Vol 38 No 2 March/April 2013

ACOUSTICS BULLETIN

in this issue… **The green way to reduce rail and road noise**

plus… **Reproduced Sound 2012**

New Chief Executive outlines his aims for the future

Infrasound rumbles on

Tranquillity in the city

Institute of Acoustics

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Front cover photograph: Vegetated facades can help with noise absorption.

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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 2013

21 March 2013
Organised by the Measurement and Instrumentation Group
Making smooth the rough – the latest in measuring human vibration
Buxton

13 May 2013
IOA annual spring conference
Nottingham

21 May 2013
Organised by the IOA working party
Wind turbine noise
Bristol

5 June 2013
Organised by the Measurement and Instrumentation Group
It should never happen to an acoustician!
London

12-14 November 2013
Organised by the Electro-acoustics Group
Reproduced Sound 2012
Salford

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

Dear Members

Welcome to another Bulletin full of interesting articles on a variety of topics, including one by Greg Watts and Rob Pheasant on tranquillity. I have noticed that since Christmas there have been quite a few discussions in the media about the importance of "quietness". Selfridges in London's Oxford Street now has a "quiet room" for customers, which got a lot of media coverage when it opened. I now know (through my Sunday night TV watching) that "Mr Selfridge" was very enthusiastic about, and supportive of, new innovations and ideas (including motorcars, aeroplanes and women's suffrage) so I am sure he would welcome this new initiative. I would be interested to know whether any of our members were involved in the design of the new quiet room – please get in touch if you were.

There has also recently been publicity about the book Quiet London which lists places in London (other than Selfridges) to visit to get some peace and quiet. What is interesting is that this book has actually been around for a couple of years, so I wonder why "quietness" has suddenly become so topical. Maybe it is due to people such as Greg, Rob and other researchers raising awareness of issues around soundscapes and tranquillity. The importance of quiet also featured in a recent Radio 4 programme on the relationship between sound and sleep, which included contributions by colleagues from Salford and Manchester.

Sadly, this Bulletin also has a number of obituaries, which include those of Peter Lord whose death was announced in the last Bulletin and of Keith Broughton who also died just before Christmas. Keith contributed a great deal to the IOA; he was on Council and treasurer for many years and before that was very active in the Industrial Noise Group. He was also extremely helpful and knowledgeable in answering any queries about HSE-related matters and, like Peter, will be sadly missed.

In my last letter I welcomed the appointment of our new Chief Executive, Allan Chesney, whom many of you will already have met. Allan has made a flying start and I and the rest of Council are enjoying working with him. With a new Chief Executive on board it seems an opportune moment to have a look at where we are now, where we want to be in the future, and to consider how we might take the Institute forward over the coming years. To this end Council is having a meeting in March to review and prioritise our strategic objectives, and discuss how we can achieve them more effectively. Last year's membership survey is proving very useful in informing these discussions, so many thanks again to those of you who responded to it.

Another area where we would welcome more input from members is in nominating people for our medals and awards. The awards are decided annually in February, and we are often short of nominations for many of them. If you know of someone who you think is worthy of one of our awards then please do nominate them. Full details of all the awards are on the IOA website, together with nomination forms. Although the deadline for the 2014 nominations is not until January next year, it is never too early to start thinking about it – or even to submit a nomination.

In the meantime I hope to see lots of you at the spring conference in Nottingham on 13 May.

Bridget

Bridget Shield, President

New Institute Chief Executive outlines his aims for the future

Allan Chesney, the IOA's new Chief Executive, has very clear ideas about his role.

"It's not my job to tell the Institute the direction of travel but rather to help it arrive at where it wants to go," he said. "I see my role very much as using my experience to support it, via the Executive and Council, to realise its goals by making things happen. I am determined to help it service members better and promote the value of acoustics in the world.

"In March we've got a key strategy meeting involving all Council members and a number of other people with the aim of giving the Institute a clear vision, and out of that meeting will come operating plans to deliver that vision. One of the things we will be doing is to look closely at what members told us in last year's membership survey to see how we can turn the wishes expressed into reality."

Although still finding his feet following his arrival in January, Allan says he is enjoying himself. "I like all the people here. There's a very positive, enthusiastic team in the office at St Albans and among members there's a real willingness to take the IOA forward and I am sure that with this spirit we will get there."

Allan's arrival follows a highly varied career that began with him becoming one of the youngest ever officers in the RAF when he was commissioned as an acting pilot officer at the age of 16 after winning a scholarship to study mechanical engineering at Strathclyde University.

However on obtaining a BSc, he never put his engineering skills into practice after being bitten by the "outdoor bug" while studying, so on graduating he transferred to the RAF Regiment as a soldier. During the next 17 years he went all over the world, serving variously as a paratrooper, instructor, second in command of an armoured infantry squadron and as the commanding officer of a Rapier missile air defence Squadron. His final posting before leaving the service in 1994 with the rank of Squadron Leader was commanding officer of a training school.

Following a spell at a charity that ran the Recycling Factory in Milton Keynes, he obtained a master's degree in Policy Studies from Northampton University, after which he joined the National Learning and Skills Council where he eventually became National Policy Manager for Adult Learning.

His next job saw him take over the principal role at the Adult Learning Service in Northamptonshire, where over the next six years he and his team transformed what had been classed as an unsatisfactory organisation into one rated as good and outstanding in parts, and placed it on a sound financial footing. During this time he also served on numerous national advisory policy groups at the Departments for Education and Business Innovation and Skills.

A restructure of the service saw him depart. With the encouragement of his three adopted children then at university, he began fostering two small children, whom he and his wife are now in process of adopting. During this time he began working for a drop-in centre for the homeless in Northampton (which he now chairs), and project managed the rebuilding of a church.

So why join the IOA? "When I saw the job advertised I was immediately attracted to it. I did not want to do just any job but one that was interesting and where there was a challenge and where I could make a difference. And it quickly became obvious that there was plenty here to get my teeth into.

"While we prepare to look further ahead, the biggest short-term barrier we face is IT and software issues: staff are wasting a lot of time and energy having to do many jobs that could and should be done by computers. If we can resolve this, we can free them to do the job they should be doing – supporting the membership.

"As many people are aware, the planned website relaunch at the end of last year has had to be put on hold. This was because we had not been able to do enough testing and it was inappropriate for the new site to go live without having done this at the key time of membership renewal.

"As part of a full review of the situation, I am looking at what has been done so far and to see what we want to do in the future. I will be putting a number of options to the executive shortly to consider, including off-the-shelf solutions

"I am hoping that we will be in a position to upgrade the membership area and introduce online booking and payment for events on the website this summer, and this will be followed by an upgrading of our accounts system that will enable us to get key financial data at the touch of a button."

Summing up the challenges ahead, Allan said: "The Institute has important decisions to make both on a strategic and on an operational level in the next few months, and I will be doing my utmost to ensure that we turn that vision and those decisions into reality so it can give the membership a better service and take the Institute to the next level.

"I'm good at seeing the wood while some people see only trees. As CEO you need to be able to do both of course, but my aim is to keep the wood better than individual trees."

Factfile

Born:	Glasgow, November 1956
Education:	Strathclyde and Northampton Universities
Lives:	Silverstone
Personal:	Married with five children
Interests:	Countryside, cycling, church, walking, working with the homeless

When did you last read the Code of Conduct?

By Paul Freeborn,
Chairman of the Membership Committee

As the Rules of Conduct have recently been amended (effective 1 March 2013), this seems an appropriate time to remind all members that they have signed up to the Code and have agreed to abide by the principles embodied in that code.

The Institute's Rules of Conduct form part of the Code and are divided into four broad categories: Professional competence and integrity; Public Interest; Duty to employers and clients; and Conflicts of interest. Guidance is provided under each category on how members are expected to maintain their professional and ethical integrity.

The Membership Committee has responsibility for dealing with complaints under the Code and for making recommendations to Council where action is needed.

Over recent years there has been an increasing trend in the number of complaints for investigation. Investigations are very thorough and require a considerable amount of time from the volunteer members of the committee.

Some cases are resolved amicably and this is always a preferred option where possible, others may require more serious action including the possibility of expulsion from the Institute for the most serious cases.

The Institute covers an extremely diverse range of areas of acoustics and of particular concern is when a member attempts to work beyond their sphere of competence. In this respect Continuous Professional Development will assist a member to know their fields of competence, to maintain their competence and, via their CPD plan, to address any future areas for development.

The Code is available on the Institute's web page under Membership/Code of Conduct (http://www.ioa.org.uk/membership/code-of-conduct.asp) and it is recommended that all members reread the Code to refresh their memory of the content.

Publication date set for wind turbine noise guide

The IOA's good practice guide on wind turbine noise is to be officially launched on 21 May at a one-day meeting in Bristol.

In announcing the news, Richard Perkins, Chairman of the IOA working group , said members wanted to thank all those who had responded to the consultation exercise, and they had been "very pleased" with the evidence provided. Redacted versions of the consultation responses can be viewed at: http://www.ioa.org.uk/about-us/news-article.asp?id=264.

"The group is pleased to report that work is well under way in drafting the final good practice guide. All being well, by the time this Bulletin reaches your doormats, it will be ready for publication following approval from the IOA Council," he said.

"The next in the series of our one-day meetings on wind turbine noise is being organised by the working group, and will be held in Bristol on 21 May, at which the guide will be officially launched. We look forward to seeing you all there."

Responding to the Environmental Noise Directive by demonstrating the benefits of rail grinding on the GB railway network

London Branch meeting

Report by Daniel Goodhand

With the government's announcement on the new High Speed Two rail links, perhaps rail noise has never been higher on the public agenda. So Oliver Bewes's presentation to the London Branch in January could not have been better timed. Ask the man on the street what springs to mind with the word "railway noise" and he probably will still respond "clackety clack", despite the fact that we've been welding railway track in miles lengths in the UK for decades. Nevertheless, the contact noise between wheel and track is the most important noise source associated with the GB railway network.

Oliver's talk gave an excellent introduction to rail contact noise, rail roughness, noise measurement methods, prediction methods, and rail grinding as a method of reducing noise. In fact the talk was based on a project focussing on Network Rail's rail grinding strategy as a response to the Environmental Noise Directive for rail noise management. Oliver showed the London Branch results of noise measured from the rail network on a date before rail grinding was regularly undertaken. The noise levels prior to rail grinding was based on data collected in the early 2000s for Defra Acoustic Track Quality study in 2004. When this data was compared with the Calculation of Rail Noise (CRN), it was necessary to include a correction of +4 dB to CRN predictions. Between 2002 and 2004, Network Rail developed a new grinding strategy to address rail contact fatigue. Oliver led us through the work undertaken to predict the effect that rail grinding might have. On the face of the evidence, it appeared that the grinding should reduce noise by 1 or 2 dB over the entire network. To everyone's surprise, the measurements undertaken after regular rail grinding had been implemented revealed a huge 8 dB reduction comparing before and after.

"Naturally we immediately began to question our results," added Oliver and he explained how he embarked on a series of verification measurements. But still, all the evidence supported the conclusion – a result that was not expected but a very happy outcome for Network Rail.

After the presentation, there were some excellent questions from the floor, including questions from representatives of Crossrail and London Underground.

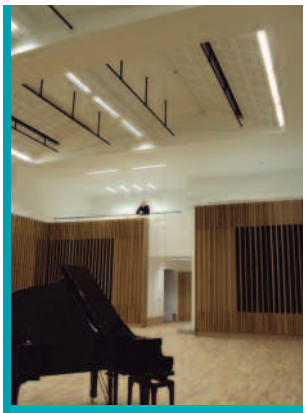
Members are referred to the November/December 2012 IOA Bulletin on page 9 where Kevin Howell has given an excellent technical summary of the same talk given by Oliver for the Midlands branch in August 2012. Many thanks go to Oliver Bewes for the engaging talk and WSP for the venue.

If you would like to make a presentation to the London Branch yourself, please contact Nicola Stedman-Jones on **stedmann@rpsgroup.com** or **01273 546 800**.

New music school 'hits all the right notes'

North West Branch meetings

Reports by Steve Swan, Geoff Kerry and Dave Logan



The Carole Nash Hall at Chetham's

The new Chetham's School of Music building in Manchester was officially opened in October 2012 and boasts extensive high quality music teaching and performance facilities, including a 100-seat recital hall, four ensemble rehearsal rooms, two recording studios and more than 100 music practice rooms. Arup advised on the acoustic design of the building and organised this tour, which was attended by 48 people, a great turnout considering the Biblical weather!

Steve Swan, of Arup, gave a presentation on the acoustic design of the building and highlighted the key design challenges, such as the small footprint of the site, its close proximity to a mainline railway station and achieving maximum value within a limited construction budget. The design has included extensive use of box-in-box room constructions (more than 50) to achieve very high standards of sound insulation and bespoke sound absorbing and diffusing finishes to achieve great acoustics and aesthetics.

He then led the tour around the key music and academic spaces of the seven-storey building, including the Carole Nash Hall and the jaw-dropping concert hall shell. Due to funding issues, the 350-seat concert hall has not yet been fitted-out, leaving this huge (more than 12,000m3) concrete shell secreted in the heart of the building. When complete, this space will have a fully independent masonry inner box supported on isolation bearings, similar to Arup's design for the Bridgewater Hall.

The measurement and prediction of sound levels inside buildings due to transient events

Thirty branch members braved the abysmal weather, snow, sleet, rain and ice on a dark February evening to journey to Liverpool University to hear a talk by Dr Matt Robinson, a research associate in the Acoustics Research Group, on *The Measurement and Prediction of Sound levels Inside Buildings Due to Transient Events*, and afterwards to tour the Group's test facilities.

Matt discussed the signal processing errors associated with measuring the maximum sound pressure level and the prediction of the maximum sound and vibration levels using transient Statistical Energy Analysis (TSEA). The inherent time-delay in octave-band and one-third octave-band filters, which is due to the filters phase response, has been quantified. When combined with the 'fast' or 'slow' time-weighted level detector, this time-delay in the filters causes the maximum sound pressure level to be underestimated. The results indicate that using the 'slow' time-weighting with any type of filter is not appropriate for assessing maximum sound pressure level as the bias error is very large. Responses from various sound level meters were given for idealized and measured transients; these showed variations in the maximum sound pressure levels for different meters, due to the combined behaviour of the filters and the detector. It was suggested that, like the magnitude response of filters, the phase response is also given upper and lower limits in order that the error in the measurement of maximum sound pressure levels can be controlled. Transient Statistical Energy Analysis (TSEA) was introduced as a counterpart to steady-state Statistical Energy Analysis (SEA), with the aim of predicting maximum sound pressure and vibration levels. Like SEA, TSEA buildings are divided into subsystems each supporting their own reverberant field (rooms, plates, etc.) and coupling loss factors describe the energy flow between these subsystems. Results from case studies on two heavyweight buildings using transient structure-borne excitation indicated that the maximum vibration level on the source plate can be accurately predicted. The maximum sound pressure and vibration level in coupled rooms and plates respectively can be predicted within ±5dB. Matt also showed that the maximum sound pressure and vibration level can be accurately predicted from using the ISO rubber ball as the source of transient excitation.

Following the talk members were given a guided tour of the acoustic laboratories by Professor Carl Hopkins and Dr Gary Seiffert. The laboratories are situated on the top floor of the Harrison Hughes Building and have been in continuous use for over half a century. Although accepted as not being an ideal location for acoustic structures, the facilities, several transmission suites, reverberant rooms and anechoic rooms, some multipurpose, have nevertheless proved to be quite versatile when accommodating the wide range of experimental work that has been carried out in them over the years. Some of the current experiments covering a diverse range of topics from tactile inputs to musicians, efficiency of low frequency exponential horns and sound radiation from machines and structures were explained. Although primarily a postgraduate research unit, the staff and facilities are used to support the IOA's competence courses and for the laboratory module of the distance learning option of the IOA Diploma.

Branch members, potentially critical visitors, by listening to competent staff and observing the wide range of facilities and equipment available, were left in no doubt that Liverpool's Acoustic Research Unit is capable of providing a first class service to the Institute and to the wider acoustics world beyond.

Quiet night time deliveries and a soundscape approach to night noise issues

The branch hosted a presentation by Lisa Lavia, Managing Director of the Noise Abatement Society (NAS), on two of its projects.

Starting with the quiet night time deliveries project, she explained that it involved setting up "out of hours" delivery trials at four sites chosen as being either under threat of having delivery restrictions imposed or ones where these currently existed, whether formally or informally.

A working group for each site was then set up, which comprised the store manager, local authority, NAS, representatives from the retailer's supply chain, including any third party operations, to agree what measures would be appropriate to minimise noise disturbance, with any costs incurred in this regard being met by the retailer. The NAS provided information from both overt and covert assessments of noise sources and of suggested site specific mitigation measures. Recommendations for improvement varied by type under the headings of mechanical, operational and training improvements.

The agreed measures formed a Memorandum of Understanding (MOU) which all parties signed up to.

It was found that where retailers enforced the MOU with rigour, no complaints were received, despite what appeared to be marginal reductions in measured sound levels. Complaints were received when the agreed measures were ignored, although resolution was achieved by sticking to the relevant MOU for that site.

Lisa explained that the soundscape project involved playing live and recorded sounds from speakers mounted at first floor level in West Street, Brighton, an area popular with night-time revellers. Monitoring by a psychobiologist showed that people interacted with the event by being less aggressive than would normally be the case, displaying open, friendly body language, and generally happy behaviour. The feedback from both residents and the police was also positive.

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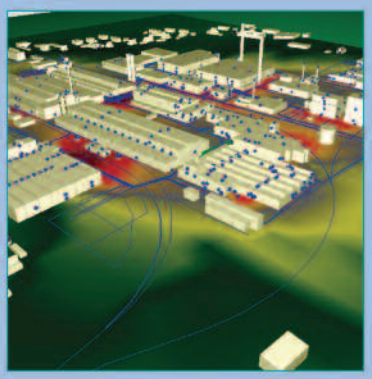
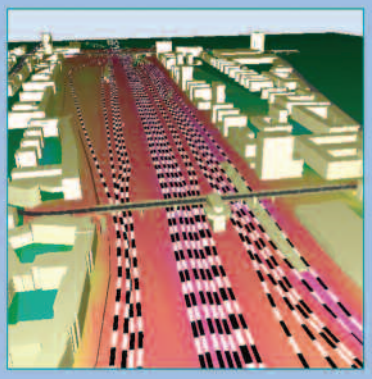
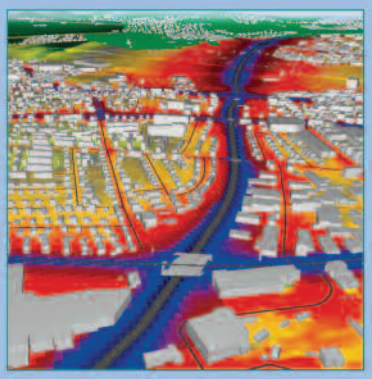


Prediction and detailed analysis of noise at industrial facilities



Optimization of building layout near roads and railway lines



Calculation of noise maps for cities of any size

CadnaA TRAINING

Basic course	Advanced/Expert course	Contact:
17 April 2013 Great Dunmow	24 & 25 April 2013 Great Dunmow	joanne@campbell-associates.co.uk

More successes in IOA short course exams

One hundred and twenty-six candidates were awarded IOA certificates of competence on sitting exams after attending short courses last autumn in one of three subjects: building acoustics measurements, environmental noise assessment and workplace noise risk assessment.

Building Acoustics Measurements

Exam date: 21 September 2012 Pass candidates

Southampton Solent University
Arkley D J
Bell J H
Brewer C
Durham M
Forster P J
Ledbetter M A
Leggett P
Pinches J
Szczepanska A M
Williams R

Environmental Noise Assessment

Exam date: 5 October 2012
Pass candidates

University of Birmingham
Barrett N R
Birkenshaw P J
Essex L N
Pigrem J
Smith Z C
Taylor F J

University of the West of England
Cross S
Harris K
Hawkins B
Holland J
Hooper P
Lewis A M
Martyr-Iche A W
Reynolds A
Spencer A J
Thomas L
Thomas D I

Colchester Institute
Adegbite H A
Brewster M F
Davey L H
Devenport A M
Forbes A D
Gregory R S
Hajdar J
Hands A
Kavanagh C D
Musk N
Paine D E
Reynolds R J
Stewart E

University of Derby
Beard S A
Carter K J
Deloughry A
Donnison M
Gell L E
Hamer M
Kirk L
Maycock J
Neaupane R
Noi T B
Osondu E
Reynolds D J
Spencer A J
Stephens R
Wilson M P
Wilson A

Leeds Metropolitan University
Baxter R
Bowler R
Bramley C E
Broughton J
Eddington C
Jobson D
McManus I

Liverpool University
Barrett P F
Bates G
Bilton K M
Cooper J
Dean A I
Hardwick D M
Madren-Britton C
Wellings G R

NESCOT
Burt G
Inman I D
Marica A
Pearson J
Walker M
Wareing I J

Southampton Solent University
Arkley D J
Beckingham W O
Cox N
Ellis D J
Fenton M
Foy A
Giddings K E C
Holdway L M
Hucklesby J
McIlroy M
Nikolova L
Ridley A
Thomson M
Wainwright P D
Wood N
Woodhams S

University of Strathclyde
Cook J
Couper P
Foulis E S J
Glover N
Harris J
Latta P
Lynch M
Macaskill R S
Martellozzo G
McGilvery S
McNeil L A
Meneguz K
Roche P J
Walsh M

Workplace Noise Risk Assessment

Exam date: 2 November 2012
Pass candidates

EEF Sheffield
Hall J E
Heath J L
Hunter I D
Jawaheer G
Sullivan M
Winterbottom H

EEF Melton
Fox C D
Myers R L
Nixon J
Savage P
Smith P

Edinburgh Napier University
Ford S
McKenna A
Selwood P
Valentine R D
Shorcontrol Safety Ltd
Kelly R
McNena M C
Mcardle Y

Full programme in 2013 for 'reignited' Southern Branch

Report by Dan Saunders

The IOA Southern Branch has been reignited with a calibrated bang following a first evening meeting in 18 months and its first annual general meeting since 2008.

The well-attended January meeting featured a presentation by Ian Campbell on certification of instrument calibration and legal metrology. Those present were given an insight into the detail and precision of the calibration procedure while noting the uncertainties involved in any process of this type.

Under the guidance of new Chairman Peter Rogers, Secretary Dan Saunders and a newly appointed committee, a further five dates are scheduled for 2013. The next meeting, on 18 April, will feature a talk by Dani Fiumicelli of Temple Group entitled NPSE and NPPF: How well is it working? We look forward to seeing you then or later in the year.

IOA gives full backing to 'noise manifesto'

The IOA has given its support to a new "noise manifesto" which calls for the Government to boost noise protection in homes and other buildings as part of the new National Planning Policy Framework.

Launched by The Noise Abatement Society and insulation specialist Rockwool, the manifesto urges the government to create better planning laws, not "just" less planning laws.

Divided into actions for the government and the property industry, the manifesto calls for minimum national standards of noise protection in buildings and lays the groundwork for a new Quiet Homes Standard to identify quieter homes, commercial and public buildings in the future.

In the face of numerous academic studies and a World Health Organisation report showing the serious effects on health, impact on children's educational achievement and damage to quality of life caused by excessive noise in the built environment, the document sets out a 14-point plan to address the issue.

Key recommendations include:

- Create a single, national standard for minimum acoustic protection in the design and construction of buildings as part of the National Planning Policy Framework review and The Code for Sustainable Homes
- Empower local authorities to refuse planning permission for developments that are deemed to create a noise issue in the finished buildings, as part of the Localism agenda
- Create tranquil spaces in new developments to allow residents to enjoy quiet areas
- Zone developments to separate commercial and residential buildings
- Strengthen planning guidelines around noise protection in schools
- Introduce a Quiet Homes Standard to identify buildings which meet minimum acoustic protection levels
- Use Green Deal and Eco funding to also improve acoustic insulation as well as boost thermal efficiency in buildings
- Improve training for architects to include modules on acoustic design.

Bridget Shield, IOA President, said: "It is well known that noise has a detrimental impact on people's health, wellbeing and performance. The Institute welcomes the Noise Abatement Society and Rockwool's manifesto and hopes that it will encourage the government to recognise the importance of the prevention and control of noise, particularly in relation to current changes in planning policy and guidelines.

New homes must be quieter

"Many of our members are involved in the study and measurement of noise and its effects, and in developing and implementing noise control measures. We believe that noise should move up the political agenda and be recognised as being a key component of planning and building policies and the sustainability agenda."

Midlands Branch meetings

Reports by Kevin Howell

IOA Diploma projects

In September the Midlands Branch convened for its annual Diploma Project evening at Derby University. The very large audience was treated to two presentations competing for a prize, once again presented by ANV.

Martin Hamer's presentation was on "Noise exposure of amateur brass musicians and noise reduction methods". Martin began by observing that amateur musicians never seem to wear hearing protection or use any other method of noise reduction. He reviewed current guidance and then sent out a survey to brass bands. He analysed the responses of 50 musicians and found that: almost all were unaware of any guidance on noise exposure for musicians; only 19 had ever used hearing protection and only five had used screens. There was a common perception that screens don't work. When asked "Would you change the band layout?" 10 said yes. However, brass bands follow a very traditional layout and it would be difficult to change. Martin carried out noise measurements in the front centre of a 28 piece brass band, and the two-and-a-half hour session resulted in a L_{Aeq} of 97.6 dB. He also carried out tests on a home-made 8mm Perspex screen using his trombone as the sound source. The tests were conducted outdoors on grass for three situations: without the screen; with the screen; with screen with an absorbent surface facing the source. The results showed very little difference and were inconclusive. Martin concluded that amateur musicians generally make no connection between playing music and the potential for hearing damage. They don't like ear plugs and only use them once a problem is identified. There is a reluctance to change the band layout, but he feels musicians could spread out more where venues allow.

Matthew Barnes presentation was "An investigation into the efficacy of a commercially available acoustic absorbent material

in reducing the airborne sound transfer of an acoustic guitar through a suspended timber floor". Matthew's project was based on the proposed conversion of a basement into a rehearsal room as he is a keen amateur guitarist. He wanted to improve both the acoustic and thermal insulation of the timber floor above the basement. This basement 'ceiling' was quite low and so a suspended ceiling was not an option. He recorded his guitar playing and, using a tape loop, performed a 1/3 octave frequency analysis. He studied construction techniques in Approved Document E and then obtained manufacturers' technical information for a number of insulation products although he found that for some products acoustic data was poor. He decided to use Rockwool. He carried out sound insulation tests based on ISO 140 before and after installation of the Rockwool between the rafters, all completed on the same day. These tests proved difficult because of unpredictable background levels due to the proximity of a railway and construction sites. His results showed a noticeable sound insulation improvement between 100 Hz and 1.25 kHz with a maximum of 13dB at 630 Hz and just less than 10 dB at the guitar's peak frequency of 1.6 kHz. The basement is now a fairly dead acoustic space and Matthew is looking at ways of remedying this.

A small judging panel complimented both presenters and the prize went to Martin. Thank you to Martin and Matthew, to Derby University and to ANV.

Underwater bioacoustic research

Our October meeting returned to Loughborough University for a fascinating presentation from Paul Lepper. Paul began by informing us that deep-water noise levels are increasing, and a rate of 3dB per decade has been quoted. There are increasing requirements from regulators to carry out impact assessments where offshore activities may introduce acoustic energy into the marine environment, and Paul described the numerous sources of man-made noise that affect marine environments including offshore renewables construction and operation, sonar systems, coastal development, dredging and land reclamation, petroleum and gas exploration and fisheries and aquaculture. The potential receptors are marine mammals, fish, crustaceans, diving birds and humans. These may suffer a number of physiological responses ranging from temporary or permanent hearing loss to death, either directly or indirectly due to stranding or evoked decompression injury. Behaviour may be affected by excluding creatures from their habitat temporarily or permanently, or by masking effects reducing the ability to communicate with others, to find partners or care for young, to find prey or to detect and avoid predators. Paul described the rapid growth of offshore wind farm development globally, the common methods of construction and the research carried out into modelling the propagation of noise from piling operations and marine dredging. Paul then continued by describing some current research into behavioural responses and impact modelling. Particularly interesting was the statistical modelling work done on the fleeing responses of animals when exposed to high noise levels, including how far they travel and how long it takes for them to return. Finally Paul described work undertaken in the Netherlands to determine the hearing acuity of porpoise including the TTS suffered when exposed to noise. Paul summarised by saying that although the noise from many offshore activities has now been acoustically characterised there is little data about emerging technologies. Measurement standards are being developed but more are needed and quickly. Physiological and behavioural studies are in progress for a few species but there are large gaps in the knowledge. These gaps are seen as major risk factors for renewable energy developers and investors and there is, therefore, a major drive for collaborative, multi-disciplinary research to help answer these questions. Thank you to Paul for his presentation and to Loughborough University for hosting the meeting.

Wind turbine noise: a brief history and some technical issues

Derby University was the venue for this very informative and entertaining presentation by Andy McKenzie of P14

P13 Hayes McKenzie. The presentation had a great deal of detailed technical content that cannot be adequately covered in this brief report. Andy began by discussing the role of BS4142, highlighting particular problems concerning the determination of background noise levels and the effect that winds have on these levels, and the lack of guidance when background levels are low. He explained some of the deliberations and conclusions of the DTI Noise Working Group which provided guidance on these issues and others and led to the procedures contained in ETSU-R-97 'The assessment and rating of noise from wind farms.

Andy described "wind turbine syndrome" which includes symptoms such as sleep problems, headaches, dizziness and nausea, exhaustion and depression, lack of concentration and tinnitus. Some evidence also suggests that some residents may also exhibit symptoms of Vibro-Acoustic Disease, a pathology previously only associated with occupational exposures. He felt that these were being linked to issues of low-frequency noise and infrasound but that this is mis-referred and is in fact due to amplitude modulation which he discussed in detail. He also discussed the emergence of evidence that turbine noise predictions could no longer be tied to 10 metre height wind speed because of wind shear effects and he outlined options for more accurate noise prediction. He was part of the 'Acoustics Bulletin Agreement' in which a number of consultants agreed a uniform assessment approach.

The Department for Energy and Climate Change (DECC) subsequently commissioned Hayes McKenzie to investigate how ETSU-R-97 is being implemented in practice and to provide recommendations to Government on how it can be applied in a more consistent and effective manner. Some 46 noise assessments have been reviewed. Recommendations from this study include that: a simplification of assessment procedures is possible; the structure of planning conditions should be improved; guidance and standards used to inform ETSU-R-97 should be updated; there should be a requirement for standardised assessments; tonal penalties included at ES stage; and post-commissioning measurements should be carried out. A working group was set up to prepare an IOA Good Practice Guide and this document will hopefully be finalised in spring 2013. Andy concluded his talk by emphasising that there is a need to focus on real issues and acknowledge that audibility is unacceptable to some and that wind turbines generate annoyance at significantly lower noise levels than other sources and that this is unlikely to be due simply to the specific features in the noise itself. Although the wind farm issue is frustrating we must be clear in our role of informing (or changing) the planning process. Many thanks go to Andy and to Derby University. Andy's presentation was preceded by the Midlands Branch AGM.

Environmental noise and effects on health: recent developments

In December our Christmas lecture was held at Derby University where we welcomed Bernard Berry as our speaker. Bernard began by posing the question "Why the interest in noise and health?" He referred us to the Noise Policy Statement for England in which the Noise Policy Vision is "Promote good health and a good quality of life…" The WHO defines health as "a state of complete physical, mental and social well-being". Bernard described the "Simplified" Noise Reaction Model which shows a hierarchy of noise exposure effects ranging from disturbance of activity to stress, biological risk factors and cardiovascular diseases. He also described the WHO pyramid of effects which shows the severity of effect in five stages ranging from "a feeling of discomfort" through to "mortality" with decreasing numbers of people affected at each stage.

Current research is aimed at improving the understanding of the dose-response relationship between noise and health effects. Bernard presented some results of annoyance studies which demonstrated the wide range of relationships apparent between different aircraft noise studies. Bernard also presented data for railway and road traffic noise and also an EEA report (2010) which shows percentages of people highly annoyed at different L_{den} levels for road, rail, aircraft, industrial and wind-turbine sources. Dose-response relationships for other health effects have been developed and Bernard discussed examples of self-reported sleep disturbance and an EU study into the reading ages of children in schools affected by aircraft noise which suggests that a 5dB increase in noise level leads to a two month delay in reading age. A 2007 study on the links between aircraft noise exposure and hypertension compared five different studies and showed a large variation between them and no usable relationship apparent. Bernard showed an example of how to apply research results on noise and health by showing the calculation of how many cases of potential early death due to heart attack may be linked to high levels of road traffic noise in London.

There are three key documents containing the current key noise values: WHO 2009 (Night noise guidelines); EEA 2010 (Noise and health effects); WHO 2011 (Burden of disease from noise). Current work that may result in new guidance in the near future include: the Health Protection Agency review – future Noise and Health Work plan: DEFRA project 2011 to determine Adverse Effect Levels in support of the NPSE: and the WHO Noise Guideline Development Group which may produce an update of the WHO 2000 Community Noise Guidelines by 2014.

Bernard concluded his talk by emphasising that "Noise and Health" is a complex issue and continues to be a very active research area, with many on-going projects, and has an increasing influence on UK and EU noise policies. Much of the evidence is mainly based on studies of road traffic noise and aircraft noise with much less research on railway and industrial noise. Bernard made available copies of a useful list of 'further reading'.

Many thanks to Bernard for his comprehensive and informative presentation and for rounding off our 2012 season so well. Thanks also again to Derby University.

The green way to reduce rail and road noise

HOSANNA workshop, London, January 2013

Report by Keith Attenborough

The research project "**HO**listic and **S**ustainable **A**batement of **N**oise by optimized combinations of **N**atural and **A**rtificial means" (HOSANNA) received funding in 2009 from the European Community's Seventh Framework Programme (FP7/2007-2013) and is near completion. The project has developed several innovative solutions and combinations of solutions for reducing surface transport noise and has assessed them in terms of numerical predictions of sound level reductions, perceptual effects (including auralisation) and cost-benefit analyses.

The project involved 13 institutions, including three from the UK (see Table 1), and was organised into eight work packages (see Table 2); four of which concerned technical developments.

The eighth of the HOSANNA work packages is focussed on disseminating the technical findings through a brochure, a

CHALMERS TEKNISKA HOEGSKOLAAB	SWEDEN
STOCKHOLMS UNIVERSITET	SWEDEN
CENTRE SCIENTIFIQUE ET TECHNIQUE U BATIMENT	FRANCE
THE OPEN UNIVERSITY	UK
UNIVERSITY OF BRADFORD	UK
THE UNIVERSITY OF SHEFFIELD	UK
INTERDISCIPLINARY INSTITUTE FOR BROADBAND TECHNOLOGY / GHENT UNIVERSITY	BELGIUM
TRANSPORTOKONOMISK INSTITUTT	NORWAY
MÜLLER-BBM GmbH	GERMANY
CANEVAFLOR SAS	FRANCE
ACOUCITE	FRANCE
CITY OF STOCKHOLM. Environment and Health Administration	SWEDEN
HANYANG UNIVERSITY	SOUTH KOREA

Table 1 List of HOSANNA partners

handbook (to be published by Taylor and Francis in 2013 or 2014) and four workshops. The first workshop was held in Stockholm in December 2012 and the second was held jointly with the IOA in London in January 2013. Two others have been held in Munich (30 January) and Lyon (31 January).

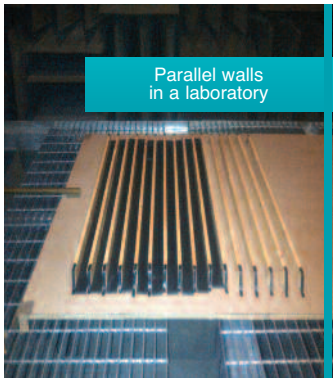
The London workshop, held at the Royal Society, was attended by 65 delegates. The first presentation from Jens Forssen, the project director, described the background and aims of the project. The project has been developing methods for the reduction of road and rail traffic noise in outdoor environments, by optimal use of vegetation and other natural materials in combination with artificial elements. The proposed "green" abatement strategies for cost effective improvements in acoustical environments include new barrier designs, planting of trees, shrubs or bushes, greening of building facades and roofs and ground and road surface treatments.

This was followed by a presentation from Keith Attenborough from the Open University, leader of workpackage 4 on ground treatments. Ground effect is well known as one of the contributing factors in outdoor sound propagation. The phenomenon is sometimes called "ground absorption" but Keith pointed out that this is a P16

WP	Work package topic	WP Leader institutions
1	Management	Chalmers University
2	Innovative barriers	CSTB
3	Trees, Shrubs and Bushes	IBBT, Gent University
4	Ground treatments	The Open University
5	Vegetation in urban areas	The University of Sheffield
6	Holistic prediction tool and auralisation	CSTB
7	Cost Benefit Analysis	TOI
8	Dissemination	Stockholm University

Table 2 List of HOSANNA workpackages and leader institutions

P15 misnomer since it is the result of interference between direct and ground-reflected sound which leads to sound reinforcement, particularly at low frequencies and sound cancellation at higher frequencies depending on the source-receiver geometry and the acoustical properties of the ground surface. The first destructive interference over acoustically-soft ground, which typically is porous, leads to attenuation over and above that due to wavefront spreading and air-absorption.


Parallel walls in a laboratory

Ground effect is often described in terms of the excess attenuation spectrum. Ground effect occurs even if the ground is acoustically-hard such as non-porous concrete or asphalt. For example, over an acoustically-hard ground 10 m from a road, at a 4 m high receiver and for sound travelling from the higher engine source on a heavy vehicle, three destructive interference minima occur in an important part of the traffic noise spectrum. This means that over hard ground at 10 m the overall level for heavy vehicles is increased by only 3 dB compared with the 6 dB (pressure doubling) that would occur for light vehicles. Apart from the propagation loss over porous road surface, little thought has been given hitherto to deliberate exploitation for ground effect for noise reduction. One of the approaches Keith described is to modify the ground effect over otherwise acoustically hard smooth surfaces by making them rough. To investigate this the HOSANNA team at the Open University has carried out laboratory experiments using various shaped wooden or metal strips spaced regularly or at random on an otherwise hard surface and has conducted outdoor experiments with household bricks on a car park in the form of low (20 cm high) parallel brick walls or a rectangular lattice.

The presence of roughness lowers the frequency of the first destructive interference that would occur of the ground were smooth and it does so in a different manner if the roughness is regularly spaced than if it is random. Having found that the Boundary Element Method (BEM) enables good predictions of these experimental data, numerical predictions have been made using BEM for other hypothetical configurations that might be exploitable for traffic noise reduction. If the treatment starts 2.5 m from the nearest lane of a two lane urban road carrying 85% cars and 15% heavy vehicles travelling at 50 km/h, roughness configurations between 3 m and 25 m wide are predicted to give insertion losses of between 6 and 12 dB compared with leaving the hard ground smooth. Such ground treatments can also be recessed but this reduces their effectiveness by 3 dB compared with the 'raised' version. So either the treatment would have to start nearer the source or it would have to be wider to achieve a comparable insertion loss. Advantages of deliberately introducing ground roughness for noise reduction compared with erecting a conventional noise barrier over hard ground is that it preserves line of sight and enables pedestrian access across the treatment. The provision of pathways through the lattice roughness arrangement leads to only small reductions in insertion loss compared with the relatively catastrophic effects on the acoustical performance of any gaps of a conventional noise fence.

Keith detailed also the predicted effects of replacing acoustically-hard ground with acoustically-soft ground. Introduction of a low flow resistivity grassland (typically one that is allowed to grow wild without frequent mowing and rolling which tends to compact the surface) between a two-lane urban road and a 1.5 m high receiver 50 m away can reduce noise by up to 9 dB. Introduction of a dense 1 m high crop can result in a further 5 dB reduction.

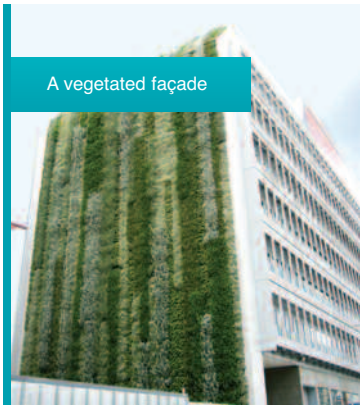
Jian Kang from Sheffield University then talked about the noise reduction possibilities offered by the introduction of vegetation in urban areas including green roofs, vegetated facades and vegetated courtyards. He introduced predictions of noise reductions ranging from 1 dBA from vegetating facades in a canyon street to 8 dBA in a courtyard protected from a busy road by a building with an apex green roof.


Drive by test on a brick lattice

Apart from the potential noise reductions, the benefits of increasing the amount of greenery include

- Decrease heat island effect in cities through reducing the air temperature.
- Absorption of airborne particles, heavy metals and volatile organic compounds from the local atmosphere.
- Increased thermal insulation of buildings, thereby reducing the energy demand for cooling.
- Absorbtion of excess rain water (summer up to 80%, winter –up to 35%).
- Decreased solar gain of building roofs.
- Provision of green spaces for relaxation and sanctuaries for wildlife.

This was followed by a talk from Timothy van Renterghem (IBBT, Gent) concerning the acoustical effects of trees. Timothy described the design parameters for a tree belt. In addition to the ground effect, which becomes particularly useful for noise reduction as leaf litter develops and decomposes, scattering by tree trunks can play a useful part to an extent that has not been exploited hitherto. In a regular arrangement, the scattering effect depends on the spacing and the trunk diameter. A not-quite-regular planting pattern can be better for noise reduction than purely regular or random one. Foliage offers only a small additional attenuation mainly at high frequencies. However foliage has an important effect on the microclimate.


A vegetated façade

A 15 m wide tree belt can be designed, using a realistic planting density, to give 6 dB insertion loss near a two lane urban road. Tree belts affect the local micrometeorology in a helpful way for noise reduction at night but in a slightly harmful way during the day. The overall micrometeorological effect of a tree belt is useful in terms of noise reduction. The micrometeorological effect of a single row of trees on the receiver side of a barrier is particular beneficial during downwind conditions.

Jens Forssen returned to the podium to describe work for the HOSANNA, lead by CSTB Grenoble, on innovative noise barriers. This work included predicting the effects of covering conventional barriers by vegetated (or non-vegetated) substrate (produced by one of the HOSANNA partners Canevaflor), Low (1.5 m) vegetated barriers and low berms, low barriers at bridge edges, vegetated barrier caps and complex shape berms. For 1.5 m high berms, a square or staircase shape is predicted to perform better than the traditional trapezoidal shape.

The research has shown that families of innovative barriers using natural materials are effective and promising solutions to abate ground transportation noise for receivers up to 5 m high. The most useful type of abatement depends on the transport noise source and its environment (see Table 3).

Predicted reductions for low vegetated barriers in streets range between 1 and 10 dBA or even higher for tramways.

Transport type and environment	Proposed abatement
Urban streets	Low vegetated barriers
Tramways	low vegetated barriers / low berms
Motorways on flat terrain	vegetated caps on barriers
Motorways on embankments	vegetated caps on barriers/ low barriers or berms
Railways on flat terrain	complex shape berms
Railways on embankments	low barriers or berms

Table 3 Appropriate uses of innovative barrier solutions

A tramway on grass

Kirill Horoshenkov from the University of Bradford described measurements to establish the acoustical properties of plants and of plant and soil combinations including those used by Canevaflor for their vegetated façade and roof systems. Among the plans studied, winter primrose which has large broad leaves was found to offer the highest absorption. The canevaflor substrate was found to be the soil type offering the greatest sound absorption. Kiril has also found and developed models for predicting the acoustical properties of plants and soils. Studies of sound transmission through hedges have shown that, typically, the transmission loss is significant above 1 kHz.

Jens Forssen gave his third presentation about possibilities for combining two or more of the HOSANNA abatements, noting that, for example, noise reduction by a tree belt already combines two abatement effects viz. ground treatment and scattering by trunks and foliage.

A hypothetical housing development incorporated a road, an elevated railway crossing the road and a park. The proposed abatements for pedestrians crossing from the housing to the park include a berm along the road, a pedestrian crossing (reduced lane width and speed) flanked by ground roughness elements, a dense strip of trees along the railway alternated with a low, lightweight barrier on the railway bridge. The trees and barrier also reduce the noise levels at housing thereby increasing the overall cost-benefit ratio.

Through the HOSANNA project, CSTB has also developed a prediction tool to incorporate the effects of the HOSANNA abatements in noise calculations based on existing methods such as rnmpb-96, iso 9613-2, nmpb-2008 and harmonoise.

A case study has been made of a low vegetated barrier which was constructed along the Quai Fulchiron in the city of Lyon. This has been accompanied by social surveys and dummy-head recordings that have been used subsequently in auralisation studies. A second case study in Berlin was of a low noise road surface augmented by buried resonators developed by a commercial HOSANNA partner MBBM. A third case study has involved a vegetated wall and a fourth case study has compared tramways separated by acoustically-hard surfaces with tramways separated by grass in Grenoble.

Other case studies that have been or are being made include a hedge in Grenoble, a green roof in Eindhoven, a motorway berm in Belgium and façade greening in France.

Dick Botteldooren from the University of Gent described work carried out in HOSANNA on the perception of the acoustic environment. He described a notice-event model for unwanted sounds in the home. It assumes that sound that is noticed becomes annoying and potentially threatens well-being i.e. a sound suddenly emerges above the background generated by everyday activities. Notice events also occur when background drops or attention for environment increases. Whether a noticed sound is appraised as annoying depends on its meaning for the listener. Greening can help by reducing peak levels as well as L_{Aeq}, increasing natural background sound and improving the scenery.

Ronny Klaeboe from the Institute of Transport Economics in Oslo, Norway, described two different approaches to the economic case for noise abatement; 'cost effectiveness' and 'cost benefit'. The former would simply compare the cost per dB of abatement measures. The importance of including aesthetic and other benefits in a cost benefit analysis for the HOSANNA abatement measures was emphasized. In this way the use of green roofs and vegetated facades for reducing noise levels in courtyards, for example, can be clearly justified.

A lively discussion raised two main points:

1. how accurate are the simulations used in the main by HOSANNA to justify the proposed abatement methods?
2. what is the engineering evidence to support the HOSANNA proposals?

It was pointed out that the numerical simulations had been supported by laboratory and outdoor experiments and by the various case studies mentioned in the seventh presentation.

A brochure was made available to all delegates after the workshop. Further copies can be obtained by emailing **Shahram.Taherzadeh@open.ac.uk** .

Reproduced Sound 2012: Auralisation – designing with sound

Report by Bob Walker

The 2012 Reproduced Sound Conference was held on 15 and 16 November, with an informal event on the 14th to allow delegates to get together. It was again held at the Thistle Hotel, Brighton.

The Institute's thanks again go to Paul Malpas for chairing the organising committee and to all the committee members for their contributions. Thanks also go to the hotel staff, who were always friendly, helpful and co-operative, greatly helping the smooth running of the conference.

The meeting room had also been equipped with an audiovisual system. This had been organised and managed by John Taylor of d&b audiotechnik. The organising committee gratefully acknowledges the effort put in by many people in setting up the technical support, especially Mincheol Shin of the University of Southampton who, at about the last minute, offered to look after the presentation computer facilities. That proved to be something of a challenge because the Institute laptop was found rather wanting and he had to use his own machine for some of the presentations. The delegates were treated to Windows menus in Korean!

The contributions of the exhibitors to the success of the conference are also gratefully acknowledged. Several exhibitors also included sponsorship as part of their exhibition package. Those were valuable and much-appreciated contributions to the conference budget, including support for the evening receptions.

The technical presentations took place in one part of the hotel's Renaissance Suite, with the remaining part being used by the exhibitors and for the refreshment breaks. The exhibition space had been augmented by a number of sofas, providing more comfort for those longer discussions. That new feature was well appreciated by many delegates. The venue facilities fitted the conference requirements well, with the hotel bar and lounge areas providing space for informal daytime and evening breaks.

The conference theme continued from previous years, with its focus on developments in electro-acoustics, room acoustics and intelligibility. In addition to one invited lecture and the Peter Barnett Memorial Award lecture, 20 technical papers were presented in six sessions.

The conference was well attended, with 97 registered delegates, of whom 22 were registered as students, plus four exhibitors. The committee was again pleased to see a number of faces new to RS, as well as the larger-than-usual complement of students.

The delegates certainly appeared to have had an enjoyable and worthwhile conference, with many already looking forward to next year. Overall, the Electro-Acoustics Group committee was satisfied with the response to the programme and is now planning the 2013 event, to be held on12-14 November near the MediaCityUK centre,

John Taylor

Salford. Though yet to be finalised, it is intended that the first part of the 2013 conference will consist of visits to the BBC and University of Salford facilities. Those visits will replace the tutorial and "get-together" sessions of recent RS conferences. After much discussion and feedback from delegates, the committee has decided to move the conference to Wednesday and Thursday, with the informal sessions on Tuesday afternoon/evening. This was in response to requests from delegates to avoid travelling home from Manchester on a Friday evening. Some delegates have also suggested that being in their workplace on Mondays and Fridays was valuable.

The conference programme

Registration opened on the evening of the14th in the Renaissance Suite lobby, with a glass of wine and the opportunity for delegates new to Reproduced Sound to make contact and to explore the venue and for regular delegates to meet friends and colleagues.

Filippo Fazi (University of Southampton) started the informal introductory session with three dimensional sound fields. That was billed as *An introduction to the fundamentals of sound fields in three dimensions*. It quickly developed into a fairly advanced account of Fourier transforms, spherical harmonics and the concept of spatial impulse responses. However, the presentation style made it easy listening and most delegates appeared to benefit from it. A lively discussion followed the presentation. It was followed by Bruce Wiggins (University of Derby) with *Practical ambisonics: a tutorial on 3-D audio production*. The main topic was the theoretical basis for decomposition of spatial audio into specific loudspeaker layouts, both regular and irregular. A number of demonstration samples were presented. The session was again followed by a lively discussion, continuing for some into the

Delegates networking

Delgates tune into a session

hotel bar and lounge areas.

The conference was formally opened the next day by Paul Malpas, who welcomed delegates. He said that the conference had been well supported, with many papers submitted and excellent attendance numbers. He thanked the committee, the delegates, the Institute, the students and all of the other people who had helped to make sure it happened. That was followed by the day's technical sessions.

The first day's sessions were followed by the presentation of the Peter Barnett Memorial Award. Afterwards, there was a break until a reception which was followed by the conference dinner. At the dinner, Brian Tunbridge was presented with the Institute's Distinguished Service Award (see Vol. 38, No.1, January/February 2013).

After dinner, Iain Laird and Jo Webb (Arup Acoustics) hosted a workshop presenting some of their work on environmental noise levels from the proposed HS2 railway. That had involved first setting up accurate and verifiable auralisations for a number of different situations. These had then been presented to the general public at a number of critical venues. The whole exercise had been deeply politicised by opposing interests and the presentation illustrated logistical and public relations issues that most acousticians don't get involved in. The delegates found the presentations interesting and there was a lively discussion throughout the workshop.

The second day of the conference started with further technical sessions which continued until the last paper of the conference.

Technical Sessions 15 November

Session 1 Auralisation, Chairman – Helen Goddard

The conference began with a keynote paper *How spherical loudspeakers came into auralisation* by Michael Vorländer (RWTH Aachen University, Germany). The presentation included a discussion of spherical harmonics and the measurement of source directivities for instruments and human voices as well as directional room impulse responses measured using loudspeakers with specified directivity. Reciprocity was discussed at length. That allowed models either using sources on the stage and arrays of microphones in the audience positions or reciprocally, depending on which of the transducers needed the higher-order spatial resolution. The presentation was well received, with an extended discussion period.

The session continued with *The role of auralisation in interdisciplinary design* by Paul Malpas (EAd, UK). The presentation began with a more philosophical comparison of the relative contributions of auralisation and visualisation to the success of projects and how all of the aesthetics needed to be represented in the design process. Typically, sound was less well considered, perhaps because it was not visible. However, in virtual spaces, sound was at least potentially capable of being accurately represented. Paul concluded with the view that acoustic design engineers would perhaps have to work even harder to redress the balance.

After a coffee break, where delegates could get refreshments and continue discussions as well as talk to the exhibitors, the programme continued with *Creation of virtual sound environments using geometrical acoustics and finite elements method* by Keith Holland, Luis Tafur and Takashi Takeuchi (University of Southampton). The paper was presented by Keith. He described the analysis of the sound field in a small room using calculated and measured impulse responses to create virtual environments for specific source-receiver positions and the verification of the results using objective and subjective methods. The presentation was followed by a lively discussion, with many contributions from the audience.

The final paper in the session was *Smyth SVS: using headphones to re-create loudspeakers in a room* by Mike Smyth (Smyth Research Ltd.). It described a personalised system for capturing and reproducing the acoustic characteristics of a set of loudspeakers in a room with the objective of creating a virtual listening experience over headphones. A demonstration of the system was available throughout the conference in a demo room.

The first session was followed by the Electro-Acoustics Group AGM and then by lunch.

Session 2, Loudspeakers and Reproduction, Chairman – Mark Bailey

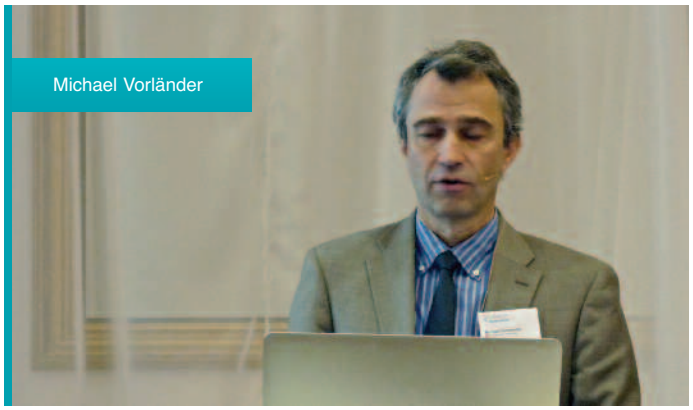
After the lunch break, Juan di Dios Rodriques (University of Southampton) presented *Stereophonic sound reproduction for multiple listeners*. He began by discussing the potential for improvements to the off-axis images for two-channel stereo and showed how, by using a least-squares optimisation process, filters could be derived to improve the experience for central and off-centre listeners simultaneously.

In the next paper, *3D audio: some thoughts and outlooks*, Francis Li (University of Salford) discussed some aspects of 3-D audio as a possible accompaniment to contemporary 3-D video systems. The potentials of multichannel, wavefield synthesis, ambisonics and binaural systems for the creation of virtual acoustic spaces were discussed, as well as the need to include the vertical (elevation) dimension.

Remi Vauchier (NEXO, France) then presented *Linear phase implementation in loudspeaker systems: measurements, processing methodology and application benefits*, in which he described the development of new firmware for the company's 4-channel DSP platform. That enabled users to define loudspeaker arrays more accurately and with less interaction because of the matched linear phase characteristics of the components.

The next paper in the session was *Tonal balance variation using line source* arrays by Julien Laval (L-Acoustics, UK). He described how in the past interference between loudspeakers in an array resulted in chaotic sound fields and position-dependent comb filtering. The new Wave Sculpture Technology could resolve these issues by bringing perfect coupling for the entire frequency range. That resulted in consistent sound over the whole audience area.

That was followed by the Peter Barnett Memorial Award presentation to Pat Brown of SynAudCon. (see Vol. 38, No.1, January/February 2013). Unfortunately, Pat was unable to be present. The citation was read by Peter Mapp and the award was made in his absence by the Institute President Bridget Shield. The presentation was video recorded and Peter received the award on behalf of Pat Brown. He later presented it to Pat on a trip to the USA. P20


Michael Vorländer


Fillipo Fazi

P19 Peter Mapp had agreed, at the last minute, to prepare and present a talk in place of Pat Brown's acceptance speech. The committee and delegates expressed their thanks and appreciation to Peter for being able to do that at such very short notice. The talk was entitled *Can loudspeakers overcome poor room acoustics?* Peter presented a review of past successes and failures with his usual entertaining and informative style. The presentation was followed by a lively and searching discussion.

Technical Sessions, 16 November

Session 3, Intelligibility, Chairman – Paul Malpas

The day started with *Preliminary validation of the STI rating male for the English language* by Lorenzo Morales and Stephen Dance (London South Bank University) and Glenn Leembruggen (ICE Design, Australia). The paper was presented by Lorenzo. He described a new validation of the original 1987 STI results using 100 subjects listening to speech programme with added reverberation in a real space. An additional validation using 80 subjects had been carried out using headphones. The real space method was found to produce higher intelligibility than with headphones. The potential errors introduced by headphone reproduction were also analysed and discussed.

The next presentation was *Can you rely on the STI? A comparison of three sound system case studies* by Glenn Leembruggen and David Gilfillian (ICE Design, Australia) and Lorenzo Morales. The paper was presented by Glenn and began with a question about the reliability of measured STIs. Glenn then went on to discuss the implications of transient responses and the time-domain effects of early reflections on measured modulation indices and STI results.

The final paper before the coffee break was *Sound design for the London Aquatics Centre* by Sam Wise (Arup Acoustics, UK). It included a fascinating insight into the politics of high-profile projects – Sam said that he had not been permitted to evaluate the completed installation and had only heard it as a member of the public, having purchased a ticket! He described the design issues implicit in the design of sound systems for large building projects. In the following discussion, the question of high music sound levels in modern venues was considered at some length.

Session 4, Room acoustics and measurement, Chairman – Bob Walker.

The first paper of the session was *Modern measurements in the presence of audience* by Wolfgang Anhert (S. Feistal, AFMG Technologies, Germany). Wolfgang discussed the principles of making acoustic measurements in the presence of an audience and demonstrated how the signals already present in the sound system could be de-convolved to give impulse responses. He showed results from a 55,000 seat stadium compared with measurements made using more traditional methods. He also showed how the measured acoustic properties changed as the stadium filled up by making measurements every 10 minutes, starting one hour before the event.

The next paper was *Human factors affecting the acoustic measurement of rooms* by Philip Newell (Consultant, Spain), Keith Holland, Soledad Torres-Guijarro, David Santos Domingues (Universidad de Vigo, Spain) and Julius Newell (Consultant). The paper was presented by Philip and included the results of different "engineers" attempting to carry out room response "correction" using 1/3rd-octave equalisers. This was apparently how the film industry was currently trying to correct things that were not actually audible. The audience was convinced by the spirited presentation and a lively discussion followed.

The final paper of the session was *Low-frequency reflection control in listening rooms* by Jamie Angus (University of Salford). Jamie began by discussing the relationship between early reflections and the phantom image location as represented by the Blumlien equations. From that, a minimum of absorption required as a function of frequency was derived. It was shown that the effects were small for floor and ceiling reflections and that the effects for lateral reflections became worse as the image moved from the centre.

Session 5, Acoustical theory, Chairman – Glenn Leembruggen

In *Psychoacoustic evaluation of spatial audio reproduction systems*, Darius Satongar (University of Salford) discussed interaural time and level difference cues synthesised by ambisonic and amplitude-panned reproduction systems. A model for the human head was validated and then used to obtain ITD and ILD cues for several reproduction arrangements. The results highlighted large ILD differences for central positions at higher frequencies, while ITD cues were more correlated with offset listening positions at low frequencies.

The second paper of the session was *Application of the boundary element method to the design of a microphone array beamformer* by Khemapat Tontiwattanakul (University of Southampton). The paper showed how mathematical expressions could be derived for beam-forming using linear, cylindrical or spherical arrays. However, in general, closed expressions cannot be found for irregular arrays. Khemapat showed how BEM could be used to obtain numerical solutions. A comparison between the numerical and analytical solutions for a spherical array was also presented.

The final paper of the session was *Transient acoustic analysis of simple rooms* by Patrick Macey (PACSYS) and Kelvin Griffiths (Electroacoustic Design, UK). The paper was presented by Patrick. It described a method, called "2½-D", in which numerical FEM methods are used to obtain pressure distributions in one plane and modal methods used to extend the results to the third dimension. Using the hybrid solution, Patrick showed how transient responses could quickly be calculated for complex room shapes, as long as they were of uniform height and constant plan section. He illustrated the method with a number of comparisons between predicted and measured responses.

Session 6, Perception, Chairman – Keith Holland and Sam Wise

After the break, *Hearing through darkness: a study of perceptual auditory information in real rooms and its effect in distance discrimination* by Neoftos Kapanis and Jose van Velzen (Goldsmiths College, London) was presented by Neoftos. He described experiments on how subjects could get a sense of P22


Paul Malpas


Sam Wise

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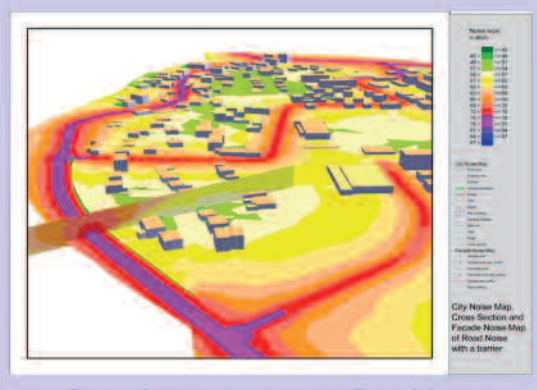

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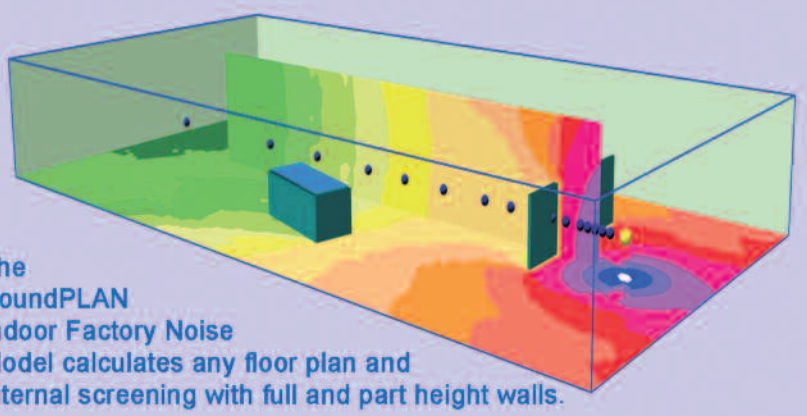

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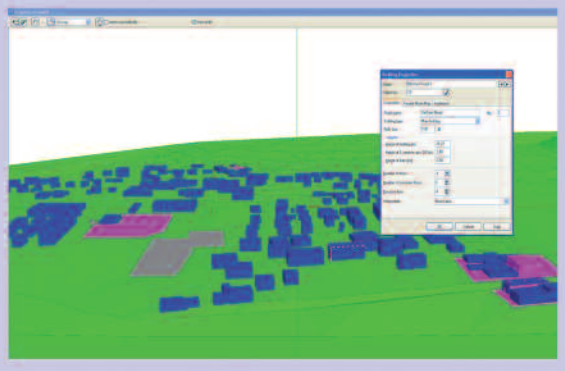

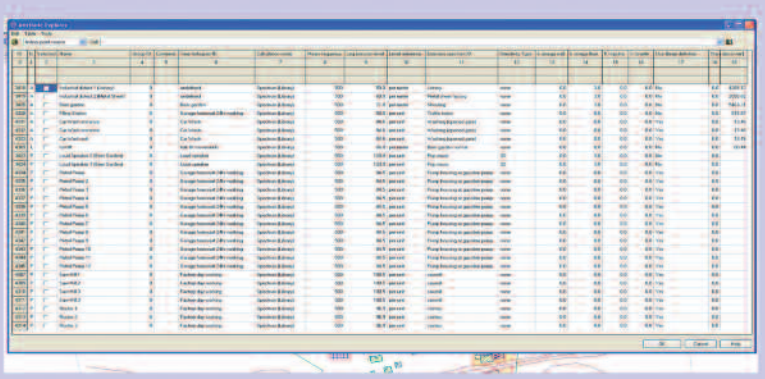

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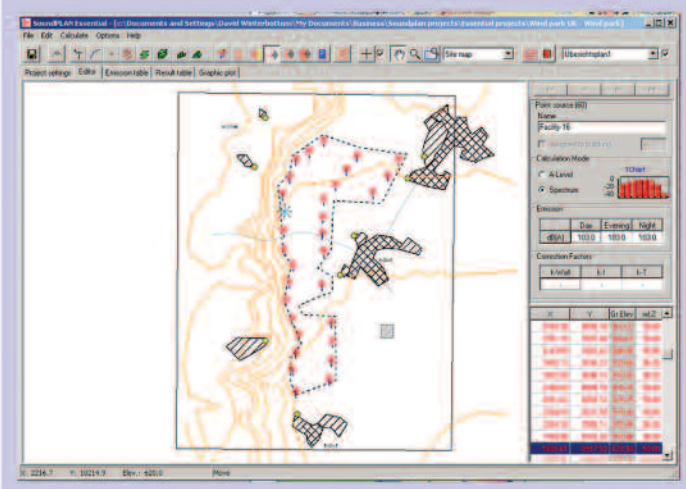
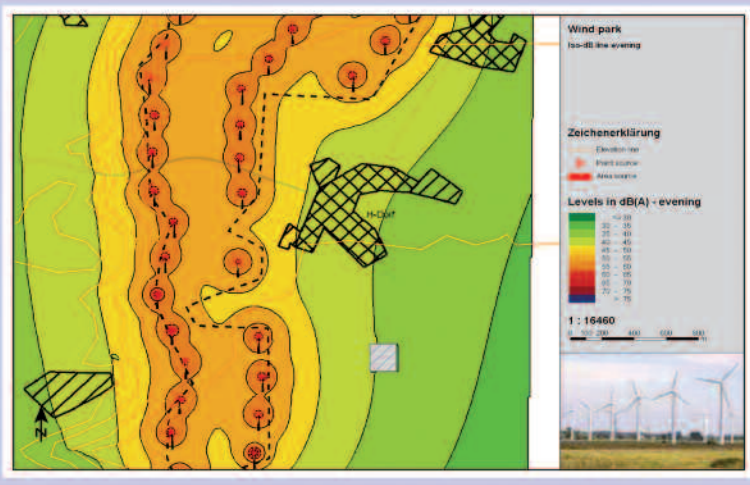




P20 spatial awareness from acoustic cues in dark rooms. Fifteen musicians and 15 non-musicians took part. The results showed that all subjects showed some spatial awareness, but musicians were slightly better. That suggested links between space perception and musical training. Also, all subjects were better with self-generated noise than externally imposed noise.

In *Towards a human perceptual model for 3D sound localisation*, Symeon Mattes (University of Southampton) presented the theoretical basis and the preliminary results of a perceptual model for human sound localisation for 3D audio systems. It was based on a biologically inspired, auditory signal-processing model for the prediction of localisation of acoustic sources. However, that model did rely solely on binaural cues and could only be used for the horizontal plane. The presentation showed how the model could be enhanced to predict the location of sounds in three dimensions by also using spectral and dynamic cues

The third paper of the session was *Towards a generalised theory of low-frequency sound source localisation* by Adam Hill and Simon Lewis (University of Derby) and Malcolm Hawksford (University of Essex). The paper was presented by Adam. He suggested that progress towards understanding of low-frequency localisation has been slow because of conflicting experimental findings, predominantly based on subjective evaluations conducted in a single closed space. By using velocity vectors rather than perception, the effects of the different underlying acoustic parameters (room size, absorption properties, source configuration, etc.) could be studied separately. The virtual results were compared with practical measurements as well as subjective evaluations.

The final paper of the conference was *Localisation of elevated virtual sources in high-order ambisonic sound fields* by Paul Power (University of Salford). He described an investigation of subjective localisation tests for virtual sources placed in the vertical plane at different elevations and azimuths, for 1st, 2nd and 3rd order ambisonic reproduction over a 16 loudspeaker system. The results provided insights into the requirements of higher-order ambisonics for broadcast and domestic reproduction.

Instrumentation Corner

Uncertainty in measurement

By Martin Armstrong MIOA, Alcor S&V

This article is in the continuing series of Instrumentation Corner, from the members of the Measurement and Instrumentation Group committee. Here the measurement is in the spotlight when reporting an evaluation, not so much the instrument where the uncertainties are small.

Why measure sound and vibration? Is it to evaluate machinery for the purposes of design, or for condition monitoring, or is it to protect humans from annoyance or harmful physical effects. In each case it is likely that some limit has to be set to evaluate the risk. Is the aim to comply with such a directive as the Control of Vibration at Work Regulation 2005, SI No 1093?

How well does a measured magnitude correlate with the magnitude of sound or vibration at the point of measurement? What are the uncertainties that need to be considered? How well can they be tabulated? How rigorous does an uncertainty budget need to be? Or have the required action and limit magnitudes been set so as to accommodate the expected upper uncertainty band for a measurement?

An apology to those acousticians not involved in vibration, for my use of 'value' for a measurement. I shall use the term value, mainly because my background is in vibration, but please take it as also including level.

Uncertainty evaluation raises many questions, as can be seen above. In any measurement there will always be a certain degree of uncertainty associated with the instrument, the location of the transducer, source variation and duration of measurement. In quantifying measurement uncertainty the IOA Diploma module has a section in the General Principles of Acoustics. There is not a comparable one specifically covering vibration. Many of the quantities that need to be addressed apply to both sound and vibration. The causes of measurement uncertainty can be split into two headings, random or systemic.

A new policy is being implemented in the testing of instruments, such as for Sound Level Meter BS EN 61672 and Human Response to Vibration Meter BS ISO 8041. Tolerance limits around design goals can be determined from the specified acceptance limits for allowed deviations, from a design goal, and the corresponding specified maximum permitted uncertainty of measurement. See the illustration below showing the acceptance interval.

U_{max} Guard band maximum permitted measurement uncertainty, 95% coverage interval.

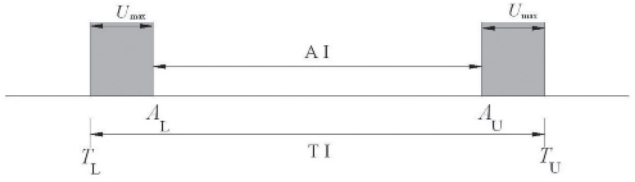
Considering the measurement uncertainty, for the Human Response to Vibration Meter BS EN ISO 8041 for HA assessment, the following component uncertainties need to be included. The display, frequency weighting, amplitude linearity, transverse motion, phase response and transducer mounting, to mention a few. A suggested expanded total measurement uncertainty is shown below, where at the reference frequency it is 7.5%.

There are two guidance documents that are useful in ensuring the best evaluation of HA vibration. BS EN ISO 5349-2 covers the measurement and evaluation of human exposure to hand-transmitted vibration. PD CEN/TR 15350 covers the assessment of exposure to hand-transmitted vibration using available information including that provided by manufacturers of machinery with the estimated exposure times. Each of these refer to the use of test code standards, the first with respect to transducer location and repeat tests and the other to the declared emission value including uncertainty K value from a test code.

How well can these work in practice? Using BS EN ISO 5349-2 the requirement is to measure and then evaluate a wide range of uncertainties. Uncertainties associated with the instrument, covering the weighting, calibration and transducer mounting are considered systemic and are small, as shown above. Uncertainty factors of measurement may be due to machine operator variability and the skill of the worker, the repeatability of the work task and variation of measurement location. The uncertainty of the overall evaluation of the exposure depends on the uncertainty of the established vibration value and its ability to represent the actual vibration total value. It also depends on the uncertainty of the exposure duration.

Even where the vibration magnitude and exposure times are measured, as in BS EN ISO 5349-2, the uncertainties associated with the evaluation of A(8) can mean that the calculated value can be as much as 20% above the true value to 40% below. There is no suggested uncertainty budget identifying the components influencing the total uncertainty.

Should a vibration measurement not be considered necessary then PD CEN/TR 15350, Guideline for the assessment of



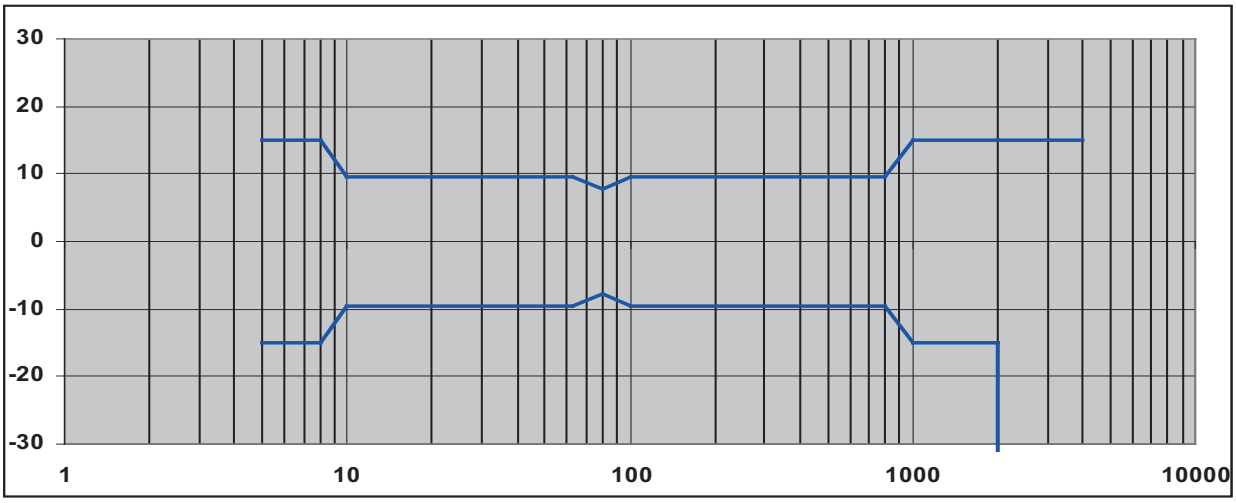
AI Acceptance interval **TI** Tolerance interval

exposure to hand-transmitted vibration using available information including that provided by manufacturers of machinery, can be used. This standard addresses the manufacturers declared values and uncertainty K. In some cases the K value can be 40% of the stated vibration value. Four groups of test codes are covered, these are electric, pneumatic, hydraulic and internal combustion engine machines. For each group, and the individual types, multiplying factors are given. The multiplying factors can be up to x2, (+100%). The uncertainty of the vibration value has more influence on the uncertainty of the daily vibration exposure than that of the exposure duration, because the vibration exposure is proportional to the vibration value and to the square root of the exposure duration.

When completing any investigation, it being vibration or acoustic, the report showing any risk should document all corrections and uncertainties that have been taken into account. These may show +40%, +60% or +100% corrections to a measured value.

Please note that the standards referred to in this article are current. However they are each undergoing revision in part, with amendments, or more extensively.

__Martin Armstrong__ is a founder member of the Measurement & Instrumentation Group and is the current secretary. Martin is on several BS and ISO working groups standardising vibration instrumentation.



Expanded total measurement uncertainty %; 95% confidence (K=2)

New technology offers low cost traffic noise monitoring

Networks of wireless sensors could be used to monitor traffic noise. A new study shows that the wi-fi sensor systems, although slightly less accurate than precision noise monitoring systems, can provide detailed information, with dense coverage, about traffic noise over a longer period. Their low cost and low energy requirements make them particularly suitable and attractive for use by local authorities or even community groups.

Traffic noise has been shown to be harmful to human health by disturbing sleep and contributing to cardiovascular problems. Its effects depend on level and pitch. Around half of the EU population is exposed to traffic noise and the Environmental Noise Directive (END) aims to prevent or reduce its harmful effects.

To achieve the aims of the END and develop noise action plans, noise monitoring could be very helpful. The new study demonstrates that it is possible for local authorities to acquire noise data inexpensively using new, low power, wireless technology based on a network of sensors called 'motes'.

Motes originally developed for both air quality and noise monitoring purposes were used to collect noise data in Leicester, UK, and Palermo, Italy. Motes can incorporate GPS sensors so their position can be tracked and can be static or dynamic. Dynamic motes, for instance, can be used to measure a cyclist's personal exposure to noise. The commercial motes are equipped with a solar-powered and two back up batteries, which together increase their potential lifespan from months to years.

Data from two motes at the side of a busy road in Palermo were compared to data collected using a precision noise monitor. The mote closest to the road was positioned next to the noise monitor and the other was positioned one metre away, with a third sensor used to check that measurements at this distance were similar. Although the researchers suspected their system would not be able to measure noise as accurately as a more expensive system, measurements were consistent and shown to be able to measure noise differences of less than 1dBA.

Next, data from a Leicester network of 50 sensors showed that noise levels varied minute by minute, ranging from 54-74 dBA in the locations sampled. The researchers were able to detect transients in traffic noise associated with traffic signals, traffic calming and bus stops. The measurements were less accurate than if a precision monitor had been used, but the researchers claim they were able to identify similar noise trends to those seen in previous studies and that longer, simultaneous monitoring has revealed greater variation in noise levels.

The study suggests that the new technology offers greater coverage (up to 100 sensors per km2) in noise monitoring at lower cost. According to the researchers, the technology is easily put into use and could allow local authorities to assess the impact of noise action plans and public perceptions of changes in urban noise.

This report is based on an article in *Science for Environmental Policy* published by the European Commission.

Public asked for views on night flight controls

The government is asking members of the public for their views on the whether current controls on night flights over the South East need to be changed.

It has mooted a range of options to reduce noise pollution around Heathrow, Gatwick and Stansted, including a ban on noisier planes.

Its other ideas include getting planes to land further along the runway and increasing their angle of approach.

In a consultation document, the government said: "If airport capacity is allowed to grow, it is essential that the aviation industry continues to tackle its noise impact."

The government aimed "to limit and, where possible, to reduce the number of people in the UK significantly affected by aircraft noise", it said.

But it added: "We are aware of the economic arguments for operating night flights. So, as well as looking at options for reducing the noise impact of night flights, this consultation is also an opportunity for interested parties to make the case for night flights and how they can contribute to economic growth."

Transport Minister Simon Burns explained that any changes to current rules on night flying would "need to strike a fair balance between the interests of those affected by the noise disturbance and those of the airports, passengers and the UK economy".

The consultation is designed to provide the government with more data on the types of aircraft that airlines intend to use in the years ahead.

Newer models, including the A380, the A350, the B787 and the B777-300, "are quieter than those they are replacing", the document said.

A ban preventing the noisiest aircraft taking off and landing at night is "potentially feasible", but it would be "difficult" to ban noisier planes such as the Boeing 747-300 from Heathrow at night, according to the government's initial assessment.

Since fewer people live to the west of Heathrow than to the east, the government also wondered whether night-time arrivals should make their final descent from the west by default.

Landing planes part of the way down the runway cuts noise pollution for those living under flight-paths, so ministers want advice on whether flights that do not already adhere to a "displaced landing threshold", such as those coming in from the east at Heathrow and those arriving from the north-east at Stansted, should start to do so.

They are also seeking "any information on the feasibility of increasing the angle of descent into Heathrow, Gatwick or Stansted".

"Though a number of technical and practical issues would first need to be addressed before a steeper angle can be introduced, the noise benefits of steeper approaches would be potentially significant," the document said.

The consultation closes on 22 April. For more details go to https://www.gov.uk/government/consultations/night-flights-consultation.

Night flight controls are under the microscope

National Planning Policy Framework comes under the ANC microscope

Austin Court, Birmingham again played host to the ANC Conference in November 2012. Sitting alongside the IOA's Building Acoustics Group conference held the previous day, the aspiration was to provide a range of sessions, with the ANC day offering more time for panel discussions and audience participation. In addition, there were short updates on varied subjects. These started with Richard Greer (Arup Acoustics) reviewing the Red Book on "Measurement and Assessment of Groundborne Noise and Vibration", and leading into a quick review of the BS4142 revision by Phil Dunbavin. This was followed by a well received and fascinating presentation on Taking a Product to Market given by Ze Nunes from Mach Acoustics; while in the afternoon A Lawyer's View on Consultants' Liabilities (Samantha Hammond-Opelt, Cundall Johnston & Partners' Legal Director) kept the audience busy taking notes of items to look out for in their contracts, both in terms of those to avoid and those to include, such as financial caps and ensuring surveys and reports included wording to restrict use of the report to the client concerned.

School acoustics

One of the main criticisms of the schools session at the 2011 conference was that it was too short, so we devoted 1.5 hours to presentations and discussion about school acoustics this time.

The session began with Andy Parkin (Cundall Acoustics and ANC Schools Committee Chair) on how the newly published re-write of BB93 Section 1 is to be applied and used in the Priority Schools Building Programme. He then went on to describe the Baseline Designs project carried out on behalf of the Education Funding Association and, in particular, the acoustic designs that complement the new environmental metrics for daylighting, ventilation and thermal comfort.

Jack Harvie-Clark (Apex Acoustics) presented plans to re-write Section 2 onwards of BB93, a joint initiative between the IOA and ANC. The committee tasked with writing this new document met after the event.

Adrian James (Adrian James Acoustics) talked about the key findings of the Essex Study and what it means for minimum standards in school design: is designing to minimum standards morally acceptable when we know how much benefit increased standards can yield?

Bridget Shield (London South Bank University and IOA President) discussed her recent attendance and speaking at an Acoustical Society of America conference and US plans for new schools acoustic regulations.

The individual presentations were followed by a panel discussion where delegates got the opportunity to discuss various topics of interest.

National Planning Policy Framework

Dani Fiumicelli chaired this session with guest speakers from three local authorities. Starting with an overview of the National Planning Policy Framework (NPPF) March 2012[1] and what it means, he gave the NPPF its background through referral to the Noise Policy Statement for England (NPSE) 2010[2] and then highlighted the limited number of pages devoted to either noise or vibration within the NPPF.

In terms of NOEL (No Observed Effect Level) he used a toxicology analogy "how much cyanide does it take for no effect", making the point that the variation between LOAEL (Lowest Observed Adverse Effect Level) and SOAEL (Significant Observed Adverse Effect Level) may be more fluid than the guidance suggests. Dani also pointed out how Planning Policy Guidance Note 24 Planning and Noise (PPG24) 1994[3] is now revoked and the new guidance refers to "tranquillity", so there is increased pressure to look at LOAEL and SOAEL in the context of a sustainable development. Therefore local authorities need to have a Local Plan. However, currently there is an inconsistency between P26

Dani Fiumicelli (centre) with Nick Tinsdeall and John Grant

P25 local authorities and their approach to NPPF and how developed their Local Plan is. The Localism Act (2011)[4] however has given local authorities a duty to take decisions. It was suggested that local authorities should have a policy, which was exactly that: a brief statement of aims. In his experience, technical officers sometimes have a preference for certain acoustic guidance, whereas other authorities do not have the relevant technical staff to provide the guidance requested. Therefore policy is consistent but the level of technical guidance is more variable across authorities.

Certain parts of the overview probed deeper into the interpretation of the NPPF, such as paragraph 2.18 from NPSE... and the implications for NOEL and SOAEL. '2.18 There is a need to integrate consideration of the economic and social benefit of the activity or policy under examination with proper consideration of the adverse environmental effects, including the impact of noise on health and quality of life. This should avoid noise being treated in isolation in any particular situation, i.e. not "focussing".

Dani concluded that local authorities do not have to differentiate on policy but should reflect the locality so if a large airport is nearby then the adopted policy should reflect that.

Clive Simmonds from Croydon Council pointed to Defra[5] for the NPPF background and jokingly referred to section 123 as there weren't many areas of "tranquillity" in Croydon! He discussed "quality of life" and asked how this was defined. The descriptors NOEL, LOAEL and SOAEL were dismissed and branded as too generic. He pointed to the fact that the document aims for sustainable local development but differing views can mean a different stance on planning policy, such as a "restricted" development based on a "not in my back yard" view of locals to the proposed development or "unrestricted" where the developer interests are precedent. The EPI is considered the first commandment for Croydon Council and so when Clive was approached by a nervous acoustician politely asking if they could use PPG24 to determine if the existing noise environment was suitable for a residential site, his answer was a simple "yes". Clive went further and explained that if a site is assessed as NEC C under PPG24 and facade mitigation is required then an internal target would need to be met in the proposed habitable room to show that residents were protected from noise. So why not use PPG24? In his summary, Clive believed that the NPPF removed "clear" guidance and relied upon interpretation.

Nick Tinsdeall of Birmingham Council reminded the audience that his views were not necessarily those of the council. Prior to the introduction of the NPPF Nick reminded us about the Institute of Acoustics/Institute of Environmental Management and Assessment Working Party Guidelines for Noise Impact Assessment (2002) (Draft Report)'[6] and how it was going to tie in with PPG24 and then... was abolished in 2011! A pertinent point was made that, regardless of the guidance used, noise issues should be addressed before becoming a problem. He spoke about various planning policies including Birmingham Council's and its SP54 Impact of New Development on Noise, describing the aim as laudable but "a moving goal". He went on to describe NOEL, LOAEL and SOAEL. If there were significant effects, a local authority would recommend refusal. If, and perhaps more importantly, some impact is observed but there are no significant

Jack Harvie-Clark (right) and Andy Parkin

effects, then it would recommend minimizing noise and mitigating but not a straight refusal; rather it would "think about it". So does SOAEL mean the highest noise level? No, as different implications for different noise sources are considered. People generally start complaining at external levels when they reach more than 55dBA – is this above SOAEL? Less than 50dBA for traffic is not anything to worry about much, but if they reach 77dBA as per upper PPG24 NEC category, then the noise is possibly excessive for development.

Nick then turned his attention to acoustic consultant reports and important changes needed or requested:

- how calculations and predictions within the report
- explain where noise levels were measured and why
- limitation of measurement locations
- justifications in reports make the local authority's life easier
- mitigation recommended should always refer to plans so that the developer is informed.

Nick concluded by describing how he had an acoustician's report submitted by an architect for a residential development where the noise levels were measured in a different town!

John Grant, Scientific Manager from Walsall Council, professed to not being a fan of "sustainabilsm". He believed that localism can have some advantages but may mean local authorities can change policy more easily. PPG24 was described as a "comfortable pair of slippers" i.e. easy but one size fits all but the guide is not quite right. For example, noise from planes is not the same as noise from trains or industrial noise and even though the NEC ranges within PPG24 can be moved +3dB or -3dB, Telford and Wrekin Council came up with its own more stringent table of NEC ranges. Indeed perhaps the biggest criticism of PPG24 is that it did not console geographic differences. He went on to compare NPSE with PPG24 with the question: Does NPSE allow development where PPG24 doesn't? On balance he thinks it can.

The various revisions to The World Health Organisation: Guidelines for Community Noise 1999 (WHO Guidelines)[7] have meant that they been used in the absence of other guidance because of their familiarity. However, the devil is in the detail of the text. For example, insomniacs were included with the populus for the assessment regarding sleep disturbance, yet when "annoyance" criteria are used they are applied to the adult population. It was suggested that WHO was possibly the starting point for LOAEL and the continued health assessment marries with guidance in NPSE.

BS8233 Sound Insulation and Noise Reduction for Buildings' 1999[8] is often used by consultants, designers and architects as it allows an adjustment to local circumstances and not just "refer to Table 5". The internal targets given in BS8233 can be used to define the maximum allowable external ambient level. A great document from John's perspective but difficult to defend in a public inquiry. Why, for example, should living rooms have the same internal noise target for bedrooms (given in Table 5) when a "good" standard of internal noise level is desired?

Other questions raised included the use of BS4142 Method for rating industrial noise affecting mixed residential and industrial areas 1997[9] referenced in PPG24. An example was given where a new road was built close to existing housing and a factory which had been there many years. The factory shuts and then the local authority has to deal with complaints regarding road noise impact. Therefore complaints are highly unreliable and therefore an unfit means of assessment. Focusing back onto BS4142, John suggested that most consultants take background noise level readings during the likeliest quietest time of the night (23:00hrs – 07:00hrs), say 02:00hrs, and not when people are trying to get to sleep i.e. around 23:00hrs. John summarised by saying that we don't have all the answers and with regard to the NPPF there is a vacuum between the state of effect to significant effect. PPG24 does still have merit and therefore should not be disregarded completely.

Richard Greer, on behalf of the ANC Board, explained that ANC was collaborating with the IOA and CIEH to establish a working group on NPPF, and he thanked Dani who is now chairing the working group. Dani provoked questions among the audience and the tactic worked as a lively debate ensued. Queries included why do some local authorities accept 50dBA for gardens and outdoor areas and others 55dBA? And indeed how does LOAEL relate to SOAEL? What better place to conclude matters than with an acronym. TTFN!

Quiet Mark

In the final session of the day Ed Clarke managed to keep delegates from leaving early with a discussion on the assistance the ANC is providing to the Noise Abatement Society in its Quiet Mark initiative. Launched a year ago, this initiative is a refreshing new direction for ANC members in recognising the benefit and value of quietness, rather than "traditional" acoustic consultancy which tends to focus more negatively on the dis-benefits of noise and how to get over them. Well over 100 specific products have been assessed by Ed and his team against a comparative sample to determine which can be fairly and objectively described as "relatively quiet for what it is". As a parting gift form the NAS Quiet Mark team, a sample Quiet Marked product – a Magimix Food Processor – was given as an early Christmas present to Phil Hainsworth from Atkins, in a prize draw incorporated in an audience poll at the end of the day (which may have been linked to the audience retention for this session). More details of the Quiet Mark initiative can be found at www.quietmark.com .

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Infrasound rumbles on

Report by Geoff Leventhall HonFIOA

Introduction

Infrasound is one of the most elusive frequency regions of acoustics – you can't hear it. Except that, of course, you *can* hear it when the level is high enough. Thresholds have been measured reliably down to a few hertz, giving the threshold at 10Hz as 97dB and rising to 107dB at 4Hz. (Watanabe and Møller 1990). Infrasound is part of our environment, one which we have evolved with over millions of years. Natural infrasound ranges from about 0.001Hz to 20Hz, although mostly below about 2Hz (Bedard and George 2000, Leventhall 2007, Haney 2009).

Some misconceptions, originating in the late 1960s and into the 1970s, led to the association of infrasound with unfortunate effects (Gavreau 1968), whilst completely ignoring the parallel work by NASA for the Apollo space programme, which used very high levels of 120-130dB and showed very few effects (Harris 1976, von Gierke and Nixon 1976).

The media, which enjoys a scare story, has played a large part in the misconceptions around infrasound and for nearly 10 years has been graphically describing the supposed effects on health of infrasound from wind turbines. It is claimed that the basis for the so-called Wind Turbine Syndrome is exclusively the influence of low levels of infrasound on the body (Pierpont 2009). A recent refutation of wind turbine syndrome described it as a "psychogenic illness", transmitted by word of mouth (Chapman 2012a). Chapman has also listed more than 200 web pages which claim health effects from wind turbines (Chapman 2012b).

However, false statements do not acquire "correctness" just through repetition, although lay persons may be influenced by such repetition. It is regrettable when a lay person misunderstands science, but distressing when scientists appear to have allowed themselves to fall under the spell of the "infrasound is harmful" publicity.

A recent paper

In the April 2012 issue of *Acoustics Today*[1], Hsuan-hsiu Annie Chen and Peter Narins raise questions about the health risks of low frequency sound in an article "Wind Turbines and Ghost Stories: The Effects of Infrasound on the Human Auditory System." (Chen and Narins 2012 (April)). Some readers of *Acoustics Bulletin* may find themselves asked to comment on the paper. This critique is intended to help with the comments.

Chen and Narins review studies which they interpreted as suggesting that sound frequencies below 20 Hz (infrasound) are detected by the human ear and brain in a harmful manner, and include other studies claiming to link infrasound to sleep disturbance, headache, annoyance, irritability, and chronic fatigue. They also refer to studies that suggest infrasound may be responsible for paranormal experiences and then progress to others about the high risk of depression, anxiety, irritability, insomnia, and psychosis among patients with temporal lobe epilepsy. They infer that because the temporal lobe includes the primary and secondary auditory cortex, then infrasound, which is detected by the auditory cortex, may cause similar psychiatric problems in the people exposed to it. The article recommends additional research about the physical and psychological effects of infrasound on humans, specifically exposure to wind turbine infrasound and concludes with a public policy recommendation that future wind turbine projects should be sited and engineered to minimise exposure to the public until more is known about the effects of infrasound. A copy of the article is available via the Acoustical Society of America website (free to members, $15 for non-members) http://asadl.org/at/resource/1/atcodk/v8/i2/p51_s1?isAuthorized=no

The following discusses and analyzes the premises, inferences, and conclusions of the *Acoustics Today* article, which is based on work by Hsuan-hsiu Annie Chen for an undergraduate final year study. If she and Peter Narins had not included wind turbines and paranormal sensations (the "ghost stories" of the title to the article), it could have made an interesting paper but, in its present form, it swings between hard science and the imprecision more typical of popular science writing. One problem is the use of loosely defined terms, such as "high levels of infrasound", which give the paper an element of "spin". Another problem is that the paper contains some factual errors, which will be described below. In addition, although it is a review of published work, it lacks the critical analysis that is normally associated with such reviews.

The premise

The essence of the paper is set out in the following:

High levels of infrasound and low frequency sounds generated by wind turbines pose a potentially serious threat to communities near wind farms. Wind energy companies remain largely dismissive, claiming that wind turbine noise is sub audible, undetectable by humans, and therefore presents minimal risk to human health. However, various cochlear microphonic, distortion product otoacoustic emission, and functional magnetic P30

What is the effect of infrasound from wind turbines?

1. *Acoustics Today* is the "popular" magazine of the Acoustical Society of America. Its main articles are normally review papers, sometimes organised and submitted by a guest editor. The April 2012 issue is devoted to psychological and physiological acoustics and contains six papers approved by a guest editor and one contributed paper. The contributed paper is the subject of this critique.

P28 *resonance imaging (fMRI) studies have demonstrated the detection of infrasound by the human inner ear and auditory cortex. Additional psychosomatic stress and disorders, including the "wind turbine syndrome" and paranormal experiences, are also linked to infrasound exposures. With wind turbines generating substantial levels of infrasound and low frequency sound, modifications and regulations to wind farm engineering plans and geographical placements are necessary to minimize community exposure and potential human health risks.*

Some questions which arise from this extract are given below, and are followed by preliminary answers:

- **What do Chen and Narins mean by "high levels of infrasound…"?** They do not clearly state this, but from examples they give later in the paper, it appears to imply they may consider "high levels of infrasound" to be over 100 dB.
- **Do wind energy companies claim that wind turbine noise is sub-audible?** Wind energy companies do claim, correctly, that the infrasound from wind turbines is sub-audible, but agree that higher frequency sounds may be heard, normally at a low level when at typical minimum separation distances from residences.
- **Are infrasound levels from wind turbines as high as the authors imply?** Definitely not at normal separation distances.
- **What is a "potentially serious threat"?** This is vague terminology which should have been clarified.
- **Is a sub- audible sound harmful?** Sub-audible sounds at higher frequencies are not considered to be harmful. There is speculation about sub-audible infrasound, largely stimulated by claims made by objectors to wind turbines, but there has been no proof of harm from this sub-audible infrasound.
- **What are the levels for detection of infrasound compared with levels from wind turbines?** Infrasound from wind turbines is below the detection threshold, and cannot be heard.
- **What is the basis for relating paranormal experiences to infrasound?** None known, but speculation.
- **Do wind turbines generate "substantial levels of infrasound"?** No
- It is also interesting to note that the series of reported health effects called the "wind turbine syndrome" is claimed by its originator (Nina Pierpont) to be a direct pathophysiological effect, not a psychosomatic disorder. Pierpont specifically rejects psychological influences.(Pierpont 2009)

Infrasound definition

The following from the paper is misleading:

At 1 kHz, the SPLs capable of triggering hearing range from 4 to more than 100 dB SPL, exceeding 100 dB in span and increasing at 10 dB/phon. In contrast, the SPL range at 20 Hz is from approximately 80 to 130 dB SPL, spanning only about 50 dB and increasing at 5 dB/phon. In other words, a relatively small increase in SPL at 20 Hz would change the perception of this tone from barely audible to very loud.

There are two correct statements here, but they are related incorrectly. It is known that at 1000Hz a 10dB increase in level indicates a doubling of loudness. It is also known that at 20Hz the loudness doubling rate is about 5dB increase. However, it is misleading to then state that "*in other words, a relatively small increase in SPL at 20Hz would change the perception of this tone from barely audible to very loud*". Of course, the facts are in the two numerical statements. The correct way to relate them is to say that, at 20Hz, a change in sound pressure from threshold to 45dB above threshold gives a similar loudness increase to a change above threshold of 90dB at 1000Hz. However, is 45dB a "relatively small increase"? Imprecise statements such as "relatively small" and "very loud" should be avoided in a scientific paper.

The paper continues with:

Furthermore, humans encounter and detect many high level infrasound sources on a regular basis, despite their high thresholds.[5] *Auditory cortical responses and cochlear modulations to infrasound exposure have also been observed, despite the subjects' lack of tonal perception.*[8,9] *These studies provide strong evidence for infrasound impact on human peripheral and central auditory responses.*

This quotation illustrates Chen's and Narins' use of references. The references are:

5 (Leventhall 2007) 8 (Hensel, Scholz et al. 2007)
9 (Dommes, Bauknecht et al. 2009).

There is nothing in Leventhall (2007) which can be interpreted in the way stated by Chen and Narins, who claim that the human threshold for infrasound is exceeded by many of the sources which we regularly encounter. Leventhall (2007) does say:

There are many natural sources of infrasound, including meteors, volcanic eruptions, ocean waves, wind and any effect which leads to slow oscillations of the air. Man-made sources include explosions, large combustion processes, slow speed fans and machinery.

Our hearing would not normally detect the infrasound in these, but only the associated audio frequency.

Hensel, Scholz et al (2007) used 6Hz at 130dB[2] to bias the operating point of the cochlea, when it was also receiving low levels at 1.6kHz and 2.0khz, in order to investigate distortion product otoacoustic emissions (DPOAE). 130dB at 6Hz is clearly audible, although not a tonal sound, since tonal perception is lost below about 15Hz. The incorrect implication by Chen and Narins is that the ear was influenced by infrasonic tones which were not perceived – "*……despite subjects' lack of tonal perception*".

Dommes, Bauknecht et al (2009) used functional Magnetic Resonance Imaging (fMRI) to investigate responses of the brain when exposed to infrasound both above and below the hearing threshold, and also investigated higher frequencies. Audible infrasound excited the auditory cortex, which is where hearing perception occurs. Inaudible infrasound did not show an excitation. This is exactly what is to be expected, since infrasound enters into the hearing system, and is transmitted to the brain, in a similar manner to higher frequency sounds. To quote from Hensel (2007):

No signs of an abrupt change in transmission into the cochlea were found between infra- and low-frequency sounds.

The final sentence of the quotation above from Chen and Narins is:

These studies provide strong evidence for infrasound impact on human peripheral and central auditory responses.

What is the authors' purpose in drawing attention in this way ("strong evidence", "infrasound impact") to the obvious fact that infrasound is a sound which is transduced by the ear and brain in a similar way to sounds of other frequencies? It may be that the authors, perhaps unintentionally, have been influenced by media and similar sources to adopt an "infrasound is harmful" mind-set, which influences the way in which they express themselves.

In a section on Infrasound Processing by the Auditory Pathway, Chen and Narins give more detail on the work of Dommes (Dommes, Bauknecht et al. 2009). My own summary of Dommes' work is as follows.

Dommes, Bauknecht et al used fMRI to carry out an investigation of brain activity during exposure to high levels of low frequency noise and infrasound. This permitted them to investigate which part of the brain responded to the sounds and how the response changed with sound level. All stimulation gave a response in the auditory cortex of the brain, which is the part known to be connected with normal perception of sounds. The following frequencies and levels were used.

Freq Hz	500	48	12	12	12	36
Level dB	105	100	120	110	90	70

Dommes, Bauknecht et al summarise the results of their work as follows. Emphasis has been added:

"In our study, no other cortical regions owed a comparably

2. A responsible experimenter would never consider exposing the human ear to 130dB at high frequencies, as this would cause immediate hearing damage. However, the exposure is safe at infrasonic frequencies, illustrating the fact that, decibel for decibel, infrasonic frequencies are less harmful than higher frequencies.

extensive response to the high-level stimuli as did the auditory cortex, indicating that LFT [low frequency tones] were ***mainly perceived via acoustic pathways instead of representing a somatosensory phenomenon****."*

"In our study, cortical activation patterns appeared to be similar for all frequencies applied, suggesting that ***LFT are processed in a similar way as frequencies of our main hearing range (200 to 5000Hz)****."*

"We presented the 12Hz stimuli at three different levels. ***Tone bursts of 120 and 110 dB resulted in cortical activation. The 90dB stimulus did not induce a significant response of the auditory cortex*** *in group analysis which, in agreement with the findings of Møller and Pedersen (2004),* ***indicates that this SPL is below the estimated perception threshold for 12 Hz****."*

What these quotations mean is that Dommes, Bauknecht et al showed that low frequency tones and infrasound are transmitted and perceived through the normal auditory pathways, the same pathway that is used at higher frequencies. Furthermore, sounds, including infrasound, which are below the hearing threshold, do not produce a response in the brain, as is also the case for higher frequencies at levels below threshold.

However, Chen and Narins summarise Dommes, Bauknecht et al as:

Dommes et al concluded that infrasonic frequencies themselves play significant roles in activating the auditory cortex.

Whilst these words may be strictly correct, they are putting a spin on the work of Dommes, Bauknecht et al, which strengthens the view that the authors may have adopted an "infrasound is harmful" agenda. *All* audible sounds, of *any* frequency, "play significant roles in activating the auditory cortex", not just infrasound.

Infrasound exposure physical and psychological health

This section of the Chen-Narins paper opens with an error where it states:

"…current research provides no conclusive evidence for infrasound hearing perception by humans..."

But a few lines further on, reference is made to two papers which give results of measurements of this perception. (Møller and Pedersen 2004, Leventhall 2007)

The authors then continue to discuss infrasound from wind turbines, basing their opinions on a single paper (Jung and Cheung 2008), which they summarise as:

Wind turbine spectral analysis by Jung and Cheung has revealed substantial noise levels between 60 to 100 dB SPL for frequencies below 20 Hz.

Comments which arise include:

- The measured 60dB is at around 20Hz, rising to the higher levels as the frequency reduces and reaching about 100dB at 1Hz. This sound is all below the hearing threshold.
- Jung and Cheung describe measurements down to 1Hz using the methods of IEC 6140-11. However, it is very difficult to obtain accurate measurements down to 1Hz in windy conditions. Special wind screens are required, but are not mentioned by Jung and Chung. Therefore it is not known whether the very low frequency levels are contaminated by wind.
- Additionally, the microphone used by Jung and Chung (B&K 4189) is described by the manufacturer as reliable down to 6.3Hz with lower limiting frequency of 2 – 4Hz, casting doubt on the accuracy of measurements of the lowest frequencies. It is even possible that the levels of the lowest frequencies have been underestimated! Given this, and potential effects of wind on the microphone, we cannot judge the reliability of Jung and Chung's work at these lower frequencies without further P32

P31 information on their measurement methods.

- IEC 61400 -11 specifies the measurement distance as hub height plus blade length, which was 98m for the turbine used.

Chen and Narins have not appreciated the importance of this small measurement distance (98m) compared with distances to residences, which are more likely to be about 500m. Residential exposures will be 10 -15 dB lower than those measured by Jung and Chung, a point missed by Chen and Narins and which leads them to erroneous conclusions.

There are sufficient measurements of infrasound from wind turbines at nearby residential locations to be fairly confident about these levels (Hayes 2006, Hepburn 2006, O'Neil, Hellweg et al. 2011, Turnbull, Turner et al. 2012) For example, at 10Hz, the level at residences is typically in the range around 60 - 70dB with a spectrum slope of 4~6dB per octave. Wind turbine low frequency levels are below the average hearing thresholds at frequencies lower than about 40Hz. Background infrasound levels increase when the wind reaches the speed for turbine operation and these natural levels of infrasound are similar to those from wind turbines. (Guldberg 2012, Howe, McCabe et al. 2012).

However Chen and Narins continue:

Wind turbine spectral analysis by Jung and Cheung has revealed substantial noise levels between 60 to 100 dB SPL for frequencies below 20 Hz.[22] As demonstrated by CMs, DPOAE modulations, and fMRI studies, high levels of infrasound can alter cochlear function and activate the auditory cortex. Potential long term changes in brain activity by nearby wind farms have raised serious concerns. Some physical and psychological health risks from infrasound exposures include the "wind turbine syndrome" and paranormal experiences.[2,10, 23, 24]

The references used in the extract are

22 (Jung and Cheung 2008) 2 (Tandy 2000)
10 (Salt and Hullar 2010) 23 (Pierpont 2009)
24 (Tandy 1998)

In this extract from the paper, the effects of the levels from wind farms are directly linked to the levels used by Hensel (130dB at 6Hz) and Dommes, (120dB at 12Hz). However, infrasound levels from wind turbines at residences are much lower than these levels and have an acoustic intensity about one millionth of the levels used in the laboratory experiments of Hensel and Dommes.

Phrases such as "potential long term changes...have raised serious concerns" might be employed in popular media, but are too imprecise for a scientific paper.

The work of Pierpont and description of the wind turbine syndrome is contained in Pierpont's self- published "popular science" book (Pierpont 2009). Pierpont's work has been criticised on both epidemiological and scientific grounds and has not been published in any medical journal. The symptoms of the wind turbine syndrome are the same as those caused by stress from an audible, unwanted noise and occur in only a small number of people. The suggestion that wind turbine syndrome is caused by inaudible infrasound is unproven.

Salt and Hullar have shown that the outer hair cells (OHCs) in the ear respond to infrasound at lower levels than the inner hair cells do. Salt and Hullar suggest it is theoretically possible that the OHCs may transmit confusing signals to the brain, but they have not produced supporting evidence for this and in their conclusions make clear that:

The fact that some inner ear components (such as the OHC) may respond to infrasound at the frequencies and levels generated by wind turbines does not necessarily mean that they will be perceived or disturb function in anyway.

It must also be remembered that our evolution has been in the presence of naturally occurring infrasound.

An example: infrasound or hum?

Chen and Narins give an example from the literature:

As reported, a family exposed continuously to 10 Hz at 35 dB SPL[3] produced by a boiler house complained of bodily pains, increased annoyance, and difficulties sleeping.[5] This family's high sensitivity to a supposedly sub-threshold stimulus supports the notion that inter-individual differences are real and that some individuals are more sensitive and susceptible to the effects of low level infrasound than others.

It is always important to check and verify comments against original papers[4]. It is not advisable to rely on summaries contained in other publications as these have been selected to illustrate a particular point. An opinion expressed in Chen's and Narins' reference 5 (Leventhall 2007) is:

The complainants' descriptions of the noise and its effects on them included "very low frequency, hum, drone, intermittent pulsating, pain in the legs and in the area of the stomach." These are similar to the effects which arise in the many unresolved "Hum" complaints…

There is no evidence that the complainants discussed in the above were responding to infrasound at 10Hz, at levels as low as 35dB as is implied by Chen and Narins.

The "Hum", is a disturbing sound reported as "low frequency" and heard by a few individuals. The source of the "Hum" is hard to localize and there may be many sources. The consequential stress effects on people may lead to a reduced quality of life. The "Hum" is discussed by Demming (Demming 2004), who has established a Hum Forum to support Hum sufferers. See: http://tech.groups.yahoo.com/group/humforum/

The Hum has not been reliably measured and a possibility is that, at least, some Hum sufferers have undiagnosed tinnitus (Van den Berg 2009). The stress-related symptoms described within the Hum Forum are similar to those described by opponents of wind turbines.

Infrasound and the paranormal

Chen and Narins state:

In his famous "ghost-buster" study, Tandy recorded a continuous infrasound emission in a 14th century cellar near Coventry University, England.[2] The cellar has been rumored to be haunted since 1997.Various local visitors reported "very strong feeling of presence," "cold chill," and apparitions upon entering the cellar. Moreover, tourists who have never heard of the rumors also reported paranormal experiences. Tandy's previous study in a supposedly haunted laboratory revealed a steady 18.9 Hz emission by a laboratory machine.[24]

Here the references are: 2 (Tandy 2000) 24(Tandy 1998)

The association of low level, inaudible infrasound with paranormal experiences (referred to as "ghost stories" by Chen and Narins in the title of their article) is very weak. Tandy assumed that a peak at 19Hz and 38dB level was a cause of the phenomena he experienced, mediated through eye vibration (Tandy 1998). This was based on a report on effects on the eye due to whole body mechanical vibration (Ohlbaum 1976). However, body resonances resulting from whole body vibration are not the same as those resulting from low frequency sound, since the energy inputs are different. Whole body vibration is usually a vertical input through the feet or seat, whilst acoustic excitation from low frequency (long wavelength) sound is uniformly compressive on the body.

Tandy's work, which was mainly personal or anecdotal, has been criticized by experienced parapsychologists, who concluded that there was no evidence for Tandy's claims (Braithwaite and Townsend 2006).Attempts by others to replicate an effect under controlled infrasound exposure have failed (French, Haque et al. 2009).

Summary

There is little substance in this *Acoustics Today* paper for either Ghost Stories or Wind Turbines. So if we take away "Wind P34

3. The hearing threshold at 10Hz is 97dB.
4. The original paper Feldmann, J. and F. A. Pitten (2004). "Effects of low frequency noise on man - a case study." Noise and Health 7: 23 – 28 can be downloaded without charge from www.noiseandhealth.org

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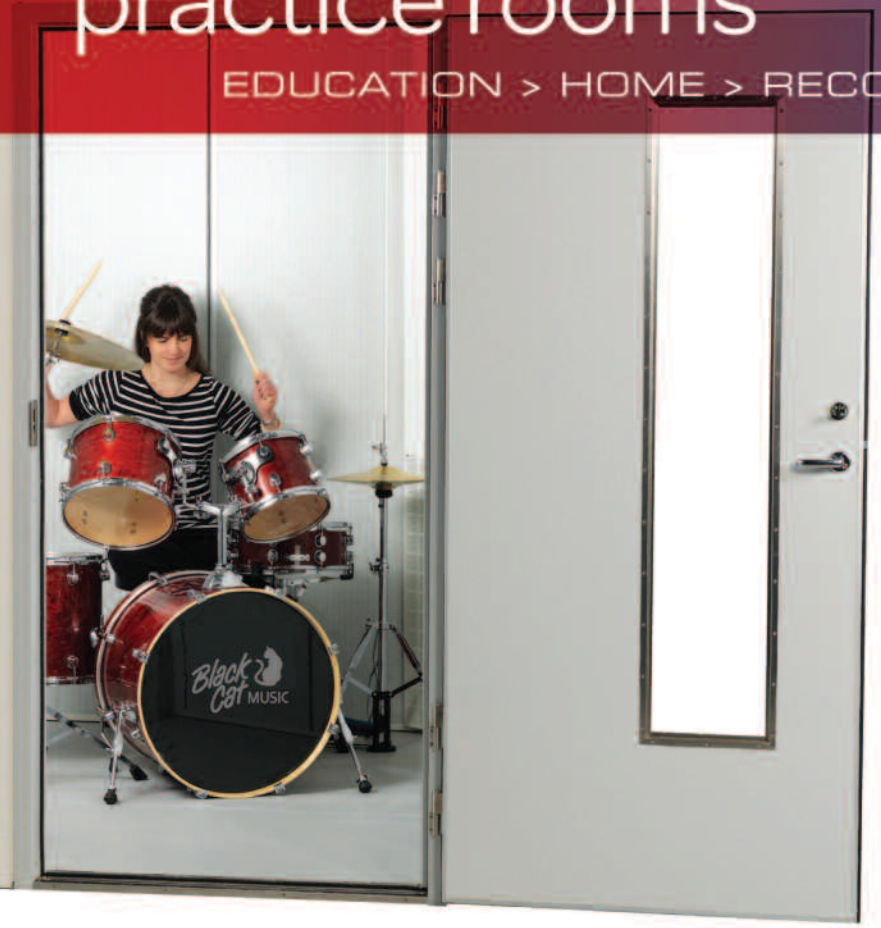

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P32 Turbines and Ghost Stories" from the title of the paper we are left with "The effects of infrasound on the human auditory system", which is what the paper really covers and where it should have retained its focus, with hard and well supported facts. Attempts to enhance its interest by straying into areas which are better suited to the popular media, have failed scientifically.

The association of the levels of infrasound from wind turbines, as experienced at residences, with the effects of high levels of infrasound used in controlled laboratory experiments is also very weak. Effects at a level of, say, 60dB should not be compared with those at 120dB. The paper bases its opinions on false information on the levels of infrasound from wind turbines as experienced at residences. Consequently, its references to wind turbines are largely invalid.

There is also the important matter of the social responsibility of scientists, who should present balanced and clear material to the wider public. Chen and Narins may not have been aware of the confusion, misconceptions and distortions which envelop the topic of infrasound from wind turbines. This is partly due to Pierpont's unproven claims of direct pathophysiological effects (Wind Turbine Syndrome), consequent upon exposure to low levels of infrasound, and which have been picked up by all objector web pages. Care should be taken to ensure that these web pages are not supplied with incorrect and unsustainable material.

One outcome of the paper is a letter to a newspaper from a Fellow of the Acoustical Society of America, from which the following is extracted:

"My concern has been strengthened after receiving the April 2012 copy of Acoustics Today, a publication of The Acoustic Society of America. It has a timely relevant technical article titled "Wind Turbines...The Effects of Infrasonics on The Human Auditory System," by Annie Chen and Peter Narins, UCLA specialists in Neuroscience & Ecology & Bio-Acoustics. These specialized trained scientists have concluded that low frequency noises in the 19 Hz range of the intensity typical of windmill generators can have psychosomatic adverse effects on humans, such as depression, anxiety, irritability, insomnia and psychosis."[5]
www.theday.com/article20120623/OP02/306239979

This is a clear example of the further misinterpretations that can follow a publication which, as demonstrated above, includes poor, and possibly biased, interpretation of its sources.

Conclusions

The paper could have been an interesting review on the perception of infrasound, but was extended into areas which were clearly outside the authors' experience, leading to errors. The authors give a very biased interpretation of the action of infrasound on the ear, not appreciating that environmental infrasound is just another sound, but one which is usually not audible. Their comments on Infrasound and Ghost Stories are supported only by work which has been heavily criticized and not replicated. Their comments on effects of infrasound from wind turbines are related by them to laboratory experiments at levels which are considerably higher than those produced by wind turbines, and which are not applicable at residences, so that the comments are invalid.

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5. Note how the writer of the letter omitted "Ghost Stories" from the title, perhaps realizing how these words affected the credibility of the paper.

Tranquillity in the city

Report by Greg Watts and Rob Pheasant, Centre for Sustainable Environments, School of Engineering, Design and Technology, University of Bradford

Introduction

The number of people visiting their local parks and countryside is increasing according to a recent survey published by Natural England [1]. An important reason given for visiting green spaces was to "relax and unwind" and these areas can be considered restorative or tranquil environments giving relief from cognitive overload and reduction of stress. Our green spaces can be a refuge from the din of city life and the green environment can provide shelter for wildlife and bird song can be heard. But are they sufficiently tranquil and what guidance do we have for improving such spaces if they are not?

We know that tranquillity is to be found in natural outdoor environments where man-made noise is at a low level though natural sounds can be relatively high. Numerous studies have shown a link between such environments and stress reduction, longevity, pain relief and even how the brain processes auditory signals [2,3,4,5]. So it is important that these natural spaces are provided particularly in urban areas. In New York where the concrete jungle compares second to none there is a policy to provide a green space within a 10 minute walk of every citizen [6]. The "High Line" in West Side Manhattan is an excellent example of how NYC authorities, prompted by citizen action, have risen to the challenge transforming a disused 1.6 km section of railway freight line in a derelict area to provide a linear park abundant with wild flowers, shrubs and trees and a "must see" for the city's many visitors (Figure 1).

Our work on elucidating the tranquillity of city parks has concentrated on the prediction and validation using the Tranquillity Rating Prediction Tool, TRAPT [7,8]. This prediction method includes two important factors: the level of man-made noise level (usually traffic noise) in the soundscape and the percentage of natural and contextual features in the visual scene. Figure 2 shows this in diagrammatic form together with the influence of other factors (moderating factors) which are generally not so influential.

The percentage of natural features in the landscape includes vegetation, water and geological features e.g. exposed rock outcrops. Contextual features include listed buildings, religious and historic buildings, landmarks, monuments and elements of the landscape, such as traditional farm buildings, that directly contribute to the visual context of the natural environment. It can be argued that when present, these visually cultural and contextual elements are as fundamental to the construction of 'tranquil space' as are strictly natural features. Based on these factors TRAPT allows the prediction of the tranquillity of a place on a 0 to 10 scale. The TRAPT equation (1) was based on laboratory studies where a number of subjects were ask to rate video clips of a range of environments from busy market place to natural coastal location far from any development.

$$TR = 9.68 + 0.041\ NCF - 0.146\ L_{day} + MF \qquad (1)$$

Where TR is the tranquillity rating on a 0 to 10 rating scales. NCF is the percentage of natural and contextual features and L_{day} is the equivalent constant A-weighted level. P36

P35 The moderating factor *MF* is added to the equation to take account of further factors such as the presence of litter and graffiti that will depress the rating and water sounds that are likely to improve it. This factor is unlikely to be large and in one experiment it was shown that the presence of litter depressed the rating by one tranquillity scale point [9]

Park surveys

To determine the tranquility of a range of city parks, seven parks were selected in urban areas within 2 miles of the centre of Bradford and a further park was Ogden Water the country park on the urban fringe that was featured in the previous article. Questionnaire surveys of park visitors were carried out in these open spaces where the dominant source of noise was from road traffic. Predictions of tranquility were made using TRAPT based on the predicted traffic noise and the percentage of natural features in view. This was later compared with results from interviews with park visitors to validate the prediction method. Figure 3 shows an interviewer at work in one of the parks.

The following parks were surveyed where the flows on the busiest roads directly adjacent to the park boundaries are given:

- Ogden Water: A country park 8km west of Bradford city centre. It comprises a reservoir with wooded slopes and access to open moorland. The closest main road with a 80 km/hr (50 mile/hr) speed limit is at a distance of 350m from the boundary and has a daytime flow of 549 vehicles/hr. The undulating nature of the terrain means that much of the road is screened from view.
- Peel Park: Irregular in shape with duck pond, formal gardens, mature trees, large statues, children's play area and sports fields. A roads runs along the north boundary for part of the way with a day time flow of 336 vehicles/hr.
- Lister Park: Triangular in shape adjacent to a major radial route into the city centre with a day time flow of 1,300 vehicles/hr. Contains mature trees, formal gardens, iconic building (Cartwright Hall) and boating lake, water features, sports area

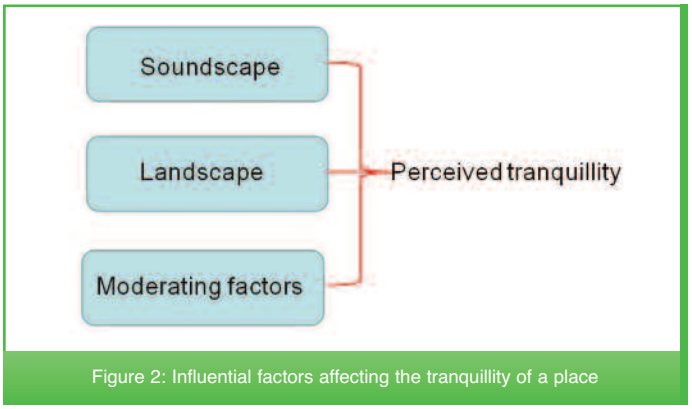

Figure 2: Influential factors affecting the tranquillity of a place

Figure 3: Interviewing at Ogden Water

Figure1: Section of the popular "High Line" in NYC cutting through the old industrial Meatpacking District showing laminar flow water feature and mixed wild grasses

and children's playground
- Bowling Park: an irregular shaped space with a road running along the length of the northern boundary with a daytime flow of 384 vehicles/hr. Contains mature trees and shrubs, few formal borders and playing fields to the south.
- Horton Park: Rectangular park with fairly busy road on north-west boundary with daytime flow of 582 vehicles/hr. Contains mature trees and shrubs, formal gardens, pond with bridge and stream
- Bradford Moor Park: Rectangular park with a major road adjacent to Killinghall Road on the western boundary. Daytime traffic flow of 1,242 vehicles/hr. Contains mature trees, grassed areas, pond, sports area and children's playground.
- Peace Garden: a relatively small rectangular space on the edge of the University of Bradford campus and adjacent to a busy route into the city centre (Great Horton Road) with a day time flow of 1060 vehicles/hr. Recently developed to include 1.8m high noise screening wall, herbaceous borders containing mature trees and a small pond.
- Thackley Green: a simple rectangular grassed open space with few trees and no formal gardens. Adjacent to a major route to Leeds (Leeds Road, A657) and with an industrial estate to the rear. Day time flow 910 vehicles/hr.

The questionnaire survey of a total of 253 adult visitors was carried out in the eight green spaces during the daytime. The following question types were included:
- sounds that attract attention
- importance of tranquillity
- factors that degrade or improve tranquillity
- rating of tranquillity on a 0-10 interval scale, where 0 is "least tranquil" and 10 is "most tranquil"
- benefits of visiting the park including level of relaxation
- access problems
- rating pleasantness on 0-10 interval scale.

Predicting tranquillity

The approach was to identify the most likely tranquil and non-tranquil spaces in these eight green spaces and calculate the Tranquillity Rating. A previous paper has outlined the method [10] and to summarise the steps involved:
1. noise maps provided by DEFRA
2. spot readings of A-weighted sound pressure levels
3. noise predictions based on the UK traffic noise prediction model CRTN
4. photographic survey of the percentage of natural and contextual features.

Steps 1 and 2 were used to assist the location of the most tranquil area at each site, Step 3 was used to calculate the daytime noise index L_{day} and step 4 the percentage of natural and contextual features in the landscape *NCF* (see Equation 1 above). Note that measured sound levels in the open spaces would include natural sounds and the sounds of people and these in general are not considered disturbing. For this reason noise prediction methods are used to separate out the disturbing mechanical noise.

The results of predicted and average ratings of tranquillity from the survey are listed in table 1.

The categorisation of tranquillity for descriptive purposes is based on earlier considerations [10] and the following guidelines in describing the levels of tranquillity achieved are:

Location	Lday (dB(A))	Percentage of natural and contextual features (NCF)	Tranquillity rating (0-10)	
			Predicted (TR)	Actual (average from survey)*
Ogden Water				
Most tranquil	36.2	100	8.5	8.8±0.2
Least tranquil	45.6	58.9	5.4	
Peel Park				
Most tranquil	44.2	99.2	7.3	8.4±0.2
Least tranquil	58.0	88.3	4.8	
Lister Park				
Most tranquil	51.8	97.7	6.1	7.8±0.4
Least tranquil	71.1	73.7	2.6	
Bowling Park				
Most tranquil	47.3	87.8	6.4	7.4±0.3
Least tranquil	50.8	82.2	5.6	
Horton Park				
Most tranquil	43.5	85.3	6.8	6.7±0.3
Least tranquil	54.5	78.8	5.0	
Bradford Moor Park				
Most tranquil	51.8	90.2	5.8	5.4±0.7
Least tranquil	71.9	79.3	2.4	
Peace Garden				
Most tranquil	60.7	55.6	3.1	4.9±0.8
Least tranquil	70.0	30.9	0.7	
Thackley Green				
Most tranquil	60.4	56.1	3.2	2.9±0.9
Least tranquil	75.7	27.3	0.0	

**95% confidence interval attached to mean values*

Table 1: Tranquillity ratings

<5	unacceptable
5.0 – 5.9	just acceptable
6.0 – 6.9	fairly good
7.0 – 7.9	good
≥ 8.0	excellent

Figure 4 shows the least tranquil open space (Thackley Green) with an average rating given by visitors of only 2.9. In contrast, visitors to Lister Park gave an average rating of 7.8. The tranquility scale runs from 0 to 10 and scores below 5 are judged unacceptable. A score of 7.8 is "good". The lack of trees and shrubs P38

Figure 4:" Non-tranquil" green (Thackley Green) and "good" tranquil park (Lister Park)

P37 in Thackley Green and the high traffic noise level due to its small size and proximity of the A657 are the main contributory factors. On the other hand Lister Park has many mature trees and a lake and is large enough that traffic noise levels near the centre are not excessive despite the presence of a heavily trafficked road on one boundary (A650).

Average ratings from respondents in Peel Park and Ogden Water were 8.4 and 8.8 respectively which is judged "excellent". In the case of Lister Park and Bowling parks the average ratings were 7.8 and 7.4 respectively placing them in the "good" category. While Horton Park was assessed at a level of 6.7 which is "fairly good", Bradford Moor Park was assessed at 5.4 which is "just acceptable". The Peace Garden and Thackley Green with ratings of 4.9 and 2.9 respectively had "unacceptable" levels of tranquillity.

Analysis

A strong relationship between predicted tranquillity and the average ratings obtained from park visitors would indicate the utility of the model in practice for design and improvement purposes. For this reason the average rating obtained in the open spaces were regressed against the levels predicted in the most tranquil areas of each space. Figure 5 shows the relationship with a linear trend line applied. There is some variation between predicted and actual values due to the subjective nature of the variables involved and the fact that not all variation is taken into account by the two variables in equation (1) L_{day} and *NCF*. Despite this it can be seen that the relationship is close ($R^2 = 0.82$, $p<0.01$).

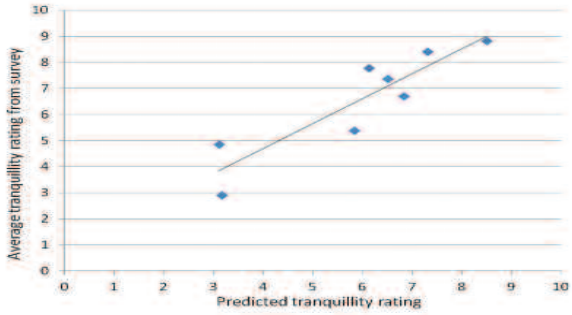

Figure 5: Predicted and average tranquillity ratings from the survey of the 8 parks

The question: "In this park/ green/ garden what sounds attract your attention the most?" produced a large assortment of replies and these were categorised as:

- "natural sounds" including sounds made by birds, animals, water and wind through leaves and branches
- "mechanical noise" including noise from traffic, individual vehicles, aircraft/helicopter noise, industrial noise and powered tools
- "people sounds" including people conversing and laughing, music and electronic sounds from hand-held devices
- "children playing" including children in playgrounds and playing games in the open spaces

Figure 6 shows the types of sounds attracting attention most in each of the parks. The bars are ordered in terms of the average tranquillity rating from the survey.

It can be observed that there are wide variations across green spaces in the percentages reporting natural sounds and especially mechanical noises. Overall 54% of respondents reported natural sounds, 40% mechanical noise, 16% people noise including music and 13% reported the sounds of children at play. By inspection it can be seen that visitors in the most tranquil parks such as Ogden Water, Peel and Horton more often report natural sounds and fewer mechanical sounds than visitors to the least tranquil spaces such as Thackley Green and the Peace Garden.

The benefits of visiting the park were obtained by asking: "Do you feel 'more relaxed', 'less relaxed' or 'no change' after visiting this park/ green/ garden?" The percentage of respondents reporting they were more relaxed was plotted against the average tranquillity rating reported by respondents. This relationship is

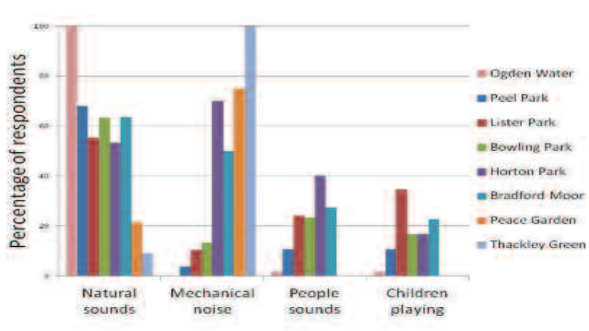

Figure 6: Sounds attracting attention

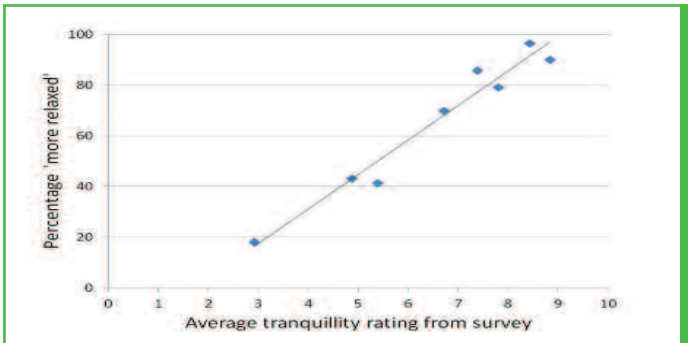

Figure 7: Percentage of respondents reporting they were 'more relaxed' after visiting the green space by average tranquillity rating from the survey

very strong ($R^2 = 0.96$, $p<0.001$) as can be seen in Figure 7.

At a rating of approximately 2 it is predicted that no visitors would have reported being 'more relaxed'. Clearly this indicates a lower bound to the tranquillity rating for creating spaces with restorative value. For a 50% response the average tranquillity rating would need to be 5.4 and for a 75% response the rating would need to be 7.2. This lends some support to the judgements noted above that a "just acceptable" level of tranquillity was considered to be ratings in the range 5.0-5.9 and a "good" level was considered to lie in the range 7.0-7.9.

Designing for tranquillity

We can conclude that tranquil spaces exist in green open spaces in cities and that some of them are likely to be judged "excellent". On the other hand some green spaces were found to have "unacceptable" levels of tranquility. In those case where tranquility is low we can use TRAPT to engineer some effective solutions. There are three approaches that can be used separately or in various combinations:

- reduce man-made noise (usually traffic noise) e.g. re-routing traffic, lorry bans, low noise road surfacing, noise barriers
- increase the percentage of natural features e.g. introduce trees, shrubs, trellising to "hide" building facades, roads, signage and advertising and to reduce the amount of concrete or bituminous surfacing used in the park
- encourage "natural" sounds by installing appropriate water features. Introduce ponds and lakes which will not only assist with increasing the percentage of natural features but will encourage water fowl and birds
- reduce litter and graffiti.

The degree of improvement can be predicted with reasonable accuracy using TRAPT allowing consideration of a range of remedial treatments. The approach could also be used in planning new tranquil spaces which will contribute to health and well being for, as we have seen, the degree of tranquillity is closely related to the degree of relaxation reported.

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Michael Smith – Vipac Managing Director

Obituary

By Graham Parry

It is with deep regret that the Institute of Acoustics has learnt of the death of Michael J. Smith, Managing Director and CEO of Vipac Engineers & Scientists Ltd. Michael was known to a large number of UK acousticians as a result of his many trips to the UK to recruit young acousticians for his Australian and Asian offices. Additionally, he also worked with other UK-based acoustic companies on a number of railway projects across South East Asia.

Michael was one of four young engineers who originally established Vipac Engineers and Scientists in Sydney in 1973. Over the next 40 years he steered it to become one of the largest consultancies of its kind, employing 280 staff in offices located throughout all Australian cities and in South East Asia.

Michael was a true innovator and led Vipac, incorporating advanced technologies with sound engineering principles, and employing those in a wide range of applications; from wind, acoustics and vibration, to fluid mechanics and thermo-dynamics, across many industries including building and construction, defence, mining, transport and consumer appliances.

Graham Parry, of ACCON UK, commented: "This is a very sad day for all those who knew and loved Michael. I had known him for 20 years since when he first asked me to go out to Australia to look at his business to explore ways in which we could work together. From that time on whenever we were able we would meet up in the UK. His company was always exceptionally enjoyable and this was allied with a tremendous talent for understanding where the business of acoustics needed to go and how best to get there. Despite the fact that we saw each other relatively infrequently, I will miss him greatly."

Michael Smith

Michael will be remembered by his colleagues as a caring and considerate leader, innovator, mentor, colleague, and friend, and an irrepressible force of nature.

Michael, who was 65, is survived by his wife, four children and two grandchildren.

Keith Broughton – former Institute Treasurer

Obituary

By Peter Wheeler

Keith Broughton served the Institute for many years, as Honorary Treasurer, working to establish and oversee our financial management systems, and as a member of, and interviewer for, our Engineering Division Committee, registering members with the Engineering Council.

I first met Keith when he was working for the National Coal Board at their research HQ at Bretby and subsequently worked with him over many years on standards development and noise policy issues.

Keith Broughton receives his Award for Distinguished Service to the Institute from former Institute Chairman John Hinton

Keith was born on 1 July 1944 and, after a period of employment in the commercial sector, joined the Coal Board, as an engineer. He was elected an associate member of the IOA in 1986 and became a corporate member in 1989, at which time he was working for British Coal as a specialist noise engineer. Papers he had written by the time of his election to corporate grade were on noise control in the mining industry and, for the IOA 1987 autumn conference, "The underground noise environment", which he co-authored. When he was elected IOA treasurer in 1998, one of his first tasks was to help introduce, with our new chief executive, Roy Bratby, the new computer network, which incorporated a revised accounting system, allowing him instant remote access to the current financial situation.

With his wife, Pat, Keith's great passion was for boating, on the canals of the Midlands, venturing as far as Ireland and France, culminating in an epic trip down the Rhone in 2009.

Keith was diagnosed last year with cancer of the oesophagus and realised that his life expectancy was very limited, but he was able to fulfil his ambition to cruise the Canal du Midi to Carcassonne. He fought his illness bravely, still serving his boat club, presenting the Commodore's quiz a few weeks before his death.

Keith will be remembered by all those IOA members who knew him as a most friendly, supportive and hard-working colleague.

Andy Nash – loss of a much loved colleague

Obituary

By Paul Shields

Our much beloved colleague Andy Nash, member of the URS Acoustics team, sadly passed away at the end of December aged 33.

Since his diagnosis in late spring 2011 Andy fought a courageous battle against Myeloma (a type of cancer arising from plasma cells which are found in the bone marrow). Despite the risks involved, Andy decided to make the very brave decision of opting for a transplant, as this was the only choice to rid himself of the cancer. A suitable donor was eventually found and he underwent transplant surgery in July 2012. The initial signs were positive, so his recent illness and rapid decline came as a shock to us all. But the illness really was only a small part of an otherwise amazing life.

Andy studied Electronic Engineering with Music Technology at York University and graduated with first class honours in 2002. The following year was spent carrying out research for the Music Technology department in room acoustic modelling. In 2005 Andy joined Acoustic Associates and in 2006 completed the IOA Diploma. He joined URS (then Scott Wilson) in 2007 and shortly after was elected as a corporate member of the Institute of Acoustics.

Andy was based in the URS Cambridge office but worked closely with colleagues in Nottingham and London. Wherever he worked he left a positive impression and was well liked and respected both for his technical skills and modest manner. He had that rare ability to get on with everyone.

He worked on a range of building acoustics and environmental noise and vibration projects. He was involved in the acoustic design of two prestigious projects in Bahrain and played a key part in the Westminster Noise Survey and Westminster Open Space study of tranquillity in London parks and open spaces. More recently he worked on Crossrail where he was the lead acoustician for Farringdon Station. He was also involved with the acoustic design for Brent Civic Centre.

He presented a number of papers in branch meetings and national conferences including the construction N+V conference in July 2010.

Andy's funeral was a celebration of his life and everyone left with the impression that he was someone special, inspiring others by his positive attitude towards life and by his many achievements. We learnt that he was a very talented musician and a loving husband and father. Despite these amazing talents, modesty was at the core of his character. He was a man whose main focus in life was the happiness of his friends and family, and he would do anything to put a smile on their face. Andy's wife, Jo, asked that no flowers be sent. Instead, there was a collection for the Antony Nolan Trust which coordinates bone marrow transplants for people with blood cancers

Andy was one of the nicest people you could hope to meet and a very good acoustics consultant with a promising career ahead of him. He leaves a wife and two very young children. Spare a thought for his family, and for those who knew him. I, for one, will remember him with a smile.

I hope you are inspired by what you have read about Andy. His friends at URS have decided that something positive will come out of this amazing man's life and will be organising events over the next year for Cancer Research and the Antony Nolan Trust to increase awareness and raise funds. The IOA Midlands Branch committee are naming the annual prize that is awarded to the best IOA Diploma project presentation the Andy Nash Award.

New head for European Wind Energy Association

The European Wind Energy Association (EWEA) has appointed Thomas Becker as its new Chief Executive Officer.

A former Danish civil servant, he has since 2010 been CEO of Genan, a company that recycles used tyres. Prior to that, he was Deputy Permanent Secretary at the Danish Ministry of Climate and Energy. He has also worked for the Danish Ministry of the Environment and for the Danish Environment Protection Agency. He joins EWEA with a long standing experience in international negotiations in the EU, UN, OECD and the IEA, and has a Master's degree in law.

"I am looking forward to working for EWEA, an organisation with an outstanding reputation," he said. "I want to turn the crisis facing the wind industry today into an opportunity to show how wind energy could contribute to jobs, exports and green growth.

"The wind industry is here to stay. It is now a mainstream industry and a major employer, and as its leading voice EWEA has to be heard even more clearly in these difficult times. I see a strong post 2020 European renewable energy policy as the key to investor security and thereby the industry's future."

Peter Lord – a founder the Institute of Acoustics and pioneering academic

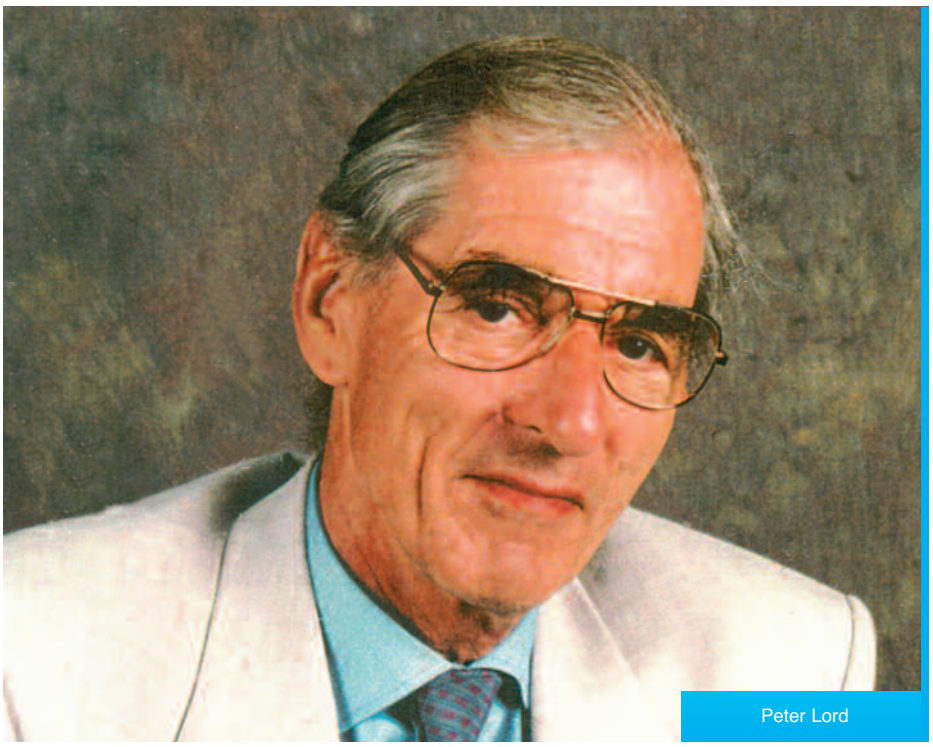
Obituary

By Geoff Kerry

A founder member and Past President of the Institute, Peter Lord, died on 2 December following a long and often difficult illness as a result of a stroke some 15 months earlier.

Peter was born on 19 January 1929 and lived his childhood in Hayfield, north of Manchester. He attended Manchester Grammar School during the difficult war years and chose to extend his A level studies at Stockport Technical College whilst gaining some practical experience working as a research assistant at the Shirley Institute, Manchester. Although his initial ambition was to become an architect, he made the pragmatic decision, in 1948, to enrol for a physics degree at Manchester, graduating with honours in 1951. He continued with post graduate studies at UMIST which led to an MSc and then a PhD in polymer physics. Whilst at UMIST, Peter organised a small orchestra and met his future wife whilst attempting to recruit female singers at the local Domestic Science College for his 1953 "Coronation" choir, to accompany his orchestra. On leaving UMIST, he worked for a while in the wind tunnels at A.V.Roe and then at the British Rayon Research Laboratories before moving to become a section leader at Alcan Laboratories in Banbury, where, following their marriage, the non singing but excellent cook, Brenda, joined him. Peter became a part time lecturer teaching physics at Oxford Technical College and it was with that experience behind him that in 1957 he applied for and obtained a Senior Lectureship at the Royal Technical College, Salford and was promoted to Principal Lecturer after it became the Royal College of Advanced Technology in 1958.

At the time, Salford was building expertise in nuclear physics and electron microscopy but Peter decided that "if he was going to achieve anything he would have to find a dark tunnel and shine like a bright light in it" (Peter's words). He chose acoustics which covered his many interests, academic and otherwise. He quickly built a small research team studying damping in polymers, transmission loss in panels, hearing loss and audiometry and somehow managed to extend his contacts into the hi-fi industry, a move that significantly improved the quality of his colleagues' home listening experience. An improvised semi-anechoic room was built in the basement of a house that had previously belonged to James Prescott Joule and, following the publication of the Wilson committee report, with the help of Per Bruel and other acousticians from both the UK and abroad, Peter organised a short course on noise control. The promise of some free consultancy resulted in local industry funding the first transmission suite, in a disused bleaching and dye works, thankfully (according to Peter) on the other side of the river from the main building and interference



Peter Lord

from the University administration. Appointed Professor of Acoustics in 1967 when Salford became a University, the research group grew under his guidance until Peter's unwillingness to embrace paperwork brought him into conflict with the then Head of Physics. The problem was solved in his usual way, he simply circumvented it. With the help of a new and unsuspecting Vice-Chancellor, he set up the Department of Applied Acoustics and with the help of his own staff and others in Electrical Engineering, launched an undergraduate course in electro-acoustics. The Department gathered strength as the undergraduate course and the research and commercial consultancy activities grew but then in 1982 the University suffered the cruel blow of a most severe cut in its grant. Applied Acoustics, the smallest Department in the University, was very vulnerable. But once again Peter's survival instinct came into play. Instead of responding to a request to cut costs he proposed a modest expansion of academic activities, funded by commercial income. The Vice Chancellor supported him, found money for new laboratories and within a few months two new blood academic posts had been secured. The move into the new laboratories and new staff breathed new life into the Department. Peter even agreed to hold the IOA spring conference at the University and invited Per Bruel to open the laboratories during the event. The Department's success with a mixed economy of teaching, research and consultancy provided a useful cushion against the many changes that an ever increasing officialdom sought to impose. However in 1990, with an ever increasing administrative load, Peter decided that he had thrown one too many of the Registrar's memoranda, unopened, into the bin and decided to retire early, although it took him another two years to hand over the reins.

Peter had, as a schoolboy during the war, helped out with farm duties in Herefordshire and fell in love with the area. For many years he had acted as a consultant to a local firm, Woodcemair, which gave him a good excuse to visit the area on a regular basis. It was no surprise that as retirement beckoned he took up an offer from a long time friend and undergraduate colleague to rent Abbotts Court, a 14C Tudor Farm House abutting the English Heritage, Oddas Chapel in Deerhurst, near Tewkesbury. One of the conditions of the rental was that Peter would organise repairs to the historic building. Unfazed by the prospect of satisfying the requirements of maintaining a grade II listed building, Peter engaged the assistance of one of the maintenance staff at nearby Gloucester Cathedral for a little weekend work. Visits to Abbotts Court became more protracted and upon retiring from full time work at Salford, Peter purchased the adjacent converted stables and moved in full time.

Peter carried out consultancy work for many companies but one of the most significant relationships was that with Building Design Partnership (BDP). This started in the early 1970s and by 1981 had resulted in BDP setting up an acoustics discipline.

Peter worked part time with BDP well into his retirement and would usually take the train up to Manchester for the day, visiting BDP in Manchester and lecturing at Salford to the second year environmental health officers course, although his colleagues often wondered why it was necessary for him to take along his violin for some demonstrations.

Whilst setting up his research team at Salford and with the many contacts he made through his short course and elsewhere, Peter, along with a few others, realised that the interests of many acousticians were perhaps not being best served by the only professional group in acoustics at that time, the Acoustics Group of the Institute of Physics and the Physical Society (now IOP). With the emphasis on noise and its control in 1962, the Society of Acoustic Technology was established based at Salford, aimed at the practical rather than academic side of acoustics. In 1964 Peter was invited to join the steering committee that lead to the British Acoustical Society and became its joint Hon. Secretary and later chair of the Programmes Committee and Vice President. He was actively involved in the development of the IOA and a signatory of the Memorandum and Articles of Association upon its foundation in 1974. In 1978 he became its President and oversaw the establishment of the Institute's own secretariat and the move of the head office to Edinburgh. Though he retired from Council in 1982, as immediate Past President and the author of the report that established the current group and branch structure he was soon back. In 1988 he was appointed the first Vice President, Engineering and successfully steered the Institute through to the status of an Institute-Affiliate body of the Engineering Council. In 1994, in recognition of his significant contribution to the Institute Peter was made an Honorary Fellow.

Peter's extra mural activities were not confined to the Institute and its forerunners. He was a Fellow of the Institute of Physics and a member of the Institute of Electrical & Electronic Engineers and a Chartered Engineer. He also served on many national committees, including the Noise Council, the Noise Research committee of the Aeronautical Research Council, the Civil and Aero committee of the Science Research Council and of the Housing of the Arts committee of the Scottish Arts Council. He wrote or edited a number of popular text books and journal papers and started and was the first editor-in-chief of *Applied Acoustics*. He was also an external examiner for many acoustics courses and PhDs. It is little wonder that his successor at Salford used him as a model for the collective noun for Professors – an absence!

Peter's life had other setbacks. He lost his son to illness a few years ago but yet he was forever the optimist, he could always see the best way forward and was an inspiration to his colleagues and to the many friends he had made throughout the world. He will be remembered not only for his practical approach to acoustics and for the support and encouragement he gave his many students but also for the fact that his "bible" which took pride of place in his bookcase, and which was updated annually, was *The Good Food Guide*.

Typical of the man was the nature of his final lecture on acoustics, to the NW Branch of the Institute. He had been asked to look back on his career and give a talk which he did, in five minutes after setting up an artist's easel. He spent the remainder of the time sketching and answering questions. When he had finished he announced: "That's it, no more lectures on acoustics, and it's art from now on."

INVC 'quiet fan' technology takes off in the US

Award winning noise control technology developed by the Industrial Noise and Vibration Centre (INVC) in the UK is taking off overseas, helping big industrial organisations cut unnecessary costs associated with noise reduction.

Engineers have installed "quiet fan" technology, which uses aerodynamic techniques to reduce fan noise at source and which can effectively be designed and installed remotely from the company's base in Slough, at several organisations across the USA.

Among the clients is a large oil refinery which contacted INVC to find ways to reduce drone from five large 1.4MW fans, as the traditional fan silencers were not only high cost, but would also reduce fan efficiency, increasing their day-to-day running costs.

Peter Wilson, INVC Technical Director, said: "The drone from these fans – each the size of a house – was causing a serious nuisance. Installing our technology required very little down-time and, as we were able to manage the project remotely from our UK office, we dispensed with site visits to further minimise costs for the client. Not only were they impressed by the energy efficiency of our technology compared with silencers, but it also reduced their capital costs by around 80% and was installed in a fraction of the time."

He continued: "Our technology differs from silencers as it eliminates the noise at source. This means that, in many cases, clients can dispense with conventional silencers, enclosures and lagging."

A project to install quiet fan technology at the Schiller power station in New Hampshire has also led to huge savings for the company. A conventional silencer had been fitted to the 3m diameter 1.5MW wood burning boiler fan at the power station to reduce noise disturbance to local residents, but the silencer dramatically reduced the fan's efficiency, leading Schiller's engineers to look for an alternative. Quiet fan technology restored the fan to full efficiency, and it eliminated the low frequency tonal noise problem at a fraction of the cost of the original conventional silencer.

Mr Wilson added: "The efficiency of fans is often seriously compromised by the silencers that have to be fitted to meet environmental noise requirements. The implications for energy consumption and carbon footprints are huge. In the UK alone, it is estimated that if the technology was used in place of silencers on many of the fans for which it is applicable, the total power consumption could be reduced by about 1,000MW."

Applying the technology to three 4MW fans at a Corus plant in the UK reduced the capital cost by an estimated £800,000 and is saving around £200,000 a year in running costs compared with conventional silencing.

For more information go to **www.inv.co.uk**, call **01753 698800** or email **consult@invc.co.uk**

The Schiller power station

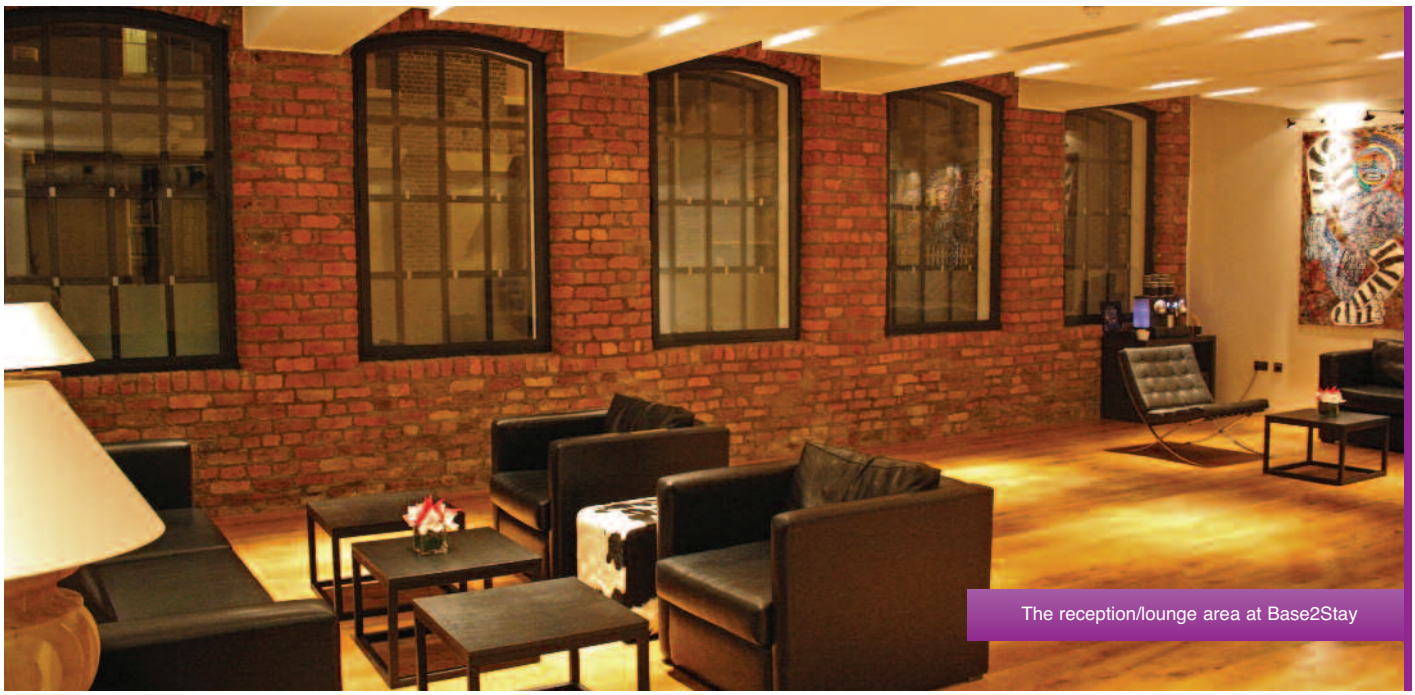
Selectaglaze turns down the volume at Liverpool hotel

Guests at Liverpool's newest boutique hotel, Base2Stay, can enjoy a good night's sleep, thanks to Selectaglaze.

The company solved the problem of how to provide peace and quiet in the former cork warehouse, which is situated in the city's busy Rope Walks area, by installing additional secondary windows to metal-framed double glazed units to form triple glazing.

Working with a local partner, Fenestral, it recommended treating most of the hotel's 160 rooms and public areas with full sized hinged casements which avoided additional sight lines and so minimised visual impact.

For more details ring **01727 837271** or go to **www.selectaglaze.co.uk**



The reception/lounge area at Base2Stay

Armstrong scores at Anfield

A refurbishment of a Liverpool Football Club private members lounge features Armstrong Ceilings.

More than 60 of its Optima mineral canopies were specified by strategic design consultants 20.20 for the room, part of a £1.2 million refurbishment of the club's corporate hospitality suites and associated public areas.

The 1170mm x 1010mm white canopies, which are highly light-reflective at 87% and are manufactured with 82% recycled content, perform acoustically to Sound Absorption Class A. This high sound absorption performance helps to reduce reverberation time and background noise level.

Some of the canopies feature lighting elements and are complemented by 136²m of 600mm x 600mm white fine fissured mineral tiles in the reception area.

For more details go to **www.armstrong.co.uk**

Goal achieved: the new private members lounge

Exporter of the year award for AMS Acoustics

AMS Acoustics was named exporter of the year at the Enfield Enterprise annual awards.

The award was made in recognition for its Middle East activities, particularly the expansion of Jeddah airport and the new King Abdulaziz terminal and, most significantly, the extension of the holy site in Mecca.

The award was presented to CEO Helen Goddard at a black tie dinner at the Royal Chase Hotel, Enfield.

Helen Goddard receives the AMS award

In the UK, AMS was responsible for activities at designated Olympic sites, including Heathrow terminals and St. Pancras International Station, and, nearer the Games itself, it was also engaged for the ExCel Arena and the public address and voice alarm design for the Westfield Stratford shopping centre.

For more details ring **020 8886 4060** or go to **www.amsacoustics.com**

New CCLD accelerometer from Brüel & Kjær

Brüel & Kjær has released a new CCLD accelerometer, Type 4527, which can operate at a continuous temperature of 180°C.

Type 4527 has wide dynamic, frequency and temperature ranges and it has low sensitivity to electro-magnetic interference due to low output impedance and also features a very low noise floor.

Using the same design and offering the same range specifications, another new high temperature accelerometer which significantly reduces setup time, thanks to TEDS technology, is the Type 4528-B. It communicates with the user's data acquisition hardware to automatically self-identify and supply calibration data from a microchip contained inside it. Type 4528-B is rated up to 165°C for continuous use.

Both accelerometers give users the ability to select the number of axes that they want to measure: three, two or just one axis – avoiding the confusion of unnecessary data, and reducing the amount of measurement channels required.

The new units contain a built-in pre-amplifier, meaning they don't need an external charge amplifier to power the signal. Instead, they are simple to 'plug-and-play' using just an ordinary signal cable.

For more details go to **www.bksv.com**

The new Type 4527 accelerometer

Datakustik unveils version 4.3 of CadnaA noise prediction software

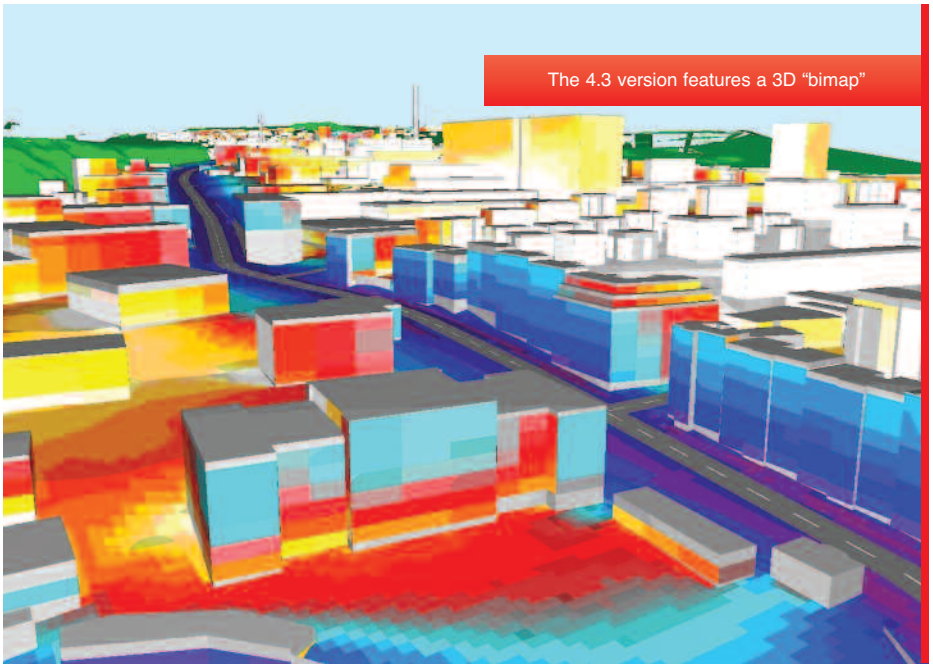
A new version of CadnaA, the noise prediction software package from Datakustik, has been unveiled.

The 4.3 version features a 3D "bimap" which allows putting a photo image of buildings on the 3D representation to give real life display in noise models and with the new pitched roof feature it is even more realistic.

CadnaA is a platform for the calculation, and presentation, of environmental noise. Noise levels from road, rail, aircraft, industrial plants, entire towns and cities can all be accurately predicted with the aid of approximately 30 pre-installed standards and guidelines.

Once modelled, noise impacts can be viewed in a number of formats including CadnaA's full colour 3D mapping feature. The virtual environment can be manipulated in detail, including the texture and shape of building facades and roof structures, and data can be edited in real time. The optical impact of a proposed environment can be properly assessed using the walk through or fly over functions. Data import and export is versatile and simple, using various formats and interfaces, including GoogleEarth.

For more information call Campbell Associates on **01371 871030**, or to download a free demo version, visit **www.campbell-associates.co.uk** and follow the 'Links' tab at the top of the screen.



The 4.3 version features a 3D "bimap"

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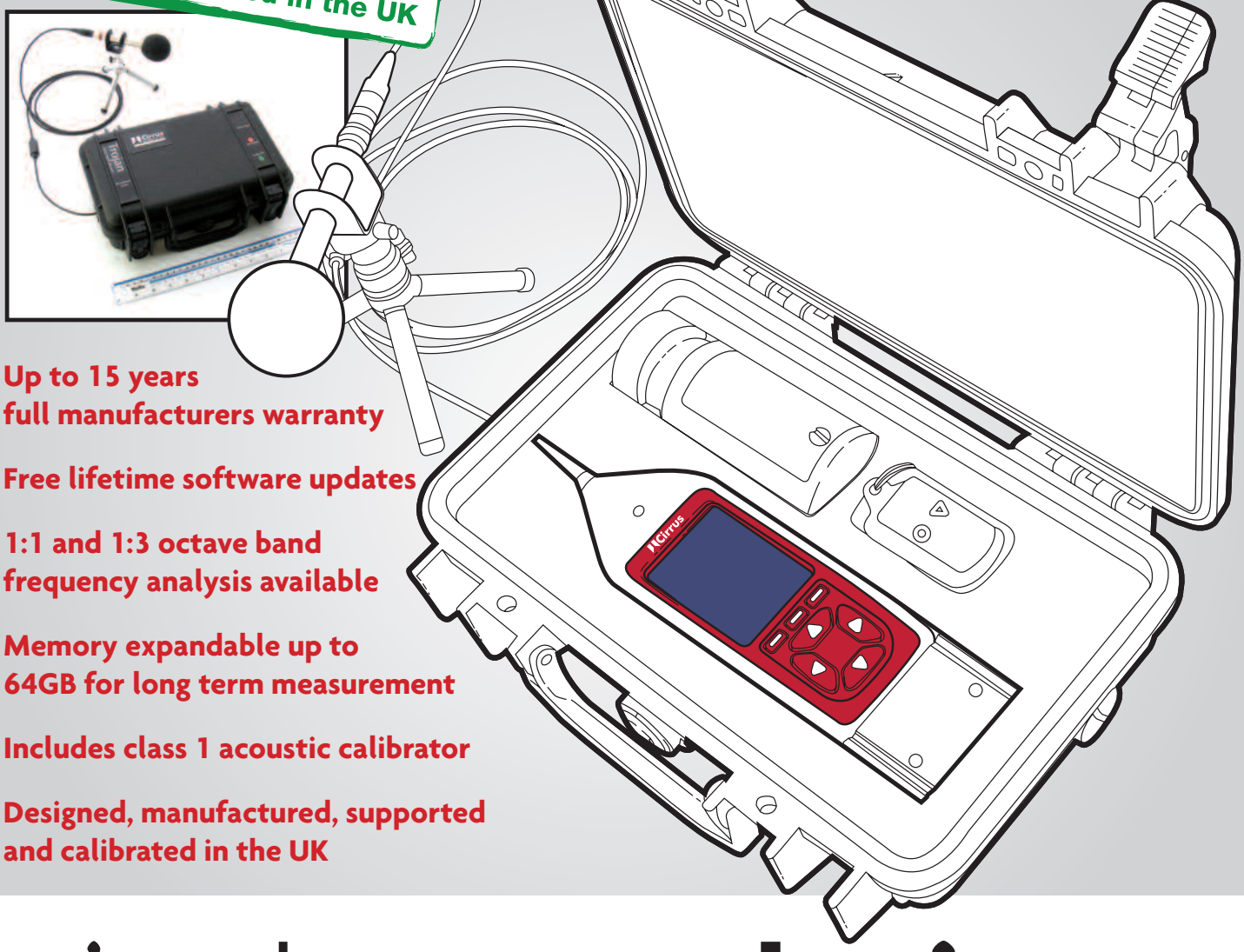

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Cirrus updates Optimus range and NoiseTools software

Cirrus Research has unveiled updates to its Optimus range of sound level meters and NoiseTools software used by the Optimus range, the Trojan noise nuisance recorder and the doseBadge noise dosimeter.

The Optimus range now includes the latest digital technology and industrial design, bringing new features and functions to hand-held noise measurement instruments. The meters can be used for a range of different applications including simple noise measuring, occupational noise, noise at work and environmental noise.

The latest version of NoiseTool features a wide variety of new applications which include Korean, Italian and Spanish translations, an improved exposure calculator to support repeated measurements, maps for use with measurements that have GPS data and Windows 8 compatibility.

For more details go to: **www.cirrusresearch.co.uk**

An Optimus sound level meter

Launch of free acoustic app

IOA member Daniel Lurcock of acoustassist has written a free app to help with acoustic reference and calculations on the go.

ToolBox is available as both a web-based app for many kinds of web-enabled devices and as a downloadable app for iPhones and iPads (with Android, Blackberry and Windows Phone downloadable versions coming soon). It will be regularly updated with new features.

For full details go to **www.acoustassist.com**

New preamplifier microphone 'turns up the heat'

Brüel & Kjær has launched the world's first preamplifier and preamplifier/microphone combinations able to withstand temperatures up to 125ºC (257 ºF).

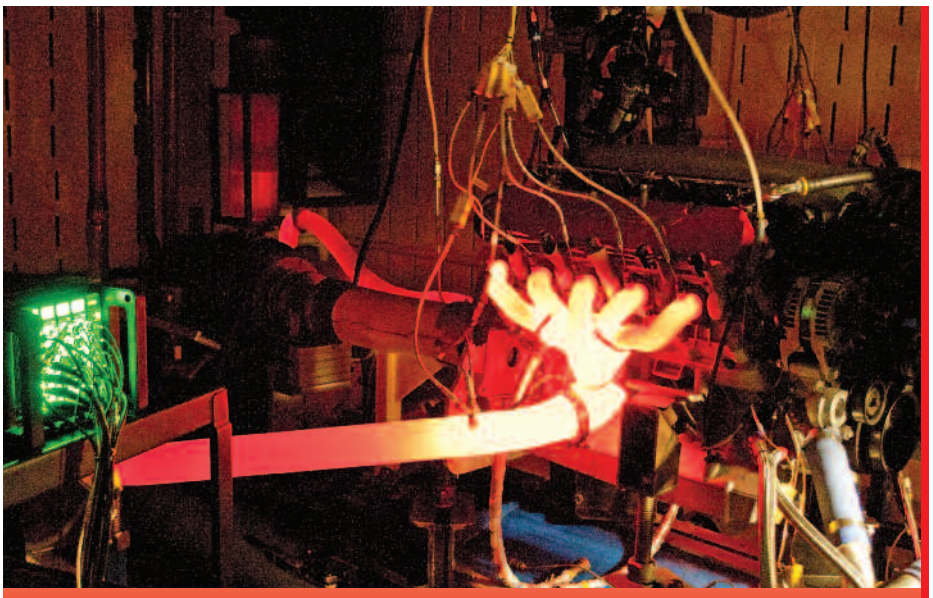
High-temperature CCLD Microphone Preamplifier Type 1706 enables engineers to make acoustical measurements nearer to the source of noises on hot devices. This simplifies identification of potential issues, making it ideal for testing applications including gas turbine auxiliary equipment, environmental stress screening, automotive engines, and exhaust systems.

A "smart transducer", Type 1706 is very easy to integrate and set up in the measurement chain. Identification, calibration, and correction data are internally stored using a Transducer Electronic Data Sheet (TEDS), which is automatically read by the analysis system.

Type 1706 works in combination with microphones designed for any field, and it is offered with combinations with free-field or diffuse-field ½" microphones where the data covering both the preamplifier and the microphone are stored on a TEDS.

A CD shipped with every transducer contains detailed information on its calibration and the compensation necessary when using accessories such as windscreens, ensuring highly accurate measurements.

For more details, go to **www.bksv.com**



The new Type 1706 with a very hot engine

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Committee meetings 2013

DAY	DATE	TIME	MEETING
Tuesday	5 March	10.30	Diploma Examiners
Wednesday	**6 March**	**11.00**	**Council**
Monday	8 April	11.00	Research Co-ordination
Tuesday	9 April	10.30	CCWPNA Examiners
Tuesday	9 April	1.30	CCWPNA Committee
Thursday	18 April	11.30	Meetings
Thursday	2 May	10.30	Membership
Thursday	16 May	11.00	Publications
Wednesday	22 May	10.30	CMOHAV Examiners
Wednesday	22 May	1.30	CMOHAV Committee
Thursday	23 May	11.00	Executive
Tuesday	28 May	10.30	ASBA Examiners
Tuesday	28 May	1.30	ASBA Committee
Thursday	30 May	10.30	Engineering Division
Thursday	**13 June**	**11.00**	**Council**
Wednesday	19 June	10.30	CCENM Examiners
Wednesday	19 June	1.30	CCENM Committee
Thursday	20 June	10.30	Distance Learning Tutors WG
Thursday	20 June	1.30	Education
Thursday	18 July	11.30	Meetings
Tuesday	8 August	10.30	Diploma Moderators Meeting
Thursday	15 August	10.30	Membership
Thursday	5 September	11.00	Executive
Thursday	**19 September**	**11.00**	**Council**
Monday	30 September	11.00	Research Co-ordination
Thursday	3 October	10.30	Diploma Tutors and Examiners
Thursday	3 October	1.30	Education
Thursday	10 October	10.30	Engineering Division
Thursday	17 October	11.00	Publications
Thursday	31 October	10.30	Membership
Tuesday	5 November	10.30	ASBA Examiners
Tuesday	5 November	1.30	ASBA Committee
Thursday	7 November	11.30	Meetings
Thursday	14 November	11.00	Executive
Wednesday	20 November	10.30	CCENM Examiners
Wednesday	20 November	1.30	CCENM Committee
Thursday	21 November	11.00	Publications
Tuesday	3 December	10.30	CCWPNA Examiners
Tuesday	3 December	1.30	CCWPNA Committee
Thursday	**5 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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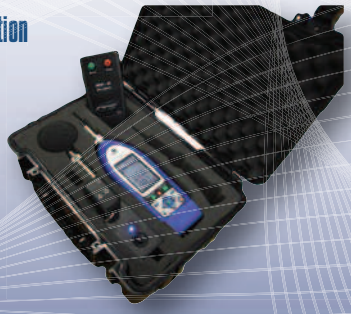

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