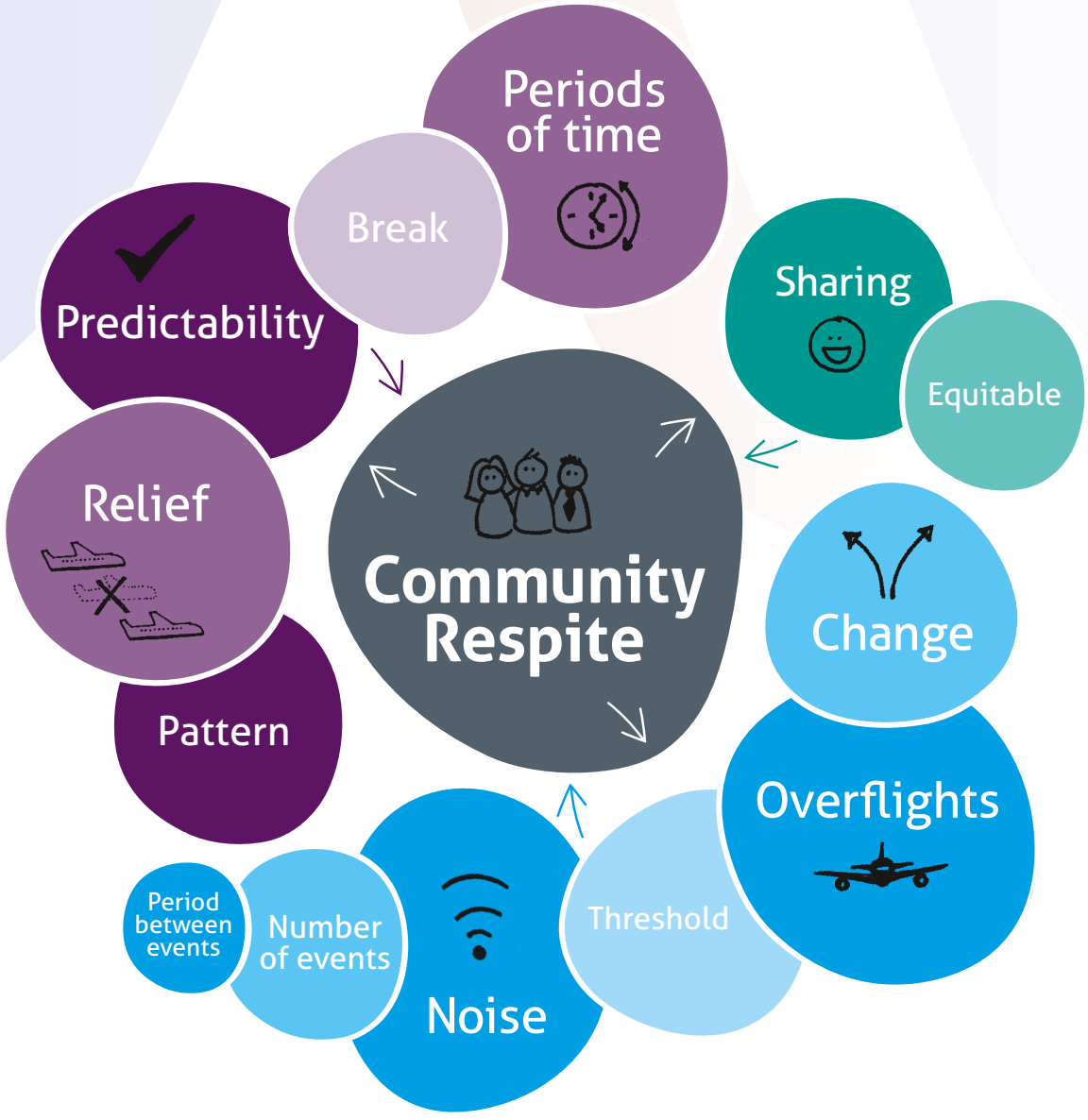
Volume 47 No 4 July/August 2021

ACOUSTICS BULLETIN



Institute of Acoustics

ACOUSTICS BULLETIN

Acoustics Bulletin Volume 47 No 4 July/August 2021

Technical articles review procedure

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

Cover image:

The image on the cover reflects the technical article 'Aviation noise management and research: reflections and challenges in light of the pandemic' (page 62) where we look at lessons learned from the pandemic and apply them to aviation noise management, identifying future challenges and tasks that should be considered, while working towards the effective management of aviation noise.

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

Institute of Acoustics

Contacts

Publisher
Juliet Loiselle

Contributions, letters and information on new products to:
Nicky Rogers
Email:
nickyr@warnersgroup.co.uk
Tel: 01778 391128

Advertising:
Dennis Baylis MIOA
Email: dennis.baylis@ioa.org.uk
Tel: 00 33 (0)5 62 70 99 25

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Dear Member

It was 1983. I had been working in acoustics for about six years. I was becoming reasonably proficient in environmental noise monitoring, learning about some of the hazards presented by the equipment in those days, such as making sure the paper roll did not become stuck in the printer.

I could undertake frequency band analysis from analogue tape recordings and use the bespoke protractor to measure reverberation times from the trace from a level recorder. (The paper did seem to have to come out at an alarming speed in order to have a good clear line to measure). My personal body strength was building up following many measurements of sound insulation between dwellings using the six microphones, the large sound generator and analyser, the loudspeaker, tapping machine and copious cables. And I had just about mastered the seemingly endless by-hand calculations of road traffic noise with the use of A0 sized plans, a scale rule and protractor in order to determine eligibility for compensation under what were then the relatively recently implemented Noise Insulation Regulations.

I had also secured my MSc in Applied Acoustics from Chelsea College and had become a Corporate Member of the Institute.

But I was conscious there was an important aspect of my education that I had yet to master; and that was presenting a paper at an acoustics meeting or conference. I recall even the thought of it made me feel very uneasy and I could never imagine standing up in front of an audience and delivering a talk. And yet, I was also aware that it was something I had to be able to do.

I had by then already started to assist in the organising of what were then the London Evening Meetings of the Institute (the precursor to the London Branch meetings) and I was asked to help organise a one-day conference. I realised that this was my opportunity and so, I put my name down to present a paper. There was no escape now, and I recall feeling extremely nervous as the day of the meeting approached. But, I did it. I stood up in front of fellow acousticians and gave a paper, based on my MSc dissertation and some subsequent work. It was probably terrible in terms of how I performed, but at least I got through it. And having given one talk, I did then find it easier to do so again.

Opportunities to experience presenting

Through the Institute's programme of conferences, one-day meetings and branch meetings there are many opportunities for members to gain experience in giving presentations. For several years, a couple of our branches have held meetings where Diploma students give a short presentation on their dissertation. For some, they were obviously natural speakers, but for others, it was clear that they found the experience very traumatic. The audience, however, was always very supportive and having done it, I am sure the students were better acousticians for the experience.

Giving presentations is part of the skills that most acousticians need to have. You might have to present your project findings to your client or you may have to present your conclusions to a local planning committee as part of your work. It is also sometimes necessary to make a presentation in order to win a contract or secure research funding. So, becoming experienced in giving presentations is an important skill.

Acoustics 2021 and Reproduced Sound 2021

Acoustics 2021 is occurring on 11 and 12 October and there is still time to offer to present a paper on any of the following topic areas: environmental noise; building acoustics; musical acoustics; speech and hearing; noise and vibration engineering; and physical acoustics. There is also a session being planned specifically for early careers members.

A month later we have Reproduced Sound (16-18 November) and there is a call for papers out for that at the moment. The topics being covered include: video conferencing; streamed and hybrid live events; acoustics in rooms; audio signal processing; loudspeakers and microphones; and case studies.

So, why not use these opportunities to get off the mark and present your first paper?

AGM

Many thanks to those members who were able to join us for the Institute's AGM on 7 June. In terms of appointments, Paul Lepper continues to be our Vice-President (International) for a further two years; Chris Barlow, Ben Fenech and Angela Lamacraft were re-elected to Council; and Daniel Goodhand was elected to Council. I look forward to working with you all.

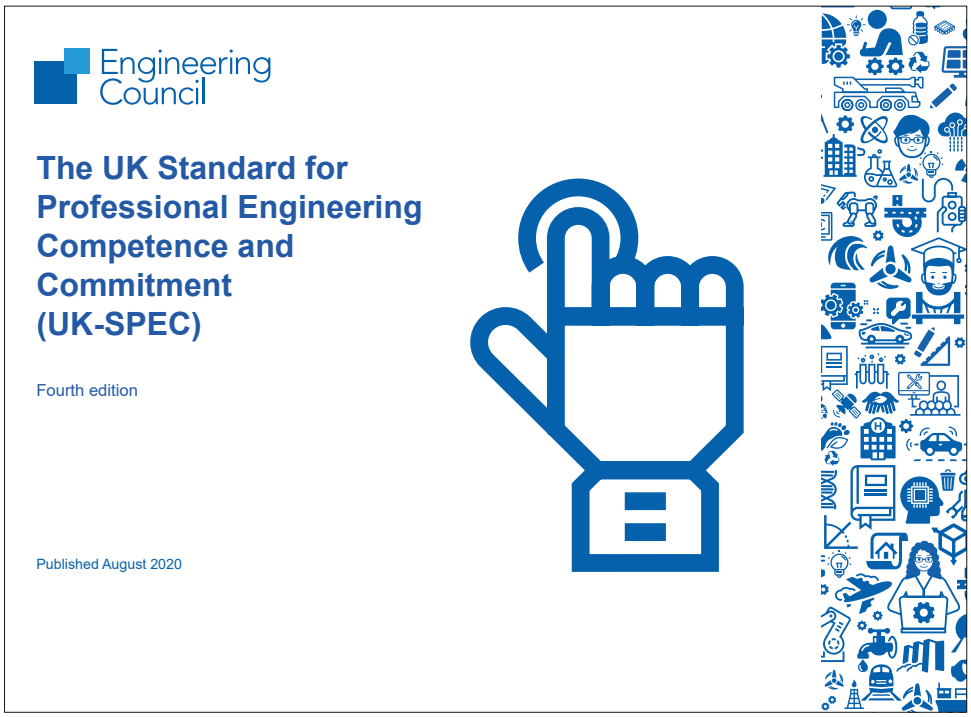
And finally, many congratulations to former IOA President, Bridget Shield, on being awarded an MBE in The Queen's Birthday Honours List for Services to Acoustic Science and to Inclusion in Science and Engineering. (See report on page 18.)

In the meantime, stay safe

Engineering Division

The IOA Engineering Division will support you through the process to help you become one of almost 225,000 registrants that hold international professional recognition.

By Blane Judd BEng FCGI CEng FIET FCIBSE, Engineering Manager



There is still uncertainty about the lifting of lockdown rules due to variants of the COVID-19 virus. As a result, the majority of our activity is still being conducted while working from home. Our thoughts go to Emma who badly broke her ankle while raising money in a sponsored parachute jump. While this has restricted her movements, she has been able to continue to offer support to prospective registrants, for which we are grateful. We all hope she will make a full recovery soon.

We have had to put the EngTech license application on hold until things return to a level of normality, but we are still looking to pursue that process once we can run some face-to-face workshops.

Interviewers

We are always looking for new interviewers so if you have already become a registrant and would be interested in being part of the interview team drop me a line and we can discuss it further. We would welcome applications (from IOA members only) who are registered at EngTech, IEng or CEng, whether with the IOA or another institution.

We will soon be issuing the new UK-SPEC version four ready for full implementation by the end of the year. The guidance material is still relevant, but will need to change slightly to reflect the minor changes in the competencies as detailed in UK-SPEC.

If you want to learn more about the new version of UK-SPEC, visit the Engineering Council website at (**https://bit.ly/3cEALQu**). For those who are already working on their submission you will be able to use UK-SPEC version three submissions up to the end of the year. From July onwards, however, we will be encouraging candidates to work to version four. The Engineering Council is expecting us to have made the transition by December 2021. Since it takes six months on average to complete the process, July is considered to be a suitable start point for transition.

We are working hard to keep response times down to a minimum while working remotely, and Neil Ferguson continues to help us with academic equivalence support for those candidates who do not have exemplifying qualifications. You can check for yourself if your qualifications meet the required specification by visiting the Engineering Council website at **www.engc.org.uk**. But please don't panic if your specific qualification is not listed, as we can still help you through the process on the individual route.

Interviews

Our next round of interviews will be early October and as usual we have candidates working towards those dates. We hold a number of 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 of your further and higher education certificates, not just your highest attainment.

Academic qualifications

The requirements for academic qualifications for CEng and IEng changed in 1999. Pre-1999 an honours degree at 2:2 or above was required for CEng or a higher diploma/certificate for IEng. Post-1999 this changed and for CEng a master's degree was required or an ordinary degree for IEng.

There are two routes:

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

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

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

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

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

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

Approved membership applications

The Membership Committee reviewed 58 application forms on 14 January by the online system. 14 have recently been approved by the Council following the recommendations of the Membership Committee. Of the total, seven were new members, 30 were IOA Diploma students and the remaining 21 had upgraded their membership.

FIOA

Tateo Nakajima

MIOA

Ludovico Ausiello
Michel Batista
Austin Chan
Kyran Ebanks
Charlie Everett
Michael Fort
Daniel Hall
Luke Hatton
Artem Khodov
Juan Luis Rioperez
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Chris Duffill
Nicholas Elms
Simon Peter Erskine
David Fryer
Helen Griffiths
Justin Haves
Mark Hebblethwaite
Bailey Hoare
Miles Hodge
Ian Hooton
Jack Hopper
Elliot Hurst
Robert Jinks
Abdul Mahin
Kate Mann
Gregor Massie
Scott McLean
Mollie Mitchell
Steven Mitchell
Laurence Nickolls
James Oatley
Nathan Parker
Aiden Quinn
Philip Richardson
Karl Sweeney
Thomas Watkin
Gabriel Whittle
Greg Wilkinson
Lucy Withers

Affiliate

Amy Harington

The Edinburgh Science Careers Hive

IOA Scottish Branch Chair, Anne Budd, reports on the Scottish Branch-led IOA activity at Edinburgh Science Careers Hive Online, which invited young people to consider what the problems of the future are, how STEM professionals will solve them and what their own skills and strengths can bring to these ambitions.

The IOA has sponsored the Edinburgh Science Careers Hive and outreach schools' programme 'Generation Science' since 2017. In non-Covid times the Careers Hive is a week-long physical event held in the awe-inspiring surrounds of the National Museum of Scotland in Edinburgh.

This year, like so many other parts of life, the event went virtual. Ten acousticians from across the UK volunteered to turn themselves into yellow-shirted avatars for the week, teaming up with a whole range of STEM professionals to speak honestly about their careers, their routes into science and to answer questions from the students such as; "how can you use acoustics in vehicle mechanics?" "What would your sound super power be?" and "Can you use acoustics to catch criminals?"

A total of 2,305 secondary school (S1-S3) students from across the whole of Scotland, who were about to choose their National Grade subjects, attended the main virtual exhibition and workshops across the six days. The virtual format brought another dimension to the science communication skills that the volunteers had to use and was certainly different to being present in the room with the pupils. However, everyone adapted quickly and this resulted in some excellent and engaging chats which we hope inspired some of the young people to consider a career in acoustics.

'Ella's Wobble'

The IOA-sponsored primary school experiment, 'Ella's Wobble' has been sent out to 200 of the most deprived schools in Scotland.

Ella's Wobble is an interactive story in which pupils explore how sounds are made. The pupils follow a young girl called Ella who has lost her voice. She goes on a journey to find it and along the way, learns how sounds are made, what sounds different animals make, how echoes are made and what the word 'pitch' means. It is a great project and one which will hopefully be the activity that switches the children onto science for life.

Expanding the IOA reach

Although this year's activities have all been virtual, we recognise that this has opened up the event and the IOA's reach to a much wider geographical area in Scotland. We hope that in years to come when the in-person event returns, that some elements of the virtual event are retained so this progress continues.

My thanks go to all the volunteers who took part this year!

Turn to page 10 to read Emily Tilbury's report on the IOA-sponsored 'Engin-ear-ing' area of the event.

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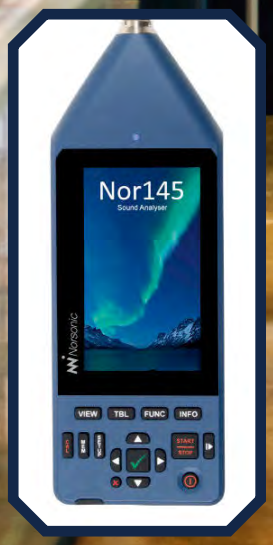

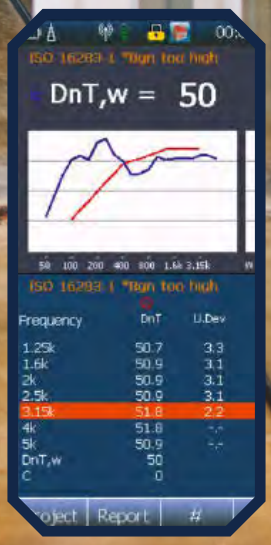

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Recreating physical STEM events in an online world

Following Anne Budd's article on page 8, Emily Tilbury reports on how successful the virtual event was at reaching even the most far-flung students.

By Emily Tilbury

As the Careers Hive moved online this year, industry volunteers interacted with students from over 30 Scottish schools through activities and Q&A sessions via web-conferencing software.

Through this medium, the festival organisers designed an interactive virtual space, creating different areas such as 'Design and Play' and 'Build and Connect' focusing on the wide range of skills and applications used in STEM careers. This format allowed students and volunteers alike to roam freely through the space, creating a similar feel to that of the in-person events.

Before accessing the space, each user created an avatar, which was controlled in much the same way as the old games that inspired the 8-bit avatar designs, with different keys covering different directions, bringing up a map of the space.

At the IOA-sponsored 'Engin-ear-ing' area of Design and Play, students took part in an interactive exploration into the different parts of the ear; considering what it would be like to suffer from hearing loss and the challenges of designing hearing-aids. This prompted interesting discussions and questions with the IOA volunteers and provided a good introduction to the world of acoustics.

The whole event was a resounding success, with schools previously unable to attend in-person logging on and taking part for the first time (including a school from as far away as the island of Unst in Shetland). Given the ability to extend the reach of the Careers Hive event, and the ability to closely recreate the physical event in a virtual setting, it is hoped that when the event returns to the National Museum of Scotland, this virtual aspect is retained blending the two formats to work together.

About the author:
While studying her BEng at the University of Glasgow **Emily Tilbury** became Head of Technical at the university's freeform student radio station. She has an MSc in audio acoustics from the University of Salford.

Investment in careers provision

A new report calls on Government to invest £40 million to improve access to careers provision for school and college students in England, enabling more of them to understand the opportunities available in STEM careers, and so support the drive to build back better and 'level up' across the UK in a post-pandemic world.

By Matt Muirhead, IOA STEM Committee

Through research conducted with 200 careers leaders and STEM teachers in secondary schools, the report highlights the challenge facing STEM ambassadors in the current climate and found that:

- over three quarters of the careers leaders and STEM teachers surveyed considered that it has become more difficult to engage with employers since the start of the pandemic;
- 68% of schools with above average free school meal eligibility said a lack of access to technology and internet was a barrier [to STEM careers activities];
- issues related to equality and diversity, including a lack of role models; and
- limited understanding of what STEM careers could entail and a general lack of confidence.

Identifying future STEM activity

The report reinforces the importance of STEM activity, and in particular, efforts to reach a diverse set of young people from lower socio-economic backgrounds. While the IOA STEM committee has helped coordinate a number of STEM initiatives throughout the pandemic, such as a producing a home learning guide with the ANC, making a wealth of STEM-related material available through the STEMHub and being highly visible at a number of online STEMfestivals, we are continually seeking ways in which to improve the quality, diversity, and extent of our outreach.

We encourage all members to carefully consider how we can best inspire a knowledgeable, motivated and diverse workforce of future acousticians.

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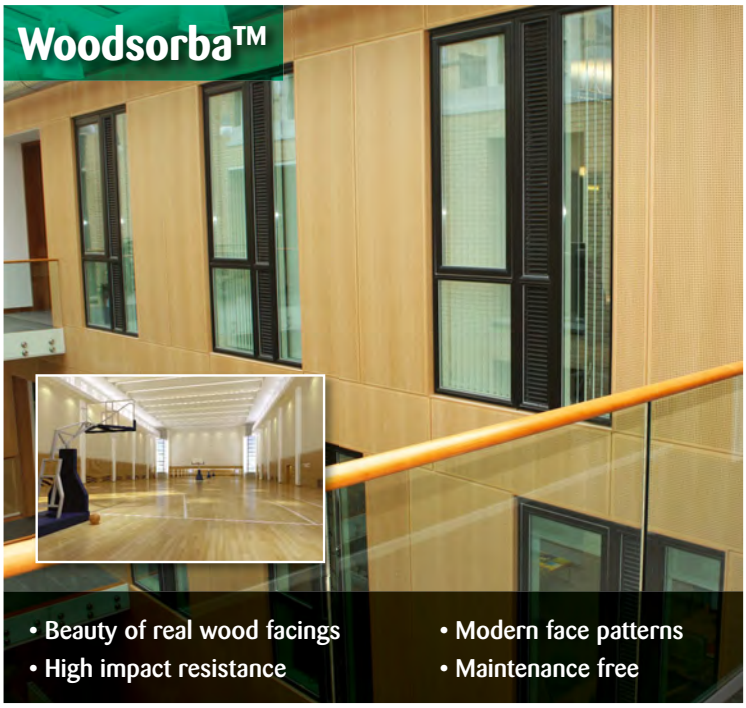

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IOA Early Careers Group

The Early Careers Group (ECG) has been very active in the past two months.

By Tom Galikowski, Group Chair

Alec Korchev (Clarke Saunders Associates) has been spearheading the ECG cooperation with other institutes and professional bodies. As a result, we are delighted to confirm that the IOA ECG will co-organise an interdisciplinary event dedicated to popularising careers across engineering, along with colleagues from IMechE, ICE, IET, and IStructE. We will be also joining the regular IMEchE event called CHAIN – keep your eyes open for further details.

We continued organising regular webinars and on 19 April, to celebrate the landing of the Perseverance Mars Rover, we invited Dr Nikhil Banda to talk about sounds on other planets. (See the report below).

We have also held a mini-series of webinars building on 'The Art of Being a Consultant'. A summary of the event is published on page 14 of this Bulletin.

Early Careers Webinar: 'Mapping the sounds of our universe: simulated examples of natural phenomena'

Dr Nikhil Banda is a research engineer in underwater acoustics at Seiche Ltd and he was previously a visiting research fellow at the University of Bath. His talk highlighted the outcomes of research carried out at the ISVR, University of Southampton, based on the work by Professor Tim Leighton, Professor Paul White and Nikhil.

The talk explored the influences of environmental parameters on the acoustic propagation on Mars, Venus and Titan, while highlighting the interdisciplinary nature of acoustics and to trigger discussions around acoustics in challenging environments.

Throughout the talk, Nikhil reminded the audience how sound is an incredibly useful asset to the discovery of environments where other sensing options are not available. For example, converting radio wave emissions into audio signals or listening for liquid splashes when landing an extra-terrestrial vehicle. By modelling the propagation of sound on other planets with different constituent atmospheric gases, it becomes possible to demystify the sounds you might hear further out in our galaxy and the distant universe.

Nikhil was very clear in his explanations, with plenty of graphics and audio samples to enjoy and help explain principles. The presentation itself made for easy viewing, with minimal clutter from equations and jargon. The IOA Early Careers Group are very grateful to Nikhil for taking the time to indulge us in something a little different and maybe we'll all now look up at the sky at night a bit differently.

Join the ECG

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

All our webinars and events are possible due to the time and effort volunteered by our guests and fantastic ECG colleagues; Daniela Filipe MIOA from Hoare Lea, Dr Niklhil Mistry MIOA from ISVR and Josie Nixon MIOA from HA Environmental, as well as the enormous help (and patience) of Linda Canty and Alex Shaida from the IOA.

If you have any burning questions about acoustics, do not hesitate to email: **earlycareers@ioa.org.uk**

The ECG is always on the lookout for CPD ideas; so if there is a technical, career and education-related topic you would like to be discussed, please get in touch at: **earlycareers@ioa.org.uk**

There are ECG vacancies at Central Branch, North West, Research Committee and Physical Acoustics Group – if you are interested, please get in touch with the ECG or the relevant groups directly.

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The 'Art of Being a Consultant' mini-series

Between 1 April and 27 May 2021 the IOA Early Careers Group (ECG) organised a series of webinars building on the popular topic; 'The Art of Being a Consultant'. Five bi-weekly panel discussions focused on non-technical topics such as avoidable mistakes, the role of networking, working remotely and calculations.

By Tom Galikowski, Chair of the IOA Early Careers Group

The webinars were attended by up to 80 people. Key points from each webinar with additional material, and recordings of some of the events are available on the IOA website at **http://bit.ly/artofconsultextras**

The event was organised, produced and hosted on behalf of the ECG by Josie Nixon (HA Environmental) and Tom Galikowski (BAP) with support from Daniela Filipe (Hoare Lea) and Linda Canty and Alex Shaida from the IOA. The ECG would like to thank them all for volunteering their time and expertise.

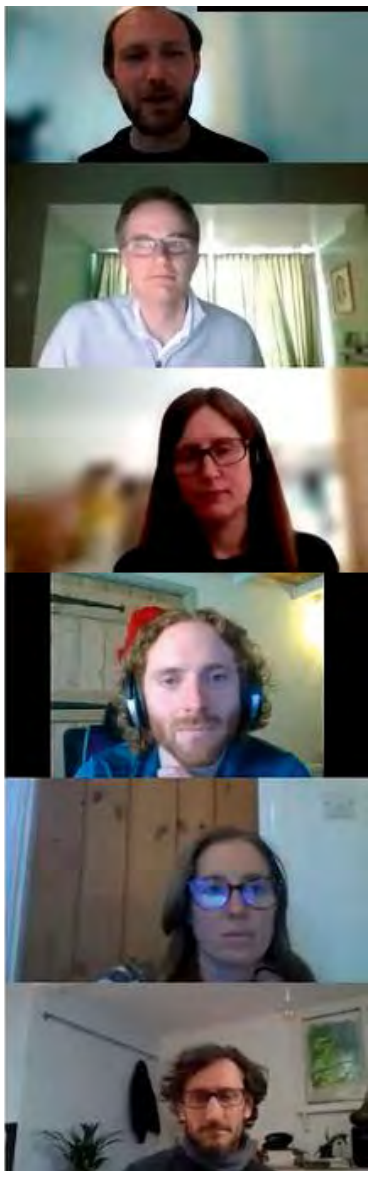
Career paths and failure

The first event focused on routes into acoustics and the role of failure. Stephen Turner (ST Acoustics and President of the IOA), Jo Miller (Miller Goodall Ltd), Paul Shields (AECOM) and Vicky Stewart (Atkins) all outlined their careers and their varied routes into the industry. Career opportunities cannot be predicted but it is important to take them when they appear.

We discussed failure and how to deal with it. Our guests described various situations when they made "world-ending" mistakes such as cut-and-paste-errors, forgetting to press record, or replying to all. Some were funny (cow licking a microphone), some were more serious (safety). The panel stressed that mistakes should always be avoided, however, when they happen, it is important to learn from them.

They highlighted flaws in processes and what can be changed to avoid them such as using checklists, templates and simplified procedures – do not rely on trying to remember everything.

Do not be afraid of failures though – they can take place at any stage of anyone's career, especially when working outside of a comfort zone, which is important to progress in your career. Take opportunities – if you fail, try again.



Right: Delegates at the remote working webinar for ECG 'Art of Being a Consultant' mini-series'

Remote working

This event focused on discussing how remote working affects consultants and how to make working from home permanent. The panel consisted of Anne Budd (New Acoustics), Mark Murphy (Vanguardia), Mike Hewett (Acoustical Control Consultants Ltd) and Robin Woodward (Hayes Mackenzie) who have all worked from varied unique places during their careers!

They pointed out that working remotely is being away from your office **and** your colleagues. Active and regular communication is crucial, so they suggested morning or end-of-the-day catch up meetings.

Online meetings are more difficult to handle as body language signals are harder to spot, but using structure and following good practice guidelines such as the ANC Meeting Code, co-authored by Anne Budd, is helpful. (**https://www.association-of-noise-consultants.co.uk/wp-content/uploads/2020/01/Meeting-code.pdf**).

Remote working does not suit every job or activity and creative methods need to be introduced to ensure productivity and overcome challenges, so it is advisable to speak up as soon as you get stuck. Be realistic with your time management and plan your day sensibly. Prepare mentally for P16

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work and switch off afterwards, by going for a walk for example.

To work regularly from home, lay the foundation, be available and communicative when you are expected to be while considering employment law, and follow your company policies.

Job hunting and networking

We were joined by directors of some UK consultancies; Ed Clarke (Clarke Saunders Associates), Russell Richardson (RBA), Paul Shields and Jo Webb (Wood and Past President of the IOA) to talk about recruitment, CVs, interviews and networking.

To find opportunities, attend industry events (e.g. those organised by the IOA and ANC), check the IOA careers web page, approach companies directly and use your contacts. Consider recruiters, however, some companies do not use them and never be bullied into making a quick decision.

A CV is the first step to landing you an interview, but it must be tailored for each company or role. Do not be generic and proof read it carefully. Prepare well for interviews (remote or in-person), remembering that first impressions matter. Be on time, be enthusiastic, dress smartly and engage. Ask for feedback, then use it.

Building quality relationships and networking are important, and can get you a job or improve your ability as a consultant. It is a long game and it is ok to feel uncomfortable at first but persevere with it. Introverts **can** network! Be aware of body language and tone of voice. Networking remotely can work but is more difficult. Keep your camera on and engage.

Writing and calculations

Anthony Hayes (Bickerdike Allen Partners LLP), Dr John Pritchard (Leeds Beckett University), Stephen Turner, and Valerie van den Hende (Sandy Brown Associates) joined us to offer invaluable advice on improving writing and calculations. (The IOA is in the process of creating a two-stage advanced course on report writing, see page 18 of this issue).

'Writing' includes reports, memoranda, emails. It is often not fun but it is the most important part of a consultant's job. It is your lasting legacy and your reputation is built on it

Think about what you want to write, what the words say and what the reader actually hears. Use the classical argument principles to structure your work: introduce the basis for your report, outline your argument, provide your statement, then present your reasons.

Allow sufficient time for reviewing. If you are the sole reviewer – wait one or two days and then go through it again.

Finding a balance between 'perfect' and 'good enough' comes with experience. Rely on senior colleagues for advice early in your career and improve your work by reading in-house reports or those written by others.

Calculations provide narrative for the report, so they need to be presented clearly – define input, variables, symbols and units. Where it will help with interpretation, include notes, screen grabs and links.

Reduce calculation errors when working in spreadsheets by limiting possible inputs using drop-downs, then check that the result is what you expected. Review carefully and include intermediate steps in the calculations to help with the checking process, use hand calculations to benchmark the result.

Templates and models should be used as guidance and checked by others before using. Understand methodology first. Does the answer make sense? Compare with other templates that you know work. Check results by hand and use extreme inputs to investigate sensitivity.

Expert witness

The last webinar of the mini-series focused on the work of expert witness. The panel consisted of consultants who appeared as witnesses on a number of occasions; Graham Parry (Accon UK) outlined the role of an expert witness, what skills are required, where and when is one needed, and what a typical process involves. Dani Fumicelli (Vanguardia) presented ins and outs of public enquiries. Rupert Taylor (Rupert Taylor Ltd) talked about parliamentary select committees and how they work. Ed Clarke compared in-person hearings with remote hearings. Additionally, Bryan Johnston (Partner at Dentons), looked at expert witness work from a lawyer's perspective.

The panel shared tips on how to become an expert witness. First, become an expert! Not everyone can be an expert witness – it is stressful, you need to be in the best health and able to take criticism. Great experts can be awful witnesses. It is vital to be aware of your own capabilities and limitations. It is unwise to think you know everything, it is better to think "I don't know, but I will go and find out".

Non technical skills are essential, expert witnesses need to understand body language, tone of voice and how to read the room (tricky if the inquiry is remote).

Next steps

We are currently in the process of organising the usual in-person event for the autumn or early 2022 and will advise of the dates and venue soon.

We hope that the mini-series provided some useful information and guidance to consultants at early stages of their careers. If you have any further questions, or suggestions for future topics, please get in touch with the ECG at **earlycareers@ioa.org.uk**

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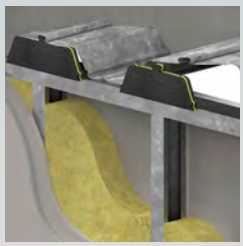

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Former IOA President, Bridget Shield, awarded MBE

Bridget Shield has been awarded an MBE in the 2021 Queen's Birthday Honours list announced in June, for 'services to Acoustic Science and for voluntary service to Inclusion in Science and Engineering'.

Bridget retired from London South Bank University (LSBU) after nearly 30 years teaching and research. The award of the MBE is in recognition of her influence, through her research, lobbying and work with government departments, in writing and maintaining building regulations and guidance concerning the acoustic design of schools.

The award also recognises Bridget's pioneering role as a woman in the acoustics profession.

When she joined the IOA there were few women members. She was the first female Council member, first female Fellow, first female Honorary Fellow and, most notably, the first female President. Her example and her encouragement of women in the acoustics industry have led to a culture shift in the Institute, with around a third of Council now being made up of women, and women taking leading roles on other IOA Committees.

Throughout her career Bridget has championed the inclusion of girls and women in science and engineering in general. In the 1980s and 1990s, she was joint chair, with Linda Edwards Shea, of the LSBU Women in Engineering Group. Together they established the national Women in Engineering Centre at the university which provided support, encouragement and information relating to engineering professions.

Bridget has also taken an active role in Public Understanding of Science activities, an example of which was the granting of a Royal Society Millennium Award to her and Trevor Cox to set up an exhibition on the acoustics of the Royal Festival Hall.

Since retiring from LSBU in 2014 Bridget has continued her academic activities, writing and publishing papers and giving conference presentations. As a visiting professor at Brunel University, she updated her influential 2006 report on the social and economic costs of hearing loss in Europe; the new report 'Hearing Loss – Numbers and Costs' was published by Hear-it.org in 2019.

Bridget's work has been recognised nationally and internationally by, in 2011, a Lifetime Achievement Award from the Noise Abatement Society, and receipt of the IOA RWB Stephens medal; and election in 2013 as a Fellow of the Acoustical Society of America.

Technical report writing skills and report evaluation short courses

Discussions are underway at the IOA to potentially develop two new certificated courses aimed at improving the quality of technical reports appropriate for the field of acoustics and noise control.

By Dr John Pritchard MIOA

The first of these will focus on report writing skills and preparation; the aim of this two or three-day certificated course will be to improve the standard of report writing in the acoustics field, focusing on the scope and purpose of such reports, with consideration given to the structure and the use of templates, detail of the content required within reports and the appropriate use of writing skills. It is anticipated that the course will appeal to newly qualified or early career acousticians, and is intended for professionals from a diverse range of backgrounds including consultancy, environmental health and other government-based organisations.

The second course will focus on the **evaluation or critiquing of acoustic technical reports**; it will be aimed at professionals in a more senior position with the responsibility of scrutinising and authorising technical reports. A critiquing course is well overdue, and this two or three-day course will be at an 'advanced certificate' level. Such a course will provide the tools and skills to enable professionals to critique both effectively and fairly, as well as providing an overview of what constitutes a well structured and written report.

Both courses will introduce delegates to examples of best practice, which will result in a consistently higher standard of report. It is anticipated that the courses will be launched in late 2021 or early 2022, delivered via face-to-face training in accredited centres across the UK.

Further details will be available shortly, so please check IOA website for details.

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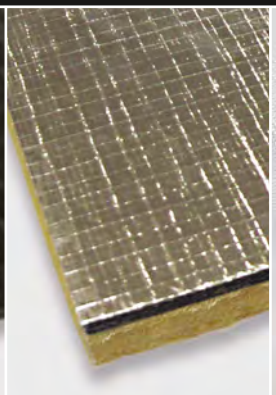

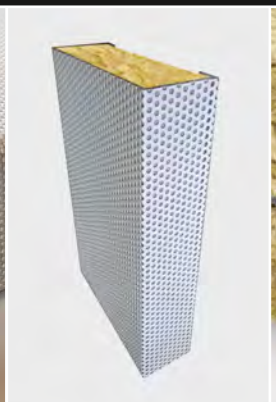

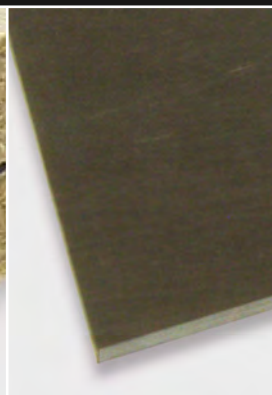

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The IOA Facebook page and groups, and how to buy and sell used equipment

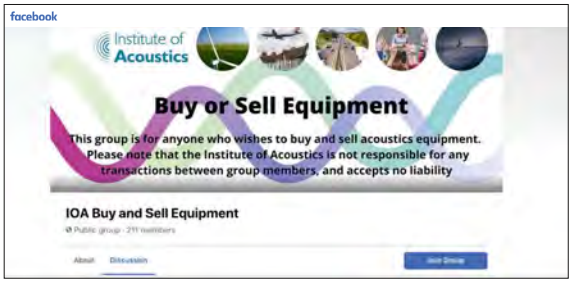
The IOA's Facebook pages and groups are thriving and fast becoming one of the most active ways we engage with the outside world. The IOA has two dedicated Facebook groups and a Facebook page.

By Alex Shaida, IOA Head of Marketing

The main purpose of the Facebook page (https://www.facebook.com/ioauk) is to notify members of general information about the IOA and our upcoming activities, it currently has close to 1,800 followers.

The Facebook group

(**https://www.facebook.com/groups/21172516499**) has over 1,000 members and has grown from just over 300 a year ago.



The Buy and Sell Equipment group

https://www.facebook.com/groups/ioakit currently has over 200 members. It was established by the IOA in August 2019 in response to members who wanted to either buy or sell used acoustics equipment. It has operated as an open group since its launch and the membership has steadily grown. The group is still finding its feet, and is likely to continue to evolve over the next few years. One of the spinoffs of the Buy and Sell Equipment group is that anyone who has equipment stolen can use the group to warn others that there is stolen equipment in circulation.

From time to time, we also publish used equipment for sale in the Acoustics Bulletin. Do bear in mind that this is dependent on available space and it is published bi-monthly. Email details of equipment for sale to Nicky Rogers, Acoustics Bulletin editor, **nickyr@warnersgroup.co.uk**

Buyer beware

Members should be aware that both the IOA Facebook group, and the Buy and Sell Equipment group are very lightly moderated. Occasionally, we do delist irrelevant contributions posted onto our Facebook group, but we do not check the validity of equipment being sold on the Buy and Sell Equipment group. Therefore, it's the responsibility of individuals accessing these groups to make sure they do their due diligence when responding to sales offers for used equipment.

Extended reach

The IOA advertises across Facebook platforms in the UK and internationally, running digital marketing campaigns in a number of countries throughout the year. Facebook is one of the primary ways we promote our Diploma programme to international students. (Please note that if you wish to participate and access Facebook pages and groups, you need to have a Facebook account, which is free to set up.)

One of the main reasons we promote the IOA so actively on Facebook is that it tends to be very popular among younger people, particularly those in the mid to late teens, and in their 20s and 30s. Facebook also has a strong presence in other parts of the world, particularly in Asian countries where it is increasingly used as a business tool and not just for personal use.

We have a presence on Instagram (**@ioauk**), where you can follow us and receive the latest updates on your phone.

We encourage all our members to actively engage with our Facebook groups, and for those who want to communicate to a more senior group of acousticians, we recommend the IOA's LinkedIn group which is fast approaching 15,000 members **https://www.linkedin.com/groups/678647/**.

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2021 Conference programme

Understandably, the 2021/22 conference programme is likely to be affected by the COVID-19 virus.

2021

ACOUSTICS 2021
11-12 October 2021
Regional Hubs

REPRODUCED SOUND 2021
16-18 November 2021
The Bristol Hotel, Bristol
Organised by the Electroacoustics Group

2022

HEAR FOR TOMORROW
30 March 2022
Royal Academy of Music, London
Organised by IOA and Hearing Conservation Association

ICUA 2022
20-24 June 2022
Grand Harbour Hotel, Southampton
Organised by the Underwater Acoustics Group

INTER–NOISE 2022
20-24 August 2022
SECC, Glasgow

UPCOMING NOMINATIONS DEADLINE FOR IOA AWARDS 1 OCTOBER 2021

The Institute of Acoustics annually honours people whose contributions to acoustics or to the Institute have been particularly noteworthy. Nominations may be made at any time either on standard forms available on the IOA website or by writing direct to the President. Note the following awards have a nominations deadline of 1 October 2021, for 2022 awards:

- Rayleigh Medal
- Tyndall Medal
- A B Wood Medal
- R W B Stephens Medal
- Institute of Acoustics Engineering Medal
- The Peter Lord Award
- Peter Barnett Memorial Award
- The Award for Promoting Acoustics to the Public
- The IOA Young Persons Award for Innovation in Acoustical Engineering (sponsored by Cirrus)
- NEW – The Bob Peters Award for Excellence in Acoustics Education

Any questions, please contact the IOA at **ioa@ioa.org.uk**
We look forward to receiving your nominations.

Entry forms are available by going to:
https://www.ioa.org.uk/about-us/awards

FOR MORE INFORMATION:
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Institute of Acoustics, Silbury Court, 406 Silbury Boulevard, Milton Keynes MK9 2AF

Institute of Acoustics

Erratum:

In the May/June 2021 issue of Acoustics Bulletin, an article on page 61 entitled 'Novel online conference held to promote mutual discipline awareness between acoustics and architecture students', misrepresented the relationship between the London South Bank University Acoustics Group and the Architectural Association School of Architecture.

This relationship was instigated by Laura de Azcarate in February 2017 to engage architects with the field of acoustics. Ms Azcarate is an alumnus of the LSBU Acoustics Group.

The conference referred to in the article was jointly organised by Dr Luis Gomez-Agustina and Laura de Azcarate, as part of a long-term commitment to advise and inform architects on the importance of acoustics.

London South Bank University apologises for any misrepresentation in the article.

The Bob Peters Award for Excellence in Acoustics Education

Education is possibly the most important activity of the IOA, but until now, the Institute has not had an award to celebrate and recognise excellence in teaching, learning or other education activities.

By Dr Luis Gomez-Agustina (FIOA)

Above: Bob (in the foreground in blue shirt) in 2012 with London South Bank University past students and colleagues

Last year, the IOA Council approved the proposal by Dr Luis Gomez-Agustina to establish a dedicated education award to be named after the late Dr Bob Peters.

The aims of the proposed award are twofold:

1. to celebrate the memory of Dr Bob Peters, who is widely remembered for his outstanding contribution to acoustics education and his long-standing commitment to teaching and student success; and
2. to recognise excellence in the design, plan, delivery and management of acoustics education, or other significant contributions to education in acoustics.

An illustrious career in education

Bob is fondly remembered by his numerous colleagues and students as a highly effective and inspiring educator, as well as a generous, approachable and affable person. Through his extensive and prolific career, Bob's teaching, influence and legacy in acoustic education has been outstanding and merits a lasting a recognition, which surely will inspire other educators to excel.

We carried a full obituary for Dr Peters, written by Emeritus Professor of Acoustics, Bridget Shield, in the September/October 2019 issue of Acoustics Bulletin. You can read Keith Attenborough's tribute to Bob at **https://www.ioa.org.uk/news/bob-peters**

Eligibility

This biennial award is open to individuals or teams responsible for acoustics education in the UK or with a strong UK link, e.g. tutoring the IOA Diploma in the Middle East, India, Republic of Ireland, etc.

Criteria

The award may be for a single outstanding or significant contribution to acoustics education and training or a sustained long-term activity in this respect.

Specific areas for consideration can include:

- strong commitment to student success;
- excellence in teaching and learning;
- promotion and application of innovative methods and techniques;
- exemplary education management;
- inspirational mentorship;
- Influential educational leadership; and
- excellent contributions to curriculum development/ course design.

Nominations can be made by third parties or by the individual(s) concerned.

Documented evidence will be required to be submitted to demonstrate merits related to the aims and criteria of the award.

These can include:

- examples of novelty/value/ impact/quality of a piece of work/ activity or programme;
- statements/letters of support from peers, students or management;
- development or improvement of teaching/learning/assessment materials;
- design of effective teaching and learning strategies;
- innovative curriculum change;
- novel course design and implementation; and
- leading responsibility for educational grant applications.

Award and recognition

The award may only be made in any given year if a worthy recipient is identified.

The physical award will consist of the presentation of a trophy or a plaque at an event with an educational benefit such as the invitation to attend/present to an IOA conference with waived fees. Wider recognition could include mention in all IOA communication channels.

How to apply

Nominations should be submitted by 1 October 2021 to **ioa@ioa.org.uk**

Check the IOA awards web page for details of all our major awards **www.ioa.org.uk/about-us/awards**

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Meet the IOA front line staff (part one)

There is an enthusiastic and loyal core of IOA staff who work hard behind the scenes to support the Institute's 3,000 members. Here, you can find out a little more about them and we will publish part two of this series in the September/October 2021 issue.

Allan Chesney,
Chief Executive
allan.chesney@ioa.org.uk
Allan joined the IOA in 2013. He has a degree in mechanical engineering and after graduation, became a soldier for the next 21 years. He advises Council on the legal, financial and administrative implications affecting their decision process, then works to enable the office team to implement Council's directives. Prior to joining the Institute, he thought he had retired and was 'working' as a foster parent to two young girls who he eventually adopted, so early retirement was over; the girls are now 10 and 11. His last full-time employment was as principal of an adult learning service with 12,000 students and he has been the National Policy Manager for Adult Learning, National Programme Manager for Inclusive Learning, a Contract Manager for Government funding of Apprenticeships and General Secretary of a charity. Allan has a Masters in Policy Studies and has served on several national policy working groups related to education.

Future fact: Allan says that the IOA direction of travel will secure its future, provide a first class service to members and will increase the appreciation of the importance of acoustics to policy and decision-makers.

Blane Judd,
Engineering Manager
acousticsengineering@ioa.org.uk
Blane joined the IOA in 2016 and has more than 40 years' experience in the engineering profession, working in power engineering, building services and, more recently, rail transport. He has significant experience in supporting candidates who are looking to register at EngTech, IEng and CEng.

Hair-raising fact: Blane was part of a small team who pioneered a technique to work on 400,000 volt live power lines.

Linda Canty,
Office and Events Manager
linda.canty@ioa.org.uk
Linda joined the IOA in March 1990 after previously working in the publicity office of Oscar Faber (now AECOM). She is responsible for the general management of the office and working with the Meetings Committee on the programme of events taking place throughout the year including branch meetings.

Cultural fact: Outside work Linda likes theatre, music, films, walking, reading and travel.

Dennis Baylis,
Advertising Manager (Acoustics Bulletin)

dennis.baylis@ioa.org.uk

Dennis has been the Advertising Manager for the IOA for nearly two decades now, managing advertising (the clue is in the job title) in Acoustics Bulletin and on the website's Jobs and Find a Specialist sections. Throughout this time, Dennis has been working remotely for the IOA, approximately 1,300 kms away in a remote corner of southwest France – aka the middle of nowhere.

Previous incarnation fact: Dennis worked in technical (acoustics) sales for a UK instrumentation company and, before that, in environmental noise with a county council.

Helen Davies,
Education Officer

education@ioa.org.uk

Helen joined the IOA on the brink of the first lockdown in March 2020. Working with the Education Manager she administers and delivers certificate and diploma courses, providing support for distance learning and centre-based candidates while liaising and corresponding with associated tutors. She assists Alex with the coordination of various filming projects and has taken on the management of the Acoustics Bulletin circulation and subscriptions. Her previous role involved her travelling to Asia and the Middle East, combining video production, broadcast and project management skills for clients in the education sector.

Entertainment fact: During the recent uncertain times, Helen has come up with innovative and fun ideas to keep the family connected and entertained via Zoom.

Julie Clements,
Accounts Officer

accounts@ioa.org.uk

Julie joined the IOA in May 2019 as Accounts Officer. She oversees all the finance functions including accounts payable, accounts receivable, payments, banking and preparation of month end and audit reports. Outside work, Julie is a UK Athletics Field Official and has represented her local club, Marshall Milton Keynes, at numerous competitions.

Literary fact: She also enjoys writing and has had one of her poems published.

Emma Lilliman,
Membership and Engineering Officer

membership@ioa.org.uk

Emma joined the IOA in June 2018 from the hospitality sector. She helps members with their accounts and upgrades and also to take the first steps to achieving Engineering Chartership. She works with three IOA committees.

Slightly worrying fact: Away from work, she has a young child and raises money for charities by some sort of adventurous activity, which doesn't always end well.

Caitlin Jesney,
Office Administrator

caitlin.jesney@ioa.org.uk

Caitlin joined the IOA in May 2020, right in the middle of the first lockdown. She works as the Education Administrator, helping with the Learning Management System (IOA Classroom) and support for distance learning Diploma candidates. Prior to joining the IOA, she worked at a substance misuse programme as a senior administrator.

Energetic fact: Caitlin is a keen photographer, has a passion for martial arts, is doing an MBA part time and loves to travel.

Alex Shaida,
Head of Marketing

alex.shaida@ioa.org.uk

Alex has worked in marketing and public relations for more than 25 years and holds an MA in marketing. Prior to joining the IOA, he spent five years working in Hong Kong, Singapore and Thailand. He started in traditional marketing in the early 1990s and moved on into digital marketing in 2003, when he joined a fast-growing ecommerce company. His video production experience helped him to develop an animation series for primary school children.

Scriptwriting fact: Alex is involved in martial arts and also writing in his spare time, having taken a professional writing course with UCLA film school back in 2017-2018.

The what, where and how of diversity, inclusion and equality in the Institute of Acoustics

Diversity and inclusion refer to the practice of including people from different social and ethnic backgrounds[i] in an organisation, in this case, the IOA. But just aiming to include people is not enough: everyone involved should have equal opportunity to participate in Institute activities and contribute to its running, which is why we now include equality in the ambitions of the Institute.

By IOA Diversity Champion, Angela Lamacraft MSc MIOA IEng, ACCON UK Ltd

Diversity, inclusion and equality (DI&E) can be summarised as:

- **Diversity:** The acoustics profession and the IOA should comprise and represent members from all areas of society.
- **Inclusion:** All members must feel able to become acousticians and to participate at all levels of Institute activity, from actively participating in online branch meetings and in-person conferences, to joining the IOA Council.
- **Equality:** All acousticians/members are equally as important and equally as entitled to participate in Institute activities.

With regard to the IOA, there are three aspects of DI&E:

1. **DI&E within IOA participation**
   We need to aim to ensure that there are no conscious or unconscious blocks to members from any social or ethnic backgrounds participating in Institute activities.
2. **DI&E within IOA organisation**
   We need to aim to ensure that members from any social or ethnic backgrounds feel able to volunteer for positions within Institute leadership, such as joining a committee or becoming a member of IOA Council.
3. **DI&E of IOA members within employment**
   We need to encourage hiring managers within our profession to recruit employees with diverse backgrounds.

Why it is important

Improving the diversity of an organisation is not about setting quotas, it is about making sure that the best person for a job is given an equal chance of success and that all members are equally empowered. A diverse membership representing members from all social and ethnic background enables all members to feel accepted, leading to greater confidence to express their ideas. It also improves the potential for the Institute to reflect the society it serves. **If areas of society are unintentionally excluded from Institute activities, the Institute and the acoustics profession miss out on their experiences and viewpoints, which then affects the delivery of services to the Institute's membership leading to an endless loop.**

What is more, study after study[ii, iii, iv, v, vi] demonstrates that **diversity, inclusion and equality within an organisation improves financial performance**, the most diverse companies are now more likely than ever to outperform less diverse peers on profitability[vii]. While the purpose of the IOA is not to make profit, there are lessons to be learnt from businesses when it comes to the benefits of improving diversity, inclusion and equality.

And lastly, acoustics, like UK engineering professions generally, faces a skills shortage[viii], therefore encouraging people from all social and ethnic backgrounds into the profession increases the total number of acousticians.

The current position

According to Engineering UK figures for 2018, 12% of engineers were women, compared to 51% of the general population of England and Wales. 8% of engineers are from BAME (black, Asian and minority ethnic) backgrounds compared to 15% of the general population of England and Wales. P30

i Oxford Languages online, accessed 06/06/2021.
ii **https://www.mckinsey.com/business-functions/organization/our-insights/why-diversity-matters**, accessed 07/06/2021.
iii Noland, M. Moran, T. and Kotschwar, B. (2016). Is Gender Diversity Profitable? Evidence from a Global Survey. Peterson Institute for International Economics, WP 16-3.
iv Gompers, P. and Kovvali, S. The Other Diversity Dividend. Harvard Business Review, July-August 2018, pp.72 77.
v Gomez M.D, L.E. Bernet, P. (2019). Diversity improves performance and outcomes. Journal of the National Medical Association, 111(4), pp. 383-392.
vi Nadeem, M. Suleman, T. and Ahmed, A. (2019). Women on boards, firm risk and the profitability nexus: Does gender diversity moderate the risk and return relationship? International Review of Economics & Finance, 64, pp. 427-442.
vii **https://www.mckinsey.com/featured-insights/diversity-and-inclusion/diversity-wins-how-inclusion-matters**, accessed 06/06/2021.
viii **https://www.raeng.org.uk/diversity-in-engineering/business-benefits-key-facts**, accessed 07/06/2021.

Figures 1 to 5 illustrate the percentage of IOA membership for different social and ethnic backgrounds.

Figure 1: Percentage female membership by grade

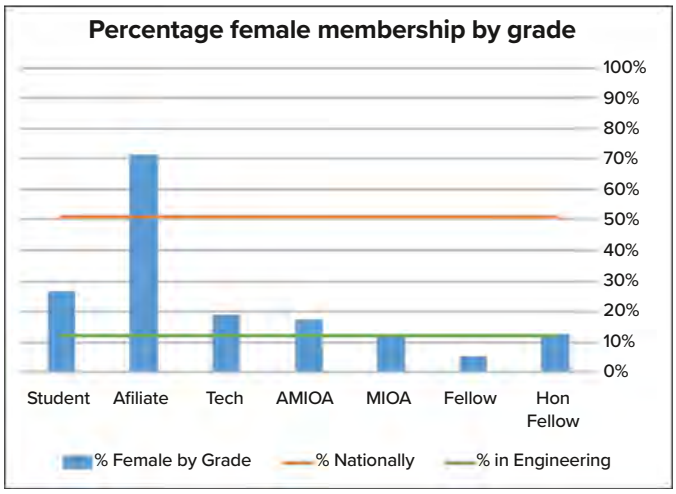
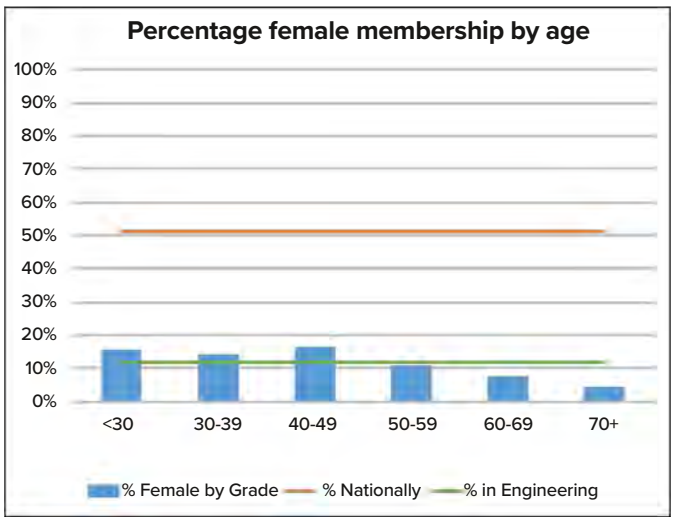


Figure 2: Percentage female membership by age



Delving into the details of Figures 1 to 5 and comparing the data with the percentage of engineers of each background and the percentage of the UK population as a whole is enough discussion for another article, but the figures do demonstrate that there is room for improvement within the Institute. The figures also do not provide the percentages of members from different backgrounds that actively participate in Institute activities, or enrol on or complete the Institute's educational courses, for example.

The IOA does not have 'targets' for the percentage of members from different social and ethnic backgrounds, rather, evaluating the current figures provides an indication of areas where the IOA may be underperforming in terms of providing support for all potential acousticians regardless of their background. **Our success in improving DI&E will not be determined by hitting a given percentage of membership for each social and ethnic background, but from discussing issues with members and achieving positive feedback from members.**

The observant among you will have noticed that a large number of members select 'prefer not to say' when responding to queries regarding diversity. What the graphs do not show is that there is also a large number of members who do not answer these questions at all. There are a number of possible reasons for this, for example, belief that the data is not required as everyone should be treated equally, or that people should not be labelled. In an ideal world, we would not need to consider diversity, inclusion and equality as everyone **would** be treated equally. However, different

Figure 3: Ethnicity of declared membership

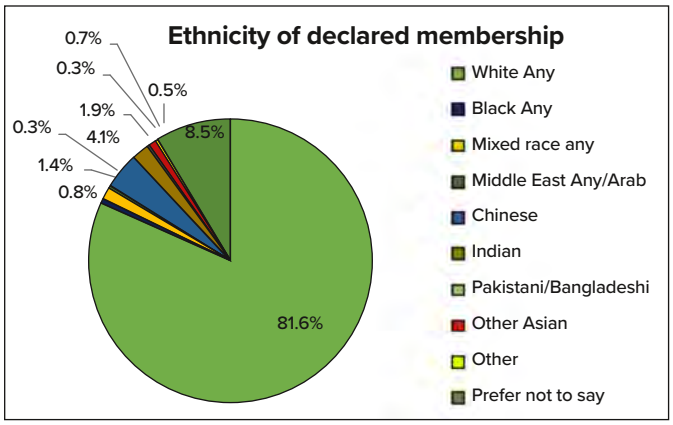


Figure 4: Sexual orientation of declared membership

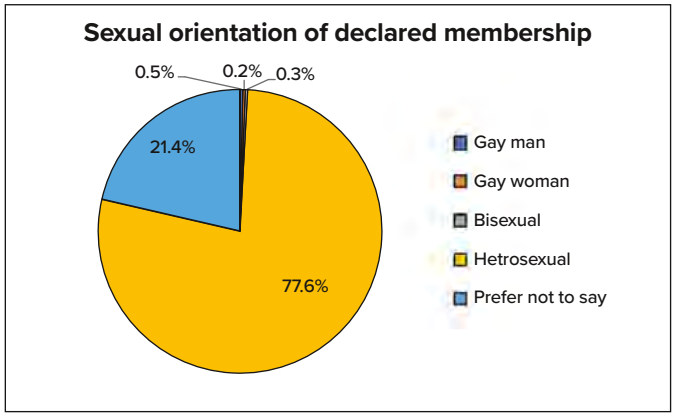
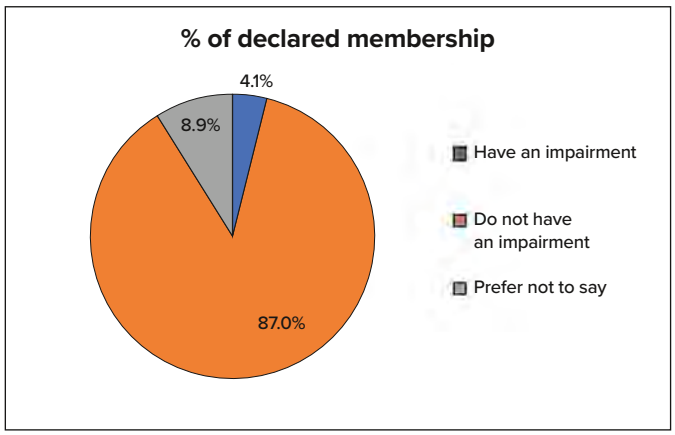


Figure 5: Physical impairment of declared membership



areas of society face different levels of challenge to fulfilling their potential, therefore some areas of Institute membership will need more support and different forms of support than the historically 'typical' demographic of engineers.

Regarding the second view, that people should not be labelled, it is vital that we understand which demographics are underrepresented so that we can enhance efforts to understand why and to make the Institute more accessible for them.

It is therefore incredibly helpful to the improvement of diversity, inclusion and equality if people answer diversity questions as fully as possible so that we begin to understand the existing diversity of the Institute and where it needs improving. You can alter your information by logging into the IOA website, going into you profile via the icon in the top right-hand corner of the webpage, then changing your information as appropriate. (Thank you!) P32

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The plan

Guidance from the Royal Academy of Engineering

The IOA is not the only professional body to be taking steps to improve diversity, inclusion and equality. Indeed, 31 professional engineering institutions (PEIs) have signed the Royal Academy of Engineering (RAEng) 'Engineering Diversity Concordat', which states that they agree to work towards achieving the following objectives:

- to communicate commitment to equality and inclusion principles and practices;
- to take action to increase diversity amongst those in professional engineering membership and registration; and
- to monitor and measure progress.

RAEng has prepared a number of reports regarding diversity and inclusion, including a series of three benchmarking reports (one for engineering and science professional bodies, one for PEIs only and one for scientific bodies only). Good practices, areas for development, future priorities and challenges to progress were identified. The areas for development are all illustrated in **Figure 6.**

These are all good ambitions for the IOA, however, they cannot all be tackled at once. The two areas in bold in the list above are therefore considered to be the priority for the IOA in the near future, although the remaining areas will not be overlooked.

The RAEng considered the future priorities illustrated in **Figure 7.**

Again, not all of these priorities can be tackled at once, therefore the areas in bold above are considered to be the immediate priority for the IOA.

The challenges to progress identified by RAEng are illustrated in **Figure 8.**

All of these challenges are relevant to the IOA and discussion of the individual challenges and potential ways of overcoming them is content for another article.

Figure 6: RAEng identified areas for development

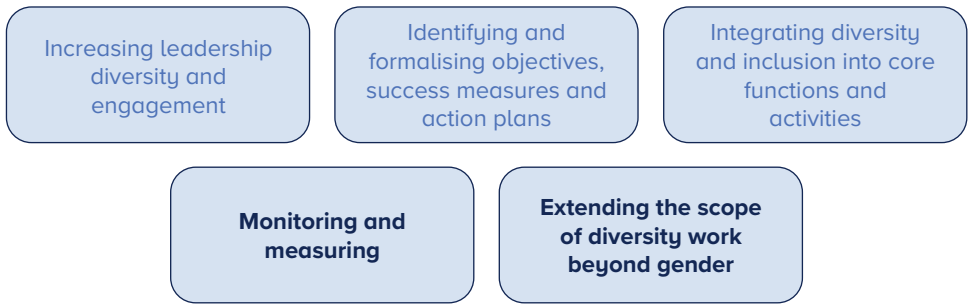


Figure 7: RAEng identified future priorities

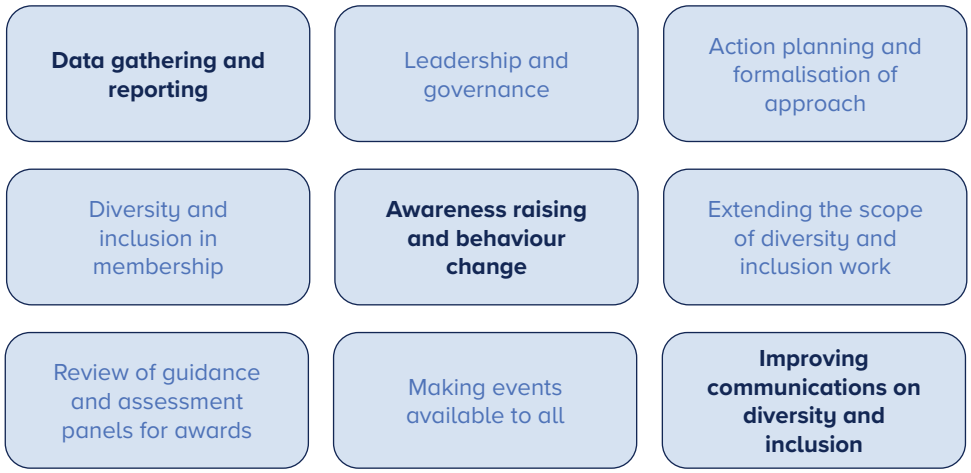
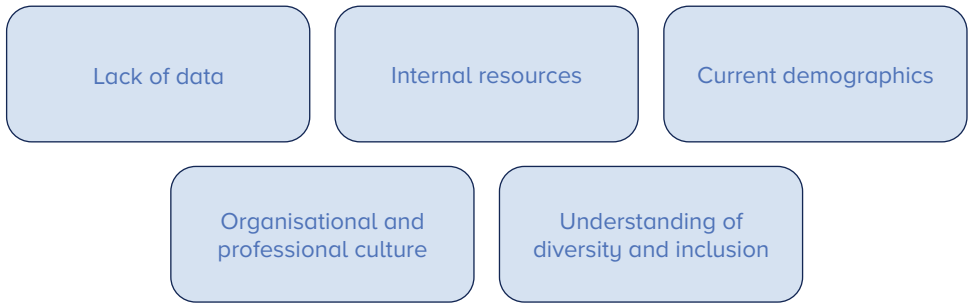


Figure 8: RAEng identified challenges to progress



How improved diversity, inclusion and equality may be achieved

As identified above, the priorities for the IOA are to gather data regarding DI&E, extend the scope of diversity work beyond gender, awareness raising and behaviour change, and improve communications on diversity and inclusion.

As Diversity Champion, I have a number of ideas:

1. create a DI&E Working Group and a dedicated email address;
2. create a survey to determine the extent of the DI&E issue and possible causes;
3. discuss the issue with the Women's Engineering Society, Women into Construction, InterEngineering, the Association of Black Engineers and any other professional bodies for underrepresented areas of society that are brought to our attention (please email the DI&E working group once the email address has been set up – keep your eyes peeled on IOA e-newsletter for details);
4. write to diversity leads at some of our major clients to discuss problem areas (such as the mismatch between the DI&E message of major clients and the requirement of their project managers and design teams that any contractor employee must be available every working day[1]); and
5. invite a diversity expert to provide a plenary lecture at the conference.

The DI&E Working Group has now been set up and our inaugural meeting took place in June. Watch this space for progress updates!

And finally...

The Working Group is very keen to hear about areas of diversity that have not been considered yet, as well as any suggestions on how the Institute can improve DI&E within its membership, within its leadership and within employment for its members. Please email the DI&E working group at **diversity@ioa.org.uk** and keep your eyes peeled for more details in the IOA e-newsletter).

1 This in turn leads to hiring managers not recruiting part-time workers for fear that major clients will not tolerate a change in company contact during periods when the initial contact is not working.

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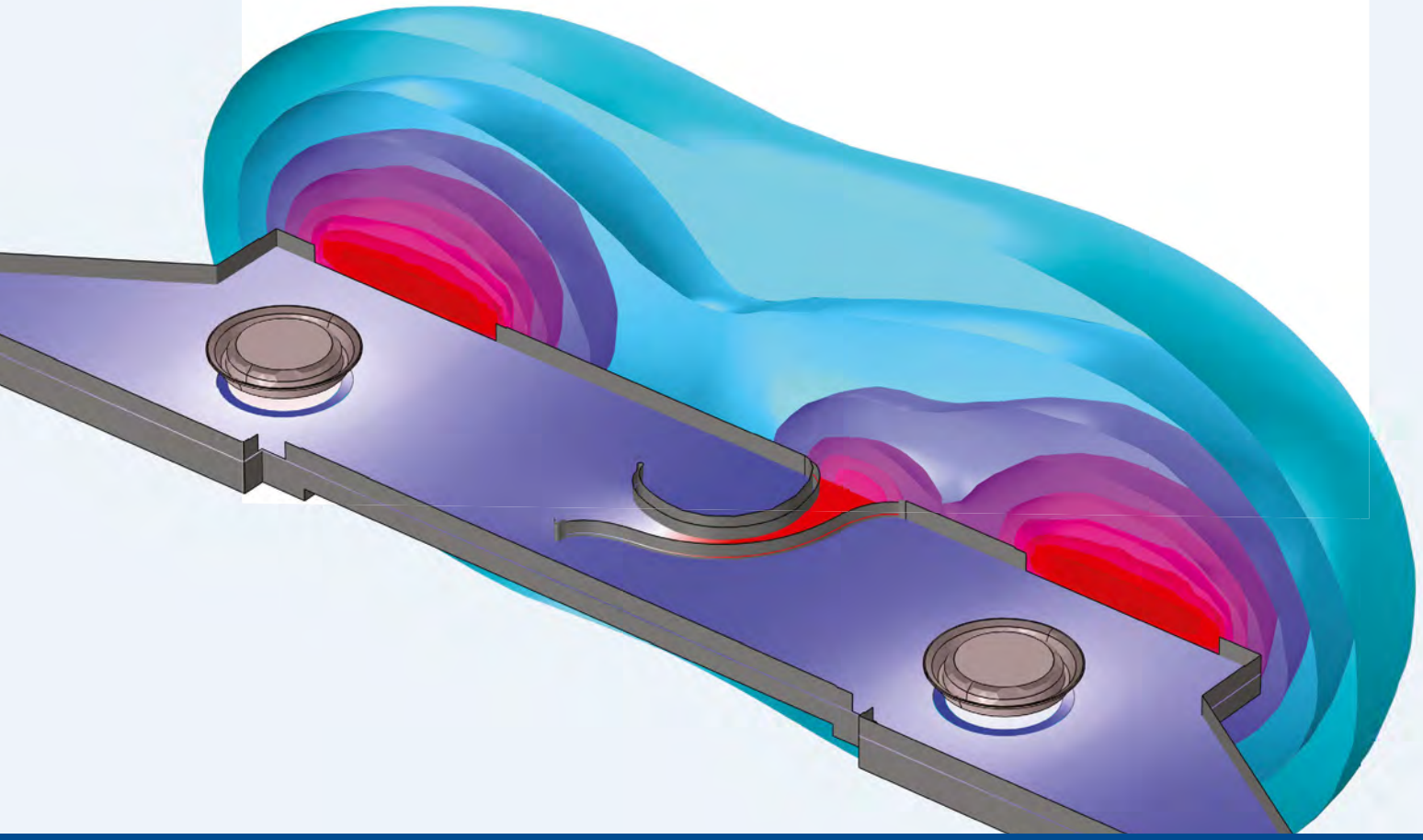

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Health impacts of construction:

An emerging research agenda

Construction is a vital economic sector to the UK economy that has significant impacts on the local communities it operates within. Best practice and regulation of the construction sector to minimise negative health impacts on local communities requires a strong evidence base, which is lacking in the UK.

This article outlines the need and priorities for research to build evidence of the impact of construction on physical and mental health and wellbeing of people living and working near construction sites.

Background

The construction sector is at the heart of UK economic and social development, building vital infrastructure, housing and commercial facilities, providing employment and investment in communities. Construction is central to economic and social recovery from the pandemic. The benefits of construction, however, come with costs, often leading to negative impacts on local environments and residents, including noise, green space, wildlife, air quality, water quality and road traffic. These negative impacts must be managed during the planning and regulatory processes, as well as through innovation in delivery and management of construction projects by contractors and their clients.

Above: Improving the performance of the construction sector in relation to local environmental and health impacts represents a significant opportunity for research and innovation

Living near a construction site can have significant impacts on the health and wellbeing of individuals and communities. Planning and environmental regulations aim to minimise these impacts within legally enforceable limits. Environmental, health, equality and other impact assessment methodologies have evolved as

part of the approvals process for major projects. Environmental limits for parameters such as noise, air quality and water quality form part of the regulatory context for construction and other activities, including the Control of Pollution Act 1974.

The evidence base for the impacts of construction activities on public health and wellbeing is underdeveloped in the UK. For instance, evidence underpinning noise regulation has focused on exposure to long-term noise such as traffic or industrial processes, whilst construction noise and its relationship to background conditions has received relatively little attention in independent research. Changing demographics, community structure and social values are not adequately reflected in evidence of impacts. There is very limited evidence in the peer-reviewed literature about the impacts of construction on mental health and wellbeing. Communities living near construction sites report significant negative impacts, but these remain under-explored by formal research studies.

Research and innovation priorities

Innovation is an important pathway to improving efficiency and productivity in the construction sector, as well as improving its contribution to a clean economy. Improving the performance of the sector in relation to local environmental and health impacts represents a significant opportunity for research and innovation. Understanding and mitigating the impacts of construction on health and wellbeing requires expertise from diverse disciplines and from interdisciplinary collaboration. Epidemiology, public health, engineering, sociology and anthropology are amongst the core disciplines required to provide a robust, holistic research base for better regulation and practice. Research is required in three main areas, viz. construction noise, mental health and inequalities:

- **Environmental pollution and health**

There is a lack of current research on construction impacts and the physical health of neighbouring communities the UK. Impacts are typically associated with noise, air quality and vibration. The current recommended sound levels for construction noise are largely based on precedent and do not have a strong underpinning from recent research. Moreover, studies on health effects of noise have been entirely reliant on self-reported health outcomes without independent measures of health. There is a strong case for further research to establish a firmer foundation for recommended noise, vibration and dust levels from construction sites and to determine whether construction noise exposure and dust exposure are associated with effects on health. Studies should include both qualitative self-report and quantitative objectively-assessed health measures. Self-report outcome measures would include questionnaires on annoyance, disturbance of activities, attitudes to construction and information of current and past health conditions.

- **Mental health**

Mental health is an important outcome in construction noise studies. Noise exposure, the presence of the construction site, perceptions of lack of control of the local environment, the combination with other life stressors can all potentially influence mental health. Additionally, the interaction with existing social disadvantage and the impacts on local social cohesion and community-level wellbeing should be considered.

- **Inequalities**

Social science-led research, in collaboration with environmental and health sciences, is needed to investigate how construction impacts are distributed within populations and communities. This could include how construction projects change community and social dynamics, resulting in both positive and negative impacts for different groups.

Research and innovation funding

Building a robust, trusted evidence base that supports effective regulation and innovation requires a balanced approach to funding. Fundamental science is needed to establish baseline data and build reliable models. This should be publicly funded, independent of the construction industry. Research and innovation funding is also needed to advance best practice within the construction industry, and should include co-funding as appropriate.

A strategic programme of research and innovation within UK Research and Innovation could extend existing funding for construction innovation to address construction impacts on health and wellbeing. This could include fundamental, independent research funded jointly or separately by the Engineering and Physical Sciences Research Council, the Natural Environment Research Council, the Economic and Social Research Council, the Medical Research Council, the National Institute for Health Research and Public Health England as well as funding for industry research and innovation through Innovate UK and the Industrial Strategy Challenge Fund.

About the authors:

Professor Sarah Bell joined Melbourne Sustainable Society Institute in 2021 as the City of Melbourne Chair in Urban Resilience and Innovation. Prior to this, she worked for 16 years as Professor of Environmental Engineering at University College London (UCL). She is a Chartered Engineer and Fellow of the Institution of Civil Engineers, and uses qualitative social research methods and theories in her work. Her research addresses community engagement with infrastructure with a particular interest in water. Her research has been funded by the UK Engineering and Physical Sciences Research Council (EPSRC).

Stephen Stansfeld is Emeritus Professor of Psychiatry at the Wolfson Institute of Preventive Medicine at Barts and the London School of Medicine, Queen Mary University of London. He was Chair of the International Commission on the Biological Effects of Noise from 2008 to 2014 and directed the 7th Framework funded European Network on Noise and Health (ENNAH). He directed the European 5th Framework funded RANCH Study on the effects of aircraft and road traffic noise on children's cognition and health. He chaired the WHO Guidelines Development Group on the new guidelines for environmental noise published in 2018. He has published more than 290 papers including at least 50 on noise-related topics, including several reviews.

John Wade is a retired environmental health officer, with a particular interest in acoustics and air pollution. He was Chair of the route-wide Channel Tunnel Rail Link and Crossrail environmental health groups during the development and construction phases. He chaired the Independent Compensation Panel for the Thames Tideway Tunnel project before being asked to conduct a review of the project's engagement with communities, local authorities and other relevant stakeholders with a view to developing best practice for other major construction projects to follow. John was responsible for the delivery of Havering's environmental and trading standards services for 17 years and is now a self-employed independent consultant. He is a former Secretary of the IOA London Branch.

KP Acoustics Research Labs is ready to deliver Diploma and Short Courses

The IOA has accredited KP Acoustics Research Labs as a new centre for delivering the Diploma in Acoustics and Noise Control, and the Certificates of Competence in Building Acoustics Measurement and Environmental Noise Measurement.

KP Acoustics Group set up their research and education division in order to focus on developing research and innovation projects in acoustics. It will also offer a range of education and training with both bespoke courses and the IOA courses.

To help develop the research and education aspects, the KP Acoustics team has taken on Professor Chris Barlow and Juan Battaner-Moro from Solent University. This was previously the Diploma centre in the south of England but which no longer runs acoustics courses.

Their new base in Southampton offers candidates access to excellent facilities, a wide range of test and measurement equipment and expertise drawn, not only from the core team, but the wider KP Acoustics Group.

Professor Chris Barlow, Head of Research and Innovation, says: "It is very exciting to join KP Acoustics Group as it grows. The combination of research, teaching and consultancy within one organisation will be a real benefit to students taking the Diploma, who can now experience different aspects of acoustics."

Above: KP Acoustics team (L-R) Juan Battaner-Moro, Professor Chris Barlow and Dr Kyriakos Papanagiotou

Industry-leading facilities

KP has agreements with Solent, the University of Southampton, as well as with the newly constructed BCTA Building Hub – giving students the opportunity to undertake high quality and varied laboratory and practical activities in a range of industry-leading facilities. Facilities that students can access include anechoic and hemi-anechoic chambers, a reverberation chamber, a specially built bungalow and an ISO 10140 compliant sound insulation testing suite.

Juan Battaner-Moro, Head of Knowledge Exchange, says: "I'm looking forward to continuing our teaching and training legacy under KP Acoustics who have always supported students with initiatives like the KP Acoustics Prize for best undergraduate dissertation in acoustics. We are already busy developing new courses and will be sharing details about these exciting ventures soon."

The new division has invested significantly in equipment including environmental, building acoustics and vibration measurement equipment. There will also be specialist technology such as a head and torso simulator, laser doppler vibrometer, impedance probes and electroacoustic testing systems.

Flexible access to learning materials

The team boasts a long track record of offering the Diploma and short courses, as well as research, training and consultancy in acoustics. They also provide significant experience in blended and hybrid learning, so can offer simultaneous web-streamed and in-situ teaching. And by using the latest technology, students benefit from more flexible access to learning materials.

Dr Kyriakos Papanagiotou, Director of KP Acoustics, says: "This is a fantastic opportunity to push the boundaries of acoustics in terms of research and training. This venture is a timely confirmation of our company's ethos of constant improvement, experimentation, and innovation in every initiative."

For more information about studying the Diploma or short courses with KP Acoustics Research Labs, or on other research and education activities, please visit the KP Acoustics Group website (**www.kpacoustics.com**) and go to the Research and Education section. You can also email **education@kpacoustics.com**

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INSTRUMENTATION CORNER

Feeling a bit peaky

How can we calculate peak particle velocity to ensure that data from different consultants or instruments is comparable?

By Steve Cawser, MEng CEng MIOA, Principal Acoustics Consultant at AECOM

Above: Vibration meter measuring construction vibration

The measurement of vibration is something that many consultants feel less confident with than carrying out noise measurements. There are many Standards that address the issue of how to measure and assess vibration and there is now a Standard that specifies the requirements for instrumentation to measure vibration (BS 8041-1:2017 Human response to vibration. Measuring instrumentation. General purpose vibration meters). Everyone doing this type of work should have the confidence that there is sufficient guidance to ensure measurements are accurate and repeatable. However, one aspect of vibration measurement that causes some discussion, particularly in the UK, is the use of the peak particle velocity (PPV) descriptor for the quantification and assessment of vibration.

The primary use of PPV originated from BS 7385-2:1993 Evaluation and measurement for vibration in buildings, a guide to damage levels from ground-borne vibration, which is concerned with the potential for damage to buildings and structures. The use of the metric has been expanded to cover the assessment of human response to construction works and is now the primary indicator used when examining the effects of mechanised construction works on both buildings and their occupants.

How do you calculate a PPV?

With such widespread adoption in the industry, it would be reasonable to expect the PPV to be well-defined. However, there is no formal definition of how instrumentation should calculate the PPV from the incoming transducer signals. If you require a peak sound level, the instrumentation Standard defines the acceptable limits on how the meter calculates this, but there is no equivalence for PPV in BS 8041-1.

So, the big question arises; how do you calculate a PPV? To answer this, you first need to understand what it is you are trying to quantify. If you look back at the literature that forms some of the earliest work looking at vibration effects on buildings; documents such as TRL report 429 (ground-borne vibration caused by mechanised construction works, 2000) collated much of the early work in this area.

Previous studies had used PPV defined in four different ways, namely:

- the peak value in the vertical direction;
- the largest of the three mutually perpendicular components;
- the true resultant, which is the maximum value of the vector summation of the three components; and
- the square root of the sum of the squares of the three components, which is the vector summation of the maximum of each component regardless of the times at which they occurred.

Which of these is the correct method? The reality is you could find people to argue in favour of all four, which is where the problem lies. If people are doing this differently, how can we be sure that data from different consultants or instruments are comparable?

Frequency bandwidth

One aspect that can be defined relatively easily is regarding the criteria used for building damage. Within BS 7385-2, Table 1 gives the guide values for cosmetic building damage and is clear that the guide values are for peak component particle velocity. This means that it refers to the largest of the three perpendicular axes and BS 7385-2 is clear that when assessing building damage, vibration should normally be measured using three orthogonally oriented transducers. But does the same hold for when measuring PPV for human exposure?

Human response to vibration is covered by BS 6472-1:2008 (Guide to evaluation of human exposure to vibration in buildings. Vibration sources other than blasting) and this requires the use of the vibration dose value (VDV) for assessing potential for annoyance from whole

body vibration. The use of PPV for assessing human response is required by Standards such as BS 5228-2:2009+A1:2014 (Code of practice for noise and vibration control on construction and open sites. Vibration), which acknowledges BS 6472-1, but states that in construction environments using PPV is more appropriate due to often needing to carry out building damage measurements at the same time.

One aspect of the calculation of the VDV is that it is based on a frequency weighted acceleration level, with different weightings for vertical and horizontal axes. The two weightings have their most sensitive regions at different frequencies, which could mean that a vibration of a certain magnitude would be perceived differently if it was experienced in the vertical or horizontal direction, but would be assigned the same PPV under the assessment method required by BS 5228-2. However, in practice, most vibration sources are usually broadband to a certain extent, so the effect on real world perception would be minor. But this leads to something that should be given serious consideration, namely what frequency bandwidth should the PPV be assessed over?

Building damage assessments

If vibration measurements are to be used for the assessment of building damage, the appropriate British Standards of BS ISO 4866 and BS 7385-2 can be used for some guidance. BS ISO 4866:2010 (Mechanical vibration and shock. Vibration of fixed structures. Guidelines for the measurement of vibrations and evaluation of their effects on structures) states that most structural damage occurs in the range of 1 to 150 Hz and BS 7385-2 covers a frequency range from 4 to 250Hz. Therefore, based on this, it is clear that when measuring the PPV, the instrumentation should cover the range of 1 Hz to 250 Hz as a minimum. When measuring whole body vibration, BS 6472-1 covers the range of 0.5 to 80 Hz and the applied weighting filters roll-off above 80 Hz and will attenuate any vibration that occurs above this frequency. This attenuation of the higher frequencies would not occur if measuring the PPV, so it may be beneficial to obtain frequency response data to ensure that measured PPV can be correlated with perceptions on site.

Transducers

This leads on to a further aspect of PPV that should be considered. It is common for many sound level meters to be sold with the ability to also measure vibration by attaching an accelerometer as the input transducer. A sound level meter, by requirement of their instrumentation Standard, can measure over the audio range of 20 Hz to 20 kHz, but many can also measure below 20 Hz.

However, of greater concern is what happens to the frequencies above the 250 Hz upper frequency required for building damage. The same is also true for general purpose data acquisition units which are designed to measure sound and vibration using the same acquisition hardware. Many general purpose accelerometers, particularly if attached to a lightweight mounting plate, can pick up airborne sound above the 250 Hz upper frequency limit, which may give a higher signal level than the vibration being measured in the structure. This can lead to an inaccurate PPV being reported by the instrument due to noise which is not part of the vibration signal. If this is the case, the input signal should be filtered to ensure that only vibration in the frequency range of concern is measured.

Another consideration that should be factored into the choice of instrumentation is the transducer to be used. When measuring PPV, it would make most sense to use a velocity transducer. However, the most common velocity transducer is the geophone, which has its resonance at the low frequency end of its frequency response. This means that the low frequency cut-off frequency is a physical characteristic of the transducer and if measurements are required to as low as 1 Hz, care would need to be taken in the choice of an adequate transducer. It should also be noted that the resonance effects of the transducer at low frequencies will affect the phase of the signal, which may have implications for the calculation of the peak value.

More common is the use of accelerometers, which being mass controlled transducers, do not often have the same low frequency considerations as geophones. Because accelerometers output signals that are dependent on acceleration, the signal cannot be used directly for measuring the PPV. To enable this, some form of numerical integration is required. Many modern instruments can carry out this integration in real time, but it should be noted that many forms of numerical integration can introduce large low frequency components as a result of the integration process. The user should be aware of this and ensure that any spurious low frequency components are filtered out, if necessary, to ensure the true PPV has not been corrupted by the necessary signal processing of the acceleration data.

Calculations

The remaining aspect of PPV which remains undefined is the time base for which the peak should be calculated over. Using a modern data acquisition unit recording raw data (or a wave recording function of an SLM), it is possible to calculate the instantaneous peak based on the highest number that comes out of the analogue to digital convertor, which is how many modern SLMs calculate the peak response. However, it is worth remembering that the limits for building damage are based on empirical data from many years ago which were used to define the thresholds. It is possible that these data are not from high sample rate instantaneous peak data and without a definition of what time considerations should be used to define the peak, it is not possible to definitively say whether data are comparable.

Many readers will probably now be wondering if this article will give definitive answers to these questions and define the correct approach to take. But that is the heart of the issue. There is no definition of what a PPV is and how it should be calculated within an instrument and what the acceptable tolerances are. It could be that if you were to take meters from different manufacturers and measure the same vibration you could get different answers. And without a definition, it is impossible to say who is correct.

ISO/TS 15666:2021 – Acoustics – Assessment of noise annoyance by means of social and socio-acoustic surveys

The revision of ISO/TS 15666:2021 Acoustics – Assessment of noise annoyance by means of social and socio acoustic surveys, was published at the end of May 2021.

By Philip Dunbavin and Charlotte Clark

Many countries have already developed regulations concerning the acceptability of environmental noise exposure, while others are likely to do so in the future. Such regulations often take into account relationships between noise exposure and noise-induced annoyance.

The intent of this standard is to provide specifications for the assessment of noise annoyance by social and socio-acoustic surveys. When these specifications are met, the statistically relevant possibilities of comparing and pooling survey results will be increased, thus offering more and better quality information for use by environmental policy makers.

This standard was last revised in 2003 and it has now been technically revised.

Scope of ISO/TS 15666:2021

This technical specification provides procedures for socio-acoustic surveys and social surveys, which include questions on noise effects. Its scope includes questions to

be asked, response scales, key aspects of conducting the survey, and reporting the results.

The scope is restricted to surveys conducted to obtain information about noise annoyance 'at home'. Surveys conducted to obtain information about noise annoyance in other situations, such as recreational areas, work environments and inside vehicles, are not included.

Historical issues

A review of published papers and reports using ISO/TS 15666:2003 suggested that some common adaptations have occurred in use that may not meet the spirit of the original standard. These adaptations include administering only one of the questions; changes to the wording or presentation; applying the standard to settings outside the home (e.g. offices, public spaces); and using a 'do not hear' question to eliminate respondents from answering the question. The checklist of reporting requirements that forms part of the standard is often not provided in published papers.

When the standard specifications are met and the checklist provided, the possibilities of comparing and pooling survey results will be increased, thus offering more and better-quality information for use by environmental policy makers. Study authors as well as those reviewing or editing journal articles all have a role to play in ensuring this detail is reported going forward.

Main changes

The main changes compared to the previous edition are:

1. relaxation of the requirement to ask both the 5-point verbal scale and the 11-point numerical scale. However, it is still recommended that both questions be asked but guidance has been provided about the advantages and disadvantages of each scale to aid question choice in situations where only one question will be asked;

2. clarification regarding assumptions that the question covers a 24-hour period (day, evening and night) and the indoor and outdoor home environment;

Above:
The scope is restricted to surveys conducted to obtain information about noise annoyance 'at home'

3. additional guidance has been added in Clause 6 describing the conventional cut-offs to define 'highly annoyed' for the 5-point verbal scale and the 11-point numerical scale, to enable comparisons between different surveys and contexts; and

4. updated references.

Rationale for the changes

The reasoning behind each of the main changes is discussed below:

1. It is recognised that it is not always possible to include both questions in surveys due to space and cost constraints. Each scale has strengths and weaknesses. The 5-point verbal scale is seen as being easier to use as respondents can easily choose a word that reflects their experience and the response is easily interpreted and analysed. However, there is debate about converting the 5-point verbal scale to a numerical scale for analysis and concerns that the meaning of the verbal P42

descriptors might change over time and vary across cultures. The 11-point numerical scale is seen to offer a more sensitive assessment as respondents have a greater number of response options. However, in turn, there are concerns that this may lead to fluctuations in annoyance ratings that are not meaningful. If having to choose between the verbal and the numerical scale, the standard recommendation is to use the 11-point numerical scale, as it affords the greatest options for statistical testing and cross-study comparisons. Using both the verbal scale and the numerical scale enhances the ability to compare findings between studies.

2. The revision clarifies the assumption that the question is designed to address annoyance over the whole 24-hour period during the last (12 months or so), i.e. annoyance integrated over the daytime, evening and night time periods and in locations in and around the home including external areas such as the garden or balcony. Recent years have seen an increasing interest in evaluating noise annoyance for certain situations (e.g. indoors at home; outdoors at home; at particular times of the day and night), and how these contribute to general annoyance. The revision reinforces the scope of the question and also offers guidance on the use of subsequent questions to examine different contexts and times of day, highlighting the importance of stating the precise hours being considered if interested in different times of the day.

3. The term 'highly annoyed' which is often used to describe community response to noise, is not always consistently defined or used across studies. The accepted rationale is that 'highly annoyed' is defined for the 5-point verbal scale 'by 'very' and 'extremely' (so the top 40% of the 5-point scale) and for the 11-point numerical scale using a cut-off at 28% – scoring 8, 9 or 10). Hence, different definitions for each scale. Some studies do not use these approaches. The standard now sets out these scoring conventions and also describes a method to weight the 5-point verbal scale to provide a 28% cut-off to aid cross-study comparison. A standardised naming convention for these different scoring methods is also provided to support comparison and harmonisation of data. All surveys are encouraged to report their data in these ways for comparative purposes, even if they wish to subsequently score their data in another way due to preference or historical need.

In addition, the questions in various languages have been reviewed and corrected where appropriate by a native speaker.

About the authors:

Philip Dunbavin is the Managing Director of PDA Ltd and a Fellow of the Institute of Acoustics. He is the current chairman of the BSI's overarching EH/1 committee on Acoustics, the current chairman of the BSI's EH/1/3 committee on residential and industrial noise, and is the convenor or the ISO working group WG62, which is responsible for this revision of ISO/TS 15666:2021.

Charlotte Clark is Professor of Epidemiology at St George's University of London and a Member of the Institute of Acoustics. She was Project Manager for the revision of ISO/TS 15666:2021. She has advised the World Health Organization, DEFRA, the UK Airport Commission, and the Independent Commission for Civil Aviation Noise on the health effects of noise.

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The Future Buildings Standard

This is the response from the IOA to the 2021 consultation on changes to Part L (conservation of fuel and power) and Part F (ventilation) of the Building Regulations for non-domestic buildings and dwellings, and overheating in new residential buildings.

The IOA recognises the importance of this consultation in connection not only with the effective management of noise, but also the integration of that management with other aspects of the built environment. The Government's noise policy recognises that the management of noise cannot be treated in isolation and these proposals seek to embrace the inevitable interaction of noise, ventilation and overheating.

Given the importance, the IOA held three online workshops in March 2021 to enable its members to discuss the issues raised in the proposals and to contribute to the formulation of the Institute's response. Just under 100 IOA members attended the workshops and offered their views.

This response has been compiled by members of the Institute, setting out a consensus of those views and which has been endorsed by its governing body.

With regard to overheating, mention is made in this response to the joint Association of Noise Consultants (ANC) and Institute of Acoustics: Acoustics, Ventilation and Overheating Residential Design Guide (AVOG) published in January 2020. It was prepared by members of both organisations and involved several years' work. The development of this guide included extensive consultation amongst the profession and describes a process which enables the issue of acoustics and noise management, ventilation and overheating to be addressed in a holistic and coherent manner.

The document can be found here **https://www.ioa.org.uk/publications/acoustics-ventilation-and-overheating-residential-design-guide**

As indicated above, the IOA welcomes the opportunity to comment on the proposed changes to Part F (ventilation) and Part L (conservation of fuel and power) of the Building Regulations and relishes the creation of a guidance document on the control of overheating.

The IOA response focuses on each of these documents individually and provides responses to the consultation questions posed, as well as additional commentary on the documents.

As can be seen the IOA is very experienced in addressing these issues and would be happy to liaise with officials in order to assist in developing these proposals and in particular those associated with overheating over the coming months.

Approved Document F (ADF) – Ventilation – Volume 1

Upon review of the proposed ADF – Volume 1, the IOA appreciates the fact that the majority of the comments submitted as part of the IOA's 2019 consultation response were taken on board, namely the reintroduction of guideline noise levels from continuous mechanical ventilation systems and the need to control structure-borne noise from such systems.

Whilst there is always a risk of structure-borne noise from ventilation systems and the proposed ADF acknowledges the need for resilient fixings to help mitigate this, consideration should also be given to vibration transfer from such systems.

One of the comments that has not been addressed, however, relates to the need to consider the suitability of external noise levels to allow the opening of windows for purge ventilation. As purge ventilation is required in situations where increased air flow rates are needed for short periods of time, such as to rapidly dilute pollutants and/or water vapour, there is no policy requirement to include specific mitigation given that occupants would experience any increased levels of noise for only short periods.

Approved Document F (ADF) – Ventilation – Volume 2

Consultation Question 63): Do you agree with the proposed guidance for reducing noise nuisance for ventilation systems in non-domestic buildings?

a) Yes
b) No

IOA's response: a) Yes – please see further information below.

Further information

In principle, the consulted IOA members agree with the proposed guidance for controlling noise from ventilation systems in non-domestic buildings. However, care must be taken when referring to noise *nuisance* from ventilation systems, which has a set legal meaning. A more appropriate term would be to control noise *disturbance* from ventilation systems.

In addition to the above, consideration could be given to the mention of industry reference documents for non-domestic buildings, such as BS 8233:2014, BS 6472-1:2008, Building Bulletin 93, British Council for Offices and CIBSE Guide A, to point readers in the right direction to find relevant information on airborne and structure-borne noise for various building types. P46

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Reference should also be made to the comments on vibration and purge ventilation given above for ADF – Volume 1.

Approved Document L (ADL) – Conservation of fuel & power

No noise-related consultation questions were provided on Approved Document L. While no specific reference is made to noise within the document, it does include guidance on a number of items that can impact on the acoustic performance of a development, namely the provision of insulation to improve thermal performance, and the use of heat pumps.

Reference to Approved Document E (ADE) – Resistance to the passage of sound

The addition of references to ADE where elements, such as insulation, are installed to improve the thermal performance of a building is welcome and will draw designers' attention to the implications of such elements on the sound insulation performance of walls and floors.

Heat pumps

One of the elements of the proposed Future Buildings Standard is the expectation that all homes would have a heat pump. Whilst the advantages of heat pumps in terms of reducing carbon emissions and other pollutants are clear, what does not appear to have been considered is the potential noise impact from these devices.

Any mechanical system that includes a fan (and compressor) has the potential to generate noise. As these pumps are attached to the exterior of a dwelling, the noise from them has the potential to impact on those living nearby.

Currently, such pumps can be installed using permitted development rights. At the time this legislation was implemented, the potential noise impact issue was recognised. Consequently, the requirements of the Microgeneration Certification Scheme (MCS) have to be followed by the installer in order to manage the potential noise impact from these devices.

If the Future Buildings Standard is to include heat pumps, it is essential that managing the noise from these units is included as an intrinsic part of this process in order to mitigate and minimise the potential adverse effects. Consideration should also be given to the fact that there is little evidence available on the potential impacts arising either from the intermittent nature of the source and/or changes in noise level/character throughout the lifetime of the unit due to poor installation and/or maintenance.

As a minimum, the IOA believes that reference should be made to:

- The permitted development requirement for air source heat pumps to not exceed 42 dB $L_{Aeq,5min}$ at 1 metre from a window or door opening of a habitable room in the façade of a neighbouring residential property (ignoring the effect of that façade);
- The assessment methodology set out in Microgeneration Installation Standard MCS 020 *Planning Standards for Permitted Development Installations of Wind Turbines and Air Source Heat Pumps on Domestic Premises.*

Reference could also be made to the assessment guidance set out in BS 4142:2014+A1:2019 *Methods for rating and assessing industrial and commercial sound.*

Approved Document [X] (AD[X]) – Overheating

Consultation Question 81): How should the Government address the overheating risk?

a) Through a new requirement in the Building Regulations and an Approved Document, as proposed in this consultation

b) Through Parts L and F of the Building Regulations

c) Through government guidance

d) I have an alternative approach

e) It isn't an issue that needs addressing

IOA's response: d) I have an alternative approach. Whilst the IOA recognises there is merit in creating a new requirement in the Building Regulations to address the risk of overheating, there are concerns about relying entirely on the Building Regulations to address this issue, and the fact that this must also still be addressed at planning stage. Please see further information below.

Further information

The creation of this new draft Approved Document is an acknowledgement by Government that controlling and reducing the occurrence of high indoor temperatures is a key factor in protecting the health and welfare of the occupants of a building. It is a most welcome, ambitious and proactive task which has been enthusiastically received by the acoustic industry.

As noted above, the profession, through the work of the ANC and IOA has developed its own guide on this issue. However, that guide is designed to be used at the planning stage of a development.

The majority of members consulted as part of the IOA response have noted that the risk of overheating could indeed be addressed through a new requirement in the Building Regulations and an Approved Document. There was some uncertainty, though regarding whether the specific details and the potential flexibility of this requirement with regard to noise management would need further consideration.

Nevertheless, if the control of noise during overheating conditions were to become a Building Regulations requirement, local planning authorities (LPAs) would need to bring their policies in line with the new requirement. This would provide additional leverage to LPAs to impose the control of overheating in new residential developments and would likely improve consistency on the minimum standards across new dwellings.

Having said that, there was a strong view that the management of overheating control should feature early on during the planning stage of a building. This is because key design decisions that affect overheating, such as building location, its orientation and massing, are made very early during the process. Consequently, the ANC/IOA guide was designed to be used during the early planning stage. Furthermore, addressing these issues at an early stage would align with the considerations for good acoustic design, required by Government policy, and set out in ProPG: Planning and Noise, which was jointly authored by the IOA, the ANC and the Chartered Institute of Environmental Health (CIEH), and is referenced in the online Planning Practice Guidance. To further support the consideration P48

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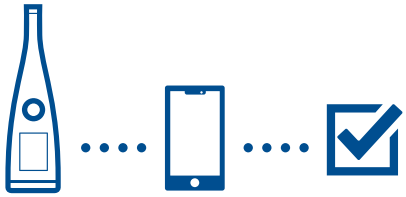

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of overheating at the planning stage, it may be worth considering including a reference to the AVOG within the Planning Practice Guidance – Noise webpage.

In addition, a potential drawback of implementing this new requirement in Building Regulations is that Building Control Officers may not be particularly well-equipped to deal with assessments of noise during overheating conditions due to the complexity of the issue. Consideration could, however, be given to the creation of an 'accredited assessor' type scheme similar to the one currently in place for ADE and pre-completion sound insulation testing. This would allow Building Control Officers to defer to an expert when considering the impact of environmental noise on occupants when mitigating overheating. The IOA would be delighted to work with other industry bodies, such as the ANC, to develop a scheme to provide minimum competence standards, technical support and audit of people or companies undertaking this work.

In summary, the IOA can see merit in addressing the risk of overheating through a new Approved Document, provided that the following is considered:

- The noise levels given in Section 3 of the draft AD[X] are amended to reflect the guidance in the ANC/IOA AVOG;
- Flexibility is built into the requirements to ensure that undue constraints are not placed on the construction of new dwellings;
- Consideration is given to the creation of an accredited assessor scheme, similar to that in place to demonstrate compliance with the requirements of ADE, to allow Building Control officers to defer to an expert on noise and overheating matters; and
- The management of noise, ventilation and overheating still has a firm place at the planning stage making use of documents such as the ANC/IOA AVOG and the IOA/ANC/CIEH ProPG to avoid key decisions at the planning stage compromising the ability to achieve the optimum outcome.

Consultation Question 85): Do you agree with the simplified method as a means of compliance with the proposed new requirement to reduce overheating risk?

a) Yes
b) No, the method should be more sophisticated
c) No, the method is too easy to pass
d) No, for another reason

IOA's response: b) No, the method should be more sophisticated – please see further information below.

Further information

Whilst the IOA agrees that a simplified method should be available to demonstrate compliance with the new requirement to reduce overheating, the proposed approach currently seems to be too simplistic. More importantly, the simplified method should not be more lenient than detailed methods.

IOA members also noted that the simplified method should allow for innovative design approaches to reduce the risk of overheating.

Consultation Question 94): Do you agree with limiting noise in new residential buildings when the overheating strategy is in use, and the proposed guidance in Section 3 of the draft Overheating Approved Document?

a) Yes
b) Yes, but with amendments to the guidance
c) No, I do not agree with limiting noise when the overheating strategy is in use

IOA's response: b) Yes, but with amendments to the guidance – please see further information below.

Further information – approach

Paragraphs 3.1 to 3.4 of the draft AD[X] set out the proposed approach so that the overheating control strategy is usable with regard to noise. These paragraphs set noise limits in bedrooms at night (23:00 – 07:00) that should not normally be exceeded when the overheating control strategy is in use for both openings on the façade and when mechanical systems are used. They also provide guidance on the evidence required to satisfy these requirements.

Care needs to be taken when prescribing limits in this context. The Government's overall noise management policy has moved away from setting fixed limits and whilst there is merit in having target values to achieve, they should not be regarded as fixed thresholds. This view aligns with the Government's planning policy on noise management.

The presence of a section on noise in relation to overheating in the draft document is welcome, but the IOA is strongly of the view that the values used should reflect those contained in the ANC/IOA AVOG.

Some IOA members also suggested that for sites exposed to low levels of noise, a simplified approach to the full AVOG assessment methodology could potentially be used. The IOA would be happy to help develop a simplified method as well as providing support in the further development of the new Approved Document.

Further information – internal noise levels

The proposed document states the following with regard to internal noise levels:

'3.1. When the removing excess heat part of the overheating strategy is in use, noise levels in bedrooms should be kept to a minimum during the sleeping hours of 23.00 – 07.00. Noise within bedrooms should not normally exceed the following limits.
a. When openings are used
i. 40 dB $L_{Aeq,T}$, averaged over 8 hours.
ii. 55 dB L_{AFmax}, maximum no more than 10 times a night.
b. When a mechanical system is used
i. 30 dB $L_{Aeq,T}$, averaged over 8 hours.'

The noise levels given when openings are used to control overheating are towards the upper end of those set out in Table 3-3 of the AVOG, though they do not necessarily match. As indicated above, during the IOA consultation, the majority of our members felt that as a minimum the numbers included in AD[X] should be in line with the recently published AVOG.

It was also acknowledged that there is a lack of evidence on the extent to which building occupants are willing to accept higher internal noise levels for lower indoor temperatures, and that further research on this topic is required.

The consultation with IOA members also included discussions on whether these noise levels should be strict limits (see above) P50

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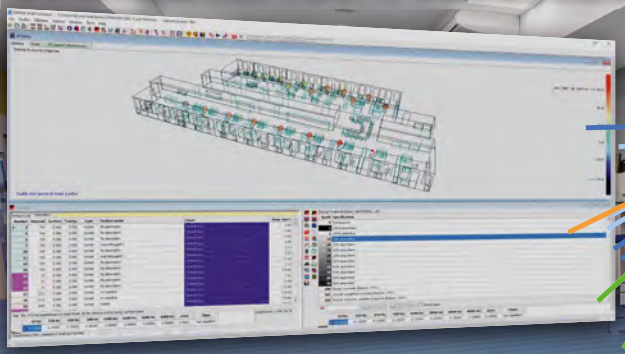

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or whether a more qualitative approach would be suitable, such as using a scale of compliance. For example, when establishing suitable relaxed internal noise levels, consideration could be given to their duration, how frequently they occur, the degree of occupant control and magnitude of the noise levels associated with the overheating condition. Alternative approaches such as the use of soundscapes instead of fixed noise limits were also tabled.

Guidance on suitable internal noise levels when a mechanical system is used to control overheating is also provided in the AVOG. A summary of the guidance is provided in Table 1 below for ease of reference. It can be seen that the base noise level in bedrooms is in line with that proposed as part of the new AD[X]. However, the AVOG and the consulted IOA members acknowledge that a relaxation of internal noise levels may still allow the impact on users to be appropriately managed, while avoiding overly stringent acoustic mitigation measures to mechanical systems.

In addition to controlling noise levels in bedrooms during overheating conditions, the IOA believes that consideration should also be given to the management of internal noise levels in other habitable rooms in dwellings, such as living rooms, including during the daytime. With the recent trend towards flexible working, accelerated by the Covid-19 pandemic, it is anticipated that a large proportion of the population will be spending extended periods of time at home, and at a time of day when overheating is most likely to occur.

In summary, the AD[X] approach to control internal noise levels in dwellings when the overheating control strategy is in use should align with the guidance provided in the AVOG.

Under normal conditions (non-overheating), overall internal noise levels in dwellings should be designed in line with the guidance in documents such as BS 8233:2014 and ProPG.

Further information – demonstrating compliance

Paragraph 3.2 of the proposed AD[X] set out the various ways in which compliance with the proposed noise criteria can be demonstrated and the evidence required to do so. These include documentation demonstrating that the local planning authority did not consider external noise to be an issue at the site at the planning stage, internal noise measurements once the building is completed, or the modelling of the internal noise environmental. Paragraph 3.3 also comments on the appropriateness of sampling a number of dwellings where noise measurements are used upon completion of the building.

Whilst the options to demonstrate compliance are welcome and show the intention to provide flexibility to designers and contractors, IOA members believe that they require further development. For instance, additional guidance on a suitable assessment method and clearer sampling requirements, potentially in line with the sampling rate of ADE, would be useful.

As before, the IOA would be happy to help develop the means through which compliance can be demonstrated, as well as providing support in further developing the new Approved Document.

Consultation Question 101): How do you see this new Building Regulation interacting with policies in local plans?

If the need to control overheating is introduced as a statutory requirement of the Building Regulations, in theory there would be no need for this point to be covered in local plans as well. The Building Regulations would take precedence. However, as indicated above, even with this approach, the IOA believes that overheating considerations must also occur during the planning stage, so that the optimum outcome is achieved. In that case, local authorities would need to cover overheating and noise in their documents, and their policies would need to align with the new requirement.

Addressing noise levels in dwellings during overheating conditions through the Building Regulations would allow a more consistent approach throughout than if left to local authority policies. However, it must be remembered that as not every external situation is the same in every location, the individual solution would not be the same.

Below:
Table 1: Desirable noise levels from mechanical systems in dwellings to control overheating

Possible system / design solution	Desirable upper internal ambient noise levels from mechanical services, L_{Aeq} (dB) [1]		
	Bedrooms	Living rooms	Bathrooms / WCs / kitchens
Ventilative cooling (increased air flow) Comfort cooling (fan coil units, etc.)	30	35	-

[1] Section 1.10.10 of CIBSE Guide A 2015 states that "*Higher or lower values may be appropriate based on economics, space use, user needs etc.*". It goes on to state that a range of +/- 5 dB may be acceptable depending on the particular situation.

Higher noise levels are likely to be acceptable in some operating scenarios, where rapid changes to the cooling or ventilation rates quickly improve the thermal comfort of the occupant. Equally, lower noise levels may be appropriate for some types of residential development.

The Institute of Acoustics
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Institute of Acoustics
Silbury Court
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ProPG and AVOG

The ProPG: Planning & Noise, May 2017 ('ProPG') is jointly published guidance issued by the CIEH, IOA and the ANC. The Acoustics Ventilation and Overheating Residential Design Guide, Version 1.1, 2020 ('AVOG') was published jointly by the ANC and the IOA.

Colin Cobbing, Dani Fiumicelli, Somayya Yaqub were members of the Working Group responsible for the production of the ProPG and are CIEH members, with a background in environmental health.

This article analyses common ground and difference between ProPG and AVOG. It identifies important areas of divergence between the guidance documents and aims to provide insights into how the two guidance documents can be used alongside each other to achieve consistent outcomes. The aim of this article is to provoke discussion and debate on some of the issues identified; such debate is intended to improve the two documents so that use of them together is more coherent than currently.

Key points

The key findings of this paper are summarised below:

1. Both documents aim to achieve integrated design[1] and good acoustic design and recognise that the overheating conditions must be accounted for.
2. The AVOG only applies to situations where good acoustic design cannot be achieved with windows open through consideration of site layout and other design options that might control internal noise levels. The starting position for AVOG is to consider mitigation of noise impact on new residential development after good acoustic design has been applied, site-wide, as described in the ProPG.
3. The noise standards are not directly comparable because the documents use different terminology. Neither is there any consistency between the documents on how the frequency and duration of internal noise levels should be considered. In other words, there is no alignment how frequency and duration of internal noise levels should be interpreted.
4. The AVOG levels are significantly greater than the levels recommended by the ProPG. A level of noise exposure that is "*increasingly dangerous*" for public health represents a level that is greater than a SOAEL and is a situation that could be unacceptable, as defined by Planning Practice Guidance. According to the ProPG, the upper levels specified in Table 3-3 of the AVOG could give rise to unacceptable levels of noise if they occurred more than occasionally[2].
5. From a public health perspective, all possible adverse effects on sleep should be considered. The advice given in the AVOG on the assessment of $L_{AF,max}$ levels, which is based on recalled awakenings, should be used with extreme caution as significant adverse effects on health and quality of life can occur at levels lower than this threshold.
6. In noisy locations, before reverting to closed windows and non-natural means of ventilation and control of overheating, practical solutions including non-standard construction types should be considered alternative to the approach of diverging from the noise thresholds in the ProPG as recommended in the AVOG.
7. It is appropriate, where possible, that noise should be assessed with windows open to avoid risk of overheating and the overheating design strategy relies on windows being open to control indoor temperatures. Overheating is not, however, the only factor that should be considered. The occupants of dwellings and other buildings may choose to open windows for a variety of reasons as well as controlling thermal comfort. Residents in noisy locations will therefore be exposed to higher noise levels when windows are open. This is a choice that residents should be allowed to make. However, the potential impacts on health and quality of life need to be allowed for when deciding if housing in such circumstances is appropriate, and design and construction optimised to permit natural ventilation and control of overheating before relying on an approach based on closed windows and non-natural ventilation and control of overheating.
8. In the absence of robust data on the frequency and durations that windows are kept open for different designs of dwelling, it is recommended that the information reported in the WHO Night Noise Guidelines or other general occupancy data is used to consider the duration of windows open/ closed over P54

1 Integrated design is a comprehensive holistic approach to design which brings together specialisms usually considered separately. It attempts to take into consideration all the factors and adjustments necessary to a decision making process.
2 For example, 5 or 6 times per year.

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a typical annual period. Even though thermal dynamic models are complex it is not possible to predict exactly how people will behave in reality. Assuming that windows are only opened when overheating occurs is inappropriate.

9. There is little if no evidence to support the assertion that the adaptive comfort model can be used to assess the impact of noise. This is especially true at night does because there is little awareness in the general population of the harmful effects of exposure to noise at night. It would be wrong therefore to assume that the occupants of dwellings can make properly informed choices about the trade-off between acoustic and thermal conditions.
10. CIBSE TM59 does not consider the adverse effects of noise. It considers overheating in isolation and provides pass/ fail criteria for thermal comfort. There is no mechanism to relax the criteria for overheating to allow a balance between overheating and noise. Practitioners should be aware of the limitations of TM59 when applied in areas of medium and high exposures to noise and be cautious about relaxing the noise standards in order to achieve strict pass/fail criteria for overheating. Such an approach is not supported by the available evidence.

Scope

There are many similarities between the guidance documents. Both consider acoustic issues associated with providing new housing in noisy locations; however, there are also material differences.

Both documents aim to achieve integrated design[3] and good acoustic design[4], while recognising that windows may need to be opened to control overheating and that this can lead to adverse noise impacts. Unlike the current version of BS8233:2014, neither document advocates that it is appropriate to assume closed windows when a mechanical ventilation system[5] is used to provide background ventilation, in accordance with Part F of the Building Regulations and without any consideration of overheating. Assuming windows closed may only be appropriate when integrated and good acoustic design cannot achieve suitable acoustic conditions with windows open. Both documents recognise that the overheating conditions must be accounted for.

People may open windows for a variety of reasons. Controlling thermal comfort only represents one of several reasons why occupants may choose to have window open. For example, connection with the outside, sense of fresh air, and sense of control over one's environment. The AVOG explicitly states that consideration of these factors is beyond the scope of the guidance.

ProPG addresses internal noise in the context of other design aspects affecting the health and quality of life of the inhabitants and other sustainable design objectives. In other words, it is based on a holistic design approach. The design aspects referred to includes ventilation and overheating. The ProPG also addresses external noise amenity. By contrast, the AVOG deals with internal noise and specifically acoustics, ventilation and overheating and is intended to supplement the ProPG.

Importantly, the AVOG only applies to situations where good acoustic design cannot be achieved with windows open through consideration of site layout and other design options that might control internal noise levels. The starting position for AVOG is to consider mitigation of noise impact on new residential development after good acoustic design has been applied, site-wide, as described in the ProPG. The AVOG therefore only considers design options that relate to the building envelope.

The AVOG aims to fill the gap left between other guidance in achieving comfortable, climate resilient, sustainable dwellings. The basis for this claim is not clear however, not least because the ProPG also considers sustainable design objectives as part of other relevant factors.

The table below summarises the key aspects of scope and application of the two documents.

Right:
Table 1: Scope of ProPG and AVOG

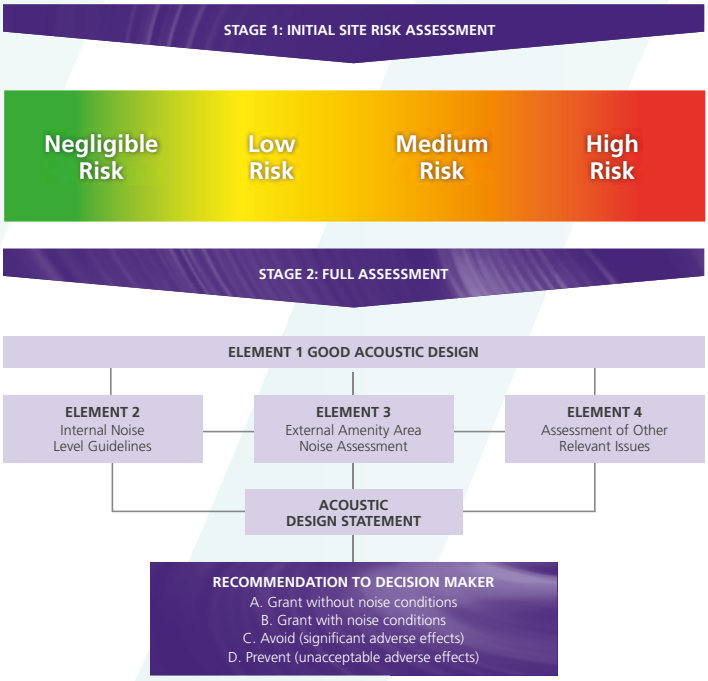
Aspect	ProPG	AVOG
Sources	Predominantly transportation noise and some commercial or industrial noise when it is not dominant	Transportation noise
Application	All residential development	Only parts of residential development not meeting good acoustic design in accordance with ProPG
Situations	Internal and external noise	Internal only
Factors	All aspects of the built environment affecting living conditions	Acoustics, ventilation and overheating
Sustainability objectives including climate change	Yes, covered under other relevant issues	Yes, indirectly
Noise from mechanical systems	No	Yes

3 Integrated design is a comprehensive holistic approach to design which brings together specialisms usually considered separately. It attempts to take into consideration all the factors and adjustments necessary to a decision making process.

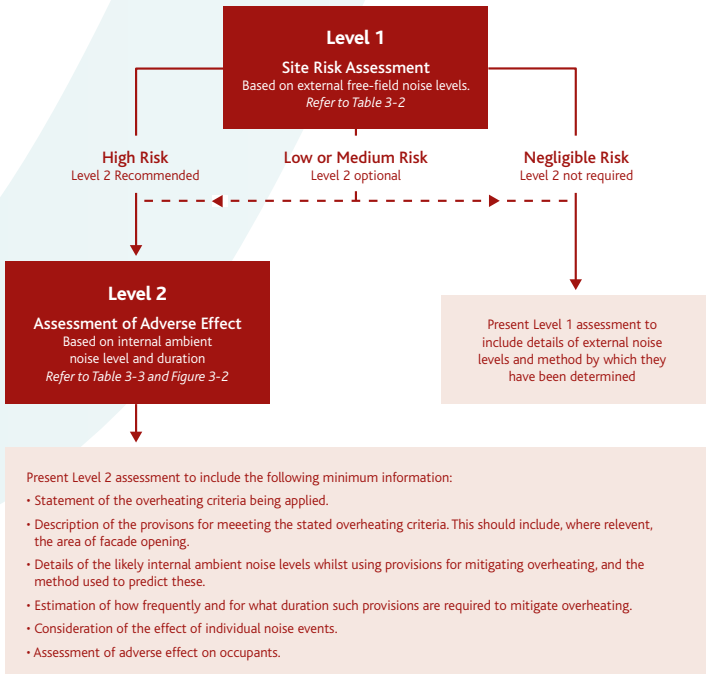
4 ProPG – "A good acoustic design will be one that continues to minimise noise impacts and to avoid significant noise effects for the lifetime of the development or as long as is practicable taking into account other economic, environmental and social impacts."

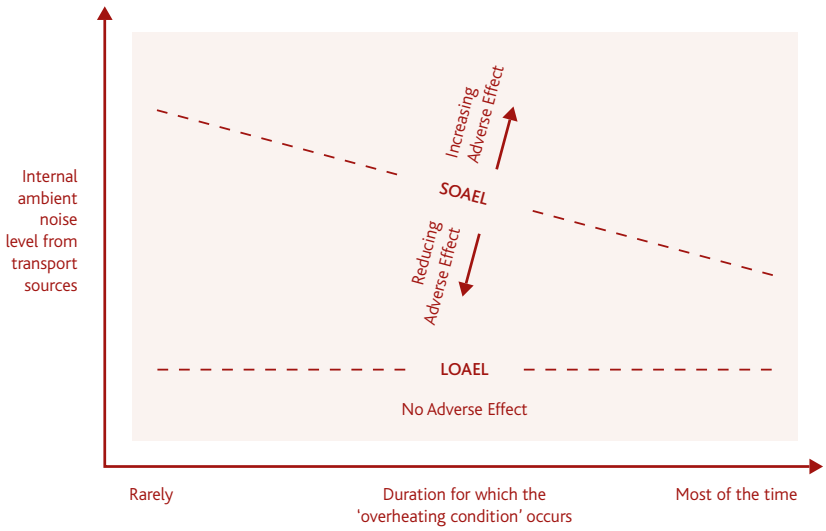
5 There is a distinction between ventilation and overheating. Background ventilation as per AD-F - is separate to the overheating, which would require much higher levels of ventilation to achieve comfortable temperatures during summer (and is not considered in AD-F). Background ventilation is the rate that is needed all year round for good air quality, prevent humidity, mould and mildew etc - additional boost ventilation and open windows for overheating is just during the summer when it's hot. Background ventilation is provided all year round to ensure that homes are sufficiently ventilated.

Below: A summary of the overall ProPG approach is provided in Figure 4.



Below: Figure 3-1 Two-level noise assessment procedure - overheating condition





Left: Figure 3-2 Qualitative guidance on combined effect of internal ambient noise level and duration for the overheating situation

Process

The ProPG advocates a systematic, proportionate, risk based, two-stage, approach. Stage 1 is an initial noise risk assessment of the proposed development site; and Stage 2 sets out a systematic consideration of four key elements for higher noise exposure sites. Where Stage 2 is applicable it leads to recommendations for the decision maker. In simple terms the choice of recommendation is as follows: grant without conditions, grant with conditions, 'avoid' or 'prevent'.

In the case of environmental noise ingress, the AVOG also describes a two-level assessment procedure for the overheating condition. The first level is a site risk assessment based on external noise levels and the assumption that opening windows are the primary means of mitigating overheating. The second level assessment considers the potential for adverse effect on occupants based on internal ambient noise level. The Level 2 assessment is recommended for 'High' risk sites. For 'Low' and 'Medium' risk sites, a Level 2 assessment can optionally be undertaken to give more confidence regarding the suitability of internal noise conditions. This may be particularly appropriate for sites in the 'Medium' risk category.

The Level 2 assessment suggests that assessment of the adverse effect from noise exposure should include an estimate of how frequently and for what duration the overheating condition occurs. No guidance is provided however on what durations and levels of frequency will be considered to be appropriate.

Rather, the Level 2 assessment provides qualitative guidance to apply a sliding scale for acceptable levels of internal noise based upon the frequency and duration over which the overheating condition occurs (see figure 3-2 reproduced from AVOG). The practitioner then has to use this information to inform an assessment of adverse effects on the occupants: however, no further guidance is given about the way in which this information should be used as part of the decision making and design process. In particular, the document provides no guidance on how to assess the risks to health and quality of life of following the AVOG guidance.

Comparison of the noise standards

Both guidance documents use the internal noise criteria derived from WHO Community Noise Guidelines 1999 and BS8233 as a starting point for desirable internal noise standards.

The ProPG allows for a relaxation of the desirable standards when it is not possible to meet internal target levels with windows open. It states: *Where development is considered necessary or desirable, despite external noise levels above WHO guidelines, the internal L_{Aeq} target levels may be relaxed by up to 5 dB and reasonable internal conditions still achieved. The more often internal L_{Aeq} levels start to exceed the internal L_{Aeq} target levels by more than 5 dB, the more that most people are likely to regard them as "unreasonable". Where such exceedances are predicted, applicants should be required to show how the relevant number of rooms affected has been kept to a minimum.'*

It can be seen that it is a question of degree in terms of the noise level, the extent of exceedances as a proportion of the development, and the frequency of occurrence if the situation is to be considered unreasonable or not. The reference to frequency and duration can be used to link the noise assessment to the overheating assessment. P56

If the internal L_{Aeq} levels exceed the target levels by more than 10 dB, ProPG advises that: *'they are highly likely to be regarded as "unacceptable" by most people, particularly if such levels occur more than occasionally. Every effort should be made to avoid relevant rooms experiencing "unacceptable" noise levels at all and where such levels are likely to occur frequently, the development should be prevented in its proposed form.'*

Again, the frequency and duration must be considered as part of a judgment on the acceptability of the situation and the need to refuse the development.

The AVOG recommends that the desirable noise standards can be relaxed during the overheating condition on the basis that: *'the overheating condition occurs for only part of the time. During this period, occupants may accept a trade-off between acoustic and thermal conditions, given that they have some control over their environment. In other words, occupants may, at their own discretion, be more willing to accept higher short-term noise levels in order to achieve better thermal comfort. The importance of control is relevant to daytime exposure, but not to night time exposure where the consideration is sleep disturbance.'*

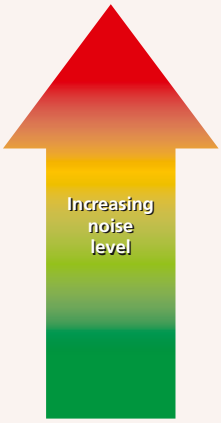
There is little if any robust scientific evidence to support this assertion at this time.

For the daytime period, the upper category of >50 dB is defined on the basis that $L_{Aeq,T}$ 50 dB represents the upper end of the range for reliable speech communication. For the night-time period, the upper category of >42 dB is defined with reference to the WHO Night Noise Guidelines for Europe. The individual noise event Lmax value of 65 dB refers to the level that has been shown in Basner et al (2006) to result in longer duration awakenings that are more likely to be remembered the next day.

The criterion is further qualified in the notes and explains that: *'The $L_{AF,max}$ indicator associated with the upper category is intended for road traffic; it may be more appropriate to use the "one additional noise-induced awakening" method for noise from rail traffic or aircraft.'*

The noise standards are not directly comparable because the documents use different terminology. Neither is there any

Right:
Table 3-3 Guidance for Level 2 assessment of noise from transport noise sources [Note 1] relating to overheating condition

Internal ambient noise level [Note 2]			Examples of Outcomes [Note 5]	
$L_{Aeq,T}$ [Note 3] during 07:00 – 23:00 [Note 6]	$L_{Aeq,8h}$ during 23:00 – 07:00	Individual noise events during 23:00 – 07:00 [Note 4]		
> 50 dB	> 42 dB	Normally exceeds 65 dB $L_{AF,max}$	Noise causes a material change in behaviour e.g. having to keep windows closed most of the time	Avoiding certain activities during periods of intrusion. Having to keep windows closed most of the time because of the noise. Potential for sleep disturbance resulting in difficulty in getting to sleep, premature awakening and difficulty in getting back to sleep. Quality of life diminished due to change in acoustic character of the area.
			Increasing likelihood of impact on reliable speech communication during the day or sleep disturbance at night	At higher noise levels, more significant behavioural change is expected and may only be considered suitable if occurring for limited periods. As noise levels increase, small behaviour changes are expected e.g. turning up the volume on the television; speaking a little more loudly; having to close windows for certain activities, for example ones which require a high level of concentration. Potential for some reported sleep disturbance. Affects the acoustic environment inside the dwelling such that there is a perceived change in quality of life. At lower noise levels, limited behavioural change is expected unless conditions are prevalent for most of the time. [Note 8]
≤ 35 dB	≤ 30 dB	Do not normally exceed $L_{AF,max}$ 45 dB more than 10 times a night	Noise can be heard, but does not cause any change in behaviour	Noise can be heard, but does not cause any change in behaviour, attitude, or other physiological response[Note 9]. Can slightly affect the acoustic character of the area but not such that there is a perceived change in the quality of life.

Note 1 The noise levels suggested in Tables 3-2 and 3-3 assume a steady road traffic noise source but may be adapted for other types of transport.

consistency between the documents on how the frequency and duration of internal noise levels should be considered. In other words, there is no alignment how frequency and duration of internal noise levels should be interpreted.

The ProPG suggests that internal $L_{Aeq,T}$ greater than 40 dB during the day (living rooms) and 35 dB at night could be unreasonable and should be avoided if the levels were expected to occur frequently. The use of the word avoid is deliberate and links to the noise objectives set out in the NPSE and policy in the NPPF and the PPG (which references the ProPG). The AVOG suggests that the upper internal ambient levels greater than 50 dB during the day and 42 dB at night could be considered to represent SOAEL values, depending on the frequency and duration. In policy terms the NPSE recommends that SOAEL values should be avoided and are therefore comparable to the ProPG levels set at 5 dB above the WHO CNG levels. Thus, it can be seen that the AVOG could potentially give rise to a significantly lower level of protection to health and QoL than the ProPG depending on the duration and frequency these ambient levels might occur. In fact, the AVOG levels are significantly greater than the levels that ProPG would recommend could be unacceptable, as defined by Planning Practice Guidance, if they occurred more than occasionally. It can be reasonably be concluded therefore that, according to the ProPG, the upper levels specified in Table 3-3 of the AVOG could give rise to unacceptable levels of noise if they occurred more than occasionally.

It is not that surprising that the upper levels defined in Table 3-3 could be considered to be unacceptable if they persisted for any period of time. Allowing an internal/ external noise correction for an open window, internal ambient levels greater than 50 dB during the day and 42 dB at night would represent external noise levels of 63 dB day and 55 dB night. An external daytime level of 65 dB is considered by many to represent a level that is considered harmful to health. An external night-time

level of 55 dB, which the WHO NNG states: *'The situation is considered increasingly dangerous for public health. Adverse health effects occur frequently, a sizeable proportion of the population is highly annoyed and sleep-disturbed. There is evidence that the risk of cardiovascular disease increases.'*

From a policy perspective, a level of noise exposure that is "**increasingly dangerous**" for public health represents a level that is greater than a SOAEL and is a situation that should be prevented (our emphasis). It is recommended therefore that such levels should be considered to be unacceptable if it is likely that such levels are likely to occur more than occasionally.

Consideration of L_{max} criteria

A detailed consideration of the adverse effects of sleep disturbance is given in Appendix A of ProPG and the article on zero sleep disturbance from aircraft noise (Cobbing, 2021)

There is clear evidence that chronically disturbed or curtailed sleep is associated with a number of negative health outcomes.

Studies have shown that noise can affect sleep in terms of immediate effects (e.g. arousal responses, sleep state changes, awakenings, body movements, total wake time, autonomic responses), after-effects (e.g. sleepiness, daytime performance, cognitive function) and long-term effects (e.g. self-reported chronic sleep disturbance; cardiovascular effects such as increased blood pressure, heart attacks). This is summarised in the schematic by Basner (2018). It is important to realise that two different types of sleep outcomes have been examined. Self-reported sleep disturbance which is linked to external average metrics such as L_{night}; and objective sleep disturbance which uses polysomnography (PSG) to record biophysiological changes that occur during sleep and changes in sleep stages which has been linked to individual noise events such as L_{Asmax}. Reports between self-reported sleep disturbance and objective sleep disturbance can differ as individuals are not always aware of or recall biological awakenings. Average metrics such as $L_{Aeq,T}$ may not be best for assessing noise impacts on sleep disturbance, as noise events in the night are intermittent not continuous, which means that the same Lnight value can result from differing numbers of events. The two types of sleep disturbance should both be considered in assessment and may have separate implications for guidance.

Disturbance of the sleep cycle that causes biological awakenings can be a significant adverse effect as defined in the NPPG Noise Exposure Categories when such arousals cause sleep disturbance on a regular basis, as this leads to poor sleep quality due to fragmentation of the sleep cycle. Researchers ([1]Eus J.W. Van Someren, 2015) note that *'Although superficially more subtle than total sleep deprivation (TSD), chronic sleep disruption has far-reaching consequences starting from the effects on brain cells and ending with recent insights in the mechanisms involved in the chronically disrupted sleep experienced by people suffering from insomnia, one of the most common disorders. In some cases, negative consequences result from the fragmentation of the normal sleep pattern into short sleep bouts frequently interrupted by brief awakenings, even if the total daily amount of sleep is not decreased.'*

The same researchers go on to say: "The relevance of findings from experimental studies is supported by observational studies on the consequences of naturally occurring sleep disruption, whether due to environmental and societal demands or pathological conditions such as sleep-disordered breathing or insomnia. The resulting insights lay ground for a mechanistic understanding of the epidemiological finding that disrupted sleep contributes to the major health challenges facing our aging society, including type 2 diabetes, cardiovascular disease, neurodegeneration, and depression."

Consequently, as well as assessing the "unacceptable" adverse effect of self-reported sleep disturbance, it is also important to consider impacts of noise on sleep at noise levels that induce biological awakenings i.e. objective sleep disturbance but can have significant adverse effects in terms of sleep disturbance which in the long-term could cause fragmenting sleep due to interference with the sleep cycle on a regular basis.

Basner et al [2006] proposed a health protection scheme for the Leipzig/Halle airport in Germany to manage the risk of sleep disturbances associated with aircraft noise. Basner et al recommended that:

- on average there should be less than one additional EEG awakening induced by aircraft per night[6] , and
- awakenings recalled the following morning should be prevented as much as possible, and
- there should be no relevant impairment to the process of falling asleep again.

P58

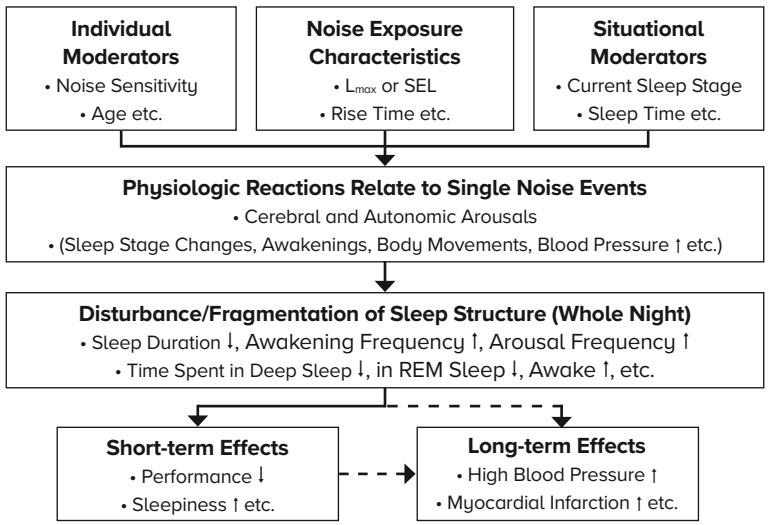


Figure 1. Effects of noise on sleep. It is hypothesised that health consequences will develop if sleep is relevantly disturbed by noise over long time periods (dashed lines: figure reproduced from Basner et al. [25])

6 On average 365 days per year

In order to prevent recalled awakenings Basner et al proposed that the maximum noise level inside the bedroom should not exceed 65 dB. The impairment to the process of falling asleep again is suggested to be dependent upon the number of events and the time interval between events.

Recent research has examined this noise protection concept in relation to railway noise exposure (Mohler, Liepert, Skowronek, Mueller, & Schreckenberg, 2018; Mueller, Schreckenberg, Mohler, & Liepert, 2018; Schreckenberg et al., 2018). Undertaken on behalf of the Hessian Ministry of the Environment in Germany and re-analysing the NORAH and DEUFRAKO studies it was found that the L_{Aeq} on its own was not enough to explain the percentage with high sleep disturbance (self-reported) and it was suggested that L_{Amax} should additionally be taken into account (Mohler et al., 2018; Schreckenberg et al., 2018). L_{Amax} on its own or in combination with the number of trains may better characterise high sleep disturbance (Schreckenberg et al., 2018). To protect sleep, an L_{Amax} criterion was proposed to supplement the German L_{Aeq} external night-time limit for noise of 49 dBA was proposed, based on the difference between the L_{Amax} and L_{Aeq} being limited to 15 dB(A), and the maximum number of awakenings not exceeding three (Mohler et al., 2018).

This study is generally supportive of the ProPG and AVOG because both documents recommend that Lamax be considered as well as the L_{Aeq}. The finding that the difference between the L_{Amax} and L_{Aeq} should to be limited to 15 dB(A), is supportive of the ProPG which recommends a difference of 15 dB(A) and is not supportive of the AVOG which recommends a difference of 23 dB(A).

The analysis also suggests that the number of additional awakenings induced by noise per night should not be treated as a fixed standard and can be modified according to the particular circumstances under consideration. The analysis showed that number of biological awakenings was higher for high volume railways (100 trains/night) compared to a low volume railway (20 trains/night). This is consistent with the findings of the 2019 paper on assessing Lmax for residential development to support the AVO Guide Approach (Paxton et al., 2019), which calculated 21 noise-induced awakenings during a single night with windows open for a busy A-road.

The upper $L_{AF,max}$ criterion set out in Table 3-3 of AVOG of 65 dB is only based upon one of the three elements of Basner's health protection concept i.e. to prevent awakenings recalled the following morning as much as possible. Simply basing the assessment criteria on recalled awakenings will effectively neglect the adverse effects of noise resulting from:

- fragmentation and interference with sleep quality caused by noise induced EEG awakenings at event noise levels below which recalled awakenings will occur; and
- impairment to the process of falling asleep again.

From a public health perspective, such effects should not be ignored. The advice given in the AVOG on the assessment of $L_{AF,max}$ levels should therefore be used with extreme caution.

The AVOG does not provide any guidance regarding the frequency of occurrence at which the objective awakening impacts of the suggested upper L_{Amax} levels in the AVOG are likely to constitute a significant adverse effect as defined in the Planning Practice Guidance. It is recommended that further information is provided as to how the guidance contained in AVOG relates to the Planning Practice Guidance for Noise.

When a detailed assessment of sleep disturbance is necessary, the ProPG recommends that this should be undertaken using available exposure-response relationships appropriate for the types of noise sources being considered, in line with the WHO Night Noise Guidelines publication and any other relevant research[7]. It is worth noting that Basner's recent paper (Basner et al, 2018) provides exposure response relationships for self-reported and objective sleep disturbance for each source of transportation noise which can be used to perform a detailed assessment of sleep disturbance.

This assessment will detail the adverse effects from individual noise events on sleep. It will also advise on risk mitigation measures and how these can be implemented and report the likely residual effects on sleep of affected persons.

A detailed risk assessment may not always be proportionate. Under such circumstances, it is recommended that a simple assessment is carried out assuming that the difference between the L_{Amax} and L_{Aeq} should be limited to no more than 15 dB(A). This would suggest that L_{Amax} values greater than 50 dB and 55 dB would be considered to unreasonable and unacceptable respectively if they were normally exceeded more than 10 times per night .

It should be recognised that there are limitations associated with the Basner exposure response relationships for road traffic noise as the evidence obtained for road traffic noise has been derived indirectly from studies conducted for aircraft and railway noise.

In the polysomnography studies reviewed by Basner to derive ERFs; road, rail, and aircraft events were identified by listening to indoor sound recordings and the start and end of each noise event was scored. For each noise event, the first sleep stage affected by a noise event (first noise epoch) was defined as the first epoch that contained more than 15 s of the event. If the subject was asleep in the epoch prior to the first noise epoch) then the next three epochs (90 s) were screened for a transition to wake or Stage S1.

During a road, rail, or aircraft event, additional outdoor or indoor noises can occur. In this analysis a noise event was considered 'undisturbed' if the following criteria were met: (1) only events from the same noise source could occur one minute before (e.g. the end of a prior noise event) and 1.5 min after the start of the event, and (2) sounds made by the subject such as turning over in bed were allowed before and during the noise event of interest as they could be reactions to the noise. Events defined as 'disturbed' consisted of those in which any other noise event occurred 60 s prior or up to 1.5 min after the start of the first (30 second) noise epoch[8] .

7 The other requirements relating to frequency and duration would also apply

8 Scoring of sleep stages is usually done on an epoch-by-epoch basis, with a 30-second length used as a standard. More information on objective sleep measurements can be found in the WHO Night Noise Guidelines Chapter 2.

It can be seen from this that the analysis only works well for discrete events that are reasonably well separated in time. Most practitioners will appreciate that such conditions do not always occur with exposure to road traffic noise, especially when the exposure results from high traffic flows. Road traffic noise can often be experienced as a series of multiple events or a steady stream of events over a period of time. There is no evidence to suggest that multiple road traffic noise events occurring within the same epoch will result in more awakenings. Equally, it is plausible that multiple road traffic noise events could be more disturbing to sleep compared to discrete events. It must also be recognised that exposure to more than one source of noise could be more disturbing than exposure to a single source of noise.

Despite these limitations, there is no reason to suppose that all adverse effects from road traffic noise can be discounted and effectively ignored and that only recalled awakenings should be considered. In fact, in the absence of evidence it must be a matter of concern that exposure to road traffic noise involving multiple events could be more disturbing than discrete events. As such, practical solutions should be considered as an alternative to the approach recommended in the AVOG. For example, it may be appropriate to determine the $L_{AF,max}$ levels within 1 or 2 minute time intervals and then use this data to calculate the number of additional awakenings for a given $L_{AF,max}$ distribution over an eight hour night period. In addition, the number of additional noise-induced EEG awakenings could be calculated using assumptions for windows open and closed over the period of a year. In this way the risk assessment on sleep could assess short-term effects as well as long-term, chronic effects. Such an assessment could be linked to the overheating assessment as well as other occupancy data for how often people open and close windows.

Until a consensus is reached on how best to assess impacts on sleep from road traffic noise it is recommended that the upper noise criterion set out in Table 3-3 of AVOG is used with extreme caution.

Adaptive models for acoustics and overheating

It must be recognised that overheating can also have significant adverse effects on health and quality of life. In extreme circumstances, excessive heat can be a direct cause of death, therefore it is clearly a serous public health issue. Three heatwaves in summer 2020 resulted in 2,556 excess deaths (**https://www.gov.uk/government/publications/phe-heatwave-mortality-monitoring/heatwave-mortality-monitoring-report-2020**). A more detailed review of the adverse health effects of overheating was reported as part of the MHCLG consultation on Approved Document [x]. (2021)

The AVOG refers to TM59 and suggests the methodology set out in the CIBSE guidance can be used to assess the risk of overheating.

TM59 does not consider the adverse effects of noise. It considers overheating in isolation and provides pass/ fail criteria for thermal comfort. There is no mechanism to relax the criteria for overheating to allow a balance between overheating and noise.

AVOG suggests that it is appropriate to relax the noise standards during an overheating condition but does not consider whether it might also be appropriate to relax the criteria for overheating. As such, there is an implied presumption that acoustic conditions can be compromised so as avoid adverse effects from overheating conditions. This is an issue that was raised during the recent consultation by the MCHLG on the proposed new Approved Document [x] for overheating. In its response to the consultation the CIEH **https://www.cieh.org/media/5168/the-future-building-standard.pdf**) argued that: *'We agree that dynamic thermal analysis provides a valuable means of reducing the risk of overheating. We also agree that the TM59 analysis approach is an appropriate method and encourages a consistent approach. We do not however agree that the TM59 pass/ fail criteria represents an appropriate method. TM59 aims to prevent overheating rather than minimising the risk of overheating, on balance. In addition, TM59 and the maximum recommended temperatures are not strongly supported by evidence, as demonstrated by the evidence review contained in the Phase 1 report: Research into overheating in new homes, published as part of this consultation.*

'Minimising the risk of overheating should be a question of balance, having proper regard to all factors affecting health and quality of life. This is especially the case in medium and high noise exposure areas where there needs to be a balance between overheating and noise. The Professional Practice Guidance: Planning and Noise for New Residential Development provides a framework for achieving an appropriate balance between acoustics, overheating and other factors. The Building Regulations should be aligned with this guidance.

'The Chief Medical Officer's report on all types of pollution has determined that "Noise stands second to poor air quality in terms of the burden of ill health caused by a single pollutant".1 The effects of noise on health and quality of life must therefore be taken into consideration when designing and building new dwellings.

'It is very likely that the strength of evidence for the adverse effects of noise at levels of exposure frequently encountered in and around homes in the UK is greater than that for overheating. The World Health Organization has found strong evidence that noise causes annoyance, sleep disturbance, impact on mental wellbeing and longer-term health effects. Weight should be given to acoustics, overheating and other factors affecting health and quality of life.Judgement is required because the evidence on health effects from overheating do not currently allow its effects to be quantified. This situation should change and the MHCLG should encourage or require post-occupancy monitoring to determine the health and quality of life implications of different design solutions. The instruments are already available to undertake such monitoring and so there is no excuse for not encouraging evidence-based designs and decision making.'

It remains to be seen how much of the proposals to manage overheating are taken forward by the MCHLG. There is a possibility that the proposals may be modified to allow for more balance between acoustics and overheating. When the outcome of the consultation is known it may be necessary to revise ProPG and AVOG. Until then, it is suggested that practitioners should be aware P60

of the limitations of TM59 when applied in areas of medium and high exposures to noise and be cautious about relaxing the noise standards in order to achieve strict pass/fail criteria for overheating. Such an approach is not supported by the available evidence.

AVOG suggests that the relationship between acoustics and temperature is linear (see figure 3-2, reproduced from the AVOG). It also suggests that there is a single exposure response to noise relating to a range of overheating conditions. These are assumptions which are not currently supported by evidence. There is a significant research gap in the way in which the occupants of dwellings respond to noise in buildings with different levels of risk of overheating e.g. low probability of overheating ranging to a high probability of overheating for sustained periods during the summer. These research gaps need to be acknowledged. It is also recommended that figure 3-2 of AVOG is revised to explain that:

- there may be a range of possible responses to noise depending on the severity of the overheating condition as well as the duration and frequency an overheating condition occurs; and
- the relationship between noise and temperature may not be linear.

So far, we have only considered the interrelationship between noise and overheating. It is of course appropriate that noise should be assessed with windows open if there is a risk of overheating and the overheating design strategy relies on windows being open to control indoor temperatures. That said, overheating is not the only factor that should be considered. As explained earlier, the occupants of dwellings and other buildings may choose to open windows for a variety of reasons as well as controlling thermal comfort. The AVOG however explicitly states that consideration of these factors is also beyond the scope of the guidance.

The windows open/closed question was considered by the WHO in the NNG. They refer to studies conducted by Passchier-Vermeer et al. in 2002 which carried out detailed noise measurements inside and outside the bedroom and at the same time measured window position with sensors. The results showed that windows are fully closed only during 25% of the nights.

It was this survey that led to the recommendation to use an annual average inside/outside differences of around 21 dB.

It was stressed that this figure should only apply to façades that have not been fitted with special appliances to reduce noise impact. For example, rooms equipped with air conditioning so that windows can stay closed or could even be sealed. It was also recognised that little is known, however, about the inhabitants' experiences (long-term use, appreciation) of these and other solutions. For example, sound-attenuated ventilation openings are sometimes blocked, in order to cut out draughts.

It is unfortunate that we have little robust information how the occupants of new dwellings open and close windows throughout the year. In the absence of better data, it is recommended that the information reported in the NNG is used to consider the duration of windows open/ closed over a typical annual period. The noise assessment should not assume that windows are only opened when overheating occurs.

AVOG suggests that it is appropriate to extrapolate the adaptive thermal comfort model to an assessment of adverse noise impacts. It states: *'It is considered reasonable to allow higher levels of internal ambient noise from transport sources when higher rates of ventilation are required in relation to the overheating condition.*

'The basis for this is that the overheating condition occurs for only part of the time. During this period, occupants may accept a trade-off between acoustic and thermal conditions, given that they have some control over their environment. In other words, occupants may, at their own discretion, be more willing to accept higher short-term noise levels in order to achieve better thermal comfort. The importance of control is relevant to daytime exposure, but not to night time exposure where the consideration is sleep disturbance.

'It is important to note that there is no specific research available to support this view regarding human response to combined exposure to heat and noise. However, the notion that control over one's environment moderates the response to exposure is well established in the field of thermal comfort, and underpins the adaptive thermal comfort model.'

Although it is suggested that the adaptive comfort model does not apply at night this advice is not carried through to the rest of the document and, in particular, the guidance contained in Table 3-3. There is no reason to assume, however, that an adaptive comfort model should apply at night. The fact is that there is little awareness in the general population, or indeed amongst health practitioners, that biological awakening impacts of noise at night can be harmful to health. Given that there is little awareness of the harmful effects of exposure to noise at night it would be wrong to assume that the occupants of dwellings can make properly informed choices about the trade-off between acoustic and thermal conditions.

High temperatures also impact on sleep and so it should not be a trade-off between noise and overheating; designs should be optimised to avoid and minimise adverse effects from noise and overheating together.

Cooling strategies and emerging policy

The starting point for ProPG is to achieve internal acoustic standards with windows open. It allows for windows to be closed but only where it is demonstrated that despite good acoustic design internal acoustic standards cannot be achieved with windows open and where such a situation can be justified. This allows for mechanical cooling systems to be used[9].

Until recently, it is fair to say that mechanical cooling systems have been used commonly in medium and high noise exposure areas to avoid the need to open windows in order to mitigate the adverse effects of noise. This is even true of development in London where the London Plan only allows for active cooling as a method of last resort[10].

9 Active cooling is a design feature to control thermal comfort, separate to providing ventilation to the home, and is the last resort of the cooling hierarchy.

10 The London Plan requires overheating to be able to be mitigated through passive means as far as possible, however it does not prohibit the installation of active cooling systems. As long as the developer can demonstrate that active cooling systems would not need to be relied upon by residents for good thermal comfort.

The MHCLG consultation on the new Approved Document [x] contained strong proposals to incorporate passive design solutions to be used to minimise the risk of overheating. The proposals included measures to avoid solar gain and to remove excess heat. Measures to minimise solar gains in summer included any of the following:

a. fixed shading devices;
b. glazing design, including limiting the amount of glazing; and
c. building design, for example the placement of balconies for shading.
d. Shade of adjacent permanent buildings, structures or landscape.

The draft Approved Document [x] then went on to propose: *'Excess heat from the residential building should be removed through any of the following:*

a. opening windows, made more effective by cross-ventilation;
b. ventilation louvres in external walls; and
c. a mechanical ventilation system.

The building should be constructed to meet [the requirement for overheating (1)] without the need for mechanical cooling (air-conditioning). However, mechanical cooling is not prohibited by the requirement.'

In its response to the consultation the CIEH sought clarification on this proposal and suggested that it be considered within a wider strategy to reduce carbon emissions. The CIEH's response raised an important point that the prohibition of mechanical colling systems could potentially sterilise brown field land and that this had not been fully considered or explored by the MHCLG as part of the proposals.

The current version of ProPG refers to sustainable development policies and suggests that the design should be considered within the context of local policies and plans. For example, the London Plan and the cooling hierarchy, which suggests that mechanical cooling should be a method of last resort.

The ProPG approach works perfectly well for now but it may be necessary to update the guidance if the UK government announces any stronger policies or standards to either prohibit or otherwise discourage the use of mechanical colling systems.

In relation to passive design the AVOG provides helpful guidance on the importance of early design considerations to minimise overheating. It advises that: *'In accordance with sustainable design and construction principles, development proposals should, amongst other things, maximise opportunities to orientate buildings and streets to minimise summer and maximise winter solar gains; use trees and other shading; increase green areas in the envelope of a building, including its roof and environs; and maximise natural ventilation. These sustainable design principles mirror good acoustic design as described in the ProPG.'*

This advice is useful and emphasises the need to consider the application at the earliest possible stage. This guidance could be improved if it provided more information on passive design solutions and how passive acoustic design could be integrated with passive design measures to minimise overheating. For example, how balconies could be used to minimise noise as well as overheating.

Recommendations

This article highlights areas of significant commonality, but it also identifies areas of divergence. It is hoped that this article will encourage discussion and debate to allow the IOA, ANC and CIEH to work together and produce guidance that is aligned as far as possible. This would be helpful to all practitioners and anybody who has an interest in planning and design.

Acoustic and environmental health practitioners should involve noise and health experts in the process to ensure that guidance accurately reflects the best available evidence on the effects of different factors affecting health and quality of life.

A series of workshops to discuss these issues may help practitioners to come together and explore these issues further.

This article identifies some limitations with the AVOG that practitioners should be aware of in the application of the guidance. It also identifies some areas where the ProPG may benefit from future revisions.

It is recommended that the IOA, ANC and CIEH work collaboratively with CIBSE to explore issues relating to integrated design for acoustics and overheating. The possibility of providing joint guidance should be explored.

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About the authors:

Colin Cobbing. Director at Pinnacle Acoustic Consultants

colin@pinnacleacoustics.co.uk

Dani Fiumicelli, Technical Director at Vanguardia

Somayya Yaqub, Head of Corporate Health and Safety at the London Borough of Ealing

The authors are grateful for the contributions and comments from:
C Clark, Professor of Epidemiology, Population Health Research Institute,

St George's, University of London

Kate Paxton, Associate at Hodkinson Consultancy, Specialist in overheating

kate@hodkinsonconsultancy.com

Alastair Baxter at ITP Energised

alasdair.baxter@itpenergised.com

Aviation noise management and research: reflections and challenges in light of the pandemic (PART 1)

By Nicole Porter, Robin Monaghan, Chris Wood and Jamie Easton, Anderson Acoustics Ltd

Foreword by Nicole Porter. In early 2020, I was busy working as a technical advisor on aviation noise; its management, impacts and research. By contrast, in early 2021, I was balancing home schooling, working as an NHS vaccinator, lateral flow testing, and partaking in many other activities while trying to keep abreast of the future of the aviation industry. No one could have predicted how quickly our lives would change as a result of the pandemic.

In this two-part article, we will reflect on lessons learned from this pandemic experience and apply them to aviation noise management and research, identifying future challenges and tasks that we feel should be considered, while working towards the effective management of aviation noise as the industry recovers.

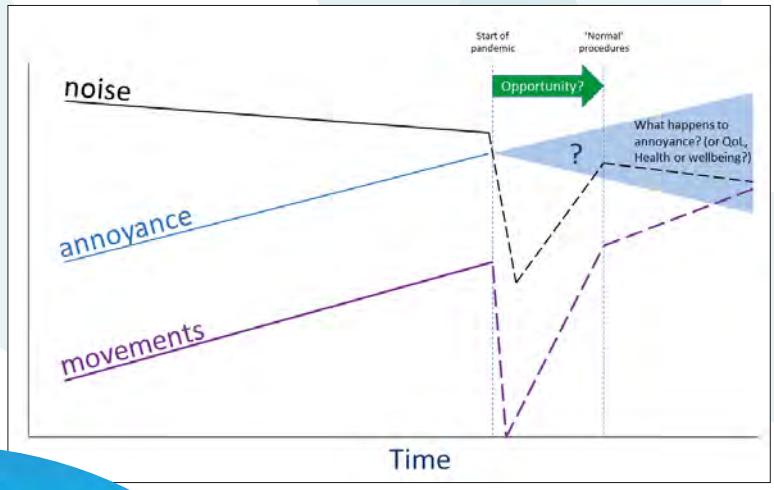
Setting the scene

Pre-pandemic, aviation was growing, billions of pounds were being spent on reducing aviation noise at source and significant effort was being made to reduce overall noise levels. The ICAO Balanced Approach to aircraft noise management was pursued.

Aircraft were getting quieter, operating procedures were improving, and better mitigation/insulation was being introduced. However, there appeared to be reduced trust between community and industry, annoyance was increasing, and there was perhaps a slavish obsession with the number of people inside a noise contour. However, in the past five years a change in airport behaviour had started to emerge.

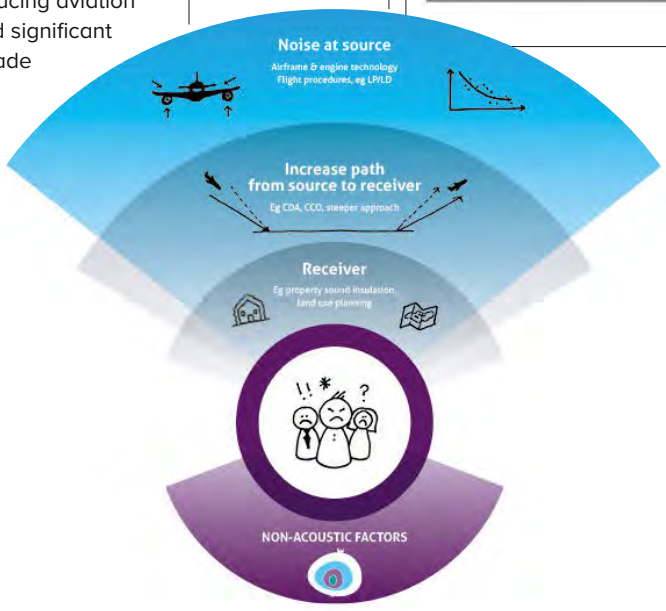
A research roadmap had been considered. It was recognised that noise management is at the core of planning; that noise had to be managed in a more sustainable and transparent way; and both acoustic and non-acoustic factors need to be taken into account.

Post-pandemic, as aviation grows back, there is an opportunity to reduce noise and build trust, leading to a more sustainable future for aviation.



Right: Aviation movements & noise have fallen during the pandemic

Below: Decades of applying principles of ICAO balanced approach



Aviation is fighting for its life. Whilst there is a once in a life-time opportunity, there is the obvious barrier of funding. The industry has few funds, and the Government has more pressing priorities. Therein lies the reality of opportunity versus the inability to maximise it, the dichotomy of chance to research and lack of funds to implement.

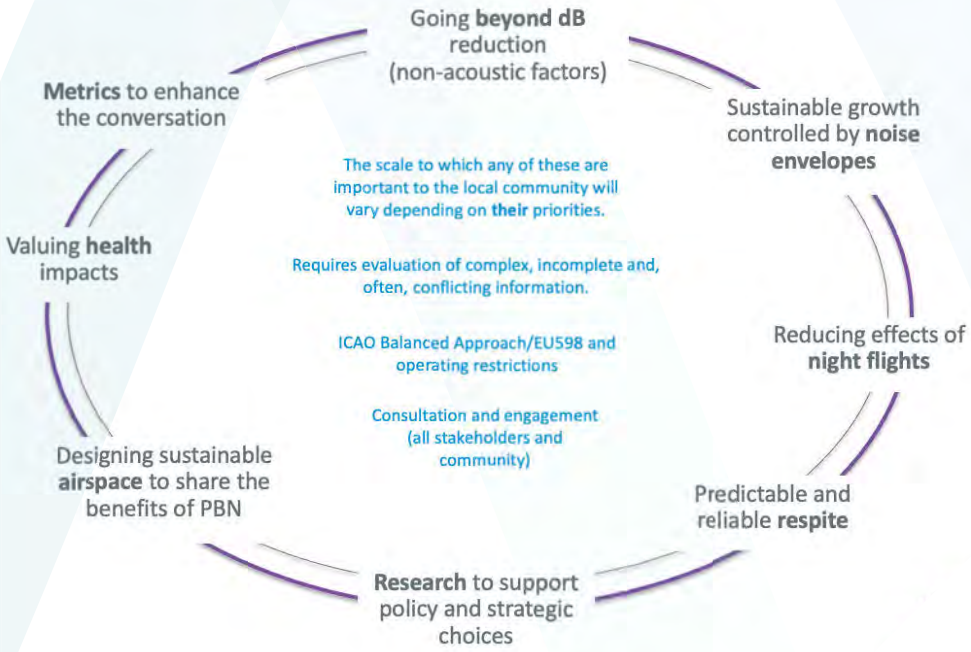
We have been constantly reminded throughout this pandemic that Government decisions and actions are to be based on **scientific evidence**. The virus was new, so scientific data was scarce.

The decision-makers were faced with a tough challenge: what is the strategy to move forward based on lacking, incomplete or insufficient scientific evidence? The decision-makers' strategy had to evolve as more evidence became available. It is easy to criticise inaction or incorrect action, hindsight is a wonderful thing, but we need to learn from events to increase our understanding and, potentially, help us take appropriate actions or decisions in future. These principles are being applied to the pandemic challenges and need to be played out in developing our understanding of many complex topics, including effective aviation noise management. We must keep building our scientific evidence to ensure this is not a lost opportunity.

What happens next?

So, after the 'dust has settled,' what will this new landscape look like? Will wanderlust be accentuated? Or will business travel become a thing of the past, replaced by virtual meetings? Will the evidence of the impact of our pre-COVID existence on the environment drive society to choose more sustainable travel options?

The pandemic has focused attention on finding effective solutions, working out who and what is important to a functioning society. It has shown that anyone may be vulnerable and that we are better working together rather than against each other. As the aviation industry starts to recover, what do we see as the challenges ahead for evolving effective aviation noise management and its research?



Our Airports Team at Anderson Acoustics had been considering some of the key challenges to developing effective aviation noise management before the pandemic. These had been presented in a number of papers ([1] [2] [3] [4]) and are summarised in the graphic above.

Above: Key challenges for aviation noise management pre-pandemic

Our thoughts on the challenges facing the aviation industry in a post-COVID world include:

Government announcements

The rest of this article, deals with the first of these challenges with the second part looking at the remainder.

Challenge: enhancing and moving the conversation on

Before the pandemic, we identified the core principle of 'open engagement' as an essential part of a noise management strategy. The challenge is to continue to develop ways of enhancing and moving the conversation forward.

Throughout the pandemic, we have been listening to regular Government announcements, briefings and scientific research findings, to increase our understanding of it and how it is P64

being managed, to identify the risks to individuals, understand how we are expected to behave and the consequences of our actions etc. Frequently, we have applied the 'so what?' question to what has been communicated and assess what all the information actually means to us personally. We ask ourselves if our own questions have been addressed in a way we have understood and whether we trust the answer.

This experience has led us, at Anderson Acoustics, to consider some lessons learnt about what may be important about effective communication and information sharing, which we feel has been applied with varying levels of success throughout the pandemic:

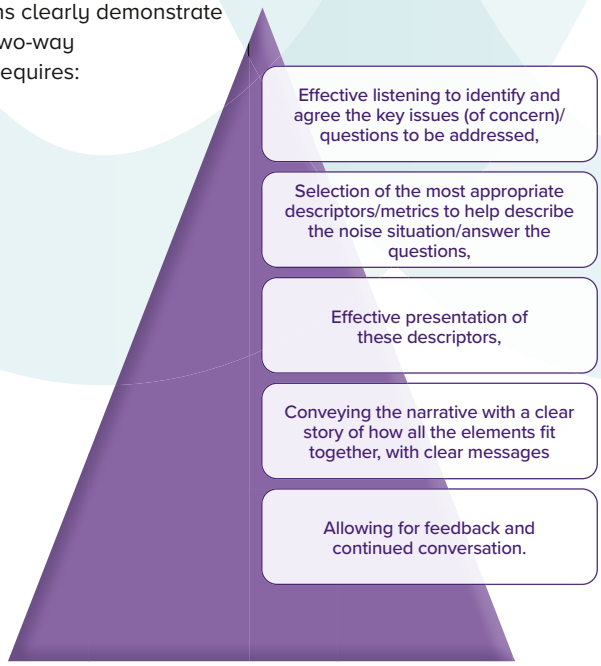
Box 1: Lessons learnt from Pandemic about effective communication and information sharing

- the need for transparency,
- dissenmination of meaningful information in appropriate laypersons language using easy to understand and relevant descriptors,
- developing a clear narrative with explanations of developing knowledge and, where appropriate, with clearly defined actions and meaningful targets,
- translation of the science to answer the 'so what?' question,
- clear evidence of opportunities to exchange and question the information (for robustness and validity together with
- open, honest dialogue, with admission of mistakes and what has been learnt from them,
- an appreciation of all stakeholders' views together with real two-way communication,
- a willingness of those in power to be challenged and face critics - no ivory towers,
- a need for constructive engagement in moving forward,
- evidence of openness to listen to new ideas, with a demonstrated willingness to try things and challenge failure.

All these considerations can also translate in the effective communication of any complex topic. As acousticians, we should aim to provide all relevant information in a simple and transparent way to facilitate the decision-making process and engagement with all stakeholders.

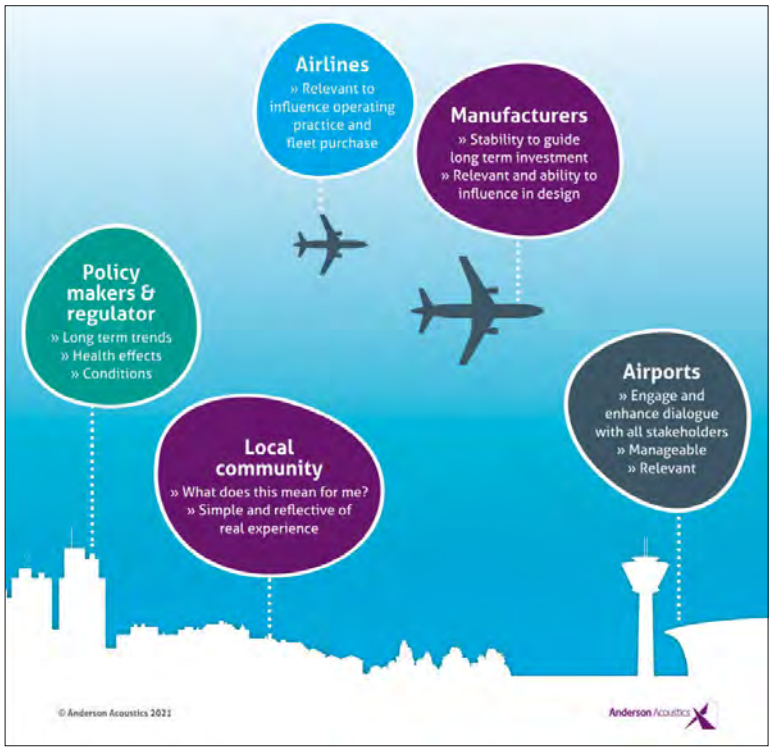
Enhancing two-way communication

Pandemic lessons clearly demonstrate that successful two-way communication requires:



1. Effective listening to identify and agree the key issues (of concern)/ questions to be addressed

During the pandemic, the nation asked many questions to help understand the risks to each of us and our loved ones. The Government, scientists and health care professionals etc. had to listen and present the answers and plans to us with supporting information. Knowing the audience is also important so their needs are better understood, and that appropriate language is used.



Right: Knowing the audience

Understanding the key issues can be achieved through open, honest conversations. We need to consider both defining the noise problem and the associated objective for any noise management actions. In aviation noise management, a number of ways have been set up to allow such conversations, including complaint help desks, community noise fora, engagement boards, stakeholder groups, consultations programmes, outreach programmes and other community relations activities.

We accept that the success of these methods as effective means of two-way communication may have been judged at differing levels! In addition, research methods to identify and understand issues can be adopted, such as social surveys and focus groups. Whichever method is used to disentangle the issues and identify the key questions that need addressing, this should allow for an opportunity to reflect back and agree the issues.

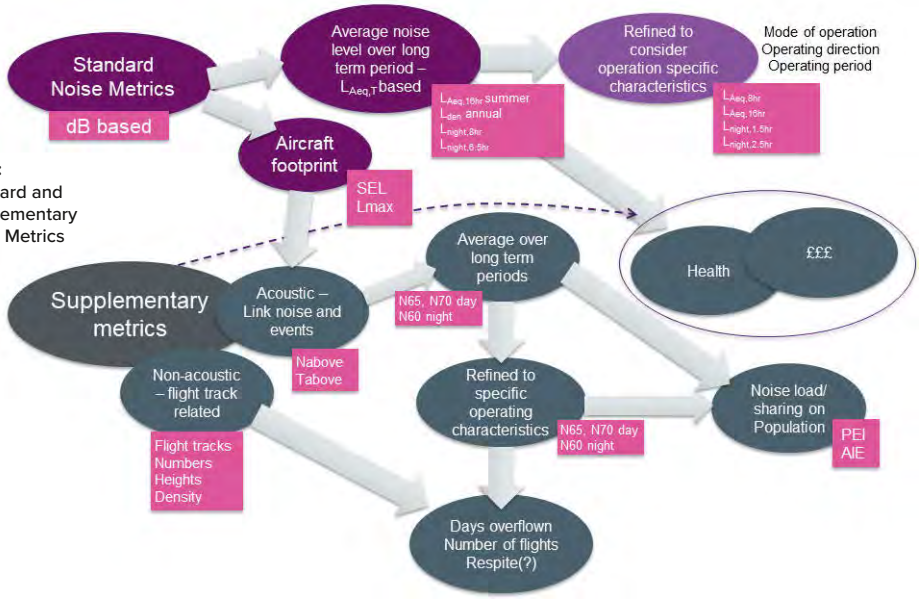
2. Selection of appropriate descriptors/metrics to describe the noise situation/answer the question

Usually, acousticians are responsible for describing the acoustic characteristics and need to select the most appropriate descriptors/metrics to help describe the noise situation of relevance.

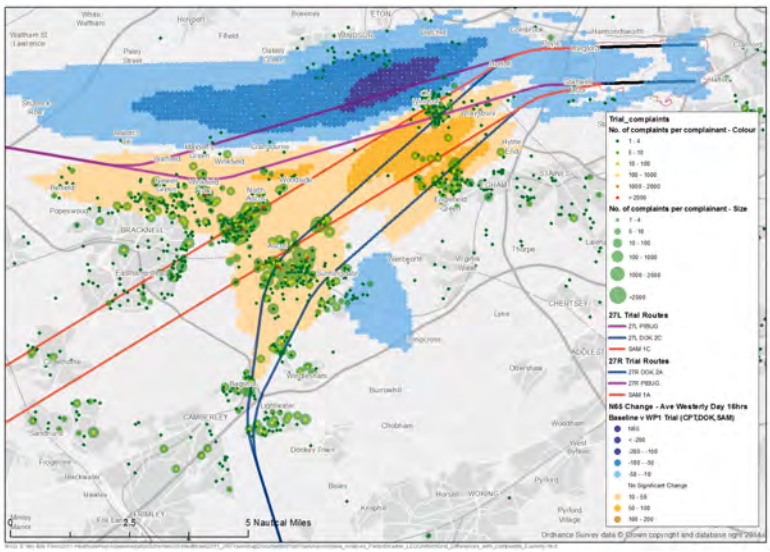
Previously, we have examined the limitations of traditional noise contours for describing noise exposure and considered a more targeted contour based on shorter-term noise measures[4] . The following figure summarises what we mean by the terms 'standard' and 'supplementary' metrics.

Anderson Acoustics was involved in the analysis of noise measurements from Heathrow DOKEN westerly departures precision navigation trials, which ran from December 2013 to June 2014. During this time, all Midhurst westerly departures followed one of four temporary precision routes according to a pre-arranged schedule. Each DOKEN route overflew different sections of the residential areas under the previous dispersed westerly Midhurst departures routes. Our analysis work showed that using supplementary metrics helped to describe the noise change.

The use of change in average noise levels and event-based metrics were valuable supplementary measures to improve understanding of noise exposure, and can be useful for communication and engagement strategies.

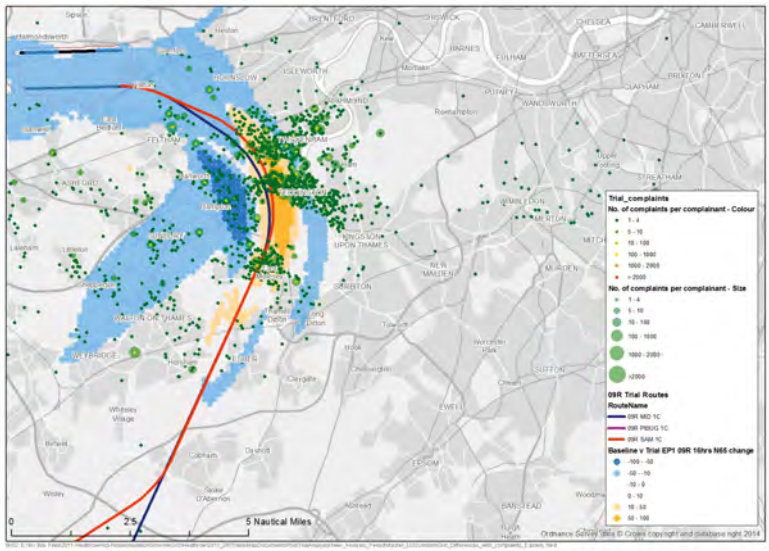


Right: Standard and Supplementary Noise Metrics



Right & below: Noise and complaint data during DOKEN trial

During westerly departures most complaints came from areas outside those that would normally be used to define and assess noise impacts (54 or 57 dB L_{Aeq16h}), but were from areas that the modelling indicated a substantial increase in the noise level and/or change in number of events.



Note: we recognise that complaints stats are also strongly influenced by non-acoustic factors

During easterly departures most complaints were from within areas that would normally be used to define and assess noise impacts (54 or 57 dB $L_{Aeq16hr}$). However, there were no substantial increases in 16-hour average noise levels in these areas. Complaints were generally from areas (or adjacent to) where the modelling indicated increases in the number of events (N65). P66

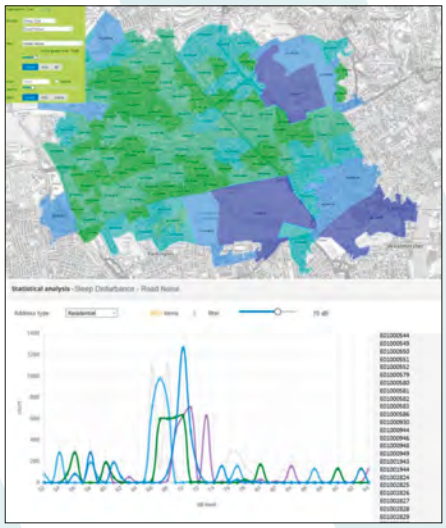
Previously, we promoted the principle that noise descriptors should be tailored towards the specific questions that are being addressed and many have heard us say “the metrics need to be fit for purpose”. So the questions being considered (and the objectives of any noise management actions) – the purpose – need to be agreed. Then one needs to consider how best to describe the noise (the fit) to meet this purpose. It is important to then use these descriptions or metrics to present the information in a way that the objective data and its validity can be agreed, and to aid understanding of trends, optioneering and decision making etc. Adopting this approach will be invaluable in understanding how the noise environment has changed as a result of the pandemic.

3. Effective presentation of the metrics and other information

It is not just metrics used in the conversation that are important, but the tools and techniques used to communicate noise and its potential impacts, describe prevailing conditions, future scenarios and meaningfully demonstrate change. Technological advances and increased capabilities have led to the development of new ways to present information in a more meaningful and tailored manner. It has been possible to present data at very detailed levels for a number of years now (grid level, postcode, property points), but the next challenge is how to manage these huge datasets while keeping the story clear and concise.

Look at he a screenshot (right) of the John Hopkins dashboard on Coronavirus cases[5]. This gives some great information including a geographical snapshot of cumulative cases, to help develop an understanding of the story. Such data has been helpful to those tracking the spread of coronavirus around the world, track trends and look at the changes due to management decisions, such as different interventions or the advent of different variants.

A challenge in aviation noise management can be to choose the best tools to present the datasets to provide an understanding of existing or predicted scenarios and to show change.



Online map-based visualisation of scenarios and noise effects-multi-platform potential – Example taken from Heathrow PEIR

Below: John Hopkins Coronavirus Resource Centre Information

GIS and data analysis tools

Using GIS and data analysis tools we have found the effects of noise on the communities near an airport can be communicated and be more understandable. Data analysis tools enables interaction using the data directly and compares different options in real time giving a clear message on how areas are affected differently.

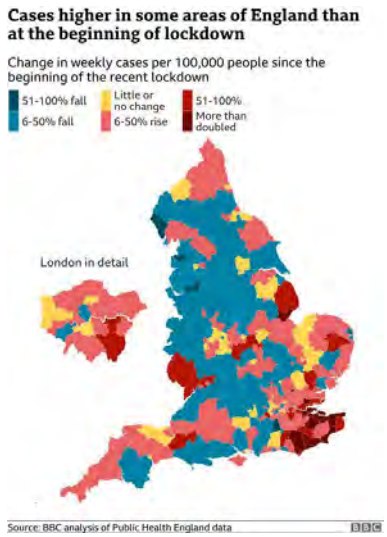
Our next challenge is to evolve these visualisation tools and techniques to improve and present our understanding of the situation, to help with noise management decisions.

4. Conveying a clear story of how all the elements fit together, with clear messages

The narrative needs to be explained together with clear messages – tell the reader what the figure or chart means in the ‘story’ so the reader knows about the ‘so what?’ An example is given next from the pandemic. It explains the key message from the data and presents the change metrics by geographical location. This example uses the measurement and monitoring of the COVID 19 statistics (assisted by Track and Trace) on a geographical basis. It helps show changes and trends and

pinpoint issues (for example, being used to identify the developing dominance of the different variants). For this, it needed the right metrics, accurate data, understanding of variance and significance of data trends and change and meaningful ways of showing these. Furthermore, it needed to present a key take-away message – in this case, below, this was 'Cases higher in some areas of England than at the beginning of lockdown'.

BBC COVID map



Through our work with airports, we have welcomed the opportunity to develop approaches to community noise reporting and we advocate developing a best practice approach. We have learnt much from developing community reports for three of the London airports, which followed an approach based on addressing key questions that the community were asking, adopting the most suitable metrics, presenting the information both graphically and using visually mapping tools, with explanatory text to give the key take-away messages and tell 'the story'. We worked with both the airports and community on refining these reports, and welcomed the feedback during the development process. Some of our lessons learnt are included:

- develop with local community to reflect their concerns/priorities;
- include 'warts and all';
- multiple metrics are needed to include noise (measured and modelled) and operations (tracks);
- deliver what is needed;
- direct engagement, before and after report is developed; and
- make it both airport and community specific, taking into account that one size does not fit all.

Having a story and then telling it can make use of a range of different forums and electronic media. Drawing from the pandemic experience again, we have seen live announcements from Government, media messaging and campaigns, which have implemented visualisation tools, live drawings or educational videos. There is a need to use a variety of media to reach different audiences using appropriately levelled language and terminology.

One approach that we have adopted was to tell the story of respite from aviation noise research as an animation, for which we received encouraging feedback.

The challenge is to test and adopt the best combination of media and messaging to reach the intended audience to effectively communicate the key messages, issues, or answers to key questions.

Left:
HAL respite website

5. Feedback and continued conversation

It is important to allow for feedback and continued conversation including the need for:

- clear evidence of opportunities to exchange and question the information;
- open, honest dialogue, with admission of mistakes and what has been learnt from them;
- willingness of those in power to be challenged and face critics; and
- evidence of openness to listen to new ideas, with a demonstrated willingness to try things and challengefailure.

This is a vital part of the open engagement process, which is often overlooked and should be built-in to any two-way communication.

Interestingly, ICCAN, which includes an aim of improving public confidence and trust in the management of aviation noise in its remits, has fairly recently completed a survey on community engagement to try to better understand existing methods of engagement used by airports with their local communities and their effectiveness[6]. There were several areas where they wanted to see improvements, particularly around understanding the impact of noise from a community perspective, developing a genuine two-way dialogue, improving the quality of information provided by making it less technical and being more honest when discussing the negative impacts.

To be continued

In the second part of this article (in the September/ October issue of Acoustics Bulletin) we will consider the remaining challenges. In the meantime, we will continue to publish our thoughts on our website **https://andersonacoustics.co.uk/our-news/**

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SOUTHERN BRANCH NEWS

In the last issue of Acoustics Bulletin, we mistakenly published an old report for the Southern Branch. The first story in this section is the report we should have published and it was made available in the digital edition immediately after we learned of the error.

A soundscape approach to create an acoustic vehicle alerting system (AVAS) for Transport for London's emerging electric bus fleet

By Jack Richardson, Hilson Moran

On Wednesday, 24th March, IOA Southern Branch members met on Zoom for a presentation on the acoustic vehicle alerting system (AVAS) for London's (TFL) emerging electric bus fleet.

The presentation; *'A soundscape approach to creating the urban bus sound',* was jointly presented by Anderson Acoustics' Grant Waters and Ed Manzano, who set the scene by introducing TFL's brief and vision for their new electric bus sound, and providing a concise technical overview of the current regulation governing sounds from electric vehicles at low speeds (< 20 kph): UN ECE Regulation 138. In short, their brief was to develop a balanced AVAS sound that was pleasant, safe and could improve urban soundscapes.

Grant and Ed took attendees through the step-by-step evolution of the AVAS sound they created alongside their client and major stakeholders. They then described the early stages of their creative process, which involved a series of moodboarding workshops to generate a variety of potential sounds, and which eventually saw these whittled down to just 10 finalists. They described how they refined the characteristics of the sounds to ensure they remained pleasant to their collective ears, but also easily identifiable and localisable by vulnerable road users and pedestrians – it was particularly interesting to learn how the requirements of the latter necessitated the addition of a comparatively impulsive 'beacon' sound, that would help people localise the source once the vehicle had begun to move.

Following numerous computer simulations conducted in their SonicRoom and some final tweaks, they described how they were eventually ready to install the prototype onto a real bus and carry out in-situ tests. Grant and Ed finished by informing us of the success of the prototype testing and successful approval of the system for trial on TFL's Route 100.

The presentation generated a lot of interest, with Zoom's live chat becoming awash with questions and comments throughout the hour-long presentation. The level of engagement was a clear indication that this area of acoustics is still very much in its nascent form and the future will undoubtedly need to see synergy between the acoustics and automotive industries. The event was a great success, with 64 people in attendance. We hope to welcome Grant and Ed back following completion of phase two.

Change of plans

By Conor Tickner, Aecom

Tony Gallagher, an associate at Quod, gave an insightful overview of the recent changes to the planning processes and use classes, in relation to the *Town and Country Planning (Use Classes) (Amendment) (England) Regulations 2020* and the *Town and Country Planning (General Permitted Development) (England) Order 2015 (GPDO)*. He also discussed the consultation on changes to the *National Planning Policy Framework (NPPF)* and a new draft *National Model Design Code*.

Tony explained in detail each of the relevant changes to the laws, including the revocation and creation of classes, the reorganisation of some others, and the practical implications of the changes in various different scenarios. He also explained some of the rationale behind the changes and discussed many of the nuances and limitations. An update was given on the consultation for amendments to the NPPF and National Model Design Code, explaining how these changes, while minor, indicate a shift in focus and priorities for how developments ought to be reviewed and assessed.

Tony also discussed some of the tensions that may arise between developers and local government when managing noise while adhering to the spirit of the changes to the law to more readily permit developers to change building uses. Some of these issues were explored in greater detail in the lively Q&A session after the talk.

There were 68 people in attendance, a respectable number that continues the Southern Branch's strong record of attracting members from other branches across the country, as well as from the southern region. Discussions were also held about how to proceed with Southern Branch meetings after pandemic restrictions are lifted, with the possibility of online meetings, in-person meetings, and combination/hybrid events. As always, we are happy to receive feedback on branch meetings as well as ideas for future presentation topics.

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Committee meetings 2021

DAY	DATE	TIME	MEETING
Tuesday	13 July	10.30	Diploma Tutors and Examiners
Tuesday	13 July	13.30	Education
Wednesday	14 July	10.30	CCENM Examiners
Wednesday	14 July	13.30	CCENM Committee
Thursday	5 August	10.30	Diploma Moderators Meeting
Thursday	12 August	10.30	Membership
Thursday	26 August	11:00	Publications
Wednesday	8 September	10.30	Executive
Wednesday	**22 September**	**10.30**	**Council**
Thursday	7 October	10.30	Meetings
Thursday	14 October	11.00	Publications
Tuesday	19 October	10.30	Engineering
Wednesday	20 October	10.30	Engineering
Thursday	28 October	10.30	Membership

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