Vol 39 No 4 July/August 2014

ACOUSTICS BULLETIN

in this issue… **Acoustic capacity as a means to deal with poor restaurant acoustics**

Institute of Acoustics
1974 - 2014

plus… **The complex wind speed referencing system in wind farm noise assessment**

No bearing on acoustics? Think again

Back to the Future – Part 3 – Aviation

ACOUSTICS BULLETIN

Vol 39 No 4 July/August 2014

Front cover photograph:
Restaurant noise is a well-known problem (Paul Prescott / Shutterstock.com).

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

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

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Conference programme 2014

4 July
Organised by the
Musical Acoustics Group
The acoustics of organs and the buildings in which they are housed
London

8 July
Organised by the Noise and Vibration Engineering Group
New technology for engineering noise control
London

17-19 September
Organised by the
Underwater Acoustics Group
Third international conference on synthetic aperture sonar and synthetic aperture radar
Lerici, Italy

14-15 October
Organised by the
Electro-Acoustics Group
Reproduced Sound 2014
Birmingham

15-16 October
Institute 40th Anniversary Conference
Birmingham

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

Dear Members

This is my last President's letter to you. At the AGM in July William Egan will be taking over as President, Trevor Cox will be stepping down as immediate past President, and Jo Webb will become President-elect.

As I reflect on my time as President I am only too aware of all those things I intended to do, and which I have failed to do. One was to get to at least one committee meeting of every group, branch and standing committee. However, I quickly realised that if I did that I would have little time for anything else. So apologies to all those committees that I have failed to visit. Being President has really brought home to me just how much time and effort is put in on a voluntary basis by our many committee members and I would like to thank you all, and all those other members who are involved in so many voluntary activities to ensure that the Institute thrives.

Another failure that I feel sad about is breaking my promise to you that we would have a conference at Windermere during my presidency. I had been looking forward to another trip to Windermere but sadly it has yet to happen – I do hope that it will sometime in the not too distant future.

We do of course have the 40th anniversary conference to look forward to in October. There was an excellent response to the call for papers, and every group has organised a lively session. Together with our distinguished guest speakers, Leo Beranek and Herman Steeneken, and several plenary medal lectures, it promises to be a stimulating and enjoyable few days. I would also like to remind the branches that they are still able to apply for £1,000 to support some activity in celebration of the anniversary. This should ideally be something which helps to raise the profile of the Institute and/or of the subject of acoustics outside of the usual branch activities and participants.

In recent years there have been some fairly major changes in the Institute. Early on in my presidency we appointed a new Chief Executive and I would like to thank Allan and the rest of the office staff for their hard work and support over the past two years. We really are very lucky in having such a loyal and well functioning team in St Albans. Among other things, we have now got our new website up and running which is enabling us to take various actions to attract new members and to widen our appeal to students, and should lead to an overall increase in efficiency and far less paperwork (which will please our new Sustainable Design Task Force).

One thing I will miss when I cease to be President is the opportunity to attend as many conferences and one day meetings as I like. I have enjoyed going to lots of interesting events, presenting our medals and awards, and getting to know many of you on these occasions. As I have just retired from my university post, I will now be joining the Senior Members' Group in its campaigning for low conference fees for pensioners, and for the timing of meetings so that we can all travel using our Senior Railcards.

Finally, I would like to thank my colleagues, past and present, on the Executive Committee and Council. It has been a real pleasure and privilege working with them all and I have greatly appreciated their help, support and friendship. I wish William every success as the next President and look forward to another two years working with him and the other members on Exec and on Council.

Most of all, thank you to all members. With your continued support and enthusiasm, the Institute should go from strength to strength for the next 40 years, and I look forward to seeing many of you at the conference in October.

Bridget

Bridget Shield, President

Lively debate over proposed changes to schools acoustic design standards

By Rory Sullivan

In April the IOA held a meeting at Bishopsgate in London to gauge members' feedback to the proposed draft acoustic document to replace BB93, presently titled *Acoustic Design of Schools – Performance standards 2014*. This related in particular to a number of key changes to Section 1.

The day featured presentations on the areas of change from Adrian James of Adrian James Acoustics, Andrew Parkin of Cundalls, Jack Harvie- Clark of Apex Acoustics, Richard Daniels of the Education Funding Agency, Emma Greenland of WSP and Don Oeters of Arup Acoustics.

The meeting was attended by almost 50 delegates, predominantly consultants, and included some lively debate at times. It allowed the committee to inform, defend or explain their decisions. The feedback from the meeting has formed the predominant part of the IOA formal response to the DfE. This can be viewed in the publications section of the Institute website under response to consultations.

The vast majority of the changes to the revised Section 1 were approved by the delegates. The key aspects discussed were:

- How the new standard generally encompasses the requirements for refurbishments and change of use was approved.
- There was also approval for the use of permitted exceptions as Alternative Performance Standards (APS), but to a minimum standard, so as to avoid indirect derogation from any required performance. These are presently considered as being moveable walls (=> 45 dB $D_{nT,w}$); interconnecting doors (=> 35 dB R_w) and associated wall (=>45 dB R_w) between teaching spaces, serving hatches (=>18 dB R_w); and vision panels for multi-purpose halls, music rooms and control rooms (=> 45 dB R_w) and associated walls (=>55 dB R_w).
- The performance requirements now expanded for refurbishments and change of use are generally relaxed by 5 dB compared with new build and will act as the minimum standard for APSs. This was, however, not considered sufficiently explicit within the draft and open to confusion, allowing potentially excessively high internal noise levels.
- The changes in general to the internal noise levels and associated matrix were accepted. This does result in some changes to the associated in-situ airborne or impact sound reduction requirements between adjacent spaces. Although many spaces remained the same, some spaces became more or less onerous, all by only 5 dB, whilst the highest in-situ airborne sound reduction is now 55 dB $D_{nT,w}$.
- The change from $D_{nT,w}$ or $L'_{nT,w}$ ($T_{mf,\,max}$) to 0.5 seconds (T_{mf}) raised much debate along with the lack of use of D_w. There was broad disagreement across the room as to which was most suitable, in respect to design, commissioning and over-penalising small rooms, which remained unresolved.
- The draft relaxes the reverberation requirement for sports halls from 1.5 to 2 seconds T_{mf}, and the potential for a deemed to satisfy design was generally welcomed, but with a note of caution with regard to special needs requirements.
- Rain noise is proposed to be included as a guidance requirement of +25 dB above the internal ambient noise levels.
- The use of a composite sound reduction for corridors walls (i.e. window, walls and ventilators), alongside a reduction in the ventilator requirements from classrooms was accepted.
- In terms of the building envelope the L_{A1} parameter as an internal noise limit is now proposed as removed, although there was a desire for some intermittent source parameter to be retained for sites adjacent to noise sources such as airports, Crossrail etc.
- The change in ventilation strategy away from building envelopes designed on specific season conditions, to number of hours required per year, was explained by Robert Pitchett of Cundalls. This created debate and confusion as to the method of calculation and whether a deemed-to-satisfy solution should be considered. It was clear that more information in respect to changing requirements outside of acoustics leaves this area in some flux, and therefore as to what school sites may, by default, be acceptable as naturally ventilated.
- For children with hearing and communication needs there was approval for stricter reverberation control for teaching spaces and within sports halls which widen the frequency range of averaging and adding some complexity.
- There was general approval for changes to the open plan teaching for STIs within critical listening/instruction and between groups, and for how this applied (i.e. not for the exception period when such spaces are not used for critical listening). There was less agreement for specific reverberation time limits for open plan areas and discussion as to how the needs for children with hearing and communication difficulties may be addressed.
- There was support for the movement of the open plan requirements out of the Building Regulations and its relationship with Building Control, to its inclusion in *Acoustic Design of Schools* supporting the School Premises Regulations and the Independent School Standards. This therefore becomes the responsibility of the client body, though the client body was not well defined.

There was some debate about the release of the associated Guidance document to Section 1 which is presently in a developed draft form and that it could be treated as a dynamic document potentially released by the end of May 2014 but there was little agreement from the members.

Overall, it was a positive meeting. Members appreciated that schools design solutions were moving with new requirements for children with special educational needs and flexibility in regard to build types was now more prominent since the introduction of free schools, and adapting the standard to accommodate natural or hybrid ventilation systems.


New acoustic standards for classrooms are on the way

Scottish wind farm noise meeting hits the quality mark for delegates

By Alistair Somerville

The Scottish Branch meeting on wind farm noise took place at the Crowne Plaza Hotel in Glasgow in May. It was opened and chaired by Alistair Somerville, Branch Chairman.

The meeting was structured to cover mainly the technical aspects and updates in the morning sessions and the local practical application/policy issues in the afternoon. This seemed to work well, with the afternoon speakers able to rely on the content provided in the morning sessions as a backdrop/context/understanding to make their practical application and policy points. Much of the technical content was similar to that which was reported in the May-June issue for the Institute's meeting in Newport, Wales, and therefore it will not be repeated here.

Andrew Bullmore gave the first presentation. He discussed blade swish and the generation of noise from the blades of the turbine on the downward slope and normal and atypical AM, with a variation of greater than 10 dB causing impulsive thumps which can be noticeable at distances of up to 1 km.

He was followed by Jeremy Bass from RES Ltd, who explained the development of the RenewableUK AM tool. This tool has been developed to rate an audio signal from wind farm sources and predict the likelihood of AM occurring.

Mike Stigwood talked about the long term monitoring MAS Environmental is undertaking at Cotton Farm wind farm. Ten months' worth of data from Cotton Farm has been considered in addition to data from two other sites to try to predict the occurrence of AM. He also gave an audio demonstration of the AM effect.

Richard Perkins gave an update on the final drafting of the IOA's six wind turbine supplementary guidance notes (SGNs). These are expected to be available in June, following approval by IOA Council. Richard explained that, whilst the main document had been endorsed by all four British governments, the IOA had retained editorial rights over the guide. It is intended to write to all British governments to seek further endorsement for the supplementary guidance notes. Richard gave an overview of each of the SGNs.

We were fortunate that Graham Marchbank, Principal Planner from Scottish Government, could attend and update the meeting on planning policy, its approach to renewable energy and to discuss several planning inquiry decisions. This included Barrogill Mains, Thurso, where the appeal was dismissed as the Reporter was not satisfied that the development would not give rise to unacceptable noise impacts, and additionally, that no background noise or wind speed data was available. Graham also discussed Hardyard Hill which had two conditions attached, one of which was specifically drafted to cover properties with a financial interest. He outlined research into 10 wind farms throughout Scotland where a large number had current complaints. The Scottish Government intends to review and analyse all data in connection with the wind farms, including consultation responses, submissions to planning inquiries, complaint information and any compliance measurements. It also intends to consider what might be different with the introduction of the Institute's Good Practice Guide (GPG).

Blade swish came under the microscope

Dick Bowdler discussed planning conditions and compliance testing. He reviewed a range of typical planning conditions along with the six tests, giving examples of difficulties in relation enforceability and precision. One condition was 4,100 words long. He amusingly observed that the whole GPG was only 2,600 words long.

Cameron Sutherland of Green Cat Renewables advised that it has been involved in more than 100 wind turbine projects in Scotland. A large percentage of these are in Aberdeenshire Council, which has adopted a simplified design noise criterion condition with a limit of 35 dB(A). He and two colleagues presented challenges in relation to compliance measurements and demonstrated this using their analysis of measurement data collected by them.

Chris Jordan was due to deliver a presentation on the content and assessment of wind turbine noise reports but unfortunately could not attend. At short notice Richard Perkins stood in and delivered Chris's presentation. Chris's experience of reviewing more than 400 reports was particularly helpful for local authorities tasked with considering noise reports submitted in support of wind turbine planning applications. Following a couple of suggestions in Chris's presentation, Alistair asked (1) whether any LAs present used directional analysis/filtering to help validate background noise data? (only one LA said it had done) and (2) whether any councils had considered grouping together to purchase 10 m masts? (none had).

The meeting concluded by Alistair leading a discussion on a number of contentious issues. He also took a show of hands vote on three specific questions: (1) Are the ESTU limits right? (2) Is current guidance re windshields clear enough? (3) Is the IOA the right body to take the lead on the wind farm noise debate and to continue developing understanding and guidance in this area, e.g. re AM? The meeting voted with clear majorities in relation to all questions. The ETSU limits are not right, the windshield guidance is inadequate and the Institute should take the lead in relation to wind turbine issues. As they say on *Question Time*, although interesting, this was the feeling of the meeting and not as a result of a carefully constructed poll!

We at the Institute are always interested to know who attends our meetings and whether they are hitting the mark in terms of quality. So I thought it would be interesting to look at some of the meeting "stats". Just under 60 delegates attended, with a good spread of interest groups represented: 40% from local authority; 35% consultants; and 25% industry. It is also worth noting that a high percentage (47%) of all Scottish local authorities were represented at the meeting. Feedback from those attending was very positive, with 96% of respondents stating that the quality of the presentations was either "good" or "excellent" and 50% stating that the coverage of the subject matter was "excellent", so a big thank you from the Institute to those who presented the papers.

Sound recording techniques and their influences on musical composition, interpretation, performance and appreciation

By Murray Campbell

The recently revitalised Musical Acoustics Group collaborated with the Electro-acoustics Group to organise this meeting on sound recording techniques, a topic of great interest to members of both groups. The meeting took place in March in the University of Salford's impressive new premises in the MediaCityUK complex in Salford. Thirty delegates attended, most of whom were university students. Thanks to the efforts of Trevor Cox and his colleagues at Salford, aided as ever by the indefatigable Linda Canty, the meeting provided an excellent and stimulating opportunity for experienced acousticians and sound engineers to meet with students entering the field, and to hear a number of very well prepared and delivered presentations.

The chairman of the Musical Acoustics Group, Mike Wright, was unfortunately unable to attend the meeting, but in a welcoming statement read by Murray Campbell he reviewed the profound influence which the process of sound recording has had on music. He noted that technological progress in the recording, manipulation and reproduction of sound has affected all genres of music, and raised some important questions about the relationship between technology and the art of music. He hoped that this meeting would be the start of further debate on such questions in the two groups. He reminded members that the Musical Acoustics Group had a very wide range of interests, including physical acoustics, music cognition, synthesis and computer analysis.

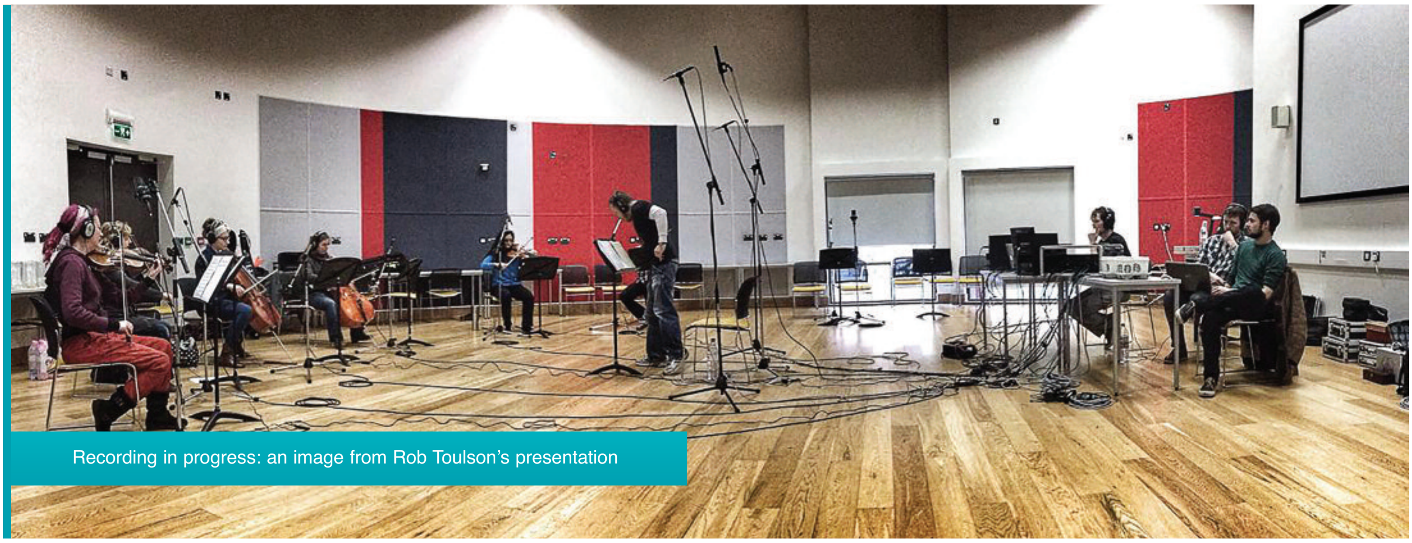
The first talk was given by Professor Patrick Gaydecki, from the School of Electrical and Electronic Engineering at the University of Manchester. Patrick has been involved for many years in the development of DSP hardware and associated software specifically designed to digitally synthesise the sound of stringed instruments, and his talk was entitled *From electric to acoustic violin: digital synthesis and emulation.* The talk explained that the tonal characteristics of a high quality violin were determined by the linear transfer function relating the time-dependent force on the bridge to the far-field radiated signal. The most recent version of a system designed to filter the raw output sound from an electric violin by convolving the signal with the impulse response of a Stradivarius violin was described and illustrated.

Dr Bruce Wiggins has for a number of years been teaching the fundamentals and applications of ambisonics to both BSc and BA students at the University of Derby. His talk was entitled *Practical ambisonics: the pros, cons and pitfalls of 3D audio* and covered a range of both mathematical and practical topics, including the use of sound field microphones, the problems which arise when audio effects are used to manipulate the sound field, and the difficulties of reproducing height information in a 3D sound system.

A sandwich lunch provided a valuable opportunity for informal discussions among participants, after which the meeting formally resumed with a talk on *Case studies in modern music production: where science meets art* by Dr Rob Toulson. Rob is Director of the Cultures of the Digital Economy Research Institute at Anglia Ruskin University, and he is also a respected musician and record producer. He presented a fascinating insight into the relationship between acoustical principles and experience-informed practice in the music production world, illustrated by his own work with recording groups such as the Mediaeval Babes.

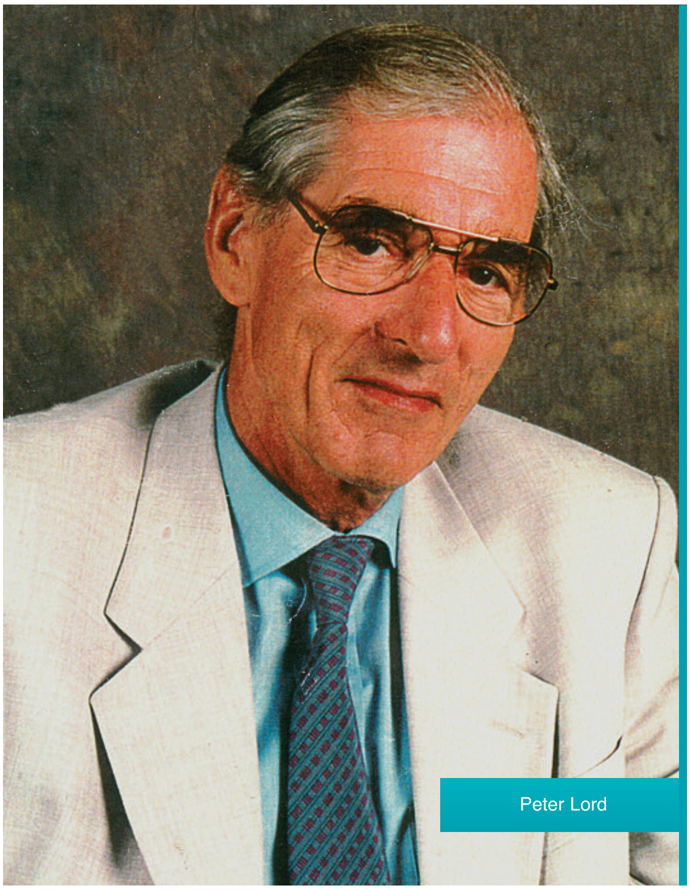
Professor Mark Plumbley, Director of the Centre for Digital Music at Queen Mary University of London, then gave a wide-ranging talk on *Analysing digital music.* Once a piece of performed music has been reduced to a sequence of bytes it is possible to bring to bear on the digitised signal an impressive array of computational analysis techniques, and Mark described how to separate out the sound of one voice or instrument from an ensemble, to extract specific notes from a mixture of music and noise, to track and transform beats, and to analyse and visualise the structure of a piece of recorded music.

The final talk was entitled *How distortion affects the perceived quality of music: psychoacoustic experiments.* It was presented by Trevor Cox, Professor of Acoustic Engineering at the University of Salford, and described work carried out together with Iain Jackson, Bruno Fazenda, Paul Kendrick, Stephen Groves-Kirby and Alex Wilson at the university's Acoustics Research Centre. The relative perceptual significance of hard and soft clipping of musical signals from many different genres was assessed using an analytical quality measure known as the Hearing Aid Speech Quality Index (HASQI), and the results compared with psychoacoustic tests. Although, as its name implies, HASQI was developed for the analysis of speech signals, it was found to be fairly robust as a measure of quality degradation in music. No significant difference between quality ratings for hard and soft clipped musical samples was identified.



Recording in progress: an image from Rob Toulson's presentation

Entries sought for new Peter Lord Award



Peter Lord

The Institute is introducing a new award in memory of Peter Lord, a former IOA President and founder member, who died in December 2012

Peter was a hugely influential figure in UK acoustics, being a driving force behind the setting up of the Institute, founder of the Applied Acoustics department at the University of Salford and first editor-in-chief of *Applied Acoustics*. The award is being introduced this summer so that the first award can hopefully be made at the 40th anniversary conference in October.

The award will be for a building, project or product that showcases outstanding and innovative acoustic design. It will normally be presented annually to the team or individual responsible for the acoustic design, and will consist of a plaque to be displayed on the winning construction or project (where possible), together with a trophy and certificate for the winning team or individual.

The Building Acoustics Group will be responsible for promoting the award and judging the entries. They will select and rank the top three entries. Their recommendations will then be forwarded to the Medals and Awards Committee. The deadline for nominations for 2014 is 31 July 2014, and for 2015 15 January 2015.

Details and a nomination form can be found in the medals and awards section on the IOA website which can be found under About Us.

North West Branch reports

By Michael Lotinga and Paul Freeborn

Sonic wonderland: a scientific odyssey of sound

In a slight departure from the norm, the branch's February meeting was held in association with the Manchester stem of Café Scientifique (http://www.cafescientifique.manchester.ac.uk), a discussion platform aimed at debating science issues outside typical academic environments. This meeting took place at the Kro Bar on the university stretch of Manchester's Oxford Road.

Professor Trevor Cox of the University of Salford (and former IOA president) ushered the audience to enter a world of unusual acoustic phenomena and exotic locations. The journey began in the Whispering Gallery of London's St Paul's before leaping back to prehistoric times, then hurtling forward again on the William Tell freeway in California, and on to pagan gatherings at Stonehenge; a brief stop off at the spherical spying station in Teufelsberg, Berlin (to whisper into one's own ears) was punctuated by the magical musical stalactites of the Luray Caverns, Virginia, ringing with the sounds of Chopin's Prelude, and the Keswick musical stones. Descending on Moroccan sand dunes accompanied by Marco Polo and Charles Darwin, the startled audience found themselves amongst bearded arctic seals before being coaxed back to acoustic reality via the surreal and haunting sound of soprano saxophone being played in the world record-breaking reverberation of the Inchindown oil tanks. This expedition was made all the more remarkable by the fact that Trevor had been the unfortunate participant in a traffic accident earlier the same day (see photo!), but despite the sling this made no apparent dent in his ability to convey the exciting and sometimes peculiar physics behind the world's varied acoustic environments.

This collaborative meeting was felt to be a success in terms of promoting awareness of acoustics amongst the wider scientific community, and it is hoped that future meetings may encourage greater contact between IOA members and other like-minded individuals and organisations.

The branch extends its thanks to Trevor and Dr Jonathan Hargreaves of the University of Salford, as well as to Penny Lewis of Café Scientifique. P12

Trevor Cox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◂P10

Uncertainty in sound insulation measurements

In April Dr Bill Whitfield presented the results of his research at Liverpool University's Acoustics Research Unit on *Uncertainty in sound insulation measurements*. The presentation offered a historical review of the standards relating to the measurement of sound insulation and in particular the guidance given to determine the accuracy (trueness and precision) of measurement methods and results. He focused on the current standard BS ISO 5725-2: 1994 for determining the repeatability and reproducibility and explained its limitations with particular reference to and the factors affecting reproducibility, namely different operators and different test kits.

The presentation explored more sophisticated statistical methods such as analysis of variance (ANOVA) and how the automobile industry has developed statistical methods for measurement system analysis (MSA) which can help determine the components of variance in the measurement process. Bill went on to explain how it was possible to strip out the components of variance, namely instrumentation, operators and part (in this case floors and walls), to get a better understanding of the factors contributing to the uncertainty of measurement, thus allowing the scientist to target improvements in the measurement process.

Bill concluded with a historic example showing how the uncertainty contribution could be determined with prior knowledge of the operator and instrument contributions.

Midlands Branch reports

By Kevin Howell

BS4142 Consultation

In April the Midlands Branch held at Derby University its second discussion session on the BS4142 Consultation Draft. The first had been held in Birmingham. In advance of the meeting members had been invited to respond to a survey to identify their priority areas for discussion. The well attended meeting then concentrated on these main issues and a very active debate resulted, chaired very ably, once again, by Richard Collman. A branch response was then prepared by the Secretary, based on the outcomes of the two meetings, and input directly to the BSI website. Thank you to all concerned.

Forensic analysis of speech and sound

The branch May evening meeting was held at the Arup Campus in Solihull. Philip Harrison (of JP French Associates and the University of York) entertained us with an excellent presentation on *Forensic analysis of speech and sound*. Philip is a forensic analyst specialising in the analysis of speech and audio recordings for legal proceedings. Common questions that arise from recordings are: Who was that speaking? What was said? What made that sound? Has the recording been edited? When exactly was the recording made? Philip has been involved in answering such questions and others for court cases in many different countries. He described the many types of analysis that are used in these investigations and illustrated these with reference to real life criminal cases. He covered newer developments including automatic speaker identification and the use of variations in the electric network frequency to accurately fix the time of the recording and detect editing. He finished off proceedings with a brief description of his, possibly highest profile, investigation into the attempted fraud on *Who Wants to be a Millionaire?* Many thanks go to Philip and to Olly Bewes at Arup.

Royal Festival Hall's restored organ hits the right notes

London Branch visit

By Richard Tyler

In May 25 members of London Branch assembled outside the artists' entrance of the Royal Festival Hall in London. They were not about to perform, but to take part in a very interesting demonstration of the revised acoustics of the building and the fully restored organ. Dr William McVicker, the organ curator, gave a lively and informative talk, describing how the original acoustics of the hall had been investigated, and the modifications that have taken place to improve the natural resonance of the building. The hall has always been thought too "dry" as designed, and even with the artificial "assisted resonance" that was installed and used up to 1999, the lack of audibility between the performers on stage and many other undesirable effects had launched the improvements that have now taken place. In order to achieve these, significant alterations to the stage area were made, which also involved removing the organ console from its original position, and positioning all the pipework closer to the rear wall, necessitating a complete rebuild of the entire organ structure. The 7,866 pipes were hand-cleaned and repaired where necessary, a new wooden frame was built, and the electrics, the bellows and wind blowing system were all overhauled.

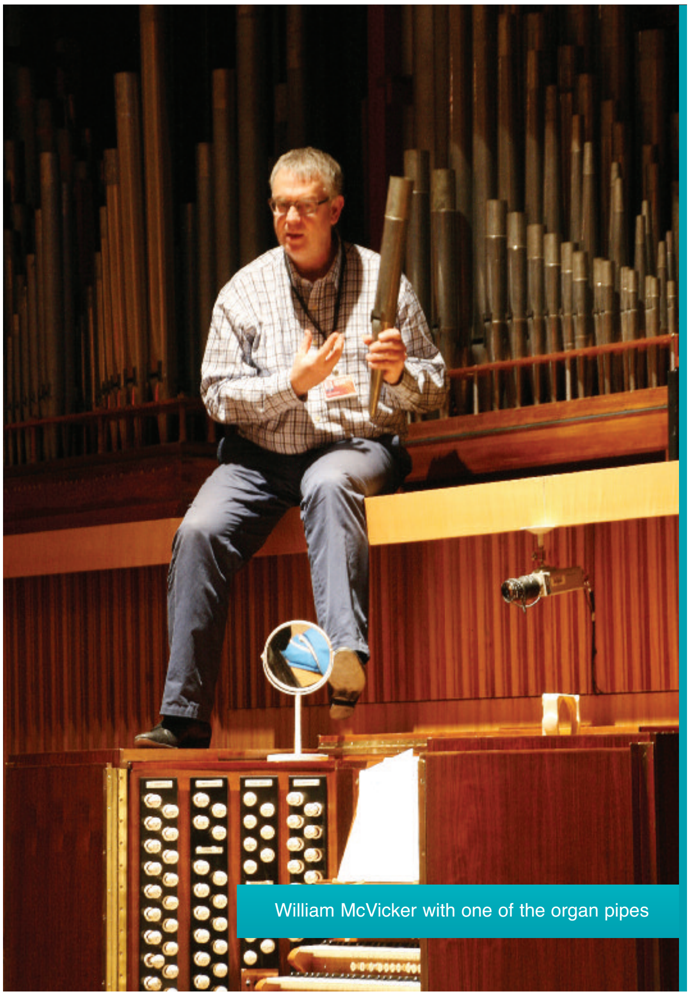
In 1954 the original organ, built by Harrison and Harrison in Durham, was installed after six years of development under the very careful direction of Ralph Downes, the first organist at the Royal Festival Hall. In 2005, the organ was removed entirely during the refurbishments, taken back to Harrison and Harrison, and the entire layout redesigned to fit the same number of pipes into a shallower recess behind the stage. This allowed not only a deeper stage, but different acoustic reflectors above the stage, and room for many more singers behind the orchestra when choral works are being performed. It also removed one other problem which was that when the stage was raised for ballet productions. The top of the original organ console position was such that it still projected above the height of the stage by a small amount, and Dr McVicker reported that many a dancer had been heard to curse as they knocked their ankles on it when leaving the stage. He went on to describe how many of the low-frequency pipes were thought not to be working, but in fact were generating plenty of sound which was promptly absorbed by the wall coverings to such an extent that they became almost inaudible. The changes made to the wall claddings, timber panelling and seats were found to now allow these pipes to speak as originally intended.

The cost of redesigning the organ was large. Not all the money was available at the time of refurbishment of the Hall, so about a third of the organ was originally returned in 2007, and successful fundraising to the tune of £2.3 million continued whilst the rest of ▸

the organ was in store. The completed restoration was first heard in March 2014, and has received many favourable reports. In the original design Ralph Downes went to great lengths to try to design an organ that used design principles which belonged to many older Continental organs, but which were almost unknown in English organ building at the time, so much so that many of the early original pipes were almost "experiments". Dr McVicker pointed out that these could be identified as a progression to more expert pipe design and building as new ranks of pipes were added during the construction of the original organ. These pipe designs, as well as the revolutionary layout of spreading the pipework right across the full width of the hall, rather than in a tall case in the centre of the stage, made significant challenges to the organ builders at the time, but the investigations carried out during the restoration showed that they had risen to the challenge with great enthusiasm and success. This approach started what has become the English Organ Reform Movement and has led to many new instruments following Downes's ideas being constructed in the UK. As discussed and then demonstrated by Dr McVicker, few changes were needed to the pipes themselves, the challenge was to fit them all in a smaller space with no detriment to their ability to speak and make a balanced sound across the whole instrument.

Over a further 45 minutes, in addition to playing a few short pieces, Dr McVicker also climbed up to the pipework and removed several to demonstrate the different types of pipe construction and the materials used and discussed the layout of the pipes and the specifications that Ralph Downes had originated and how these sounded today. He then invited anyone interested to have a short play, and Richard Tyler, Chairman of the Measurement and Instrumentation Group, made a short foray onto the full instrument,(not quite the sort of instrument the Group usually deals with!) with Dr McVicker adding more and more stops to make a very loud climax to the visit.

Our thanks go to the Royal Festival Hall and especially to Dr McVicker for a lively and informative presentation. As the requests to join the visit were oversubscribed, it is hoped to organise a return visit later this year, as numbers visiting at any one time are restricted.


William McVicker with one of the organ pipes


William McVicker in action

Tool time and a review of vibration tool timers

By Simon Bull and Will Vernon

Very often in this feature we are looking into measuring the magnitude of sound or vibration in the best possible way and with the fewest errors. In this article, I am going to assume that you already have reliable numbers available. The purpose here is to simply review the products currently available for assessing tool usage time and to uncover the methodology used.

Tool timer methodology

Let's get this clear at the beginning: no tool timer currently available on the market has the capability to measure vibration levels; you need to determine the magnitude separately. This can be achieved using either manufacturer's data – providing you understand the limitations of such – website databases, peer-group sharing or your own measured levels – definitely the best way, but that's for another day!

Most of the tool timer devices do include an accelerometer but this is simply to sense for the operation of the tool. These accelerometers are usually MEMS (chip based) and do not have the specification needed to take measurements to ISO8041:2005, nor do any of the systems report the acceleration value anyway. There are systems available that measure the vibration level over time, such as the Svantek dosemeter and the CVK glove system, but these are not in the scope of this article.

So what's the point?

Measuring an employee's exposure time to vibration is an essential part of a vibration risk assessment, whether you do it manually with a stopwatch or automatically with a tool timer. The point is that no matter how good your vibration measurements are, the final exposure number you arrive at (the A(8) – weighted eight hour acceleration value) is only ever going to be as good as your ability to measure the exposure time!

What tool timers are there on the market?

Currently, to the best knowledge of the authors, there are only four dedicated tool-timer products available on the market. Depending on your requirements, they offer differences in methodology, application, size, appearance and cost and all have their pros and cons!

The Curo

The Curo is a rugged piece of equipment; easy to set-up and use, it is attached to the tool via a permanently fitted holster, which is either glued or cable-tied on. Holsters are programmed with the vibration magnitudes for the tool and each worker is allocated a Curo. The employee will then "clip" the Curo onto each tool they use and is notified by a clear LED indicator at the EAV (100 points) and the ELV (400 points) – when the light goes red, work must stop! Holsters are programmed by a separate device, which comes with software and also allows for simple data transfer from the Curo to a PC, so exposure times can be logged and stored for management action and future reporting.

Pros and cons. The Curo is certainly a robust unit and collects and stores all the data required for HAVs management. The only downside is the lack of a "points" display and the fact that the red LED is fixed to either 100 or 400 points. There is no charging to worry about although the battery cannot be changed so replacements will be needed after 12 to 18 months.

The HAVi

The HAVi is the quickest and cheapest way to set up and go with vibration exposure measurements. There is no software to worry about, with users simply entering results into a HAVi Log Book. This solution, once implemented, allows workers to manage their own exposure. There is a metal cover available for added ruggedness and a Manager Pack can be purchased, which includes all the documents and information you need to comply with the Control of Vibration at Work Regulations (2005).

Pros and cons. The HAVi has all the information directly available on-screen and is very simple to use. It is also cost-effective although each unit will need replacing every 12 to 18 months as the battery runs out. On the negative side, the operator does have to manually enter the vibration level for each tool, but this is quickly learned.

The Havmeter

The Havmeter is the most advanced vibration exposure measurement system, which is reflected in the initial cost. The Havmeters are charged in a Base Station where data are also transferred into an SD card post-measurement. The SD card is then inserted into a PC and data can be viewed with the "ToolMinder" software. "Tool Tags" are programmed and glued to each tool and employees are allocated a swipe card, which links the person with the Havmeter unit. Each card can even be programmed with a different maximum daily 'points' allowance.

Pros and cons. The HAV meter may be costly, but is the most automated system available and, once installed, will provide for the most robust reporting. The units do last longer too, with battery life of up to five years. The only reported downside other than the initial cost is that the HAV meter can be knocked off the tool although there is a strap available now to help with this.

Tool timers (pneumatic/electric)

The original method of counting vibration exposure time, these "tool timers" plug into the power (air/electricity) supply of the tool, detecting the trigger time of the worker by measuring the time for which the supply is flowing. This method gives a good assessment of "trigger time" and is also useful for tool maintenance. With no additional device attached to the tool. This is the most user friendly system available, simple to set up and use straight out of the box. Workers simply use the tools as they normally would.

Pros and cons. These tool timers are so easy to use and provide the information directly on the display with nothing to press – simply a key to reset the time. The obvious downside is that the time doesn't necessarily relate directly to an employee, so you do have to know what you are measuring!

Conclusion

There is no clear winner when comparing these products, although it is quite possible that each one may suit any individual application or customer more than the others. There are some factors to consider:

- Are you planning on using tool timers for continuous measurements as a HAVS prevention system, or for a fixed term as part of a risk assessment?
- How many employees and tools are you looking to monitor?
- What kind of tools do you use?
- Are you interested in training workers to measure their own exposure, or would you rather keep the responsibility in the hands of managers?

The authors

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Simon is Managing Director of Castle Group Ltd, which specialises in compliance solutions for health, safety and environment issues. Simon trained in Business Studies at Leeds, and has worked for the past 20 years in the health and safety and environmental arenas. He regularly presents on related subjects. He is a member of the Institute of Acoustics, where he is an active member of the Measurement and Instrumentation Group committee. He is also a Member of the Institution of Diagnostic Engineers as well as an Associate Member of IOSH.

Will Vernon
Will Vernon is a recent graduate of Hull University where he achieved upper second-class honours in BA Business. After successfully completing a three month internship at Castle Group Ltd he was offered the permanent position of Marketing Executive, to oversee the external communication of the group's main brands.

Within this role Will has been trained in various subjects relating to Castle's operations, one of which is vibration, covering making measurements, and monitoring vibration exposure.

Aviation set to enter a new era as latest electric plane takes to the skies

First there was the electric car; now comes the electric plane. The Airbus E-Fan, the latest in a group for all-electric aircraft, has made its first public test flight, in France.

Although in the near term it is intended to be a training aircraft, Airbus hopes that the technology behind it will eventually allow it to develop a hybrid-electrical regional plane that could seat 70 to 90 people.

The two-seater E-Fan is equipped with two lithium-ion polymer batteries (250 volts total) which provides 60 kilowatts of power to its electric motors which drive a variable pitch fan.

The plane can fly for up to about 45 minutes, but Airbus says that it can eventually get that flying time closer to 75 minutes.

Although noise emission data are not yet available, the aircraft is said to be far quieter during take-off and landing than a similarly sized combustion-powered aircraft.

Airbus says its development forms part of its response to help the industry meet the European Commission's target of cutting aviation noise levels by 65 per cent between 2000 and 2050 (and reduce carbon dioxide and nitrous oxide emissions).

The E-Fan

Bickerdike Allen hold nerve to lift the Acoustics Cup

Acoustic consultancies across southern England gathered in Bishops Stortford for the Acoustics Cup, Campbell Associates' annual five-a-side football competition.

The line-up comprised Sharps Redmore, Pace Acoustics, AIRO, Bickerdike Allen, SRL, Sandy Brown, Cole Jarman, Stansted Environmental and newcomers RBA and Xodus.

After a goalless final Bickerdike Allen, who had lost in the final on penalties two years, ago held their nerve to win the trophy 3-1 in a penalty shoot-out against RBA Acoustics

There was a separate plate completion for the remaining teams. This was also decided penalties in the final, with AIRO beating Sharps Redmore 1–0 after a 1-1 draw.

The player of the tournament was named as Ignacio Alonso of RBA Acoustics

The event raised £1,147 for Grove Cottage, a Mencap centre in Bishops Stortford, which has passed on its appreciation and gratitude to all the teams.

If you want to enter a team next year contact **john@campbell-associates.co.uk**


Over the moon: the successful Bickerdike Allen squad

The quest for glory: action from a match

Civil Aviation Authority unveils blueprint to manage aircraft noise

The UK Civil Aviation Authority (CAA) has published a series of recommendations to help drive improvements in the way the aviation industry manages aircraft noise.

With the Airports Commission currently considering proposals for increasing the UK's aviation capacity, the CAA says it is clear that the industry will not be able to grow unless it first tackles its noise and other environmental impacts more effectively.

To help drive improvements from the industry, the CAA has published *Managing Aviation Noise*, a document setting out a series of recommendations to help reduce, mitigate and compensate communities for aviation noise.

The recommendations cover changes airports and airlines could make now, as well as improvements policy-makers and industry could make ahead of any future increases in capacity. There is a strong focus on making sure airports work with their local communities more closely, as well as operational changes and ideas for incentivising airlines to reduce the noise impact of their flights.

Key recommendations for the aviation industry include:

- Airports and airlines should ensure that operational approaches to mitigate noise are incentivised and adopted wherever feasible. The CAA will work with industry to consider, trial and promote novel operational approaches to noise minimisation.
- When looking to expand, airports should do more to ensure local residents see benefits from additional capacity – whether through funding community schemes, direct payments, or tax breaks.
- Airports seeking expansion should significantly increase spending on noise mitigation schemes to get closer to international competitors – including full insulation for those most affected.
- Airlines should focus on noise performance when purchasing new aircraft.
- Airports should structure their landing charges to incentivise airlines to operate cleaner, quieter flights.

In addition, the document proposes creating a new Airport Community Engagement Forum bringing together local residents, the aviation industry, policy makers and planners focussed on how new capacity can developed and operated to minimise noise impacts and maximise community benefits, rather than whether it should be built.

Iain Osborne, Group Director for Regulatory Policy at the CAA, said: "Very many people in the UK are already affected by aviation noise and it's clear that unless the industry tackles this issue more effectively, it won't be able to grow. The recommendations we're making will help the industry to reduce and mitigate its noise impact, whilst also making sure the communities affected by aircraft noise are fairly compensated and feel much more involved in the way their airport operates.

"We believe these measures could make a real difference to people living near airports today, as well as ensuring any future decisions on aviation capacity increases take full account of the impact of aviation noise on people's quality of life."

For more information please visit: **www.caa.co.uk/noise**

Noise pollution software makes good CENSE

New software has been developed to rate the health risks of different activities in the urban environment, for example, cycling or driving in different areas of a city.

CENSE is based on a variety of different pollutants and environmental health hazards encountered in urban environments and may provide a useful tool for urban planning and improving residents' quality of life, its developers say.

Individuals living in urban environments can be exposed to environmental factors, such as air and noise pollution, which may have severe effects on health. However, people are often exposed to a range of different health hazards simultaneously and it can be difficult for decision makers to understand the overall risk and effectively mitigate its effects.

CENSE is the first software capable of assessing combined exposure to environmental health stressors in outdoor urban settings for individuals. It produces easy-to-understand ratings of combined exposure levels for different activities, such as driving, cycling and walking along a particular urban route.

Results are displayed as symbols on a colour-graded scale. For example, cycling a particular route might be classified as "unhealthy" for the individual, owing to stressors such as air pollution and this is displayed as a cycling symbol at the red end of the scale. By contrast, reduced exposure levels inside vehicles driving the same route might be classified as "very good" – displayed as a driving symbol at the green end of the same scale.

To produce the ratings, the researchers used two key indicators. The first, the combined exposure indicator, integrates exposure to a variety of pollutants including hydrocarbons, fine particles, noise and radiation. The second, the combined exposure and dose indicator, considers personal exposures based on activities, accounting for the duration of each activity. This indicator also takes into account breathing volumes based on the effort level of the activity.

In this way it becomes possible to compare the exposure of two people – one cycling for 10 minutes and another standing outside for an hour – in the same environment, although currently the approach does not allow for balancing the negative effects of higher exposure during heavy exercise against the physiological benefits of exercise.

This report is based on one that first appeared in *Science in the Environment.*

New European guidance on quiet areas

A new European Environment Agency (EEA) report, *Good practice guide on quiet areas*, provides guidance and recommendations for authorities who need to identify and maintain these places.

Hans Bruyninckx, EEA Executive Director, said: "When we think about noise pollution, we often think about loud music or a neighbour's barking dog. But in most cases, the real health problems are caused by long-term exposure to noise from road traffic, railways, airports or industry. Quiet areas are important because they can provide respite from noise, ultimately improving quality of life."

There are many different interpretations of what a quiet area means in practice, and how they should be preserved. This is understandable – an appropriate scheme in one place may not suit another location. The report provides an overview of quiet area measures across Europe. For example:

- In Dublin, Ireland, the City Council combined noise modelling and measurement to identify long term average noise levels below the levels that harm health, subsequently designating and protecting eight quiet areas in the city
- In Oslo, Norway, authorities asked "key persons" with knowledge of potential areas and mapped noise to identify 14 areas of quiet that are easily accessible by local people
- A slightly different approach was taken in Tallinn, Estonia, where many different criteria were used to identify recreational areas in or with low average levels of long-term noise.

Elsewhere, the scheme also aims to protect rural areas undisturbed by noise from traffic, industry or recreational activities.

The report can be found at **http://www.eea.europa.eu/publications/good-practice-guide-on-quiet-areas**

Another approach to the problem of noise is the idea of soundscapes, creating healthier and quieter environments. The European Soundscape Award 2014 aims to draw attention to the most innovative product, campaign, innovation or scheme solving a noise problem.

The award is a joint initiative of the European Environment Agency (EEA) and the Noise Abatement Societies of the Netherlands and UK. The deadline for submissions is 18 August 2014. For more information go to **http://www.eea.europa.eu/themes/noise/the-european-soundscape-award**

Later in 2014, the European Environment Agency will publish its first Europe-wide noise assessment report. It will draw on data from Member States, highlighting the main sources of noise in Europe as well as its impacts on health and the environment.


chrisdorney / Shutterstock.com

New guidance is available to protect quiet areas

Sonar could be used by scientists to spot invisible Arctic oil spills

Sound could be used to spot Artic oil spills, say scientists after warnings that the next big leak could be out of sight. Climate warming has packs of Arctic sea ice in retreat, opening up vast areas for oil and gas drilling off northern Alaska. That is posing a new problem for spill detectors: there is still a lot of ice in the region, and people cannot see through it.

It is feared that a giant slick similar to the one that appeared in the Gulf of Mexico after the Deepwater Horizon oil rig blowout in 2010 would likely be shielded by miles of drifting ice.

One answer could be to use sound rather than sight. High-frequency sonar chirps can reveal oil underneath ice, even when it is sandwiched between ice layers. Christopher Bassett, a postdoctoral researcher at Woods Hole Oceanographic Institution, said: “We were able to distinguish two different signatures: oil together with ice versus just ice alone.”

He and colleagues presented their work at a recent meeting of the Acoustical Society of America (ASA). Other researchers showed that sonar was sensitive enough to detect even tiny leaks, down to the level of individual oil and gas bubbles.

Flying spotting planes or sending scout ships may not find oil spills after they have drifted miles from their origins, Bassett said. The oil could be hidden under moving packs of seasonal ice that form and melt every year in the region – hidden from visual observation, that is.

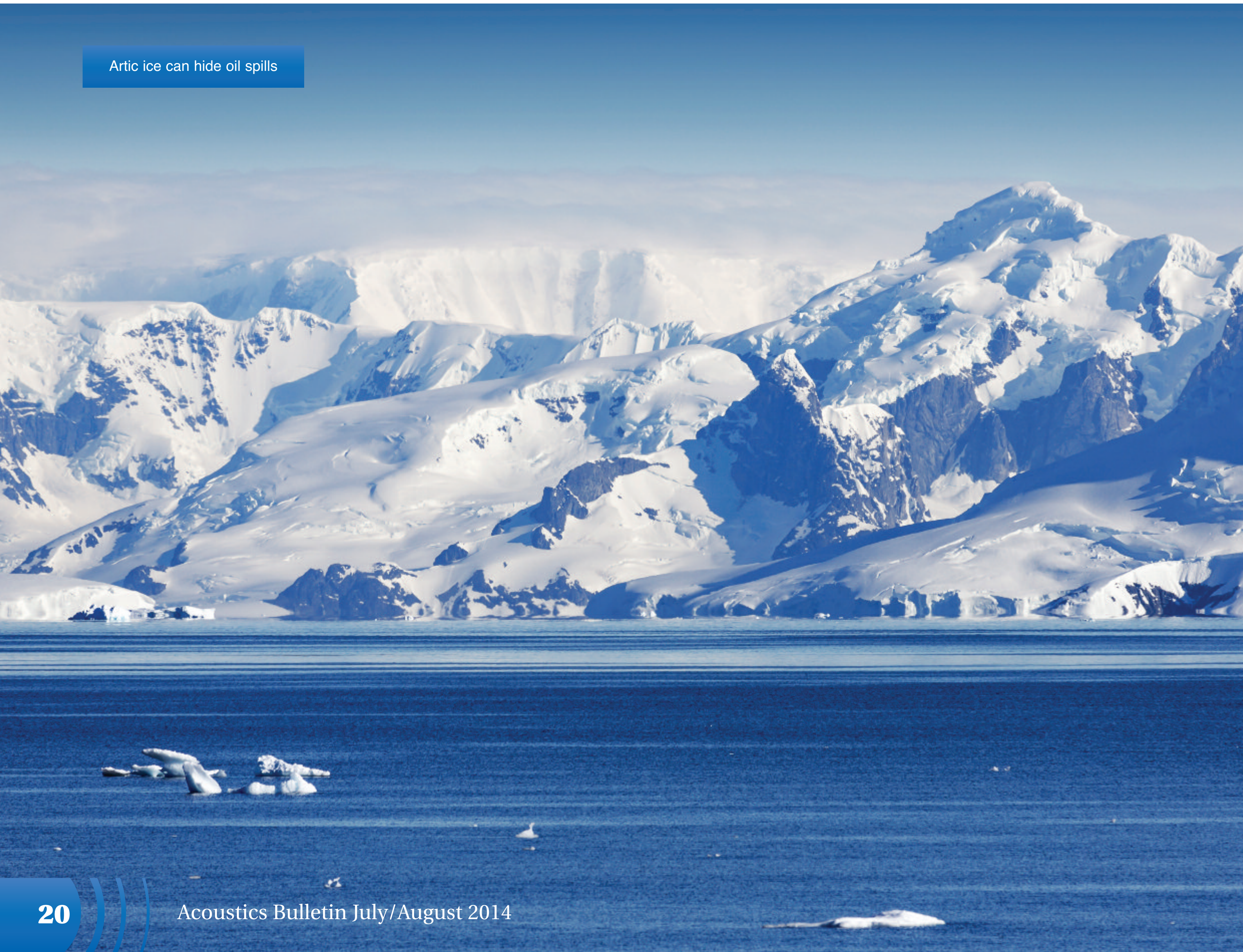
But not from sound waves. In a cold seawater tank in Hamburg, Germany, Bassett and his group grew a 12-centimeter-thick layer of ice. Then they squirted 50 litres of North Sea crude oil under it and continued to freeze the water until they had created an ice and oil sandwich.

At the bottom of the tank, about a metre away, they placed several sonar emitters, aimed them at the ice and analyzed the echoes. Unlike the single-frequency sound waves used in commercial depth sounders and fish finders, these instruments gave off a quickly ascending burst of frequencies, spanning a range from 200 kilohertz up to one megahertz. The broad band of frequencies allowed the scientists to trace different kinds of echoes from the same spot. That gave them more information about the material that made up each target. Bare ice, it turned out, looked different on a sonar plot than did oil under ice or oil trapped within ice.

At the ASA meeting, Geir Pedersen of Christian Michelsen Research, Norway, showed they could use multi-frequency sonar to monitor streams of bubbles from leaks.

He and colleagues placed equipment five metres away from pipes leaking vegetable oil in a Norwegian fjord. “At that range we could detect down to single bubbles and oil droplets,” said Pedersen. The technique could be particularly useful for finding the source of a subsurface leak.

This report is based on one that first appeared in *Scientific American.*



Artic ice can hide oil spills

New good practice guide for underwater noise measurement

The National Physical Laboratory has published a *Good Practice Guide for Underwater Noise Measurement*, which aims to present best practice for in-situ measurement of underwater sound, data processing and the reporting of the measurements using appropriate metrics.

Measured noise levels are sometimes difficult to compare because of the use of different measurement methodologies or acoustic metrics, and results can take on different meanings depending on the application. This leads to a risk of misunderstandings between scientists from different disciplines.

Acoustical oceanography, sonar, geophysical exploration, underwater communications and offshore engineering all require acoustic measurements. More recently, there has been an increased need to make in-situ measurements of underwater noise for the assessment of risk to marine life, such as whales and dolphins.

The guide addresses the need for a common approach and the desire to promote best practice. It is designed for those making in-situ measurements of underwater sound, for example consultants, offshore developers, oil and gas companies, and developers of marine renewable energy, as well as regulators wishing to base their requirements on a firm scientific foundation.

A free electronic copy can be downloaded at bit.ly/RL55MU

Teachers' opinions on schools acoustics wanted in an online survey

The Acoustics Group at London South Bank University is running an online survey of teachers, to gather more information about the acoustics of schools and possible links with general health or voice problems.

They are keen for as many teachers as possible to take part (whether or not they experience voice or health problems). If you have contacts who are school teachers, former or retired teachers, please could you invite them to participate.

The survey is anonymous and takes about 15 minutes to complete via **www.survey.bris.ac.uk/lsbu/voicesurvey**

If you have any questions please contact the researcher, Nick Durup (**durupn@lsbu.ac.uk**).

Company fined after staff develop Hand Arm Vibration Syndrome

A company responsible for maintaining the grounds of a naval base has been fined £10,000 after three workers were diagnosed with a debilitating condition that left them with permanent nerve damage.

The three men, who do not wish to be named, were employed by Babcock Flagship to maintain the grounds at HMS Raleigh in Torpoint, Cornwall, where they were exposed to high levels of hand arm vibration (HAV) caused by using tools such as hedge cutters and strimmers for long periods.

Truro Magistrates Court heard that all three were diagnosed with Hand Arm Vibration Syndrome (HAVS) or Carpal Tunnel Syndrome (CTS) by occupational health providers in January 2012.

An investigation by the Health and Safety Executive (HSE) revealed the company was aware each worker had vibration-related conditions or health issues that could be aggravated by vibration, having had health surveillance reports between 2009 and 2011.

The court was told, however, that Babcock Flagship failed to put control measures in place before or after the condition was identified in the workers.

HSE said the company did not properly assess the vibration risks faced by staff using hedge cutters, strimmers and other tools and failed to implement suitable controls, such as limiting their exposure to such machinery or providing alternatives. Grounds maintenance staff could regularly work eight hours a day using the same tools.

The court heard the permanent damage caused to the three men's health had a significant impact on their ability to work and their quality of life.

Babcock Flagship was fined a total of £10,000 and ordered to pay £10,000 in costs after admitting two breaches of the Control of Vibration at Work Regulations 2005.

Speaking after the hearing, HSE Inspector Emma O'Hara said: "Almost half of all the ill-health reports sent to HSE relate to Hand Arm Vibration and Carpal Tunnel Syndrome associated with working with vibrating tools, many from the horticulture industry.

"Babcock Flagship Ltd failed to take action – despite the warning signs raised in earlier health surveillance reports – to prevent the physical damage caused by prolonged use of such tools, causing these three workers pain and discomfort.

"Babcock Flagship should have properly assessed the level of vibration to which these workers were exposed and limited the amount of time they spent using tools such as hedge cutters and strimmers."

Scientists create tractor beam made of sound

Acoustical engineers, led by Christine Démoré and Patrick Dahl at the University of Dundee, have developed an acoustic tractor beam that can reel in centimeter-size objects.

The device is a square array of about a thousand ultrasound emitters placed at the bottom of a water-filled chamber. In their experiments, detailed in *Physical Review Letters*, the researchers used the array to pull in hollow triangular objects.

To pull the objects, the array generates a low-pressure zone in front of the targets. For the array to work, it must have sound emitters spaced far enough apart to bounce sound waves off the backside of a target.

When it does, sound waves can ricochet off the rear part of an item – after reflecting off the target, the waves continue forward in the direction they were traveling, helping to push the object they hit toward the array. For example, if the device faced the flat side of a triangular object, emitters facing the item would emit sound waves against its sloping backsides.

While the acoustic tractor beam blows away its predecessors, it pulls with just millinewtons of force – thousandths of the force exerted by a falling, medium-size apple.

Furthermore, the acoustic tractor beam would have problems with objects that do not have a backside sticking out – for example, if the tractor beam had to deal with a flat board face-on. The acoustic tractor beam also will not work in space, as vacuum does not carry sound.

New quiet deliveries guide 'could cut rush hour road congestion'

New guidance has been published by the Department for Transport to help freight operators make more out-of-hours deliveries.

Quiet deliveries was developed following successful trials held by local councils before and during the London 2012 Olympic and Paralympic Games.

Transport Minister Stephen Hammond said: "The London 2012 Games were extremely successful and proved that with the right planning, we could reduce the number of delivery vehicles on the road at key times when roads are likely to be more congested, such as rush hour.

"The guidance helps freight operators and retailers plan their deliveries using techniques to minimise disturbance to residents and will help to free up peak time road space for other road users and reduce congestion. It will also help reduce the impact of carbon emissions and lead to more reliable delivery schedules."

Trials of out-of-hours deliveries were held by local authorities in 2010 and a temporary code of practice was issued in 2012 by Transport for London for the Olympic Games.

The new guidance builds on that by setting out the benefits from quiet deliveries and provides a comprehensive guide to establishing a scheme. It consists of separate sections for retailers, hauliers, local authorities and construction firms. A further section for community groups will follow shortly.

The guidance is available on GOV.UK.

Ultrasound used to destroy reservoir algae

Ultrasonic waves are being used to kill off algae at an English reservoir. Sembcorp Bournemouth Water (SBW) has installed an ultrasonic algae control system at Longham Lakes, Dorset.

The system, supplied by Dutch company LG Sound, is used widely in mainland Europe but is the first to be installed by an English water company.

The ultrasonic waves "pop" the air bubbles in the algae causing it to lose buoyancy and sink to the bottom of the lake and die.

The system is run on solar energy, requires no chemicals and has no harmful effects for fish, water plants and insects.

It comprises a buoy which monitors water quality every 10 minutes. Based on information received, the ultrasound transmitters are activated.

Tim Latcham, Head of Water Supply, said the system was installed in February and has been fully operational since March.

"We're working closely with the supplier who is able to fine-tune the sound frequencies to deal with specific outbreaks of algae," he said.

"It's early days and we haven't hit the peak time for algae but following the first significant outbreak, we've already seen a dramatic reduction which is very encouraging."

For more details go to **http://www.lgsonic.com**

The buoy in action

'Silent' inflatable wind turbines on the way?

Could this floating wind turbine sound the death knell for the traditional wind farm?

Altaeros Energies, a US start-up company, has developed a helium-filled, cylindrical blimp 35 ft in diameter that encases a three-blade wind turbine. It is tethered to the ground by cables which are used to transfer the energy it produces.

It sits at between 1,000 to 2,000 feet in the air where the wind is up to eight times stronger. Because the turbines can access these high-altitude winds, they generate roughly double the energy of standard turbines.

Ben Case, a company spokesman, said: "We have not done any quantitative noise measurements during testing, but qualitatively, the two key differences are that 1) the noise is lessened by the higher altitude and helium-filled shroud, and 2) the noise generated is higher frequency than traditional turbines due to the higher RPM turbine."

The invention, known as a BAT (buoyant air turbine), could have a major impact in remote places off the grid where residents have to use expensive diesel generators.

The turbines could serve as sources of internet connectivity and cellphone service and they will also be able to provide weather data to communities.

The BAT turbine

New noise rating system for New Zealand cafés and restaurants

Noisy cafes and restaurants in New Zealand are being "named and shamed" by diners in a new scheme aimed at making eating out a better experience.

The Acoustical Society of New Zealand has introduced a Café and Restaurant Acoustical Index (CRAI) under which eateries are rated by diners according to their acoustics environment.

"Restaurants and cafés are engaged in a perpetual competition for good reviews," it said. "Most reviews focus on food and service, but seldom mention noise.

"The CRAI rating system aims to provide the public with the ability to match the type of eating experience they want with the acoustic environment.

"If you're heading out on a Friday night with a few mates for a nosh up with a couple of beers, you probably want a fairly boisterous venue. Come Sunday evening, when you're celebrating your wedding anniversary over a candlelit banquet with an expensive bottle of red, your requirements are somewhat different."

Under the scheme, diners rate eateries on a scale of between one and five – the higher the score, the quieter the venue. Results are sent to the society which publishes them on its website and in its quarterly journal. For more information go to **www.acoustics.org.nz**

In search of the perfect sound: the UK's largest horn loudspeaker

The UK's largest horn loudspeaker is the centrepiece of a new art installation at the Science Museum, London, where it is on display until 27 July.

The colossal Denman Horn is 27ft long – it is the same length as a Routemaster bus – and has a 7ft 1in square mouth.

Originally commissioned in the 1929, it was built to establish a benchmark in audio quality. Throughout the 1930s the exhibit was a popular highlight of the museum daily tours, but it was destroyed in an accident in 1949.

It was painstakingly rebuilt over a period of eight months by the museum's workshops team. Made from 12mm thick fibreglass, it features a 9ft section from the original made from a much heavier metallic alloy.

Aleks Kolkowski, the museum's sound artist-in-residence, said: "This audio leviathan, seemingly primed to blast through the museum walls, instead offers up a uniquely immersive aural experience, one in which sounds and voices from the past and present converge."

Aleks Kolkowski with the giant horn
Photo: Science Museum

Acoustic capacity as a means to deal with poor restaurant acoustics

By Jens Holger Rindel, FIOA of Odeon A/S, Scion-DTU, Denmark and Multiconsult AS, Norway

Introduction

Noise in restaurants is a widespread and well-known problem, and in the last issue of *Acoustics Bulletin* (March/April 2014, p. 20) we read about a recent investigation into the problem. When many people are gathered for dining or other social reasons, the verbal conversation causes an ambient noise that in some cases can grow to such high levels that the quality of conversation suffers and can result in a bad experience. This is particularly true for elderly people or other people with reduced hearing ability.

This article presents some recent findings concerning the Lombard effect, which is an inherent part of the problem, and a simple model based on the assumption of a diffuse sound field. Described next is a more general room acoustic simulation method that allows estimating the ambient noise level due to many people speaking. The concept of "acoustic capacity" is introduced as a means for evaluation of the results in a way which is easily understood by architects and restaurant owners.

The Lombard effect – a simple model

It is a well-known phenomenon that many people speaking in a room can create a high sound level, because the ambient noise from the other people speaking means that everyone raises their voice, which again leads to a higher ambient noise level. This effect is called the Lombard effect after the French otolaryngologist Étienne Lombard (1869 – 1920), who, in 1909, was the first to observe and report that people with normal hearing raised their voice when subjected to noise.

The increase of the speech level as a function of the A-weighted ambient noise level is described by the rate c (the Lombard slope). The Lombard effect starts at an ambient noise level around 45 dB and a speech level of 55 dB. Assuming a linear relationship for noise levels above 45 dB, the speech level can be expressed in the equation:

$$L_{S,A,1m} = 55 + c\cdot(L_{N,A} - 45),\ \ \text{(dB)} \qquad (1)$$

where LN,A is the ambient noise level and c is the Lombard slope. The valid range for this relationship is limited to speech levels above 55 dB or noise levels above 45 dB.

Applying simple assumptions concerning sound radiation and a diffuse sound field in the room a calculation model for the ambient noise level was derived in [1]. By comparison with several independent cases of measured data covering a wide range of number of people present, it was found that only the Lombard slope c = 0.5 could make a reasonable agreement with the measured data. Different values of the Lombard slope are reported in the literature, and often the data behind are statistically weak or cover a range of variation, which is too narrow for a precise result.

The suggested simple prediction model can be expressed in the equation:

$$L_{N,A} = 93 - 20\log\left(\frac{A}{N_S}\right) = 93 - 20\log\left(\frac{A\cdot g}{N}\right),\ \ \text{(dB)} \qquad (2)$$

where A is the equivalent absorption area (in m2) of the room and NS is the number of simultaneously speaking persons. The sound absorption per person should be included, and this depends on the clothing; typical values are from 0.2 to 0.5 m2. However, the contribution of absorption from people is often of minor importance and can be neglected [1].

A very interesting consequence of (2) is that the ambient noise level increases by 6 dB for each doubling of the number of individuals present. The same result was found by Gardner already in 1971 [2]. Another interesting consequence is an unusual strong influence of the amount of absorption in the room; doubling the absorption area leads to a 6 dB decrease of the ambient noise level.

Fig. 1 shows both the ambient noise level and the speech level as functions of the absorption area per speaking person. However, in general only the total number of people N present in the room is known, and thus it is convenient to introduce the group size, defined as the average number of people per speaking person, $g = N / N_S$. This parameter contains all the lesser known properties, such as the kind of gathering, whether the people are young or old, how well they know each other, whether alcohol is consumed, etc. From a number of cases where measured data could be compared to predicted levels, it is found that in restaurants the typical group size is around three or four, with a minimum value of 2.5 for a noisy bistro. In large dining places, the average value of 3.5 is a good guess, and this is the value recommended for noise prediction in a restaurant.

Quality of verbal communication in a noisy environment

For the evaluation of acoustic quality of a restaurant it is suggested to consider the quality of verbal communication, which can be related to the signal-to-noise ratio (SNR), see Lazarus [3]. Thus a SNR between 3 dB and 9 dB is characterized as "good", and the range between 0 dB and 3 dB is "satisfactory". A SNR below -3 dB is characterized as "insufficient".

A simple approach is suggested here, namely to define the signal-to-noise ratio as the level difference between the direct sound from a speaking person in a distance of 1.0 m and the ambient noise in the room. Thus, the SNR is the difference between the two curves shown in Fig. 1. By use of (1) and (2) the SNR can be expressed in terms of the absorption area per speaking person [1]:

$$SNR = L_{S,A,1m} - L_{N,A} = -14 + 10\log\left(\frac{A\cdot g}{N}\right),\ \ \text{(dB)} \qquad (3)$$

This applies to A-weighted noise levels between 45 dB and 85 dB, or a range of the speech levels between 55 dB and 75 dB. The corresponding range of SNR is between +10 dB and -10 dB.

"Satisfactory" verbal communication (SNR ≥ 0 dB) requires about 6-8 m2 absorption area per person, and the double amount is required for "good" verbal communication. By use of Sabine's equation the SNR and thus the quality of verbal communication can be displayed as a function of reverberation time and volume per person, see Fig. 2.

Acoustic capacity for restaurants

It is sometimes difficult to convey acoustical facts and recommendations to architects and in particular to restaurant owners. So, instead of talking about reverberation times or noise levels, the concept of "acoustic capacity" for an eating facility has been introduced [4]. It is defined as the maximum number of persons in the room for "sufficient" quality of verbal communication.

Sufficient quality of verbal communication requires that the SNR is better than -3 dB, or that the ambient noise level is below 71 dB. From the results in Fig. 2 it follows that the acoustic capacity is approximately:

$$N_{\max} \cong \frac{V}{20\cdot T} \qquad (4)$$

where V is the volume in m3 and T is the reverberation P28

P27 time in seconds at mid frequencies (unoccupied). This is the maximum number of people in the restaurant if the noise level shall not exceed the limit for sufficient quality of verbal communication. Thus, it is possible to have a conversation across a 1 m wide table. However, when the number of people exceeds this limit, e.g. to the double, the expected ambient noise level is raised by 6 dB to around 77 dB, and verbal communication requires a closer distance. It is still possible to have a conversation with the person sitting next to you within a distance of 0.5 m, but not across a wide table. The expected ambient noise level as a function of the number of people relative to the acoustic capacity is shown in Fig. 3.

It may be argued that the assumption of 1 m distance between the people to communicate is too strict for a restaurant. Of course this distance depends on the size and shape of the tables where people are sitting, and many restaurants have smaller tables. On the other hand, the above considerations are related to normal-hearing people. For hearing-impaired people or older people the acoustical conditions may be less satisfactory. If the principles of "universal design" are followed, the design should fulfil the needs of an average 80-year-old person. So, there are good reasons to keep relatively high ambitions when using the acoustic capacity.

A simulation model without restraints on room geometry

In many cases the volume and/or the reverberation time are not well defined, and thus the above equations cannot be used. Instead it is possible to use a room acoustic simulation program. First a room model must be created with absorption data for the different surfaces. The principle is then to define a surface source representing the area where people are sitting, and let this source emit the sound power and spectrum of speech (e.g. raised or loud voice as defined in [5]). A grid of receivers is placed just below the surface source, and the median (50% percentile) of the A-weighted sound pressure level is calculated. In this way, a kind of transfer function is determined from the room acoustic simulation. The next step is to enter the number of simultaneously speaking persons, i.e. the total number of people divided by the assumed group size; then the simulation will give the corresponding ambient noise level. The method is described in detail in [6], which also contains more information about cases, where measurements are compared to calculations, see Table 1.

The three halls are located at the Technical University of Denmark, and the measurements were made during the annual celebrations in May 2011. The reverberation times were very different, ranging from 0.8 s to 2.5 s at mid frequencies in furnished but unoccupied state. The sound pressure levels were monitored in three positions in each hall during the whole evening. The measurements started at 19:00 and after about half an hour the noise level had reached a level which remained stable for several hours. As seen in Table 1, the calculated noise levels using the ODEON simulation are within ± 1 dB of the measured results.

Conclusion

A simple prediction model for the ambient noise due to speech in eating establishments is presented. The model takes the Lombard effect into account, and it has been verified for several test cases. The main uncertainty in the prediction model is connected to the parameter called group size, which is the average number of people per speaking person. For noise predictions in typical restaurants and similar places a group size of 3.5 is recommended. Being a statistical model, it should not be applied for rooms with less than 50 people.

For the characterization of the acoustical conditions the quality of verbal communication is applied, using the signal-to-noise ratio for a speaker in a distance of 1.0 m as an objective parameter. The limit for sufficient conditions, namely a signal-to-noise ratio of -3 dB, is suggested as a basis for design. This leads to a combined requirement for the reverberation time and the P30

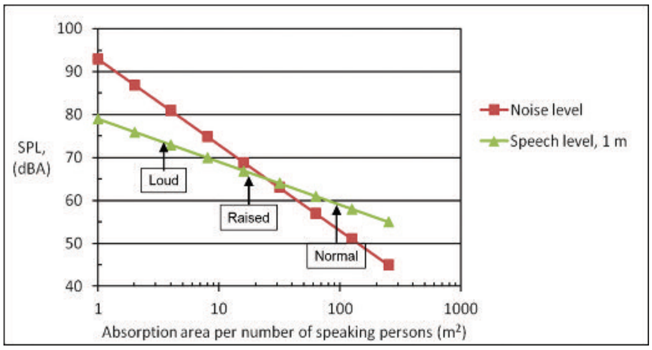


Figure 1. The ambient sound pressure level and the speech level 1 m in front of the mouth, as functions of the absorption are per speaking persons. Vocal efforts normal, raised and loud are indicated as defined in ANSI 3.5 [5].

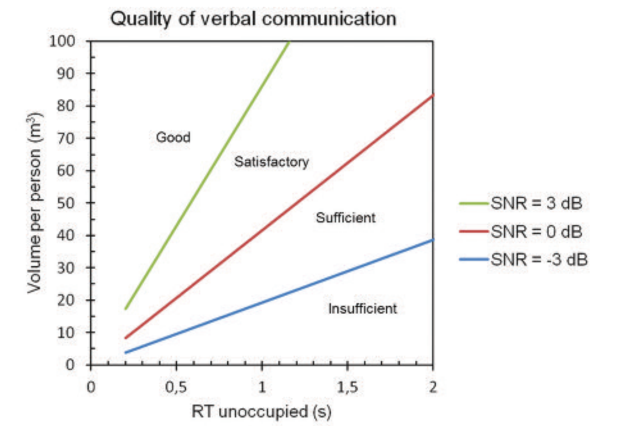


Figure 2. The quality of verbal communication displayed as function of reverberation time and volume.

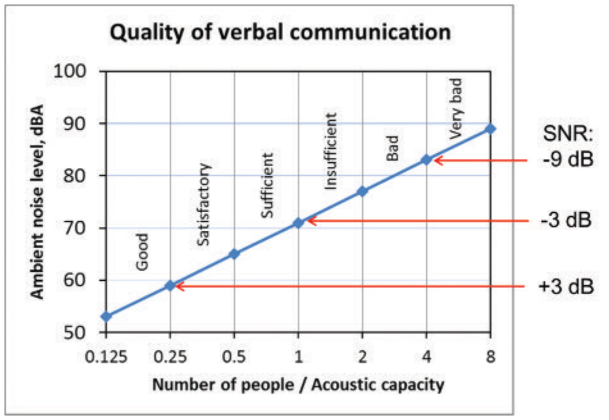


Figure 3. The relation between ambient noise level and number of people relative to the acoustic capacity. Also shown are the regions of different quality of verbal communication.

	Number of people	Reverber-ation times	Measured $L_{A,eq}$ (20:00 - 22:00) dBA	Simulated (Raised voice) dBA	Simulated (Loud voice) dBA
Hall A	480	2.5	87.3	87.9	87.7
Hall B	530	0.8	82.5	82.8	83.4
Hall C	380	1.0	82.9	82.9	83.1

Table 1. Results from measurements of noise in three dining rooms, and the calculated ambient noise level using the simulation method described in [6].


Sports Hall
Central Sussex College
Haywards Heath
EchoCheck
...the high performance UK size acoustic block
The new UK size high performance
Class C acoustic block by
Colinwell
Architectural Masonry since 1888
OSCAR
ACOUSTICS
For Ireland enquires contact Colinwell:
028 9061 8145 - www.colinwellconcrete.com
For Great Britain enquires contact Oscar:
01474 854 902 - www.oscar-acoustics.co.uk

◄ P28 volume; the reverberation time should be as short as possible, but in addition a large volume is necessary. The volume per person should be at least T ·20 m³, where T is the reverberation time in s. So, a basic condition for a restaurant is a high ceiling, and sound absorbing treatment must be applied not only to the ceiling, but also to other surfaces in the room.

It is not necessary to assume a diffuse sound. An efficient simulation method has been developed to estimate the ambient noise level in a restaurant with a certain number of guests, also in cases where the volume and the reverberation time are not well defined because of a complicated geometry. Using the simulation model has the additional advantage that the effect of various acoustic treatments such as screens or absorption materials can be compared and evaluated, and this can be done in terms of the acoustic capacity.

It is clear that the acoustical problems in a restaurant depend strongly on the number of people present in the room. So, in addition to the design guide for the acoustical treatment of rooms, it is suggested introducing the "acoustic capacity" of a room as information about what number of people allows an adequate quality of verbal communication. In other words, if the number of people in the room exceeds the acoustic capacity, the quality of verbal communication must be expected to be inadequate, and many guests will leave the restaurant with a bad experience.

References

1. J.H. Rindel: Verbal communication and noise in eating establishments. *Applied Acoustics*, 2010, Vol. 71, pp. 1156-1161.
2. M.B. Gardner: Factors Affecting Individual and Group Levels in Verbal Communication. *J. Audio. Eng. Soc.* 19, 560-569, (1971).
3. H. Lazarus: Prediction of Verbal Communication in Noise - A Development of Generalized SIL Curves and the Quality of Communication (Part 2). Applied Acoustics 1987, 20, 245-261.
4. J.H. Rindel: Acoustical capacity as a means of noise control in eating establishments. Proceedings of BNAM 2012, Odense, Denmark, 18-20 June 2012
5. ANSI 3.5-1997. *American National Standard – Methods for Calculation of the Speech Intelligibility Index*, (1997).
6. J.H. Rindel, C.L. Christensen, A.C. Gade: Dynamic sound source for simulating the Lombard effect in room acoustic modeling software. Proceedings of Internoise 2012, New York, USA, August 2012

The complex wind speed referencing system in wind farm noise assessment

By Moise Coulon AMIOA of TNEI Services

Abstract

Wind farm noise assessments are a complex mix of acoustic and wind resource work. Wind speed and noise data needs to be measured and analysed, and both need to be correlated. The noise measurement location during a background survey is an agreed parameter in the industry, using a microphone (covered with a suitable wind shield) recording at 1.2-1.5m height above the ground installed at a number of representative receptors which are typically residences surrounding a proposed wind farm. However, the measurement of wind speed is still widely discussed.

It is considered accepted practice for wind speed measurements to be undertaken within the wind farm site. In 1996, ETSU-R-97[1] introduced 10m height wind speed measurements as a requirement in the standard for background surveys for wind farms in the UK. As wind turbines increased in size, it was acknowledged that it was essential to account for site specific wind shear, that is the difference in wind speed which exists between 10m height and the proposed (or operational) turbine hub height. The hub height is the height determining the speed of the turbines and the level of noise emitted. Various methods were used between 2004[2] and 2009 to account for this effect. In 2009, a method for assessments where large mast data are available during the noise survey was proposed in an article in 2009 in *Acoustics Bulletin*[3] which was then adopted by most practitioners and accepted by planning inspectors to represent good practice. When no large mast data are available and only 10m masts are available during a background survey, other alternative methods have to be employed. The method put forward in article was reiterated in May 2013 in a more official form in the Institute of Acoustics' Good Practice Guide[4] (IOA GPG) which was endorsed by Government. So between 2009 and 2013, wind shear and the methods for wind speed measurements were hot topics in the wind farm industry. As illustrated by two articles in *Acoustics Bulletin* (September-October 2013 and November-December 2013), where opposing views are expressed, the merits of alternative approaches continue to be debated. This technical contribution takes a small step back from the ongoing debate, to look at the concept of wind speed measurements for a wind farm noise assessment and thereafter relates to how these concepts are applied in practice.

A generic 10m height referencing system

Wind speeds are very frequently stamped with the word "standardised" in wind farm noise. The concept was introduced in IEC 61400-11[5] Edition 1 in 1998 as a 10m height wind speed referencing system. It is a generic mathematic formulae for adjusting a given wind speed (usually recorded in m/s) measured at a high height (>10m) to a notional equivalent wind speed (m/s) at a lower height of 10m. Adjusting the wind speeds results in a shift of the noise curve on the wind speed axis (where the x axis=wind speed and y axis=noise level). The formula only has two variables, a height above 10m and a wind speed measured at that height. As an example, a wind speed of 8m/s measured by an anemometer at 80m height always results in 5.7m/s wind speed standardised to 10m height. And 8m/s measured at 60m always results in 6m/s standardised at 10m height. The generic formula was introduced so that the reported sound power curves (and future predictions based on that curve) could be relatively comparable to background noise surveys, which used a 10m mast at the time. During an IEC 61400-11 survey, the noise level of the tested turbine is correlated to wind speed calculated from the power curve, which is essentially the hub height wind speed. For the purpose of reporting the results of the test, the standard (Ed1 1998 and Ed2.1 2006) specified that calculated sound power levels should be correlated to an adjusted 10m height notional equivalent wind speed (i.e. not the actual measured wind speed at hub height). The formula is well documented and the process well known, the use of the word "standardised" being widely used in wind farm noise. However, its meaning is often misunderstood. Standardised wind speeds do not account for site specific shear. Standardised wind speed should be seen as a representation of hub height, a downgraded hub height wind speed. It has no physical value as ►

opposed to the hub height wind speed which it refers to. In practice the words "standardised 10m wind speed" are often used on their own, without any context of the higher height they refer to. If using these words for reporting, it is essential to state the higher height of reference. As an example, for measurements made on a mast at anemometers at 80m height during a survey, wind speed can be reported as "80m height wind speeds standardised to 10m height for reporting". In this example it is clear that the 80m height wind speed is the origin, and the standardised 10m wind speed is only a downgraded version created for reporting. Because of the standardisation process, instead of having one sound power level curve valid for any hub height, we see multiplication of sound power curves which creates issues of multiplication of data and traceability. Figure 1 illustrates this point with one example based on data reported at various height in the Appendices of one single IEC 61400-11 report[6].

The need for a generic 10m height referencing system is becoming less relevant as one can now measure at or near hub height with tall masts or remote sensing devices which were not as practicable in 1996-1998 when the 10m height referencing system was instigated. In fact the new IEC 61400-11 Edition 3 (2013) requires sound power level curves to be reported referenced to hub height wind speed (it was always measured that way but until recently not always reported) as well as being referenced against wind speeds as standardised to 10m height. Hereafter in this article, only hub height wind speed is used and if one prefers to think "standardised", as a simplification think about it as being the same as hub height as you always need to know hub height first before being able to create a "standardised" representation of it.

Consideration of wind speed measurements across all phases of a wind farm noise assessment

Table 1 lists three generic methods (not wind farm specific) which can be used for correlating noise with wind speed measurements.

A proxy measure can be defined as "alternative choice of measure, used when a better measure is not available"[7]. Applying this definition, methods WS1 or WS2 which do not rely on a proxy may be seen as preferable. It is a reasoning which also applies for the collection of noise data; a sound level meter located at the property to be assessed will offer the most specific results for that property, as opposed to a sound level meter installed at a proxy location. The use of proxy is practical and sometimes necessary, which is why WS3 is considered here.

In the context of a wind farm noise assessment, there are three main phases which all require careful consideration of wind speeds. These are listed in Table 2.

It is important that noise is correlated to wind speed consistently across these three phases, for consistency and to avoid discrepancies. If for example WS1 is used during a background survey, wind speed referencing from predictions and a follow up compliance survey should also ideally be in accordance with WS1.

Method WS1 is widely used in wind farm noise assessments. It is prescribed by IEC 61400-11 and the IOA GPG. The IOA GPG provides recommendations for measurements during Phase 1 and Phase 3, and IEC 61400-11 for Phase 2. Both prescribe that wind speed measurement should be made at (or near to) hub height (where turbine noise is emitted) at the turbine site during noise measurements. IEC 61400-11 is firm that noise measurements have to be correlated with hub height wind speeds during the survey. The IOA GPG is more flexible but clearly recommend measurements at (or near to) hub height during a noise survey (background or compliance). If the height of measurement is not quite the desired hub height, a power law extrapolation is used to estimate wind speed at the desired hub height. This should not be considered as a proxy measure (i.e. unlike method WS3) as the extrapolation is done for every 10min data based on anemometer readings at two relatively high heights both well above the ground and well above 10m. A 1.9% mean difference when P32

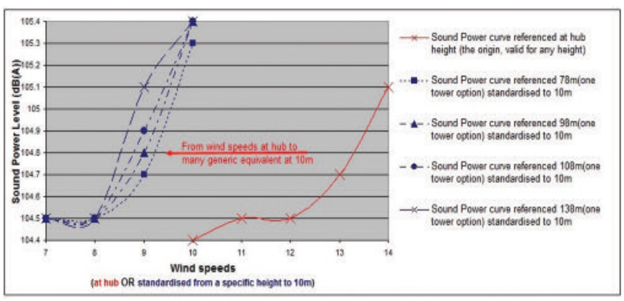


Figure 1 - From one curve at hub to many standardised 10m curves

Method	Method description
WS1	Correlate noise with wind speed where the noise is emitted (source)
WS2	Correlate noise with wind speed where the noise is received (receiver)
WS3	Correlate noise with wind speed at a proxy, which is neither where noise is emitted nor received

Table 1: Methods for correlating noise with wind speed

Phase	Phase description
Phase 1	Survey in the absence of wind turbines (background survey for a proposed wind farm)
Phase 2	Predictions of wind turbine noise, based on sound power data established from a survey in the presence of a single turbine (IEC 61400-11)
Phase 3	Survey in the presence of an operational wind farm (compliance survey)

Table 2: Assessment phases requiring careful consideration of wind speed

◄P31 comparing extrapolated 40/60 against measured 80m was reported in a paper at EWEC 2010[8]. As an example, in a situation where a proposed turbine would have an 80m hub height and only a 60m tall mast was installed during the background noise survey, every 10 min wind speed from the anemometers at 40m and 60m would be used to extrapolate to 80m (desired hub height) wind speed. This extrapolation is often required as measurements at 80-100m are not as widely available compared to measurements up to 60m height. If the mast was ideally as high as 80m in the above example, then the values from the anemometers at 80m provide the wind speed as measured directly at the desired hub height.

Method WS2 is not used in wind farm noise assessments. It would require measurement of wind speed at approximately 1.5m height above the ground at each receiver, basically next to each of the installed sound level meters. This would allow an assessment of the masking noise potential, which is not possible using the other methods. One important consideration is that in the three phases of wind farm assessment, sound power curves (used in Phase 2) relate to the location of the source, not to the location of the receiver. Sound power level curves are and will always be related to the source location, therefore to hub height wind speeds in the case of wind turbines. Whilst it is possible to adjust sound power curve (or indeed prediction curves) from wind speed experienced at the receptor to wind speed experienced at the hub height, this would require a complex site specific analysis. In this particular case, wind speed would ideally need to be measured at (or near to) the desired hub height but also at each receptors 1.5m above the ground (next to each installed noise kits). Average wind shear coefficients would be calculated from such data and then be applied to adjust the wind speeds from hub height to each receptor. For increased accuracy, large period (months) of such data is preferable to establish representative shear coefficients. Correlating noise with wind speed at the receiver is impractical and will continue to be so.

Method WS3 is very practical and is therefore widely used. In practice wind farm noise assessments have relied (since 1997) and still rely (post 2009 *Acoustics Bulletin* article and post IOA GPG) on wind speed measured only at one height of 10m. A 10m height measured wind speed should be considered as a proxy wind speed measurement. There are two reasons for this: the height of measurement and the location of the mast. The height of 10m is neither hub height (unless the assessment is considering a small turbine) nor the height of the noise meter microphone, typically 1.2-1.5m above the ground. When a 10m mast is used, only one single mast is installed on the turbine site, not a number of masts installed at each receiver (usually quite some distance away). Also, measurement at a height of 10m is influenced by local obstacles. Woodland, for example, can be as high as or higher than 10m and can influence the measurements. So if a 10m measurement is meant to be representative of where the noise is emitted, sometimes 70m or more above 10m, it may suffer the influence of local obstacles which measurements at higher heights would be less influenced by. Since 2009, most wind farm noise assessments which rely solely on a 10m mast during the noise survey adjust wind speed in some form to account for the site specific difference between 10m and the desired hub height. This can be done either by adjusting the wind speed reference for the background/limit from 10m to hub height or the other way around by adjusting the wind speed reference for the sound power curve/predictions from hub height to 10m. The adjustment may be a basic +-2m/s shift for example but preferably would rely on analysis of long term wind speed data from a large mast installed before or after the background noise survey at or near the proposed site. Such wind shear analysis would aim to calculate mean wind shear coefficients to represent the shift in wind speed from 10m to desired hub (which could be 60,70,80m...). The precision of such calculation largely depends on the amount of long term data available and at which heights the data was measured. For example, measurements taken directly at 10m are rare on long term wind resource masts so it is frequent to have to rely on long term data measured at 20m and 50m height to estimate shear between 10m and 80m. This adjustment from 10m measured to hub height wind speed is not to account for the discrepancies in wind speed between where the noise is emitted and received; it is an adjustment to relate all results with reference to the noise source location. If one mast measuring at a height of 10m at one central location was used to represent the receiver location, uncertainty would be associated with the various local obstacles and terrain between the mast location and the 1.5m height receiver locations and it would be complex (see WS2 above) to adjust it from 10m height to an equivalent wind speed experienced at the receptor.

Summary of the complex wind speed referencing system with reference to current and past practice:

Figure 2 (page 33) illustrates the methods currently recommended in the IOA GPG whilst Table 3 summarise practices pre 2009 and post 2009, in relation to the three phases and the three methods detailed above.

Conclusion

Proxy wind speed measurements are very practical and commonly used, however these have limitations. The use of 10m measurements should be considered to be proxy (unless applied to very small turbines) and there are no evident scientific reasons which would justify in a wind farm noise assessment the choice of such proxy over more reliable measurements at greater height which are not a proxy. Direct 10m height measurements became the norm only because 10m height masts were practical, economical and widely available at the time, not because it related in the most precise possible way to the source or the receiver. In fact, it has been demonstrated that 10m height measurements relates to neither.

As it stands, every wind farm noise assessment in the UK use a hub height wind speed of some sort at one point, and then as a final stage converts it to an estimate at 10m height. This final step is sometimes misinterpreted by some which feel that this means that 10m height is considered (as per ETSU-R-97). P35►

	Pre 2009 UK common practice (no site specific shear)	Post 2009 UK preferred good practice (which accounts for site specific shear)	Post 2009 UK alternative good practice (which accounts for site specific shear)
Phase 1	WS3	WS1	WS3*
Phase 2	WS1 adjusted down to WS3 with generic assumption ("standardised")	WS1	WS1 adjusted down to WS3 with site specific shear. The shear is usually based on the calculated average of long term wind shear if available or a conservative estimate*
Phase 3	WS3	WS1	WS3*
Pros	One 10m mast is practical, economical and widely available.	Use of WS1 across all phases No adjustment required	One 10m mast is practical economical and widely available.
Cons	No site specific adjustment to consider wind shear.	Requires measurements at higher heights, more expensive than 10m masts	Complex adjustment required. Potential for inaccuracies largely dependant on quality of long term local wind speed data.

* Assumes adjustments are made to the sound power curve/predictions. In the case that adjustment are made to the background/limit, then Phase1&3 will use WS1 adjusted, and Phase2 will be WS1 not adjusted.

Table 3: Summary of some wind speed measurements methods used in wind farm noise assessments

01dB

Advanced noise & vibration measurement

CUBE ▪ DUO ▪ FUSION

Comprehensive range of smart products to enhance productivity

Acoustic1

www.acoustic1.co.uk - sales@acoustic1.co.uk - 01550 777925

01dB
Brand of ACOEM

www.acoemgroup.com

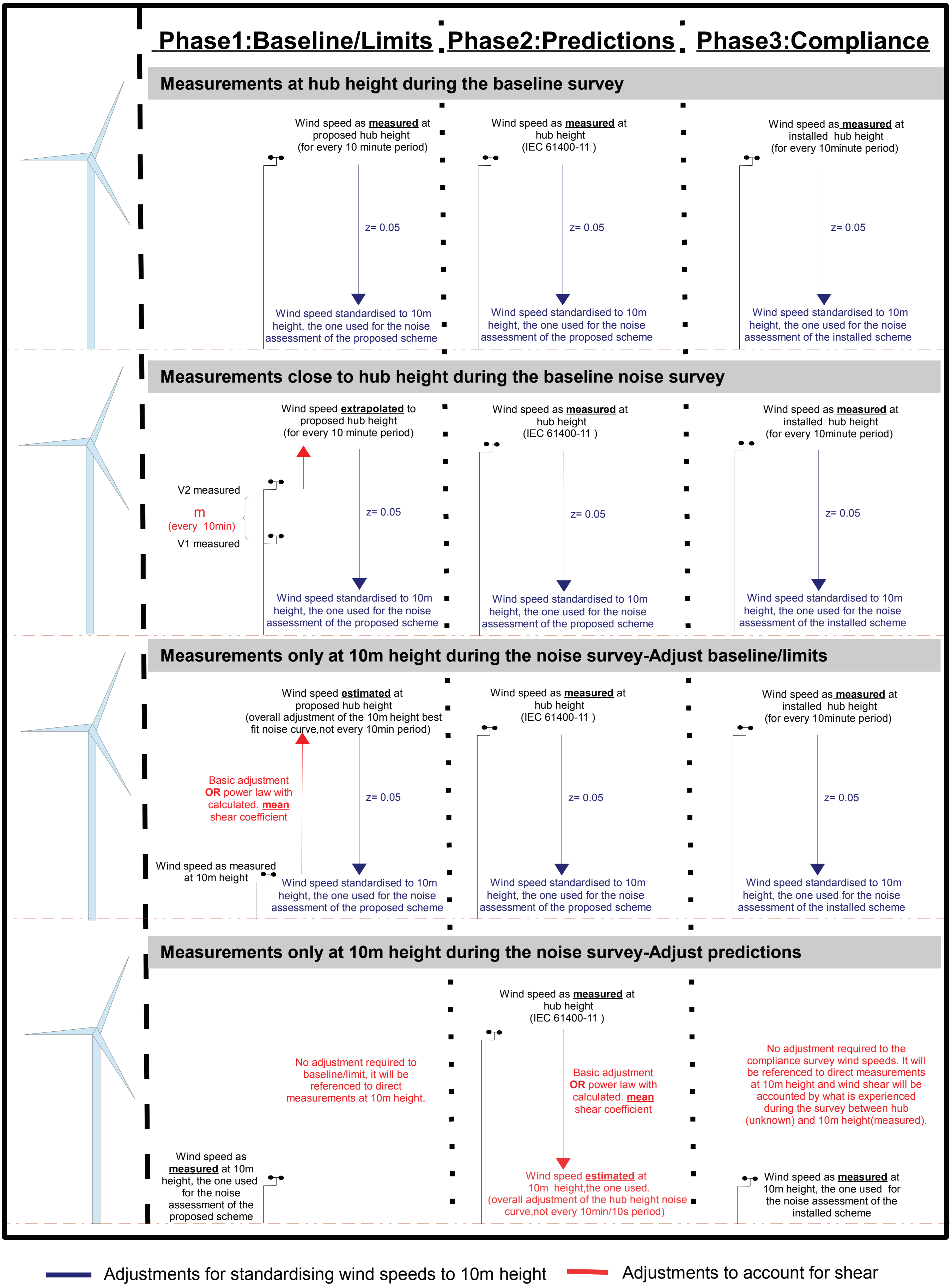


Figure 2 - Current(april 2014) wind speed referencing for wfn

◄P32 In reality, in most cases every effort has been made to try to relate noise to hub height wind speed before undertaking this conversion. It confuses matters and it should be said that it has no scientific basis; it is purely a layer to present a report with the word "10m height" in it. Since actual physical measurements at (or near to) hub height are considered current best practice, do not require complex adjustments and provide consistency across all phases (background, predictions, compliance), the generic 10m referencing system (standardisation) may be considered unnecessary. A hub height referencing system would be less confusing, more transparent and avoid duplication of sound power curves. Assessments which rely on direct 10m height measurements during a background survey would still be possible via adjustments of the background/limit from 10m to hub height wind speed (already one of the current good practice option), but without the need for the final stage of reporting back to "standardised".

References

1. 1996 ETSU-R-97 'The Working Group on Noise from Wind Turbines: 'The Assessment and Rating of Noise from Wind farms', ETSU Report ETSU-R-97, 1996.
2. 2003 G.P. van den Berg "Effects of the wind profile at night on wind turbine sound"
3. 2009 Institute of Acoustics Bulletin Article March/April
4. 2013 Institute of Acoustics (May 2013) 'A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and rating of Wind Turbine Noise'
5. 2013 IEC 61400-11:2013 Wind turbine generator systems - Part 11: Acoustic noise measurement techniques.
6. IEC 61400-11 Test report ENERCON -82 E3 M89 031/2
7. Proxy measure definition from http://www.sphsu.mrc.ac.uk/glossary/
8. Walls, Hastings-Black & LaWhite,"Understanding and Quantifying the Uncertainty in Tower Extrapolation and AEP Estimations Using SODAR" , EWEC 2010

No bearing on acoustics? Think again

By Rhys Owen MIOA of Atkins

Acousticians might be excused for thinking that railway vehicle axle-boxes have no bearing on acoustics (if one may be excused a pun). However, axle-boxes certainly do have a bearing on acoustics, as will be seen…

Wheel-sets are the link between the vehicle and the track and the axle-bearings are consequently critically important. A failure of an axle-bearing can lead to a delayed train, derailments or, if through friction they get really hot, fire.

Plain bearings and wedges

Axle-boxes carry the journals of the wheel-sets and it is essential that the axle-boxes can move vertically in order to accommodate variations in track level. In traditional railway practice this vertical movement leads to wear of the horn guides (which are attached to the frame) and to the faces of the axle-boxes that slide upon them. The horn guides act to guide and to retain the movement of the axle-box.

Figure 1 is a photograph taken from within the frames of locomotive 030 T 3 of the Chemin de Fer Touristique du Vermandois at St Quentin, France (www.cftv.fr). Here can be seen the wedge and the nut for its adjustment.

It should be noted that the traditional axle-box shown in Figure 1 is a plain bearing, that is, the bearing face is a circular surface surrounding the journal of the axle, the bearing surface being of low friction white metal.

Wear of the axle-box and horn guide surfaces is especially undesirable for a rod-driven machine where the connecting and coupling rods have a fixed length. Excessive wear leads to play and hence to increased noise and vibration as the axle-box collides with its guides (about a century ago a driver reported that "*…riding on this engine I can only compare to sitting on a galvanic battery with the noise of a boiler shop thrown in.*").

Axle box wedges are used on some traditional railway vehicles, in particular locomotives, to control the free moment of the axle-box in the frame by minimising play between the axle-box and the horn guides. Control of the play between the axle-boxes and the horn guides has the same effect on controlling noise and vibration as does, in a factory, restricting the height from which a component falls into a bin. Reducing the distance reduces the build up of the energy that is ultimately expended in the final collision with the bin, or in the case of the locomotive, of the axle-box colliding with the horn guide.

Whereas gravity causes a build-up of kinetic energy in the case of the falling component, there are a number of forces acting on the axle-box. In the case of 030 T 3 not the least of these forces is the thrust of the connecting rods which could be as much as 16 tons' force spread over three axles.

However, it is not possible totally to eliminate play as it is necessary to ensure that the axle-box is not so tight in its horn guides that it cannot move freely up and down (in 1951 a major railway accident occurred at Weedon on the West Coast Main Line precisely because of a lack of play between one of the locomotive's leading axle boxes and its horn guides, although these would not have been fitted with adjusting wedges). On a locomotive with rod drive such as a steam locomotive, adjustment of the axle-box wedges to take up play must thus be done carefully so that the slight movement of the axle bearing position caused by the wedge adjustment does not adversely affect the rod drive. Accordingly, the procedure is to tighten the wedge up and then release it slightly. The French text book *La Machine Locomotive* suggests releasing the wedge by 5mm so that, for a wedge with a 1:20 taper, 0.25 mm of play will be allowed.

The acoustic advantages of minimising play are, however, incidental to the reduction in wear and, hence, to the increased distances travelled between overhaul. This greater P36►

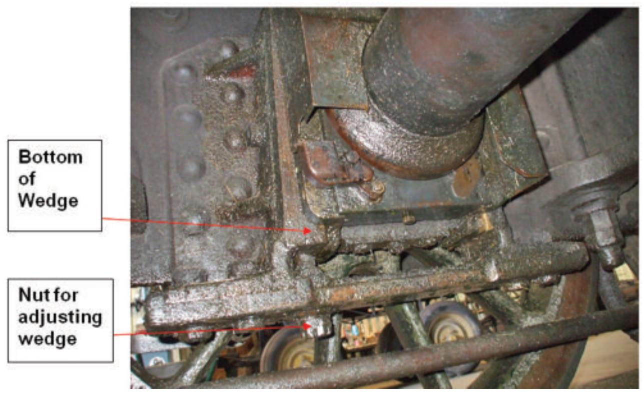


Figure 1: a traditional axle-box fitted with wedge adjustment

◂ P35 distance increases availability and reduces costs.

A certain amount of play is also necessary between a plain axle journal and its bearing to enable lubrication (it is worth noting that lubricating oil acts as a damper).

See figures 2 & 3.

While axle-box wedges have been used in the UK the tendency in British practice is to reduce wear by using hard-wearing materials such as manganese steel for the wearing surfaces. Manganese steel liners are still in use on many freight vehicles.

As mentioned earlier, wheel-sets (that is, wheels mounted on axles) are of critical importance to safe railway operations. Older readers may remember hearing the wheel-tapper hitting the wheels of railway vehicles, listening for the cracked tyre that did not ring true. Modern railways use ultrasonic testing to detect flaws – this works either by measuring the arrival time of reflected sound waves or by measuring the attenuation of the sound waves through the material.

Modern practice

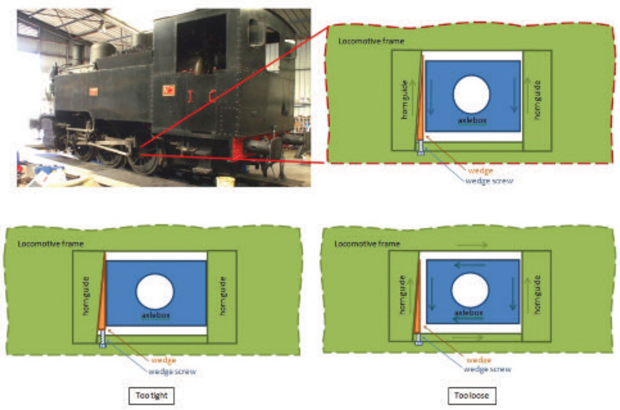
One way of monitoring axle bearing condition is by temperature and the hot box detector is sometimes used (hot metal loses its strength and this can cause a serious accident). A hot box detector monitors the temperature of the passing train (the fireboxes of preserved steam locomotives have been known to trigger these devices!). However, acoustics provides better methods and two companies offer two different acoustic techniques that are currently in use in the UK.

Modern rolling stock generally uses cylindrical roller bearings rather than the plain bearing hitherto discussed. Noise and vibration methods can be used to detect faults in roller bearings – when such a bearing develops a fault vibration in the structure of the bearing generates noise, the frequency of this noise being a clue to what type of fault has occurred while the amplitude of the noise is an indication of the severity of the fault. Two diagnostic systems (at least) are available.

Perpetuum offers a system that is mounted on the axle-box. Effectively this is equipment that monitors the vibration of the bearing. A sensor mounted on the axle-box communicates by radio with a receiving station elsewhere on the vehicle, a particular refinement being that the energy to drive the sensor is obtained by harvesting vibration energy from the train itself. The vibration arising from the bearing is monitored and, since vibration is a very early indication of degradation when initial signs of wear are identified, the vehicle can be scheduled for maintenance months in advance of a potential failure.

The precise details of how the vibration from the bearing is monitored and evaluated are, sadly, closely guarded proprietary information.

An alternative method is RailBAM, as devised by TrackIQ of Australia, in which trackside equipment "listens" for the first signs of distress from a bearing. The concept is not dissimilar to a hot-box detector but the essential difference is that the RailBAM method identifies a faulty bearing when there are still thousands of kilometres to go before total failure. Basically, ▸

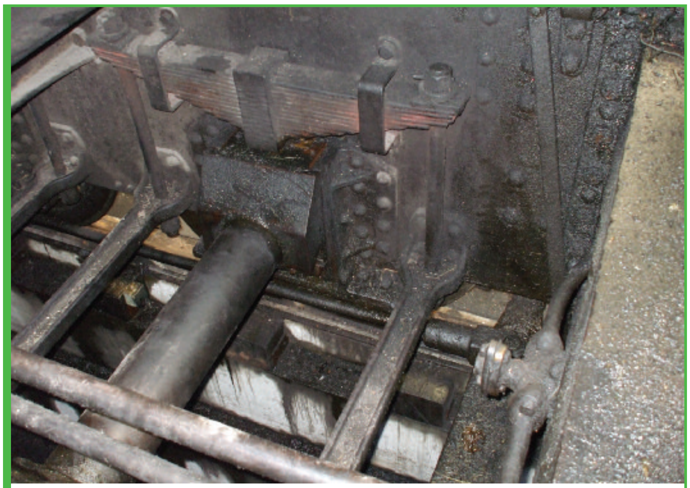


In the top right hand diagram the axle-box has enough play to move freely in the vertical direction (under the control of a spring).

In the bottom left hand diagram the axlebox is too tight and cannot move.

In the bottom right hand diagram the axlebox can move freely in the vertical direction (controlled by the spring) but also in the horizontal direction (with no control).

Figure 2: diagrams showing the various scenarios



Traditional railway equipment uses leaf springs which have considerable intrinsic damping.

Figure 3: a view of the springing arrangement on 030 t 3

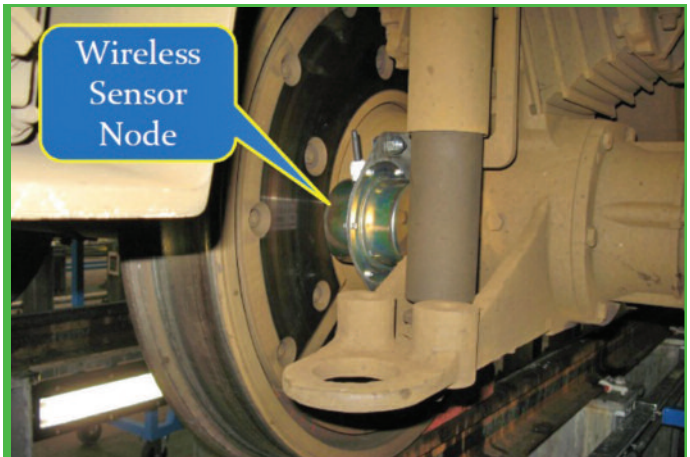


Figure 4: Perpetuum wireless sensor node

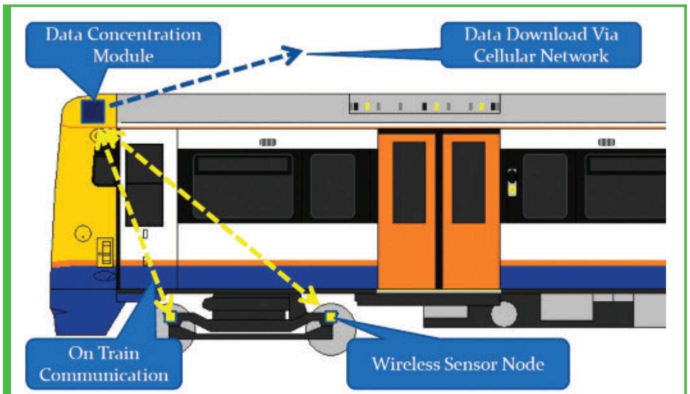


Figure 5: Perpetuum on-board communications set-up

the bearing acoustic fault signatures provide a stream of data that allows trackside condition monitoring. The bearing noise is distinguished from other sounds that arise mainly from wheel/rail interaction arising from poor condition of either the wheels or the rails, from axles or bogies which do not "track" well and from brakes that are locked on (again the precise details of the technology are closely guarded).

The RailBAM method is significantly better than a hot-box detector because, if a hot-box detector correctly identifies a hot axle-box then there are only a few minutes of life left in the bearing and hence, at the very least, the train will be delayed. Advanced warnings of this kind lead to a more controlled method of maintenance and a reduction of train failures.

With the support of Network Rail and South West Trains an acoustic bearing monitor has been introduced at Swaythling, near Southampton. The equipment is designed to detect bearing defects on the Class 444 and Class 450 Electric Multiple Unit fleets well in advance of failure by monitoring the health of the axle bearings and providing a report on them in real time. This means that the vehicles affected can be removed from service for attention. For example, after a number of alerts that showed an increasing trend, a bearing was withdrawn from service, subsequent inspection by the manufacturers showing a clearly defined defect, although spalling (fragments breaking off the bearing surface) had not yet started to occur. There was no immediate danger and SKF, the bearing manufacturers, estimated that the bearing could have travelled several tens of thousands of miles further. However, this pre-emptive withdrawal prevented a "reactive withdrawal" with consequent disturbance to the services.

The installation at Swaythling consists of equipment monitoring both the up and the down lines, an array of sensitive microphones being mounted in each trackside cabinet to record the sound of the vehicle passage, including the individual axle bearings. A "wake up" sensor activates the system, while further sensors measure the wheel diameter and speed and a reader identifies the vehicle and its orientation. Following on-site data collection and analysis the results are communicated automatically to a website, defects being classified by severity and their location within the bearing. The ability to observe trends in, and to make forecasts of, axle bearing health enables preventative measures to be taken.

Acknowledgements

Grateful thanks to my colleague Chiara Morbelli of Atkins for her help in preparing Figure 2, and for information to Derek Chatto of Atkins Rail and also to Steve Turley of Perpetuum and to Mirek Vesely of TrackIQ .

References

E Sauvage & A Chapelon, La machine locomotive, Dixième edition 1947 (La Libraire Polytechnique Ch. Beranger: Republished 1979 by Editions du Layet)

Extracting meaningful uncertainty data from calibration certificates and associated sound level meter standards

By Ian Campbell of Campbell Associates

Abstract

Any measurement made for regulatory or other legal reasons now comes into the general field of Legal Metrology and the uncertainty associated with the measurement has to be evaluated. This is particularly true if the results of the measurement exercise are to be challenged in either an enquiry or court proceedings. All "noise" measurements have a number of key elements that need to be considered when considering the uncertainty that will be associated with the result. These include the variability of the source, effects of the transmission path, the environment and of course the measurement instrument its self. This paper considers the impact of the instrument, its standardisation and maintenance and how these elements can be quantified.

The measurement instrumentation is a natural element within the total uncertainty budget associated with a "noise assessment". With correct standardisation, maintenance and field calibration routines it is one that can readily be controlled and quantified. As always the devil is in the detail as sound level meters are required to quantify the sound whilst most audio kit is just required to reproduce it, either for communications or entertainment purposes. For these latter applications the end result is judged subjectively and so changes of a few dB are not going to be noticed. With sound level meters these few dBs could be very significant in the overall project that the measurement is designed to support. For general audio applications wide tolerances on system stability, frequency response and dynamic range are acceptable; however for quantifying the sound field these parameters have to be closely controlled over a wide range of environmental conditions.

Historically there has been an attitude of *caveat emptor* (the buyer is responsible for the validity of the manufacturer's claims) and this has allowed a large number of sound level meters to be introduced without any verification that they actually do what is expected of them. Over the past 15 to 20 years there has been a development of the established "weights and measures" inspection procedures into a system of Legal Metrology that will deliver a high degree of confidence in the performance of measurement systems. These comprise of basic standards (BS EN ISO etc.) that determine what the instrument should do; these are supported by three levels of confirmation.

1. Firstly there are the "Pattern Evaluation" requirements that provide for an independent testing regime that will confirm that the basic design of the instrument does what the specification requires over the complete range of environments and measurement conditions covered by the basic specification. The manufacturer normally sends three to five samples of the instrument to a National Testing Laboratory (NPL, PTB, LNE etc.) who will issue the necessary confirmation that the basic design of the instrument allows it to meet its claims.
2. Secondly there is the "Periodic Verification" which is an annual or bi-annual examination by an accredited laboratory where a sub-set of the pattern evaluation tests are performed to confirm that the instrument is still within its original calibration limits.
   a. If the pattern evaluation has been carried out by a National Metrology Laboratory and the periodic verification by an Accredited Laboratory then a certificate of calibration and conformance to the standards can be issued as opposed to just a certificate of calibration
3. Finally the user of the instruments will find details in the instruction manuals of the field checks that they should carry out before and after each set of measurements to confirm that the kit is working correctly. These include use of a sound calibrator, checks on the power supplies, range settings, self-noise etc.

In respect of sound level meters and sound calibrators the governing standards for these various levels of verification are set out in figure 1.

Instrument Type	Valid dates	Specification	Pattern Evaluation	Periodic Verification
Sound Level Meters	1979 to date	BS EN 60651 & 60804	OIML[1] R58 & R88	BS 7580
	2003 to date	BS EN 61672-1	BS EN 61672-2	BS EN 61672-3
	2013 to date	BS EN 61672 Ed2-1	BS EN 61672 Ed2-2	BS EN 61672 v2 -3
Sound Calibrators	2003 to date	BS EN 60942	BS EN 60942 Annexe A	BS EN 60942 Annexe B

Figure 1 Sound level meter standards

Pattern evaluation is the responsibility of the manufacturer in conjunction with a National Metrology Laboratory and the Periodic Verification is the responsibility of the user in conjunction with an accredited calibration laboratory.

Earlier versions of the standards had comments about the basic accuracy of the sound level meter of ±0.7 dB for a class 1 device and ±1 dB for a class 2. This, however, related to the accuracy at reference level and reference frequency (normally 114 dB at 1k Hz) as well as at reference conditions (23°C, 101.325 kPa and 50% RH). As these conditions hardly ever exist in relation to a practical noise measurement, they are not very helpful and so they do not appear in the more recent version of the standards.

There are two elements to the measurement kit to be considered both independently and how they work together. These are the sound calibrator and the sound level meter.

The periodic verification requirements for a sound calibrator are for there to be three replications, to give a measure of how good the fit to the microphone, a measurement of the short term stability of the output, a measurement of the frequency and the frequency stability as well as a measurement of the total distortion. An example of these results is given in figure 2.

Measurement Results:	Level	Level Stability	Frequency	Frequency Stability	Distortion
1:	114.00 dB	0.01 dB	1000.74 Hz	0.00 %	0.35 %
2:	114.00 dB	0.01 dB	1000.73 Hz	0.00 %	0.34 %
3:	113.99 dB	0.01 dB	1000.72 Hz	0.00 %	0.34 %
Result (Average):	**114.00 dB**	**0.01 dB**	**1000.73 Hz**	**0.00 %**	**0.34 %**
Expanded Uncertainty:	0.10 dB	0.02 dB	1.00 Hz	0.01 %	0.10 %
Degree of Freedom:	>100	>100	>100	>100	>100
Coverage Factor:	2.00	2.00	2.00	2.00	2.00

Figure 2 Typical statement of results for a sound calibrator as per Annex B of BS EN IEC 90942

The standard deviation of the three replications is combined with the uncertainty of the basic measurement (Expanded

Uncertainty row) to give the degree of freedom and coverage factor. If this figure is two then there is 95% confidence that the result lies within the basic uncertainty figure. If there was a poor fit to the microphone then the three independent measurements would differ and the coverage factor would move away from the required result and it would not be possible to use the basic accuracy of 0.1 dB in the overall measurement uncertainty calibration and a higher figure needs to be calculated. For example, if the three values for the level were 114.0, 114.1 and 113.9 due to coupling problems the mean value would still be 114.0 dB and the results are within the laboratories basic uncertainty but the combined uncertainty would be 0.14 dB and the coverage factor would be 2.4

The resulting average figure for the calibrator level given on the calibration certificate has a tolerance and can vary by ± 0.4 dB and it is this actual calibrated value that must be used when setting up the meter and not the nominal value marked on the sound calibrator. If not, the permitted variation from nominal must be included in the uncertainty budget. If the sound level meter and calibrator were paired during the periodic verification and environmental conditions were close to reference it would be safe to use the paired value quoted on the calibration certificate. If however a different calibrator is being used then additional corrections would be needed for the pressure to free field correction, volume loading effect and environmental characteristics.

The pressure to free field corrections and volume loading are often combined and quoted in calibrator manuals as the correction to be applied for that specific combination of microphone and preamplifier, typically 0.2 dB at 1k Hz. Environmental correction will be a combination of the effects on the sound calibrator and the microphone whilst for most meters the effect of the electronics and humidity can be discounted leaving just temperature and barometric pressure effects to consider. The table below gives details for the combination of a typical class 1 meter and calibrator combination and based on information like this a combined environmental uncertainty of around 0.3 dB over the specified range of environments would be reasonable. If, however, the information is not available then the calculation would have to be based on the limit values given in the specification which would double this figure.

Model number	Temperature, °C			Barometric Pressure, kPa			
	Coefficient	Ref = 23		Coefficient		Ref = 101.325	
		-10	50		65	85	108
Nor-1225 Microphone	-0.007	0.23	-0.19	-0.01	0.36	-0.16	-0.07
Nor-1251 Calibrator	0.003	-0.10	0.08	0.005	-0.18	-0.08	0.03
Result		**0.13**	**-0.11**		**0.18**	**-0.24**	**-0.03**
Acceptance interval specified		**0.5**	**-0.5**		**0.9**	**0.4**	**0.4**

Figure 3 Typical environmental effects on the basic calibration setting of a sound level meter

The Nor-1251 is a "smart calibrator" having internal compensation for environmental and volume loading effects; should an uncompensated calibrator be used (designations L or C under the standard) then corrections should be applied to bring performance into line. The uncertainties of these corrections are not quantified at the moment. See figure 4.

Having determined the accuracy of the setting of the meter at the reference level and frequency it is then necessary to consider the performance at other levels and frequencies.

The system frequency response is predominantly determined by the microphone and the effects of the case etc. The example below is for a class one device shown with its tolerances over the normal test range of 100 to 20k Hz. The three stars show the only

Model number	Temperature, °C			Barometric Pressure, kPa			
	Coefficient	Ref = 23		Coefficient		Ref = 101.325	
		-10	50		65	85	108
Nor-1225 Microphone	-0.007	0.23	-0.19	-0.01	0.36	-0.16	-0.07
Gras 42AA Pistonphone	0.0005	-0.02	0.01	0.0853	-3.10	-1.39	0.57
Result		**0.21**	**-0.18**		**-2.74**	**-1.56**	**0.50**
Acceptance interval specified		**0.5**	**-0.5**		**0.9**	**0.4**	**0.4**

Figure 4 Environmental effects when an uncompensated calibrator is used

points at which the standard mandates an acoustic measurement of the frequency response; the rest of the data is optional, including the extension down to 2 Hz. These results confirm that over the central range of 25 to 8k Hz this individual device is essentially flat and additional uncertainty elements are only needed if there is significant content outside this frequency range.

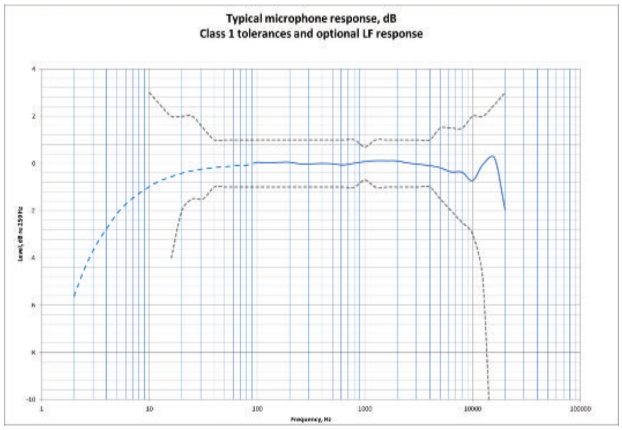


Figure 5 Typical microphone response, with optional LF extension

The natural frequency response of the system will be post processed to provide the frequency weightings A, C and Z. These will be tested electrically and then these results are combined with the acoustic tests made on the microphone along with the correction data provided by the manufacturer for the case reflection and the effects of any accessories such as a windscreen. The acceptance interval quoted in the standards applies to the overall instrument and accessories and not just the microphone. These combined results should be inspected to confirm that there are no significant deviations from the required response. In the example shown as figure 6, which shows the combination of the electrical, acoustic and accessory data, it can be seen that the results for frequencies above 4k Hz would need to be corrected in the results or additional elements added to the uncertainty computation to take account of the errors in these frequency bands. The optional extension of the results to 2 Hz also show deviations and these too would have to be treated in a similar manner.

As amplitude linearity is normally very good in modern sound level meters it is only really necessary to consider the limit values, the minimum values will be controlled by the self-noise and the maximum by the overload point.

Most modern sound level meters have a single range covering over 120 dB and have their overload point set to 130 or 140 dB so this does not usually cause a problem. Should the meter P40

◀ P39 show an overload then its effect on the measurement needs to be considered. It may not be significant if the object was to determine an L_n background level but is very significant in a L_{Aeq} or L_{Cpk} measurement; correction data is not usually available in these latter cases so they need to be avoided. At the bottom end there are two elements to the self-noise; firstly there is the electrical noise of the preamplifier and secondly the microphone capsule its self. The electrical noise is measured during the periodic verification using a dummy microphone and is usually around 10 dB(A) however most half inch 50mV/Pa free field measurement microphone capsules have a self-noise of around 14 dB(A) and these two figures need to be combined to give the limiting level to which measurement can be made. With a 10 dB margin added to the combined level this gives a minimum level of 25 dB below which additional uncertainty elements need to be considered. Within this total amplitude span for the measurement there are allowable limits for amplitude linearity that would need to be considered.

Combined acoustic and electrical results						
A-Weighted results						
Freq. (Hz)	SLM (dB)	Mic. (dB)	Case Ref. (dB)	Wind Scr. (dB)	Tol. (dB)	Dev. (dB)
31.5	-0.1	0	0	0	-1.5	-0.1
63	-0.1	0	0	0.1	-1.5	0
125	0	0	0	0	-1	0
250	-0.1	0	0	0	-1	-0.1
500	0	0	0.1	0	-1	0.1
1000	0	0	-0.1	0.1	-1	0
2000	-0.1	-0.3	0.2	0.3	-1	0.1
4000	-0.1	-0.9	0	0.7	-1	-0.3
80000	0	-1.2	0	-0.1	+1.5,-3	-1.3
12500	0	-0.8	0.1	-0.5	+3,-6	-1.2
C-Weighted results						
Freq. (Hz)	SLM (dB)	Mic. (dB)	Case Ref. (dB)	Wind Scr. (dB)	Tol. (dB)	Dev. (dB)
31.5	-0.1	0	0	0	-1.5	-0.1
63	0	0	0	0.1	-1.5	0.1
125	0	0	0	0	-1	0
250	0	0	0	0	-1	0
500	0.1	0	0.1	0	-1	0.2
1000	0	0	-0.1	0.1	-1	0
2000	0	-0.3	0.2	0.3	-1	0.2
4000	-0.1	-0.9	0	0.7	-1	-0.3
80000	0	-1.2	0	-0.1	+1.5,-3	-1.3
12500	0	-0.8	0.1	-0.5	+3,-6	-1.2
Z-Weighted results						
Freq. (Hz)	SLM (dB)	Mic. (dB)	Case Ref. (dB)	Wind Scr. (dB)	Tol. (dB)	Dev. (dB)
31.5	-0.1	0	0	0	-1.5	-0.1
63	-0.1	0	0	0.1	-1.5	0
125	0	0	0	0	-1	0
250	0	0	0	0	-1	0
500	0	0	0.1	0	-1	0.1
1000	0	0	-0.1	0.1	-1	0
2000	0	-0.3	0.2	0.3	-1	0.2
4000	0	-0.9	0	0.7	-1	-0.2
80000	0	-1.2	0	-0.1	+1.5,-3	-1.3
12500	0	-0.8	0.1	-0.5	+3,-6	-1.2
Tests Passed						

(orange)	Results obtained by electrical testing
(green)	Results of acoutic testing, some labs use nominal data for these tests
(blue)	Correction data provided by the manufacturer, without uncertainties!

Figure 6 Combining electrical, acoustic and manufacturer's data to determine complete instrument response

The final consideration is the computation of the actual measurement metrics; L_{AF}, L_{AS}, L_{Amax}, L_{Cpk}, L_{Aeq} etc. A series of tests have been devised to check these parameters by means of gated electrical signals having known relationship to the noise indices to be verified. The first step is normally to determine the accuracy of the time constants Fast and Slow. This is achieved by examining their response to signal bursts. The rise time is determined by the time constant specified for each test and hence a single test gives a good guide to the accuracy of the RMS calculation. In the example shown the results for these two basic time constants are in order. Note that for impulse time constant the test has to be more comprehensive as in this case the rise and fall times are different.

Time averaging, L_{Aeq}					
Burst value (ms)	Reference value (dB)	Tolerance value (dB)	Measured value (dB)	Error value (dB)	Result
1/10^3	107	1	106.9	-0.1	P
1/10^4	97	1	96.8	-0.2	P

Figure 7 Tests for time weightings

The peak time constant is the one that normally needs special attention as it is the metric that is specifically mandated in the Noise at Work Regulations; it is an offence to expose any employee to levels above 137 L_{Cpk}. Basically, it is tested by comparing the response to a very short burst to a longer one. The result shown is from the BS EN IEC 60651 standard and shows that this particular meter is reading 1 dB low in the peak mode hence this should be accounted for when risk assessments are being made using this particular instrument.

Time weighting F & S						
Time constant (ms)	Burst duration (dB)	Reference value (dB)	Measured value (dB)	Tolerance value (dB)	Error value (dB)	Result
Fast	200	112	111.9	1	-0.1	P
Slow	500	108.9	108.9	1	0	P

Figure 8 Peak response test results

Following on from the calculation of the time domain indices are computed and the most common one is the $L_{eq,t}$. This result is very much affected by the peak values logged during the measurement so it seems reasonable to test using short duration pulses. The basic test is that the pulse mark space ratio is increased by a factor of 10 and this will result in a reduction in the $L_{eq,t}$ value of 10 dB. ▶

Peak response							
Pulse duration (ms)	Pulse polarity (dB)	Reference value (dB)	Measured value (dB)	Tolerance value (dB)	Error absolute (dB)	Error relative (dB)	Result (dB)
10	+	116	116.2	0.2			
0.1	+	116	115.1	2	-0.9	-1.1	P
10	-	116	116.2	0.2			
0.1	-	116	115.1	2	-0.9	-1.1	P

Figure 9 Time averaging test results

The other time history metric in wide use is the Ln value; at the current time these are not covered by the sound level meter standards but there are a few regulations that specify how they should be calculated, i.e. the sample rate, time constant used and bin size for the classification of the distributions. There is a DIN standard that specifies these tests and this is used for verfication when clients require it to be done.

It is good practice to keep a running log of the calibrator's periodic verification as this provides evidence on which to base the recommended recalibration interval. An example is given in Figure 10 below showing the value returned at each calibration over a 16 year period. The error bars on each measurement show the uncertainty of the laboratory performing the verification. With data like this it is possible to use an uncertainty of 0.1 dB for the basic sensitivity setting of the meter and calibrator combination; we have seen examples where this could extend to 0.25 dB or higher where the laboratory uncertainty or the fit of the devices is not as good as this example.

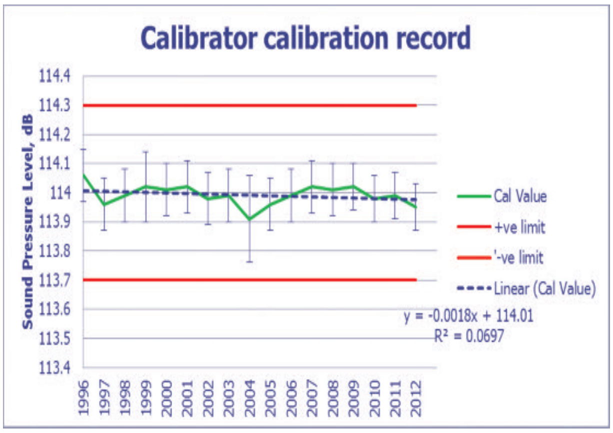


Figure 10 Calibrator periodic verification record for drift analysis

References

1. Organisation International de Metrologie Lègal

- **BS EN IEC 60651:1994**
  Specification for Sound Level Meters
- **BS 5969:1991**
  Specification for Sound Level Meters
- **BS EN IEC 60804:2001**
  Integrating-Averaging Sound Level Meters
- **BS EN IEC 60942:2003**
  Sound Calibrators (Specification, pattern evaluation & periodic verification)
- **BS EN IEC 61672-1:2003**
  Sound Level Meters, Specifications
- **BS EN IEC 61672-2:2003**
  Sound Level Meters, Pattern Evaluation
- **BS EN IEC 61672-3:2006**
  Sound Level Meters, Periodic Tests
- **BS 7580:1997**
  Specification for the verification of sound level meters
- **OIML R58 1998**
  Sound Level Meters, Legal Metrology Requirements
- **OIML R88 1998**
  Integrating Averaging Sound Level Meter, Legal Metrology Requirements

Back to the Future – Part 3

Aviation

By Stuart Dryden FIOA and
Rupert Taylor FIOA of Rupert Taylor Ltd

This technical contribution is the third and final paper in a series expanded from presentations given at the Royal Society in October 2013 as part of the conference 'Wilson 50 years on'

Background

This paper reports on the final topic in a Defra research project commissioned in January 2012 to carry out 'An investigation into the effect of historic noise policy interventions' to cover the period from about 1960. The background to and an overview of that study were included in a technical contribution in the March-April 2014 issue of *Acoustics Bulletin*. That contribution and another in the May-June 2014 issue also described the process and presented the findings for four of the five topics studied for the project. This paper describes the work undertaken in respect of aircraft noise but sets it in the context of a wider consideration of changes in the operating environment for aviation over the past 50 years.

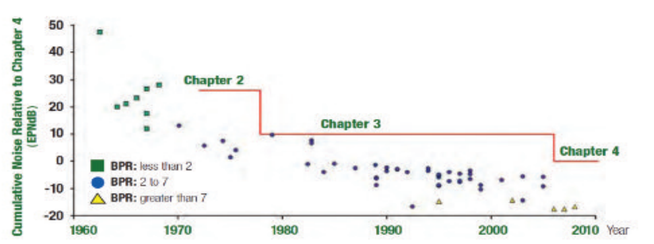


Figure 1 - Noise envelope for ICAO Chapters and related Engine Technology BPR = Bypass Ratio

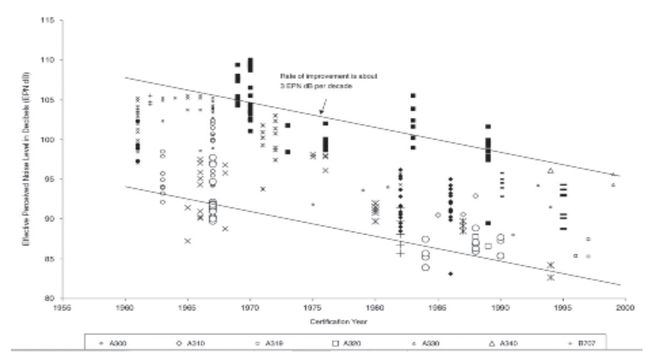


Figure 2 - Trend in reduction of aircraft 1955 – 2000 and EPNdB ratings of A300 types

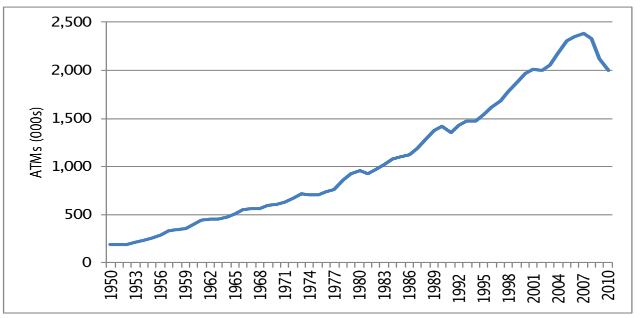


Figure 3 - Thousands of ATMs each year for all UK airports (DfT) (NB Includes double-counting of domestic traffic)

Changes in aviation in the last 50 years?

In the period since the Wilson Report was published there have been changes in virtually all the many fields that affect aviation noise including technical developments in aircraft design, regulatory control of aircraft, and evaluation methods as shown in BOX 1.

The Defra study described above considered the effect of the EU Directives (item 7)[1] that implemented the requirements of the ICAO Annex 16 Chapters[2] and drove the technological development of quieter aircraft (item 8). These inter-related factors are shown in Figures 1 and 2.

However, successive Directives and the ever quieter aircraft that came into service to comply with them operated in the context of increased air traffic (item10) as is illustrated in Figure 3 which shows the change in Air Transport Movements (ATMs) over the study period. It was that combination of the reducing noise from individual aircraft and the increasing ATM that the Defra study sought to evaluate.

Evaluation of effects of policy – aircraft noise

Question to be answered: Has the reduction in noise emission from aircraft led to smaller areas/populations within a specified noise contour?

For the Defra study the six English airports having the largest number of ATMs were selected for analysis. The six airports and their designatory codes (also used as abbreviations for them in this article) are:

- London Heathrow LHR
- London Gatwick LGW
- Manchester MAN
- London Stansted STN
- London Luton LTN
- Birmingham International Airport BHX

The ATM changes for these airports are shown Figure 4 over various periods ranging from 1972 to 1994 up to 2009/10[3].

Noise from aircraft flying into or departing from airports is typically assessed by considering the population within a specified noise contour and/or the area within that contour. The population count is clearly related to the area enclosed by a contour but it can be affected by several factors and the population count within a given noise contour could even change when there has been no change to the airport's operations. For ▶

1 Noise measurement indices have been invented and developed
2 Policy has been developed
3 Noise insulation schemes have been introduced
4 Social surveys have been carried out
5 Research into health (including sleep) and educational effects as taken place
6 Regulation has been introduced
7 EU Directives have been issued
8 Aircraft have got quieter
9 Populations have become more articulate
10 Air traffic has increased
11 Composite noise index values have gone down (even though number of events has gone up)

Box 1 - What has happened in the last 50 years in Aviation?

Consider the green line for STN (which corresponds to data for 1990)

There were 24300 ATMs and the chart shows that area within the 57 dB 16-hr contour was 20 sq km and the 63 dB 16hr contours enclosed 7 sq km.

If the number of ATMs had been a quarter of the actual value, then (assuming no other changes) there would have been 6 dB reduction in the noise emitted by the flights and so the contour labelled 57 dB would correspond to a 51 dB contour etc with the actual 63 dB contour representing the 57 dB contour for the reduced number of ATMs.

Box 2 - Example of use of charts in Figure 6

1 Reviewed the airport noise problem which had been made unexpectedly worse by the growth in the proportion of jets
2 Commissioned a jury study of the acceptability of aircraft noise
3 Commissioned a noise and social survey around Heathrow and introduced the Noise and Number Index (NNI)
4 Worried about sonic boom from supersonic aircraft
5 Recommended a noise insulation (partial) grant scheme above 50 NNI
6 Foresaw future aircraft engine noise reduction due to increased by-pass ratios
7 Considered heliport noise and recommended more investigation

Box 3 - What did Wilson do?

the Defra study the effect of the EC directives was assessed by using the area within a specific noise contour.

BOX 1 notes that over the study period noise measurement indices have changed as new methods have been developed and that is certainly the case in the UK. From 1963 the scale used in the UK for the assessment and control of aircraft noise was the Noise and Number Index (NNI) which was developed following a social survey commissioned by the Wilson Committee and noise measurements and analysis by the Ministry of Aviation. In the 1980s the Department for Transport (DfT) commissioned a more widespread social survey and noise measurement study to consider alternative noise indices. This was followed by consultation and a further report which ultimately led to the adoption of the 16-hour, A weighted, equivalent continuous noise level (Leq, 16-hr)[4] and the correspondence between NNI values and Leq levels was derived so as to continue policies previously defined using the NNI scale[5]. Subsequently, a Department for Transport study – Attitudes to Aircraft Noise from Aviation Services in England was published[6]. Consequently, the Defra study used noise contour values of 57 dBA Leq 16-hr for data from 1989 and 35 NNI for the period before then (though for practical reasons some charts are only labelled '57 dB').

One way of examining the effect of the introduction of quieter aircraft is to compare the change in the area within the 57 dBA contour to the change in ATMs over the study period. This is shown for LHR in Figure 5 where the contour areas and ATMs have been plotted as ratios of their initial values. Figure 5 also shows the approximate periods during which the requirements of Chapter 3 and, later, Chapter 4 would have been met by the majority of aircraft.

However, in order to provide a quantitative analysis of the effectiveness of the policy a method is required that enables the influence of ATMs to be accounted for in a systematic way. Three approaches were investigated. An often used rule of thumb is that a change of noise exposure of 1 dB will generate a change of approximately 20% in contour area and this relationship could also be used to adjust for changes in ATMs if they area expressed as ratios using dBs (eg, a doubling of ATMs is equivalent to a change of 3 dB in noise). The empirical area/dB relationship of the rule of thumb is close to that for an ideal line source on a reflecting ground plane which was also considered. The third method was dubbed the 'available contours method' and relied on the fact that for some airports in some years, areas within noise contours were provided in 6 dB (or sometimes 3 dB) steps above 57 dBA. In those cases it was possible to deduce the effect of, say, a 6 dB reduction in ATMs by using the area associated with a noise contour for 63 dB Leq, 16 hr provided by the data for that year. However, this approach could only be directly applied when multiple contours were provided and for changes in ATMs equivalent to at least 3 dB.

These approaches are compared in Figure 6 which shows the trade-off between noise level and contour area for: an infinite line source over a reflecting ground plan, the 'rule of thumb', and for real data using the 'available contours method' for four airports. Note that the noise levels and areas for the airports are actual values whereas the plots for the line source and the rule of thumb are at arbitrary positions selected to avoid obscuring the other data. The important feature in all cases is the slope of the line which reflects the trade-off been noise level (equivalent to a change in ATMs on a decibel scale) and contour area. (See the worked example in BOX 2.)

The plots illustrates that there can be wide variation in the slope for different airports and can also vary at the same airport. Thus for STN the three lines are approximately straight and parallel whereas at LGW and MAN there are marked changes in slope. It is also apparent that the 'rule of thumb' is a reasonable fit for STN but has a steeper slope than some of the real data; on the other hand the slope of the line source is exceeded by part of the MAN plot. In practice, the approach used was customised to suit the data available for each airport; using 'real data' was preferred but interpolation and extrapolation were used where necessary[7].

Year	Actual ATMs (000s)	Actual Area Increasing ATMs With Policy	Amended Area Fixed ATMs With Policy	Predicted Area Increasing ATMs No Policy
Heathrow				
1972	257	1.00	1.00	1.00
2007	476	0.14	0.09	1.67
2009	460	0.13	0.08	1.65
Gatwick				
1972	73	1.00	1.00	1.00
1985	150	1.62	0.74	2.20
2007	259	0.26	0.10	2.73
2009	245	0.22	0.08	2.77
Manchester				
1990	123	1.00	1.00	1.00
2005	218	0.44	0.29	1.53
2010	149	0.32	0.28	1.17
Stansted				
1988	24	1.00	1.00	1.00
1993	48	1.16	0.71	1.63
1998	102	2.11	0.69	3.07
2006	190	0.96	0.14	6.32
2009	156	0.79	0.14	5.50
Luton				
1976	19	1.00	1.00	1.00
1989	38	0.56	0.29	1.96
2005	75	0.20	0.06	3.19
2008	86	0.24	0.06	3.86
2010	69	0.19	0.07	2.81
Birmingham				
1993	69	1.00	1.00	1.00
2002	112	0.35	0.23	1.54
2010	85	0.31	0.26	1.20

Table 1- Normalised 57 dBA contour area with and without policy intervention

Analysis of aviation policy effects

Because the number of ATMs increased over the study period the effect of the policy of reducing noise emissions from individual aircraft was P44

P43 assessed using three scenarios. First, the actual change in contour area was determined in which the effect of the policy was (usually) counteracted by the increase in ATMs; this was termed the 'Actual Area' case. The first of the two other assessments estimated the contour areas, assuming that the ATMs had not increased from the value in the year at the start of the data[8] – this was termed the 'With policy – ATMs' case. The second of these extra cases was to estimate the contour areas assuming that the ATMs had grown in accordance with the data but the policy had not been implemented – the 'Without policy + ATMs' case.

The start year for this analysis and the absolute area within the 57 dB/35 NNI contour in the start year are airport dependent and varied over a wide range; the start years were from 1972 to 1993 and areas at the start ranged from 835 sq km (LHR 1972) to 31 sq km (STN 1988). In order to make comparisons between airports more straightforward the areas that were computed in the analysis were then normalised to the value at the start of the analysis period for each airport. The results of this analysis are shown in Table 1 where for each of the three scenarios the change in contour area has been normalised to the area in the starting year for each airport.

Conclusions for aviation policy effects

The evaluation method was based on the values reported to DfT of contour area and ATMs for each airport for each year. Consequently, the results of the analysis in the study are subject to any limitations in those figures. The additional scenarios assessed relied on adjusting the 57 dBA contour area to account for changes in ATMs and the analysis applied used interpolation and extrapolation from the DfT data. Had more detailed base data been available then it is possible that slightly different values would have been obtained, however, the principal findings would not be expected to change.

DfT data showed the actual areas that arose as a result of the combined effects of reductions in the ICAO noise limits in changing the fleet mix towards quieter aircraft, changes (mainly increases) in the number of ATMs each year, and other factors such as local operational measures. The influence of local mitigation measures to control noise was not accounted for separately in the study[9].

Table 2 is a summary of Table 1 showing the changes as percentages. So, for example, over the period 1972 to 2009 the actual percentage fall in the contour area from the start year at Heathrow was 87%, but if there had been no increase in ATMs over that period the percentage fall would have been greater at 92%. On the other hand, it has been estimated that if the policy had not been implemented but ATMs had increased as they did in practice, then the area within the contour would have increased to be 65% more than the value at the start (in 1972).

The wider context – starting with Wilson

One of the points that became clear from the presentations at the IOA conference on '50 years of Wilson' was how much original thinking was evidenced in the committee's final report in many fields of environmental acoustics and aviation is no exception. BOX 3 shows the topics that were addressed which included commissioning fundamental research.

In the aftermath of Wilson's report there have been many more reports and studies and a selection of the more important ones for the UK is shown BOX 4. In parallel there were developments in noise scales and indices (BOX 5), progress in noise policy (BOX 6), and changes in the legislation and regulation (BOX 7).

Several factors have influenced these changes. Historically noise indicators and criteria have been developed from dose-response studies in which objective values for aircraft noise levels expresed on various scales were compared to the results of jury judgements or social surveys. Thus the PNdB system derives the calculated Perceived Noise Level by applying to objective values of noise level (measured or predicted in frequency bands) a weighting derived from test subjects judgement the perceived noisieness before combing the band contributions. The NNI scale was originally devised by analysing the results from a social survey and objective measurements that were processed to provide the well-known relationhsip:

NNI = (average peak noise level)[10] + 15 log10 N – 80

NNI therefore takes into account the number of aircraft and the logarithmic average of their noise levels. In the initial study the minimum noise level of the aircraft included was 84 PNdB[11] and it was considered that these aircraft were 'likely to be heard'[12]. Subsequently, common P46

Airport (Start and End Years)	WITH POLICY Actual ATMs	WITH POLICY No increase in ATMs	WITHOUT POLICY Actual ATMs
Heathrow (1972 to 2009)	– 87%	– 92%	+ 65%
Gatwick (1972 to 2009)	– 78%	– 92%	+ 177%
Manchester (1990 to 2010)	– 68%	– 72%	+ 17%
Stansted (1988 to 2009)	– 21%	– 86%	+ 450%
Luton (1976 to 2010)	– 81%	– 93%	+ 181%
Birmingham (1993 to 2010)	– 69%	– 74%	+ 20%

Table 2 - Change in Area of 57 dB/35NNI contour for three scenarios[1]
Note 1 - As a percentage of the area in the start year for each airport

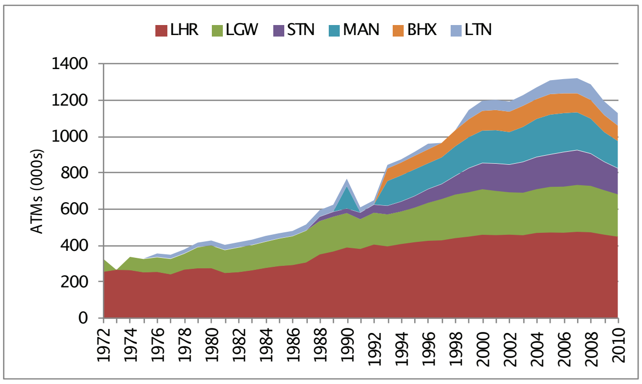


Figure 4 - ATMs (000s) each year for 6 English airports
Note data gaps: Gatwick (1973) Manchester (1991-2) and Luton (197-8)

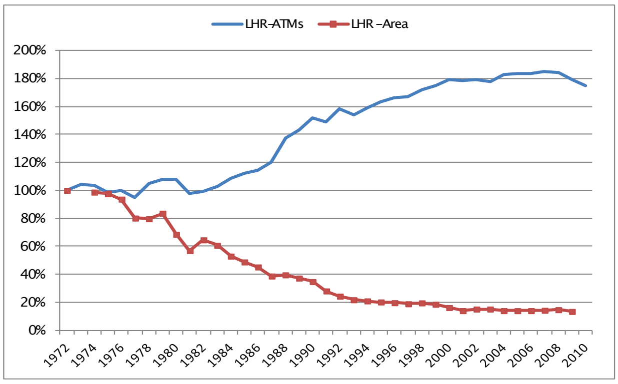


Figure 5 - Normalised Area within 57 dBA 16-hr Leq/35 NNI contour and ATMs for Heathrow. (1972 = 100%. No Area data for 1973 or 2010.)

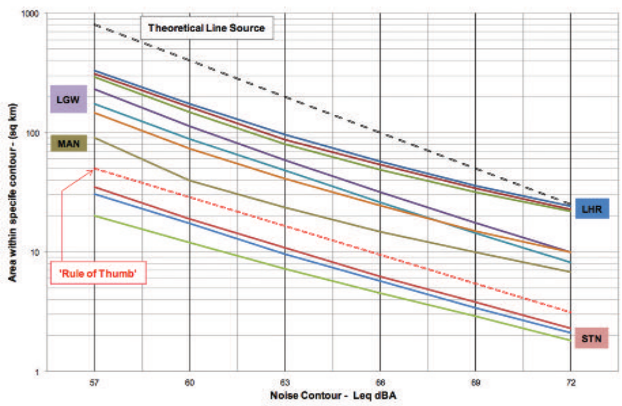


FIGURE 6 - Relationship between contour area and noise level for 1988, 1989 and 1990 for Heathrow (LHR), Gatwick (LGW), and Stansted(STN), and for Manchester (MAN) for 1990. Also shown is the relationship for a theoretical line source and for the 'Rule-of-Thumb' (See Box 2 for worked example)

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P44 usage was to include aircraft with a PNdB value of more than 80[13]. As noted earlier in this article, following a later DORA study[14] the NNI scale was replaced by the A weighted $_{Leq, 16\text{-}hr}$ index. That scale also takes account of the number of aircraft and their noise levels and uses logarithmic averaging (duration is an addititonal factor in this index). The weighting factor for the number term in the NNI formula is 15 whereas on the $L_{eq, 16\text{-}hr}$ index it is 10. However, Schulz has observed that if the factor of 15 in the NNI formula is replaced with a value of 10, the resultant curve fits the [original] data about as well[15]. Other widely used scales for the assessment of aircraft noise are based on L_{eq} and so share the same equal-energy trade-off between the number of aircraft events and the steps on the scale in dB[16] which is now established as the norm.

When $L_{eq, 16\text{-}hr}$ supplanted NNI in the UK, values of the two indices that provided equivalent measures of community response were derived to ensure contunuity of policy objectives. However, the relationship between the steps on an L_{eq}-based scale and community response does not appear to have remained constant over subsequent years as is illustrated by the references in BOX 8[17,18,19,20].

Other indicators are now being used to supplement those described above. These newer indicators are not based on a dose-response relationship but are believed from community feedback to present airport operations in a format which is accessible for members of the general public potentially affected by new proposals. The emergence of these indicators appears to have started in Australia in the 1990s, culminating in the Transparent Noise Information Package (TNIP) from Australian Government's Department of Infrastructure and Regional Government[21]. TNIP is not a single indicator but a suite of information sets including contours showing the number of overflights above a given noise level (e.g. N70, = number above 70 dB(A)) and Respite Charts (Number of hours with no jet movements, expressed as a % of the total number of hours during the period of interest).

It is interesting to note that over the past 25 or so years Environmental Impact Assessment (EIA) has become a well-established (and still developing) process. An important aspect of EIA is the provision of clear information to the public as well as for the benefit of the decision-making body (which might itself include both professional and lay members). Thus the adoption of new supplementary indicators is in keeping with that philosophy and consideration of supplementary indicators has now reached England and Wales (see BOX 9[22,23]). In view of the emerging role, a small study of the effectiveness of supplementary indicators in communicating information has been carried out[24]. This study found that even some of these less complex indicators were not well understood or could be misinterpreted. As part of the study, a new presentation method (a bar chart based on specific locations) was developed which showed promise in communicating the information presented. However, the authors concluded that further studies are required of the Australian experience in this field and the benefits of other new methods.

In addition, to the use of new supplementary indicators the application of more traditional indicators has been extended to provide criteria not only for annoyance but to include sleep disturbance and other health effects (BOX10[25]). Once again there is a link to EIA in which the role of Health Impact Assessment has become more prominent as that technique has developed.

Conclusions

Wilson created a noise and number index system, which in principle, ▶

1963 Wilson Report NOISE
1963 McKennell Report Aircraft Noise Annoyance around London (Heathrow) Airport
1971 MIL Research Second Survey of Aircraft Noise Annoyance around London (Heathrow) Airport
1971 Noise Advisory Council Reports
1979 DORA Reports on NNI
1971 ICAO Annex 16
1985 ANIS
1990 Batho Report
1992 DfT Report of a Field Study of Aircraft Noise and Sleep Disturbance
2002 ERCD Reports
2003 Air Transport White Paper and predecessors
2005 RANCH
2007 ANASE
2009 Night Noise Guidelines for Europe
2010 Good Practice Guide on Noise Exposure and Potential Health Effects
2013 Aviation Policy Framework
2013 Airports Commission Report "Aviation Noise"

Box 4 - Key Publications from Wilson onwards 1963 – 2013

- PNdB
- dB(A)
- NNI
- EPNdB
- Leq
- L_{den}, Lnight
- TNIP (including N70 etc)

Box 5 - Development of noise scales

1963 35 NNI "Onset of annoyance"
1973 Circular 10/73 – "Planning and Noise"
1994 PPG 24 – "Planning and Noise"
2003 Air transport White Paper (AWTP)
2010 Noise Policy Statement for England (NPSE)
2013 Aviation Policy Framework

Box 6 - Progress in Noise Policy

- Airport Noise monitors and limits
- ICAO Annex 16 and noise certification
- Planning conditions (e.g. Leq contour size limits or detailed dose-related limits such as London City Airport)
- Quota Count System
- Elimination of Chapter 2 aircraft from the UK register
- Environmental Noise Directive and Noise Action Plans

Box 7 - Changes in Noise Legislation and Regulation

ANASE
"For both this study (ANASE survey work carried out in 2005), and the ANIS survey (undertaken in 1982), LAeq is effective at explaining much of the variation in respondents' reported annoyance. However, this comparison has also shown that for the same amount of aircraft noise, measured in LAeq, people are more annoyed in 2005 than they were in 1982"

Good practice guide on noise exposure and potential health effects
"The EU-relations for aircraft noise have been criticized by Guski, who noted in series of recent surveys a decrease of the level needed to cause 25 % highly annoyed over time. Subsequent analyses seemed to confirm this, but could not find an explanation. Recent detailed study on the entire dataset failed to find a single cause, but confirmed a trend breach around 1990. This coincides with the introduction of the ISO-standard questionnaire, but it is doubtful that this actually caused the increase"

HYENA*
"Our data indicates that annoyance due to aircraft noise has increased throughout the recent years, and that the current EU prediction curve for aircraft noise annoyance should be modified. No respective changes were found with respect to annoyance due to road traffic noise"

** Charts illustrating this point are included in Fig 3.3 on page 10 of this reference but the quality of the originals does not permit them to be reproduced here.*

Box 8 - Changes in Community Response

Stansted G1 inspector's report (2007)
" ... I share the views expressed by many that the Leq metric has limitations in the representation of aircraft noise which is generally experienced as a series of discrete noise events with quiet periods between rather than as part of a continuous but fluctuating noise, and so Lmax and the number of aircraft are also significant parameters"

Aviation Policy Framework (2013)
"We will continue to treat the 57dB LAeq 16 hour contour as the average level of daytime aircraft noise marking the approximate onset of significant community annoyance. However, this does not mean that all people within this contour will experience significant adverse effects from aircraft noise. Nor does it mean that no-one outside of this contour will consider themselves annoyed by aircraft noise."

"…the Government recognises that people do not experience noise in an averaged manner and that the value of the LAeq indicator does not necessarily reflect all aspects of the perception of aircraft noise. For this reason we recommend that average noise contours should not be the only measure used when airports seek to explain how locations under flight paths are affected by aircraft noise. Instead the Government encourages airport operators to use alternative measures which better reflect how aircraft noise is experienced in different localities…"

Box 9 - Supplementary Indicators in England

Night Noise Guidelines for Europe
LOAEL (lowest observed adverse effect level)
40 dB Lnight, outside (Night noise guideline)
"Above 55 dB the cardiovascular effects become the major public health concern" (Interim target)

Box 10 - Noise and Health

has survived for more than 50 years (with some issues about the exchange rate between noise and numbers). He also recommended the introduction of noise insulation grants schemes which have been developed over the past 50 years.

He also foresaw growth in the noise problem owing to increased movement numbers, and though he saw that the reduction of aircraft noise [at source] as the only other noise minimisation measure, he was unable to lay down any "hard and fast rules concerning the future noise limits at London Airport".

He suggested that airport noise limits should be progressively reduced particularly at night, and that differential noise limits should be introduced.

He even anticipated the noise issues that might arise from supersonic airliners and their sonic boom though, at the time of writing, his report has outlasted that futuristic mode of air travel which has come and gone.

He would have been gratifyingly surprised at the progress that has been made in aircraft noise reduction.

References

1. EC Directive 92/14/EEC on the limitation of the operation of aeroplanes covered by Part II, Chapter 2, Volume 1 of Annex 16 to the Convention on International Civil Aviation, second edition (1988). Directive 2002/30/EC March 2002 on the establishment of rules and procedures with regard to the introduction of noise-related operating restrictions at Community airports http://eur-lex.europa.eu /LexUriServ/LexUriServ.do?uri=OJ:L:2002:085:0040:0046:EN:PDF
2. Annex 16 — Environmental Protection, Volume I — Aircraft Noise to the Convention on International Civil Aviation
3. The periods reported for each airport were determined by the availability of data.
4. The DfT uses the style "Leq 16 hr" though this does not conform to ISO 1996-1. The Air Transport White Paper "The Future of Air Transport" used Leq 16-hr, in units of dBA and reports by the CAA (and its Environmental Research and Consultancy Department) all do the same.
5. DORA Report 9023 - The use of Leq as an Aircraft Noise Index. September 1990.
6. Attitudes to Noise from Aviation Sources in England (ANASE) study. November 2007.
7. This is discussed further in an Appendix to the Annex on aircraft noise that forms part of the Defra study.
8. The start year depends on the airport.
9. Other confounding factors include changes over the study period in the noise calculation methods.
10. The 'average peak noise level' is the logarithmic average of the peak [ie, maximum] noise levels (in PNdB) during the passage of the aircraft.
11. Wilson Report Appendix XI paragraph 14.
12. Op. Cit., Appendix XII, first paragraph
13. The Noise and Number Index, DORA Communication 7907. CAA 1981.
14. Endnote 5
15. Community Noise Ratings p49. Applied Science 1972.
16. eg, L_{den}, which divides the 24-hour day into 3 periods and applies weightings of 5 and 10 dB respectively to the actual evening and night-time values.
17. Attitudes to Noise from Aviation Sources in England (ANASE) study. DfT 2007.
18. United Kingdom Aircraft Noise Index Study (ANIS). CAA 1982.
19. Good practice guide on noise exposure and potential health effects. EEA Technical report No 11/2010. ISSN 1725-2237.
20. HYENA: HYpertension and Exposure to Noise near Airports.
21. See this URL: http://www.google.com/search?sourceid=ie7 &q=tnip+aus&rls=com.microsoft:en-GB:IE-Address&ie=UTF-8&oe=UTF-8&rlz=1I7LENP_enGB547GB547 accessed 20 May 2014.
22. G1_Inspectors_Report_in_Full, paragraph 14.103. 2007.
23. Aviation Policy Framework, paragraphs 3.17 and 3.19. 2013
24. "Indices to enhance understanding & management of community responses to aircraft noise exposure". OMEGA Community Noise Study. 2009, www.omega.mmu.ac.uk
25. Night Noise Guidelines For Europe, WHO 2009. ISBN 978 92 890 4173 7.

Peter Smith appointed to new sales role at AcSoft

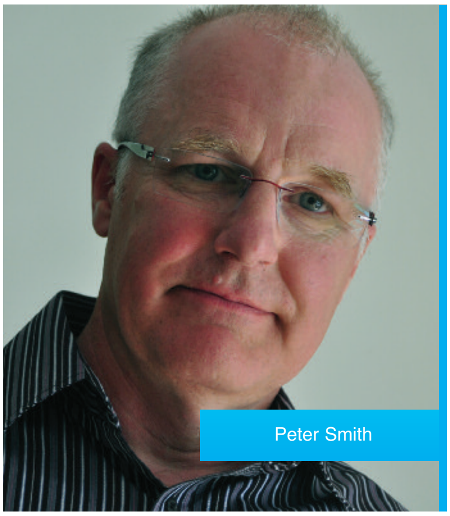
Peter Smith has been appointed as Sales and Application Engineer at AcSoft.

In this newly created role, he will drive pre-sales support and play a pivotal role in the sales process to ensure customer satisfaction through the installation of AcSoft's noise and vibration products across a wide range of markets, including environmental, aerospace, engineering, automotive and telecommunications.

Prior to joining AcSoft, Peter spent five years as Industrial Sales Manager at colour calibration company, X-Rite Europe GmbH. Before that, he was Sales Manager at Konica Minolta 3D, selling 3d laser scanning hardware and software.

John Shelton, Managing Director at AcSoft, said: "We are delighted to welcome someone of Peter's calibre to AcSoft. We are experiencing major growth for our noise and vibration instrumentation and sensors across virtually all target markets."

For product information contact Paul Rubens on **01296 682040**; mobile: **07815 087905**; email: **paulrubens@svantek.co.uk** or web: **www.svantek.co.uk**


Peter Smith

Ignacio Alonso scoops the 2014 RBA Acoustics prize

Ignacio Alonso has been awarded the 2014 RBA Acoustics prize for the best dissertation on the MSc Environmental and Architectural Acoustics course at London South Bank University.

RBA has close links to the university and has awarded this prize for several years. This year the choice of winner was made harder by one of its own engineers being shortlisted by LSBU so it asked the university itself to make the choice.

The judging panel comprised Course Director Steve Dance and Institute of Acoustics President Bridget Shield. They considered Ignacio's dissertation was a clear winner with his study, *Attenuation of Groundborne Vibration Generated by Overground Trains and Mitigation Measures.*

Ignacio was presented with the prize by LSBU Vice-Chancellor David Phoenix at a ceremony at the Faculty of Engineering, Science and the Built Environment.


Back row, l-r: Ignacio Alonso, Russell Richardson (RBA Acoustics) and David Phoenix; front row: Steve Dance and Bridget Shield

Craig Storey appointed General Manager of Cirrus Environmental

Craig Storey has been appointed General Manager of Cirrus Environmental (CE). He is based in the company's new offices in Priestgate, Peterborough.

He joined sister company Cirrus Research two years ago and has held positions in both technical support and business development.

The new offices will form a central base for both the CE sales and telemarketing teams under Craig's leadership. Peterborough was chosen for its excellent rail links to London and the South East as well as access to Stansted, Birmingham and Luton Airports for international clients.

Cirrus Director Rick Heap said: "This is a very important move for us; the new base will allow our sales team to be within easy reach of the capital, where many of our clients are working on large scale projects such as Crossrail.

"Equally as important, the team are only a short distance away from our Yorkshire head office and manufacturing base, so they are available for any company-wide developments and R&D involvement."

To find out more information visit: **www.cirrus-environmental.com**

Craig Storey (right) with Sales Manager Justin Barker

New honour for Tim Leighton

IOA Fellow Professor Tim Leighton from the University of Southampton has been awarded a Fellowship of the Royal Society, the UK's national academy of science.

Each year, the Royal Society awards up to 44 Fellowships to the best scientists in recognition of their scientific achievements and is one of the highest accolades a scientist can achieve.

Tim, who is Professor of Ultrasonics and Underwater Acoustics at the University's Institute of Sound and Vibration Research (ISVR) and Associate Dean (Research) in Engineering and the Environment, said: "I am humbled to receive an honour that counts so many great and heroic scientists amongst its membership, past and present."

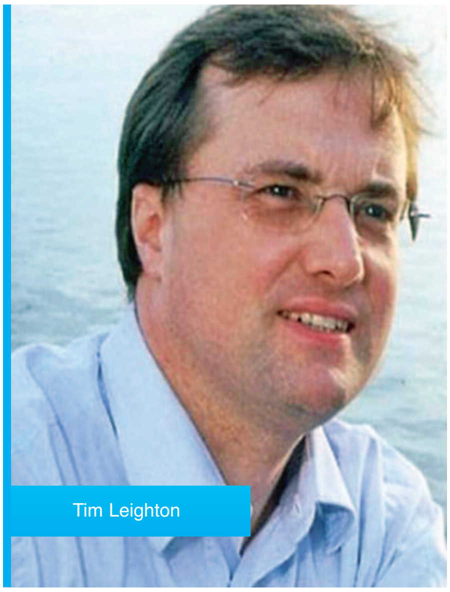
His ground-breaking research is concerned with the way sound travels through liquids in a number of different fields including underwater acoustics, acoustics in space, animal bioacoustics, medical ultrasonics and industrial acoustics.

The research has improved the Ministry of Defence's ability to predict sonar performance in coastal waters.

He developed a technique for the detection of gas leaks from undersea pipelines, he invented sensors for the $1.4 billion dollar Spallation Neutron Source at Oak Ridge National Laboratory in the USA and has developed a radar system for the detection of buried catastrophe victims, covert 'bugging' devices and hidden explosives such as roadside bombs.

Several hundred patients have now benefitted from use of a kidney stone sensor, which he (as Principal Investigator) developed in collaboration with Guys and St Thomas' Health Trust and Precision Acoustics Ltd. His research on conical bubble collapse led to the development of needle-free injection systems and in 2011, he shared the Royal Society Brian Mercer Award for Innovation with his colleague Dr Peter Birkin of Chemistry for ultrasonic cleaning technology, which is now licensed to several users and manufacturers in the UK and abroad.

In other work, he co-authored the guidelines under which foetal ultrasonic scans are done (currently around two billion children since the guidelines were published), his discoveries on whale song are part of the standard repartee of whale tour guides in the USA and his work on extra-terrestrial sound led to a device which simulates the sounds of other worlds.


Tim Leighton

New London home for Temple Group

Temple has moved across the Thames to new offices in St Katharine's Dock, London.

Due to huge growth in recent years, its previous premises In Bermondsey Wall West were no longer able to accommodate the company.

The new 9,000 square foot office will increase the available desk space and offer more client meeting rooms as well space for events.

The address is Temple Group, London Office: **Devon House, 58-60 Katharine's Way, London E1W 1LB.**

Hydrophones aid Japanese company with ship monitoring

JRC Tokki, a Japanese company specialising in system-support engineering for installations on ships and the manufacture of peripheral equipment, has integrated Brüel & Kjær hydrophones into its sophisticated underwater measurement system.

In order to get a complete characterization for the whole of the underwater structure of a ship, it needed a portable system that would enable in-situ measurements to be made. As the curvature of ship's stern and bow often varies, JRC Tokki required a solution that could account for this by following the hull closely, at a uniform distance.

Underwater sound intensity measurements are problematic due to the difficulty of determining particle velocity. In order to do this, JRC Tokki needed carefully selected, phase-matched hydrophones in combination with specified cable lengths and special connectors.

JRC Tokki created a portable system to position the measurement transducers at the correct point, which does not require a permanent setup. A floating raft is moved along the sides of the ship, and stops at a planned point where a measurement is made. After a measurement has been done, the floating raft is moved on to the next measurement point. Taken together, all of the points that are measured create a virtual "mesh" that covers the entire underwater surface of the vessel. The process is repeated for both sides of the vessel, as well as the bottom, in the same way.

The full case study is available to read at: **www.bksv.com**

Researchers use 3-D printing to produce interactive speakers of any shape

Scientists at Disney Research in the US have developed methods using a 3D printer to produce electrostatic loudspeakers that can take the shape of anything, from a rubber ducky to an abstract spiral.

The simple speakers require little assembly, but even those few manual steps might be eliminated in the future, said Yoshio Ishiguro, a Disney Research post-doctoral associate. "In five to 10 years, a 3D printer capable of using conductive materials could create the entire piece," he predicted.

The method developed by Ishiguro and Ivan Poupyrev, a former Disney Research, Pittsburgh principal research scientist, was presented in April at the Conference on Human Factors in Computing Systems (CHI) in Toronto.

The speaker technology could be used to add sound to any number of toys or other objects. Because the same speakers that produce audible sound also can produce inaudible ultrasound, the objects can be identified and tracked so that they can be integrated into games and other interactive systems. The objects can be touched or held in a user's hand without a noticeable decrease in sound quality, so simple tactile feedback may also be possible.

The speakers are based on electrostatic speaker technology that was first explored in the early 1930s, but never widely adopted. This type of speaker is simpler than conventional electromagnetic speakers and includes no moving parts, which makes it suitable for producing with a 3D printer.

An electrostatic speaker consists of a thin, conductive diaphragm and an electrode plate, separated by a layer of air. An audio signal is amplified to high voltage and applied to the electrode; as the electrode charges, an electrostatic force develops between it and the diaphragm, causing the diaphragm to deform and produce sound as the audio signal changes.

For more information go to **http://www.disneyresearch.com/project/printed-speakers/**

IAC on song at new student practice centre

IAC Acoustics has completed a major acoustic installation project at the Royal Academy of Music's new Cross Keys Close rehearsal and practice centre in Westminster

By installing the latest acoustic technology such as acoustic doors, walls, ceilings, flooring, windows and ventilation systems, IAC ensured that the 18 new individual practice rooms and the two chamber music spaces meet the Academy's stringent acoustic criteria.

The installed technology is designed to minimise noise transfer between individual rooms and nearby buildings. This allows dozens of Academy students to practice under the best possible conditions at the centre of one of the world's most busy urban areas without upsetting the neighbours.

The project is the second major work IAC has completed for the Royal Academy of Music, following the installation and renovation of a number of sound-proofed practice rooms in 2010.

The Cellini Quartet rehearses at the new centre

Architects praise acoustics at showcase academy

A West Midlands school's new £28 million building has won praise from architects across the region for achieving excellent acoustic standards.

The architects visited Grace Academy, Darlaston to celebrate the successful use of sustainable acoustics around the showcase building, which comply with BB93.

Shane Cryer, Concept Developer – Education at Ecophon, said: "Sustainable acoustic rafts and wall panels were installed in classrooms, and the entrance atrium, to absorb unwanted noise, creating a calmer learning environment which is likely to assist greatly with an increased attainment level.

"Lecture theatres in particular can also have significant acoustic problems, such as flutter echoes, due to high ceilings, with sound bouncing between the walls. Students may either hear everything twice or experience poor speech intelligibility. However, with the careful positioning of wall absorbers, the acoustics in the lecture theatre are on a par with the best in the country."

Architects tour the new building

David Shaw, Academy Principal, said: "We are extremely pleased with our new building which was built for around £1,750 per square metre, compared with the former BSF schools programme average of £2,200 per square metre, without compromising on a high standard of acoustics.

"The acoustics help improve the concentration and focus of students, contributing to the whole learning environment. Where the acoustics are good, attainment levels go up and behaviour improves.

"We are extremely proud of our lecture theatre which has excellent acoustics, and is used every day for college assemblies, special guests, and gives a university feel to our students' learning."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New $10 million investment will develop acoustic separation technology

US-based FloDesign Sonics is to use $10 million in fresh investment to perfect its acoustic separation technology platform and to start selling it to pharmaceutical companies.

The platform is intended to eliminate the need for filters or centrifuge-based methods of purifying proteins to make biologic drugs.

CEO Stanley Kowalski III said: "Our solution will enable a new thinking about pharmaceutical manufacturing. In our first application we replace traditional filters and centrifuges used in therapeutic protein based drug development."

Bart Lipkens, company founder and Chief Technology Officer, said: "The system employs a 3D acoustic force field to trap particles or droplets that are suspended in a flow. Subsequent particle aggregation and coalescence leads to separation of the particles resulting in a clarified flow."

FloDesign Sonics has spun off several companies over the years, all based on applying aerospace technology to products for industries ranging from wind and water turbines to making quieter firearms for U.S. troops to reduce hearing damage.

Selectaglaze helps 'silence' the Hallé Orchestra

Selectaglaze has solved noise emission problems for the world renowned Hallé Orchestra at its new rehearsal venue by installing a secondary glazing system which can provide noise reduction of up to 50dB.

It treated 44 large round head windows and one three metre diameter circular feature window at the building, a grade two listed former Victorian church in Manchester, using a total of 109 secondary window frames.

Hinged casements were specified to all locations apart from the half round window heads and circular window which were treated with shaped fixed panels. The casements were fitted with high performance compression seals, flush hinges, multipoint locking and installed with a 150mm cavity to the primary window to ensure the tightest fit and the optimum noise insulation. All frames aligned with the existing sight lines.

The installation was a challenge due to the size and height of the windows and Selectaglaze worked closely with the contractor, City Build, delivering fully fabricated frames that could be rapidly installed from the access scaffolds.

The building, formerly St Peter's Church, is now fully operational as the home for the orchestra and its associated choirs. It is the first time the orchestra has had a permanent rehearsal venue in its 156 year history. The refurbished church also provides facilities for small orchestral and choral public performances.

For further information, contact the marketing department on **01727 837271**; e-mail: **enquiries@selectaglaze.co.uk** or visit **www.selectaglaze.co.uk**


A rehearsal in full swing

Armstrong goes vertical by adding baffles to ceiling range

Armstrong's new ceiling baffles

Armstrong Ceilings has added metal and mineral baffles to its portfolio to meet the growing demand for noise reduction solutions that "do not compromise the aesthetics of contemporary public areas".

The metal baffles are precision engineered with a regular perforation pattern and a high-performance glass wool insert for optimised acoustics, providing a α_w between 0.45 and 0.55(H), depending on its size and the void depth.

Comprised up to 30% recycled content and with 65% light reflectance, they are washable and resistant to scratches, fire (Euroclass B-s1, d0) and humidity (90%).

The mineral Optima baffles range, which comprises 80% recycled content, is available off-the-shelf in standard white (with up to 87% light reflectance) or in bespoke colours and sizes. These provide between 1.00 and 1.45 sabines of sound absorption as discrete absorbers, depending on size, spacing and void depth.

For more information go to **www.armstrong-ceilings.co.uk**

New family of portable vibration measurement instruments

MachineryMate is a new family of portable vibration measurement instruments targeting industrial machines.

The machine characteristics are stored in the instrument, enabling users to identify deviations in an early phase and thus helps avoiding breakdowns.

The series is designed for monitoring machines in a broad number of industries, ranging from power generation and air conditioning to petrochemistry, paper manufacturing and food processing.

The MAC200 as the entry-level model of the product family compares the measurement results with the acceptable vibration amplitude and frequency thresholds according to ISO10816; on and issues a warning if those thresholds are exceeded. A simple display in signal colours (green, yellow, red) informs service staff quickly on the condition of ball bearings and other relevant parts. Upon the push of the button, operators can retrieve detailed date with regards to each parameter.

The products measure acceleration and speed and indicate figures in Bearing Damage Units (BDU). They cover the ISO frequency range from 10 Hz to 1 kHz which corresponds to rotational speeds from 120 to 60.000 rpm. An integrated FFT spectrum analyser with 100 or 800 characteristic curves facilitates detailed problem analysis.

The MAC800 is equipped with an additional Bluetooth interface that connects to the optional earphones. This enables the user to perform acoustic surveillance on machine parts to detect irregularities. In addition the MAC800 can be connected to a strobe light that can be synchronised with the rotational speed of the machine. The attached DataMate software allows monitoring of up to ten machines. An upgrade to an unlimited number of machines is available as an option.

For more information visit **www.althen.de**

Campbell Associates adds AVA Trace Monitoring to its products portfolio

AVA Trace Monitoring Systems are now available for purchase or hire from Campbell Associates.

The M60 vibration meter registers, data processes and temporarily stores measurement data from vibrations and air shock waves locally in the instrument.

Measurement data are automatically transmitted over the mobile phone network and the Internet to the AvaNet web-based measurement system according to an individual and adjustable schedule. Alerts are automatically sent by e-mail and SMS to those responsible when a measurement is registered that exceeds set limits or if a failure occurs, such as a cable break.

The M60 measures both peak values and waveforms with up to four individual measurement channels. The design provides up to five months of battery operation on regular alkaline batteries (six size-D batteries). It measures up to 160 seconds of a continuous vibration wave form with a pre-trigger of up to 10 seconds. This is especially well suited to the automatic measurement of vibrations from rail traffic.

For more details ring **01371 871030**, email **hotline@campbell-ssociates.co.uk** or visit **www.campbell-associates.co.uk**

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Committee meetings 2014

DAY	DATE	TIME	MEETING
Thursday	17 July	11.30	Meetings
Thursday	14 August	10.30	Diploma Moderators Meeting
Thursday	21 August	10.30	Membership
Thursday	4 September	11.00	Executive
Thursday	**11 September**	**11.00**	**Council**
Thursday	25 September	10.30	Engineering Division
Monday	29 September	11.00	Research Co-ordination
Thursday	23 October	11.00	Publications
Thursday	30 October	10.30	Membership
Tuesday	4 November	10.30	ASBA Examiners
Tuesday	4 November	1.30	ASBA Committee
Thursday	6 November	11.30	Meetings
Thursday	13 November	11.00	Executive
Wednesday	26 November	9.30	CCBAM Examiners and Committee
Wednesday	26 November	10.30	CCENM Examiners
Wednesday	26 November	1.30	CCENM Committee
Thursday	27 November	10.30	Diploma Tutors and Examiners
Thursday	27 November	1.30	Education
Tuesday	2 December	10.30	CCWPNA Examiners
Tuesday	2 December	1.30	CCWPNA Committee
Thursday	**4 December**	**11.00**	**Council**

Refreshments will be served after or before all meetings. In order to facilitate the catering arrangements it would be appreciated if those members unable to attend meetings would send apologies at least 24 hours before the meeting.

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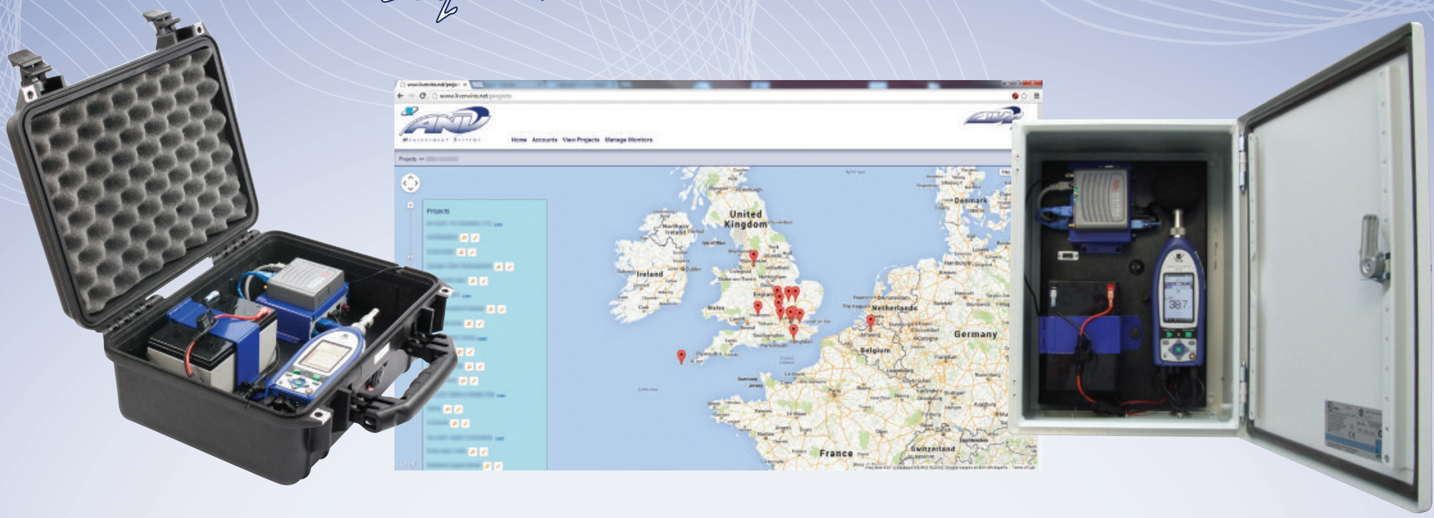

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