment, Food and Rural Affairs (Defra)

IOA 'kitsches' it up

IOA Council members and staff got into the festive spirit in December in support of the 'Hearing Dogs' charity and raised, at time of print, more than £100.

For the second year running the IOA Council embraced the twin aims of 'kitsching it up' by wearing Christmas jumpers for the final meeting of the year, and donating money to this worthwhile acoustics-related charity.

'Hearing Dogs' identifies and trains assistance dogs for those living with hearing loss and degrees of deafness. The aim is to provide more fulfilled, inclusive, and safer lives for those who are partnered with one of these highly skilled and much in demand dogs.

There were a range of knits worn by all, as evidenced in the photo, and it appears that animals were an unspoken theme. CEO Allan Chesney was even sporting images of his own dogs on his knitwear!

Thanks to everyone who got involved and for their generosity, which will contribute to a richer life for someone in the UK in 2024.

The seasonal giving campaign is open until the end of February 2024, so you can donate easily by scanning the QR code and please tick the Gift Aid box if you are able.

SCAN ME

The Early Careers Group

By Josie Nixon

The ECG is open to all members of the IOA (both corporate and non-corporate) who shall normally be under 35 years of age or within first five years of their career. The Early Careers Group (ECG) is always keen to hear from members and non-members alike. To join the ECG, to find out more information or to voice your concerns, visit https://www.ioa.org.uk/early-careers-group.

Recent ECG activity:

'Experimentally-tuned synthesis of a thin plate' — Sebastian Duran
By Aaron Tomlinson

Sebastian Duran gave us an insight into his research studies as part of his PhD at the University of Bologna. Sebastian's work has the goal of developing techniques to model the sound of ancient musical instruments based on limited information about them. This is part of the NEMUS project.

Sebastian's research goes back to fundamentals, looking in the first place to validate by computation and experiment, the acoustic response of thin isotropic plates. While eventually demonstrating a good agreeance between computational and experimental data, it was noted that reliably producing rigid boundary conditions in an experimental test is difficult to do in practice!

Looking long term, there are several big challenges that stand out, even before the application of modelling musical instruments is floated:

- **shape complexity** – current models rely on a consistent aspect ratio of a material. Changing this will affect the eigenfrequencies and response; and
- **material properties** – current model rely on isotropic material properties.

Orthotropic materials such as wood, which not only have bi-directional grain patterns on generally, can exhibit complex grain patterns which will behave differently from veneer to veneer.

In both cases, a model will need to be adapted and generalised to account for these aspects.

If you're interested to know more about Sebastian's work, along with other aspects of the NEMUS project, use the QR code or the link below.

Numerical restoration of Ancient Musical instruments
ERC-funded project (July 2021-June 2026)
https://site.unibo.it/nemus-numerical-sound-restoration/en

'Impact sound insulation of balconies' webinar — Lucas Heidemann
By Josie Nixon

On 27 November 2023, we were joined by Lucas Heidemann, who is currently undertaking his PhD at the Stuttgart University of Applied Sciences. Through his PhD, Lucas is developing a reliable prediction method to determine the sound reduction impact performance for balconies. Lucas comes from a brass instrument background, having learnt to play the trombone at a young age, and he moved into acoustics as his career progressed. The event was hosted by Diogo Perreira, our ECG Secretary and the webinar was well attended with about 60 participants.

Lucas explained that balconies in Germany need to have thermal insulation to keep the buildings warm, without this it can create cold ceilings/floors for the flats/rooms on the same level and below. This thermal insulation can also provide some noise reduction. In Germany the impact sound performance of balconies needs to be undertaken by simulation before a development is constructed and is then tested upon completion as part of the building sign off. The buildings acoustic standards in Germany, provide a minimal requirement for health protection.

Lucas found that by simulating the five hammers of a tapper, rather than just one hammer there is less deviation from onsite measurement, but it takes longer to run. Simulating the five points of the tapper machine, and considering the phase, is currently having a very small standard deviation from what Lucas is measuring on site. Lucas also explored the excitation of the balconies by locating the tapper in different locations. Lower frequencies are excited more when the tapper is put into a corner position. This is therefore considered the more critical position when locating the tapper and simulations/ onsite testing should include the tapper located in corners. The dimension of the balcony floor to ceiling has also been researched and Lucas has found that typically a 2m balcony gave better results than anything smaller or bigger.

Our thanks go to Lucas for presenting and ECG members wish you all the best with the rest of your research project.

If you would like to present at a webinar, or have a topic suggestion please get in touch directly with us: **earlycareers@ioa.org.uk**

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Members are reminded that **ONLY** Sponsor Members are entitled to use the **Sponsor IOA logo** in their publications, whether paper or electronic (including web pages).

Committee meetings 2024

DAY	DATE	TIME	MEETING
Thursday	18 January	10.30	Membership
Thursday	1 February	11.00	Publications
Thursday	8 February	10.30	Meetings
Thursday	15 February	10.30	Diploma Tutors and Examiners
Thursday	15 February	13.30	Education
Thursday	22 February	10.30	Engineering Interviews
Thursday	29 February	10.30	Engineering Meeting
Tuesday	5 March	10.30	Diploma Examiners (London)
Thursday	7 March	10.30	Executive
Wednesday	**13 March**	**10.30**	**Council**
Tuesday	19 March	11.00	CPD Committee
Tuesday	2 April	10.30	CCWPNA Examiners
Tuesday	2 April	13.30	CCWPNA Committee
Thursday	18 April	10.30	Membership
Thursday	25 April	10.30	Meetings
Thursday	2 May	11.00	Publications
Thursday	9 May	10.30	CCHAV Examiners
Thursday	9 May	13.30	CCHAV Committee
Wednesday	15 May	10.30	Research Co-ordination (London)
Thursday	16 May	All day	Engineering Interviews
Thursday	23 May	10.30	Executive
Thursday	30 May	10.30	Engineering Meeting
Wednesday	**5 June**	**10.30**	**Council**

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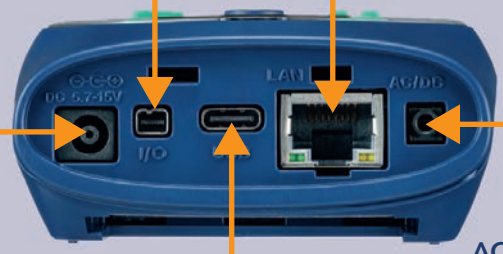

USB-C for: Downloading data instrument control, external power supply (e.g. USB power bank)

AC/DC Signal output for: Level recording, analogue audio

Need live-to-web data and real-time alerts? Connect the NL-53 to:

NUVIRO

Connect via WAN (router with internet connection required) to check the status of the unit, view and acquire data, and listen to real-time sound.

Compatible with existing NL-Leq hardware

Options for:
- Wave Recording
- Octave/1/3 Octaves
- FFT Analysis

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