Vol 42 No 5 September/October 2017

ACOUSTICS BULLETIN

in this issue... **People, policy, and health: assessing historic interventions in practice**

plus... **High standards again at annual ANC excellence awards**

Uncertainty in noise modelling

Going great guns: measuring high noise levels

Institute of Acoustics

ACOUSTICS BULLETIN

Vol 42 No 5 September/October 2017

Front cover photograph:
Under review: the health effects of aircraft noise exposure

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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WE MAPPED THE SOUNDS OF CHILE

With a population of around 17 million and roughly one-third of that living in Chilean capital of Santiago, traffic noise mapping wouldn't seem top of the urban research agenda.

Not so, last year a report stated that new car sales were up a staggering 27.3% in the country as the economy continues to improve. Santiago is also one of General Motors' manufacturing bases in South America. That's why Prof. Jorge Arenas undertook a two-year noise mapping study using equipment from Cirrus Research.

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Conference programme 2017/18

18 October
Organised by the
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Autumn conference
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8 November
Organised by the
Environmental Noise Group
The noise management assessment of Crossrail – outcome and lessons learned
London

21 November
Organised by the
Musical Acoustics Group
21s century developments in musical sound production, presentation and reproduction
Nottingham

21-23 November
Organised by the
Electroacoustics Group
Reproduced Sound 2017
Nottingham

23-24 April 2018
Annual IOA conference
Acoustics 2018
Cardiff

5-7 September 2018
Organised by the
Underwater Acoustics Group
The 4th international conference on synthetic aperture sonar and synthetic aperture radar
Lerici, Italy

4-6 October 2018
Organised by the Institute of Acoustics
10th international conference on auditorium acoustics
Hamburg

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

Dear Members

ICSV24 was held in London at the end of July. The conference was a tremendous success with more than 1,000 attendees from around 50 countries. A quarter of the delegates were students, and there were many fascinating posters presented. The future of acoustics is clearly in safe hands. The country fielding the greatest number of attendees was China, closely followed by the UK. I would like to say a massive "thank you" to everyone at IOA head office for their contributions and above all Linda Canty, who has worked tirelessly on the arrangements for the conference on top of her normal workload since it was agreed that it would be held in the UK. Thanks also to our volunteers who filmed presentations, manned the welcome desk and helped out in each session ensuring that things ran smoothly and help was always on hand. I hope that the IIAV is as grateful as I am to the organising committee and session Chairs without whom this festival of knowledge-sharing wouldn't have happened.

I particularly enjoyed the plenary lectures, which presented accessible insights into a range of acoustic areas. These are available on YouTube via the IOA website and well worth a look.

During the conference I had the honour of presenting this year's Rayleigh Medal to Professor Juan Gallego-Juárez. The award was made in recognition of his world-leading academic research in the field of ultrasound and nonlinear acoustics, as well as the translation of basic research ideas into commercial products. See page 10 for full details.

Looking a little further back, to June, the launch of the *Professional Practice Guidance on Planning and Noise for Residential Development (ProPG)* was very successful. The initial half-day session was quickly oversubscribed, so a repeat session was added the same day. It's worth keeping an eye out for an event on this topic near you if you weren't able to attend the launch, as there will be talks at a number of our regional branches. Attending a branch meeting can provide the opportunity to discuss the finer points with fellow practitioners in an informal environment. You could also invite contacts, who might not be IOA members, from local authority environmental health or planning departments. See page 6 for details of the launch events.

I'd like to congratulate our six members who have successfully achieved Engineering Council registration following the latest round of interviews (see page 14). The status of engineers in the UK is often lamented, and the Engineering Council works continuously to improve that status. Achieving registration demonstrates that you've met internationally recognised standards of competence and ethics. If you'd like to find out more about what's involved in becoming registered our Engineering Committee members will be happy to provide guidance to potential applicants.

In July we held an election for new members of Council. Thanks are due to our candidates, and of course to those of you who voted. I'd like to extend a warm welcome to our three new members of Council, and thank the three re-elected members for being prepared to continue giving their time and energy for the benefit of the Institute. To our colleagues who have completed their term on Council, or chosen not to stand again, I would like to extend my thanks for your enthusiasm and your wise counsel.

I'm proud that women now hold a third of the seats on our Council, and look forward to the day that within our membership and on Council it could be 50%. Diversity means different things to different people and is something our profession, like many others in engineering, is struggling to achieve. Please see if you can take three minutes out of your day to watch the short video: #InclusionStartsWithI - https://www.youtube.com/watch?v=2g88Ju6nkcg

Jo

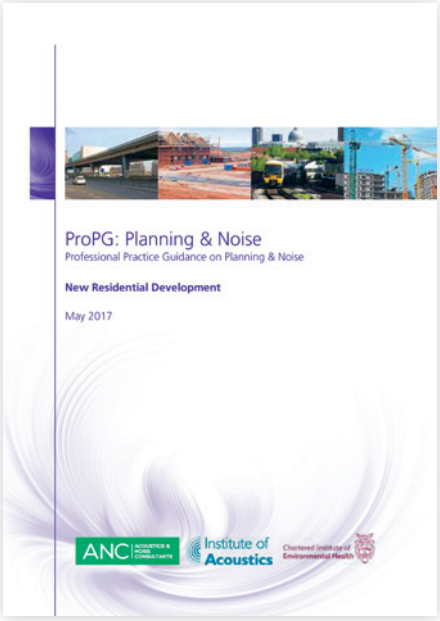
Jo Webb, President

ProPG: Planning & Noise – the key need to spread the message

By Colin Grimwood and Steve Mitchell

For those who have not yet heard, *ProPG: Planning & Noise* was officially launched at an event in Birmingham on 22 June. This was organised by the IOA and supported and co-chaired by all three partner organisations – the IOA, the Chartered Institute of Environmental Health (CIEH) and the Association of Noise Consultants (ANC).

There was so much interest amongst members that two launch events were held on the same day, attended by nearly 230 delegates. The first speaker was Colin Grimwood (CJGEM), lead author of the ProPG, who gave an overview of the document(s) and the recommended approach. Also speaking was Dani Fiumicelli (Temple), chairman of the ProPG working group, who gave an overview of recent research on the impact of noise events on sleep that underpins Appendix A of the ProPG and the associated guidance on dealing with night-time noise events. The third speaker was Jack Harvie-Clark (Apex Acoustics), who spoke about acoustics, ventilation and overheating in dwellings. This was the topic that had resulted in the most feedback from members during the consultation stages of the ProPG. Jack welcomed the carefully considered advice provided in the ProPG on this topic that had been developed in consultation with key members of a new ANC Acoustics Ventilation and Overheating Working Group. The final speaker was Adrian Passmore (Arup), who, while not a member of the ProPG working group, delivered an inspiring talk that called on all present to respond to one of the key messages of the ProPG – the need to promote a good acoustic design process for all new dwellings.



Copies of all launch presentations are available on the IOA website at **http://ioa.org.uk/publications/propg** Printed copies of the ProPG are available from the Institute at £30 a copy including postage while stocks last. Email **publications@ioa.org.uk** to request one.

Use of the ProPG is already gathering pace. The committee producing the document went to great lengths to make it as accessible as possible to both acousticians who need the detail and planners, house builders and others who may not. Ingenious Design, a graphic design company, were used to bring the text to life and lead the reader through the material in the same logical way as the user should carry out their assessment. Whilst the detailed words are all important, it is hoped that also making the document attractive to read will improve its uptake. Time will tell, but it seems to have got off to a flying start.

The ProPG is proving of great interest to those IOA members who are working as acoustic consultants advising residential developers. However, many IOA members also work in local authorities advising local planners. In this article, we would like to highlight the words of Alan Higgins of the CIEH who started the afternoon launch event with the following speech:

"As the CIEH, we very much welcome the publication of *ProPG: Planning & Noise* and would like to thank our two partners – the IOA and ANC – for working together with us on this useful document. We were pleased to see excellent involvement from environmental health practitioners in putting this document together, both as part of the working group and in response to the joint consultation that was run last year.

"Good acoustic design is a vital component of good quality housing, especially in many urban and semi-urban areas, which are more densely populated. We know that everyone benefits when potential noise issues are considered early on in the planning process for a new development. The chance to mitigate and minimise noise as part of the design process ensures that there are better outcomes for the residents of new developments, for businesses that are located nearby as well as for local authorities, who should receive fewer noise complaints as a result.

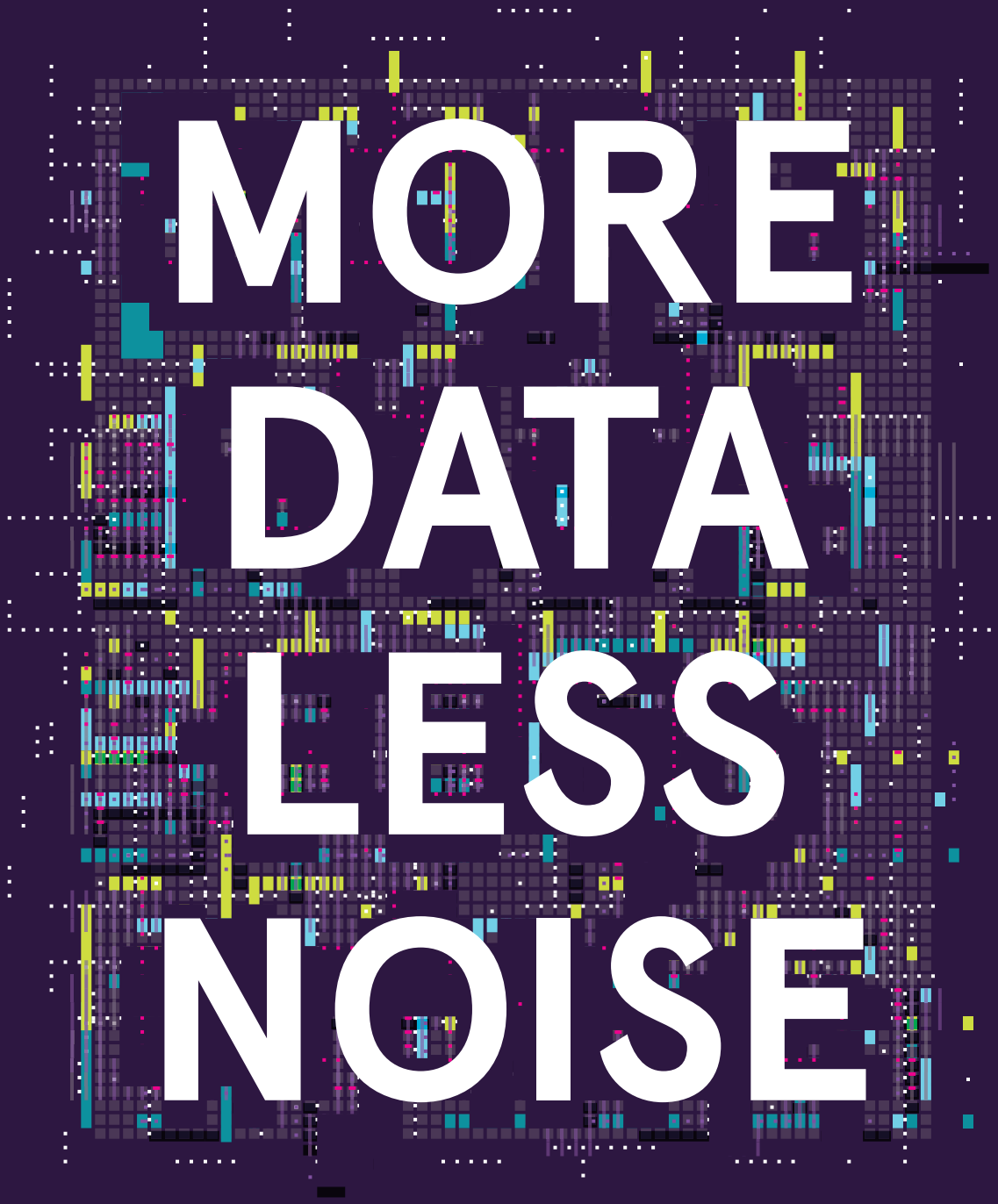
"In February of this year, the Government published its Housing White Paper which included an ambition to increase the pace of development in England to meet a rising demand for housing. Throughout the recent general election campaign, every political party also acknowledged the importance of addressing the current housing shortage in England by increasing the supply of housing stock.

"This guidance on noise therefore couldn't have been published at a better time. We would like to see many more homes built to meet national demand, but the planning system must also carefully consider health and wellbeing outcomes as part of the planning process. New homes being built should provide a comfortable, affordable and secure place for people to live. As environmental health practitioners, we know that good quality housing underpins residents' health and wellbeing. Therefore we need to ensure that any new wave of housing built as a result of current and future Government initiatives, protects its residents from noise, excessive cold and from exposure to air pollution.

"Whilst the Government published its new planning guidance in 2015: the National Planning Policy Framework (NPPF), the advice on noise was very concise. The ProPG is intended to complement the NPPF and to provide practitioners with more guidance on noise mitigation strategies. In our view the ProPG should therefore be seen by all planning officers and developers so that new residential developments have access to the best advice when building a new housing stock that is fit for the future."

One of the key messages from the launch was the need to communicate with other relevant professions, particularly planners and architects as well as new house builders in general. The working group will be meeting again to consider possible next steps. With one million new homes promised by 2020 it is clear that, as members of the IOA, CIEH and ANC, we will all need to do what we can to support the clear calls in the ProPG: "Good acoustic design should provide an integrated solution ... without design compromises that will adversely affect living conditions and the quality of life of the inhabitants or other sustainable design objectives and requirements" (para 2.21). "It is imperative that acoustic design is considered at an early stage of the development control process" (para. 2.18).

***Colin Grimwood** is a Director of CJGEM, providing independent advice, consultancy, research and policy analysis. **Steve Mitchell** is Technical Director at ERM and Chairman of the IOA Environmental Noise Group. Colin and Steve were members of the working group that has produced the ProPG and collaborated with Ingenious Design over the final appearance of the guidance.*



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EPSRC announces £691,000 funding for UK Acoustics Network

Professor Kirill Horoshenkov FIOA

We are delighted to announce that the Engineering and Physical Science Research Council (EPSRC) will fund the UK Acoustics Network. This project is for three years, commencing in November 2017. It is led by Professor Kirill Horoshenkov (University of Sheffield) and Professor Richard Craster (Imperial College, London). This project opens up many opportunities and funding for the acoustics community to take part in a range of networking activities. The EPSRC grant to support the network is £691,000, of which £474,000 is allocated for workshops, special interest groups and related activities. The network arose from the activities of the IOA Research Co-ordination Committee (RCC) and most notably the Acoustics Research Challenges Workshop organised by the RCC at the Royal Society in London in April 2016. The network benefits from active support from industry, government agencies and from two other EPSRC-sponsored networks: EPSRC-funded Image-Guided Therapies Network+ (IGT) and Fluids Network.

The network's vision is to bring together the internationally leading but disparate UK acoustics research community, to promote acoustics in the UK both nationally and internationally and to provide a coherent single point of access to acoustics research for industry and governmental agencies. The network sets six objectives to achieve its vision:

- to expand key research themes and to identify their contributions to the future research challenges
- to facilitate and promote knowledge transfer between Special Interest Groups (SIGs)
- to initiate and facilitate novel and innovative research in acoustics and accelerate impact
- to develop a strategic plan to scale up acoustics research in the UK towards critical mass in key areas
- to provide a forum for the acoustics community to speak collectively to EPSRC
- to deliver a sustainable research network that will become self-sufficient in the medium to long term.

Rationale for the network

Acoustics is a pervasive discipline that contributes significantly to many different technological areas, including healthcare, manufacturing, defence, built infrastructure, communication and power generation. Its importance is reflected in the growing levels of UK Research Council (RCUK) funding for acoustics related research. The RCUK (now a part of the UK Research and Innovation, UKRI) funding for acoustics grew by a factor of four from £25.6 million in 2010 to £120 million in 2014. The current level of funding in 2017 is £140.3 million showing consistent growth in funding of acoustics-related research. Industry is increasingly recognising the importance of acoustics and investing in new capabilities, for example Jaguar Land Rover have recently invested £150 million in new acoustics research facilities. This increase in research activity reflects the multidisciplinary research environment in which acoustics operates where it is a key enabling science playing an increasingly important role in the successful delivery of future technological innovations across many different sectors.

Although acoustics-related research supports many different technological areas, in the UK it has often evolved in a fragmented manner. As a result, the level of RCUK funding for various acoustics related research has varied significantly as shown in Figure 1. This figure shows the value of the live grants in five areas of research related to acoustics recorded from 2014. For example, funding for audio and sonic research has grown substantially since 2014 whereas funding for noise-related research has remained relatively small and its level has changed marginally.

There are now many different research groups in the UK based in a range of different departments (e.g. mathematics, physics and engineering) that draw heavily on acoustics-based research, but tend not to consider themselves as "dedicated acousticians". Groups focus on their own particular applications of acoustics and there is a general lack of communication and co-ordination between different groups in industry and academia. This is not surprising given the wide range of applications common in acoustics (underwater acoustics, aeroacoustics, phononic crystals, soundproofing to name but a few). Such fragmentation leads to duplication of effort, a lack of awareness of progress made in related areas, inefficiencies both in the growth of research capacity and in the use of facilities and equipment. Moreover, the profile of acoustics continues to be limited in the UK, and the discipline does not successfully present itself with a unified voice to research councils, government agencies or the wider population. Accordingly, as research funding in acoustics, and demand from industry and technology, continues to grow it is crucial that our discipline develops a more co-ordinated and united approach to meet future technological and societal challenges. As it is often seen as an enabling science, the discipline of acoustics has never been part of an initiative to co-ordinate its research activities across the wide spectrum of acoustics research. The benefits of doing so will have a broad impact as this network will bring together the wide range of research areas aligned to acoustics. P10

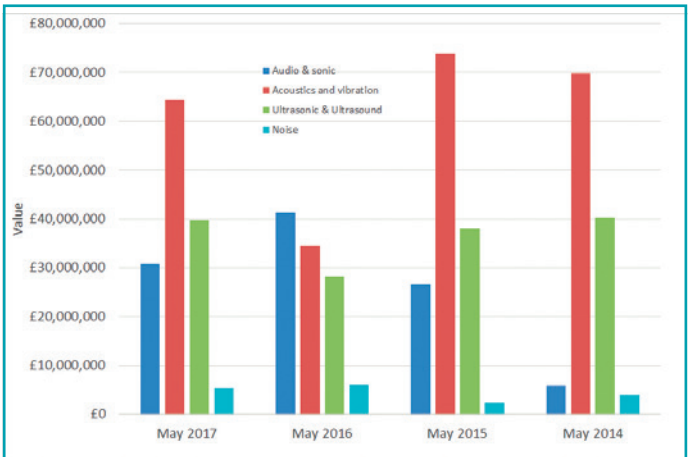

Figure 1. A summary of the RCUK funding (live grants) for acoustics related research over the last 4 years.

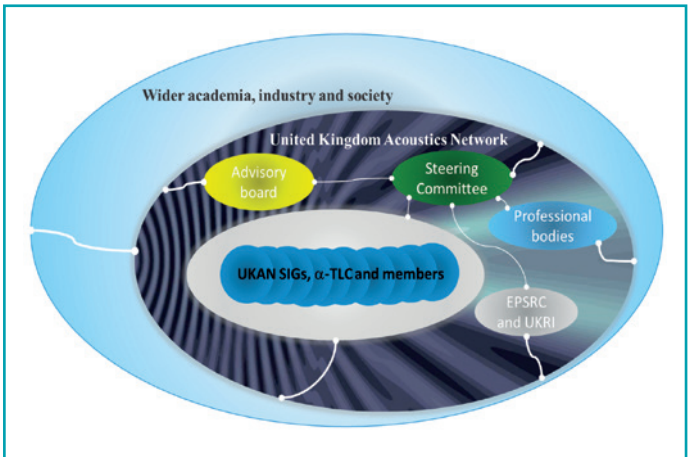

Figure 2. A diagrammatic representation of the network management structure and links between its key elements

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P8

It will facilitate the identification of common interests, foster knowledge transfer and research leaders for the future and accelerate the impact of acoustics related research in the UK. Figure 2 illustrates the structure of the new network which aims to achieve broad membership, wide industry backing and strong support from key government bodies. The core of the network will be the SIGs which are sub-networks focused on specific themes. A part of the core is an Acoustics Thought Leadership Club. which will be formed to hold workshops with key strategic thinkers and innovators to develop a strategic research programme for innovation in acoustics. The network will be managed by the steering committee involving the investigators and representatives from each SIG. This steering committee will be responsible for preparing an overall strategy for the network and ensuring it is run in the interests of the UK acoustics community. The network will also have an advisory board to provide constructive, high-level independent feedback on the network activities and to make sure that it is engaged well with other academic and research groups, industry and professional bodies in the UK and overseas.

Developing research capacity and national importance

The network will align to the EPSRC Delivery Plan as illustrated in Table 1 showing the SIGs that the network will initially support. These SIGs are sub-networks formed of all interested members of the network and responsible for delivering the defined outputs, development of future challenges and for building critical capacity and mass in terms of acoustics related research in the UK. The network itself will coordinate the exchange of knowledge and ideas and accelerate impact. The network will enable the discipline of acoustics to focus on meeting a key recommendation from the Dowling Review of Business-University Research Collaborations by facilitating the "scaling up of collaborations so that they evolve into a critical mass of activity, with multiple points of contact, a clear framework and a longer-term horizon". Enhancing communication between different research themes will enable the network to identify new potential areas for growth and to provide a more coordinated response to developing emerging themes to stay internationally leading and competitive.

Launch of the UK Acoustic Network and membership

There will be a special launch event in London in November or December 2017 which will be open to any interested participants from industry, government/public bodies and academia. The date will be fixed shortly and it will be advertised via the IOA and Institute of Physics websites. The network needs a broad membership and industry backing to be effective

One objective of the launch event is to begin to expand the membership of the nine SIGs which have been already identified (see Table 1) and to propose new SIGs that will directly support the four outcomes in the EPSRC Delivery Plan. Each SIG will form around the interests of stakeholders and members will be drawn from academia, industry and public bodies.

The ethos of the network will be open and inclusive to attract new members who will be encouraged to join through early-stage networking, outreach, website and other activities. A sign-up page on the network website will be used to build a searchable directory of the UK acoustics researchers, facility, software and equipment. The network will invite proposals for new SIGs on an annual basis with the list of those who would be interested in joining the SIG.

	Special interest groups (SIGs)	*Physical acoustics*	Numerical methods in acoustics	Non-destructive evaluation	Sensors	Underwater acoustics	Aeroacoustics	Noise	Communication acoustics	Metamateials
EPSRC themes	Digital economy				✓				✓	
	Energy	✓	✓	✓	✓	✓	✓	✓		✓
	Engineering	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Global uncertainties	✓	✓		✓	✓		✓		
	Healthcare technologies	✓	✓	✓	✓			✓	✓	✓
	ICT				✓				✓	
	LWEC	✓	✓	✓	✓	✓		✓		
	Manufacturing	✓	✓	✓	✓		✓	✓		✓
	Physics/ maths	✓	✓			✓	✓	✓		✓

Table 1. Impact of the Acoustics Network to key EPSRC Themes.

Contacting the network

IOA members are welcome to contact the network leader, Kirill Horoshenkov (**k.horoshenkov@sheffield.ac.uk**) with any questions regarding its structure, operation and membership. We welcome your views on the activities which you think the network should offer new and existing members.

See page 32 for details of EPSRC multi-million pound funding for an acoustic energy research project.

Juan Gallego-Juárez awarded the 2017 Rayleigh Medal

Distinguished ultrasound expert Juan Gallego-Juárez has received the IOA's premier award, the Rayleigh Medal. The award, which recognises "outstanding contributions" to acoustics, was presented to him by IOA President Jo Webb at ICSV24 in London. Below is a summary of his citation.

Professor Juan A Gallego-Juárez is a Research Professor at the Spanish Higher Council for Scientific Research (CSIC), where he founded the Ultrasound Laboratory in 1971 and was Director of the Instituto de Acústica for more than 12 years. He was also Director of the Center for Physics Technologies that integrated several research institutes. Now he is in the position of *ad honorem*.

He has a Doctor in Physics degree from the University of Rome and a Doctor in Physic Sciences degree from the University of Madrid. He also holds an Honorary Doctorate from the University of Santiago de Chile and was awarded the Gold Medal of this university and the Golden Whistle Award 2011 of the International Congress on Ultrasound. He was appointed Fellow of the IOA in 1984 and of the Acoustical Society of America in 1997. He is also a Member of Merit of the Spanish Acoustical Society.

P12

Professor Juan Gallego-Juárez receives the Rayleigh Medal from IOA President Jo Webb

P10

He was the organiser and chairman of the Ultrasonics International Conference in 1989 and of the International Congress on Acoustics in 2007, both of which were held in Madrid. He was a founder and a board member of the World Congress on Ultrasound (WCU) from its institution in 1993 and also of the International Congress on Ultrasound which replaced it since 2006. He also served on the board of the Spanish Acoustical Society from 1981 to 2015 and the International Commission for Acoustics from 1998 to 2008. His international leadership in expanding the dissemination of ultrasonic acoustics has to be highlighted, particularly in Latin America through his direction in organising the Iberoamerican Network of Ultrasound (RITUL) as well as in receiving and supervising PhD and Master students from these countries.

Professor Juan Gallego-Juárez has contributed to acoustics more than 300 publications and 43 patents. He has been an invited lecturer in more than 45 international conferences and is the author of more than 200 contributed papers to international and national conferences. He has given lectures and courses all over the world and has developed more than 100 research projects, mostly as principal investigator. His research work has been specifically focused on power ultrasound over a wide range of topics involving the use of intense, high frequency acoustic waves to create changes in materials through nonlinear physical effects. In particular, he has opened new fields of application of sonic and ultrasonic energy in low density and in homogeneous media, as gases and multiphase media, where its use was notoriously discarded due to the difficulties for efficient generation and propagation. The concept, design, development and application by him of a novel family of power sonic and ultrasonic generators with extensive radiating surfaces of stepped profile has significantly contributed to addressing this challenge by allowing the implementation, at laboratory, semi-industrial and even industrial scale, of a number of new ultrasound assisted technologies for the environmental, food, and manufacturing sectors.

The recent publication of *Power Ultrasonics*, a huge volume of more than 1,000 pages co-edited with Karl Graff, where much of his new technologies are collected, represents a milestone in the field of ultrasound.

Professor Gallego-Juárez founded in 2008 a spin-off company, PUSONICS, for the industrialisation and commercialisation of the new power ultrasonic technologies and processes he studied and developed at laboratory stage.

In summary, this medal recognises his world leading academic research in the field of ultrasound and nonlinear acoustics as well as the translation of basic research ideas into commercial products.

Actran™ and RBA Acoustics share 2017 Peter Lord Award

A challenging building conversion project and an innovative modelling and design system have shared the 2017 Peter Lord Award which recognises a building, project or product that showcases outstanding and innovative acoustic design.

The awards to Actran™ and RBA Acoustics were presented to company representatives at the ANC conference in Birmingham by IOA President Jo Webb. Below are summaries of their citations. (Details of other IOA awards will appear in the Bulletin following their presentation).

Actran™

Actran (***AC****oustic* ***TRAN****smission*) is a finite element-based, modelling and design system which simulates the behaviour of acoustic and vibroacoustic systems. It was developed by Free Field Technologies, a Belgian software company now a wholly owned subsidiary of the MSC Software Corporation. The evolution of Actran started in 1998 when Jean-Pierre Coyette, now professor at the Université catholique de Louvain, and Jean-Louis Migeot, now professor at the Université Libre de Bruxelles and past-president of the Royal Academy of Science, Letters and Fine Arts of Belgium, co-founded Free Field Technologies (FFT) based in Louvaine-la-Neuve, Belgium. Both had previously been associated with the development of SYSNOISE, another major acoustic modelling tool. FFT has grown steadily since then and now employs more than 50 staff who develop the Actran software family and support a large user base around the world.

The original idea was to develop a finite element-based simulation tool for acoustics able to overcome the limitations of the then dominant Boundary Element Method. The use of finite elements allowed the simulation of complex noise sources and the combination of multiple materials in predictions for acoustic transmission through complex partitions and trim panels, leading to robust multi-million degrees-of-freedom models. A central feature of Actran was the use of Infinite Elements to directly calculate the far field as an alternative to BEM. The first 'open' commercial release of Actran was in 2002, after a three-year period of exclusive use by the members of an industrial consortium which supported the initial phase of its development.

Actran has subsequently divided into a number of different modules depending upon the target application and the physics involved. One of these, Actran TM, for which the award is given, was developed initially for turbomachinery noise but is widely P14

Jean-Louis Migeot of Free Field Technologies receives the award from Jo Webb, IOA President

Torben Andersen of RBA Acoustics receives the award from Jo Webb, IOA President

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P12

used in many other applications where propagation on non-uniform subsonic mean flows is a critical element. It has become an industry standard in the aviation sector and is used by airframers, engine manufacturers and nacelle designers worldwide. In the hands of acoustic specialists working in industry, in research centres and in universities, Actran™ has made and continues to make a significant contribution to improving the effectiveness of engine and nacelle noise treatments, thereby reducing overall noise for current and future commercial aircraft.

RBA Acoustics

RBA is one of the UK's leading independent acoustic consultancy practices, providing specialist advice on all aspects of acoustics, noise and vibration from planning stage through detailed design to construction phase and commissioning.

It was commissioned to work on the Queen Street development in Mayfair; a project which had been rejected by other practices due to its technical challenges. Taking a practical approach to complex problems, RBA essentially allowed the redevelopment of a listed building directly above a Tube line for high-end residential use.

As always, RBA provided clear and concise information on what was required as well as working closely with the contractors to ensure that this design was installed correctly on site.

IOA Honorary Fellowship awarded to Richard Perkins

Richard Perkins, former Chairman of the Institute Engineering Division Committee, has been made an Honorary Fellow. The award was conferred on him by President Jo Webb at the AGM in London in July. Below is a summary of his citation.

Richard studied electroacoustics at the University of Salford and graduated with honours in 1994. After six years at Acoustic Air Technology he moved to Parsons Brinckerhoff (now WSP) where he is Technical Director – Acoustics, Noise & Vibration. Between 2003 and 2011 he was seconded as Noise Research Manager to Defra. Richard was Chairman of the Engineering Division Committee for six years from 2010 and was a very supportive Vice President of Engineering on Council. He also has been an active member of the South West Branch Committee since 2002 and was a member of the Research Co-ordination Committee from 2008 to 2012.

His contributions to the Institute and to the acoustical engineering community have been considerable. Notably he was chairman of the IOA wind farm noise working group which issued good practice guidance to the industry in May 2013. The work Richard undertook to achieve a successful outcome for the IOA in this process was considerable, and maintained the integrity of the IOA despite vociferous challenges from anti-wind farm groups, setting the template for future IOA engagement in politically sensitive areas. Further he continues to be active in national and international standards development.

Richard continually strives to foster the development of acoustical engineers to achieve Engineering Council registration both in WSP and the Institute. He led the successful presentations to the Engineering Council to achieve renewal of IOA's licence for CEng and IEng registration in both 2010 and 2015 which was re-accredited to 2020.

Richard Perkins receives his Honorary Fellowship from IOA President Jo Webb

Richard is a role model to those aspiring to excellence and dedication to acoustical engineering. He is a committed engineering professional and thoroughly deserves this award.

Six more candidates achieve Engineering Council registration

By Blane Judd, Engineering Manager

Engineering Division has had a busy quarter with six candidates achieving professional registration with the Engineering Council (see profiles on pages 16-17). Feedback suggests that the support provided by the team is a real help in getting through the process. I have been working with a number of companies which are looking at professional registration as a core part of their development of their staff and this seems to be reflected in the numbers now coming forward.

We are of course indebted to the volunteers in the Engineering Committee without whose help this process could not take place. Their willingness to critique submissions before they are placed before the assessors means that we can be sure that candidates stand the best chance of successfully going through the interview process. I have often said to candidates that we would not wish to put them before a panel if we did not think we had done enough to help them prepare.

Our next round of interviews will take place in October so anyone interested in being part of that group should submit approved drafts by mid September. What better way to spend your summer holiday? We hold a number of interview events P16

Sound Masking

from aet.gb ltd

Open plan offices benefit from Sound Masking

Cellular offices achieve better speech privacy with Sound Masking

Sound Masking is a cost effective solution to the problem of improving speech privacy in today's modern office environment. Best installed during office fit out but often installed as retrofit, Sound Masking from AET has improved the office environment for many international companies throughout Europe over the last 20 years.

In today's office speech privacy becomes a key aim and open plan offices can suffer from two speech problems:

- Other people's conversations can be an irritating distraction
- Confidential conversations can be almost impossible to conduct

Similar problems also exist in cellular offices. Apart from noise breakthrough via partitions, flanking over, under and around them, other problem areas include light fixtures, air conditioning systems and services trunking. Sound masking compensates for these problems.

An investment in increasing privacy of speech is certainly cost effective, with Sound Masking one of the easiest ways of achieving this aim. Sound Masking systems along with acoustic panels and acoustic door seals are increasingly used to achieve the desired level of privacy by a number of our major clients including:

- Vodafone World HQ
- Procter & Gamble
- Swiss Re
- Mobil Exxon HQ
- Elizabeth Arden
- Barclays Bank
- Freshfields
- KPMG
- PWC
- BP

Sound Masking is now available with a host of extras including:

- PA, either all call or zone by zone call
- Dual level options for audio visual room etc
- Automatic ramping to conserve energy and produce profiled masking
- Fault reporting
- Automated amplifier changeover

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Sound Masking is also known as sound conditioning or white noise systems

P14

through the year, depending on the number of candidates coming forward for registration. The team is working with a number of candidates to prepare their paperwork in time for the next set of interviews. We can offer face-to-face interviews at head office as well as at other UK sites or by video link. If you are interested in taking the next step to becoming a professionally registered engineer, contact us on **acousticsengineering@ioa.org.uk** .

The requirements for academic qualifications for CEng and IEng changed in 1999. Pre 1999 an Honours Degree at 2:2 or above was required for CEng or a Higher Diploma/Certificate for IEng. Post 1999 this changed and for CEng a Master's Degree was required or an Ordinary Degree for IEng.

There are two routes: standard route if you have the appropriate EC-accredited qualification in acoustics and the individual route, which requires further preparatory work from you before submitting evidence of your competence. Remember we are here to help you get through the process and advice and support is offered to every candidate.

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

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

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

The opportunity is there and we are ready to support you through it. Below are profiles of the recent successful candidates.

Steve Cawser CEng

AECOM

Steve Cawser

I graduated from ISVR with an MEng in engineering acoustics and vibration in 2001 and have since worked in consultancy. I joined AECOM in 2006 where I am Principal Acoustics Consultant. Working for a large multi-disciplinary consultancy gives the opportunity to work on many diverse projects, but my primary area of work is railway noise and vibration. I've been fortunate to work on many large infrastructure projects, each of which had its own unique challenges to overcome, and I've acted as an expert witness at public inquiries for promotors of new transport infrastructure.

Becoming a Chartered Engineer is something I have had as a career goal for many years and it's something that I feel is a real achievement and demonstration of technical knowledge and competency. When you work in large multi-disciplinary teams, you realise that being either a Chartered or Incorporated Engineer is something which is common in other engineering disciplines and was therefore something that I wanted to achieve for both my own personal benefit and as something that would provide a benefit to my employer.

My degree allowed me to follow the standard route, but it still required a significant amount of work to produce the necessary information. The process itself is worthwhile in that it allows you to reflect on your day-to-day work and how much of what we consider the day job is actually equipping you with valuable skills. I would encourage anyone considering registration to do it sooner rather than later; it is something I could have definitely achieved earlier, and I have found the process and outcome a confidence boost which has left me with a sense of achievement.

David Harbon CEng

SRL Technical Services

David Harbon

After working as a Postgraduate Research Assistant at the University of Salford, where I obtained an MSc in acoustics and audio engineering, I joined Ramboll as an Acoustic Consultant in 2012. In October I joined SRL Technical Services, where I am now Senior Acoustics Consultant, specialising in 3D room acoustics and environmental noise modelling.

It is very rewarding to achieve this internationally recognised award. The IOA helped to review my application and provide feedback on any areas that needed improvement. Preparing the documentation for the interview helped me to identify any areas that I needed to improve upon, or focus my CPD for the near future. I would encourage members of the IOA and prospective candidates to start collating the reports and CPD records at their earliest opportunity, to prepare themselves for applying to become a Chartered Engineer.

Tim Ives CEng

Cass Allen

Tim Ives

After graduating from the University of Salford with a BEng(Hons) in electroacoustics in 1997, I obtained a PhD in psychoacoustics from University of Brighton. I then worked as a research scientist at the University of Madison, USA , the University of Cambridge and the Ecole normale supérieure, Paris. Since 2014 I have been a Senior Acoustics Consultant at Cass Allen.

My thoughts on the registration process are that is ultimately rewarding and makes you think deeply about your skill set and what areas need further development. I think EC registration will help my career as it demonstrates a commitment to quality and continued learning. It also shows a professional attitude and the willingness to take on new challenges. I found the process very rewarding, the help and guidance from the IOA was very good and invaluable to my succeeding.

Max de Salis CEng

PDA

Max de Salis

I began my career as a contract researcher at the Acoustics Research Unit at the University of Liverpool. During this period I completed my PhD in engineering acoustics while also being involved with aspects of consultancy work and completing the IOA Diploma. I then worked in consultancy in Australia for three years before returning to the UK. For the past 12 years I have worked for PDA and for the last seven of these I have been a director.

I am delighted to have attained the status of Chartered Engineer; it is important and worthwhile as it signifies a standard of professional competence that is clearly recognisable across the disciplines and throughout the many industries that we service.

The process of putting an application together has helped me reflect on the diverse and interesting work that I have been

lucky enough to be involved in over the years. In addition, it has allowed me to take stock of and improve the way I conduct my role as an acoustics professional. I would also like to thank the IOA which was extremely helpful and supportive throughout the whole process. I would recommend others to seek registration, as both the process and the rewards are enriching and it will likely give a new and exciting perspective on what it means to be an acoustics professional.

Ben Saunders IEng

WSP

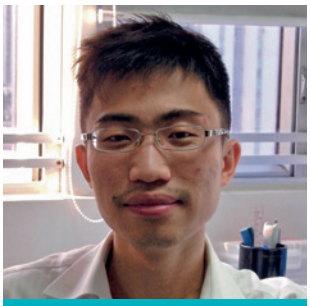
Ben Saunders

I completed my Master's degree in Environmental Acoustics at the University of Salford in 2015. I started my career at Acoustical Control Engineers before joining WSP in their Bristol office. I have worked on a broad range of projects involving the assessment of noise and vibration, including residential, commercial and industrial developments as well as large road and rail schemes.

I took the Individual route to registration and had to demonstrate the competencies and commitments outlined in the engineering council's UK-SPEC document. Working through my CPD and assessing my project experience helped me to explore my own skills, knowledge and understanding. This allowed me to recognise the areas in which I needed further development and create a plan to fulfil my goals. Attaining registration as an Incorporated Engineer has been extremely rewarding and I am very pleased with the recognition it provides. I am very grateful for the help and support provided by the IOA and my colleagues at WSP.

Banting Wong Sam Kan CEng

Wilson Acoustics



Banting Wong Sam Kan

I have a BEng and MSc in Mechanical Engineering from the University of Hong Kong. I joined Wilson Acoustics in Hong Kong as a research assistant in 2007 and was promoted to Senior Consultant in 2011. My current duties include proposal preparation, project management, staff technical training and R&D.

Obtaining chartership has always been a major career goal. I am grateful that the IOA provided me with useful guidance throughout the registration process. They helped me to reflect holistically on the multiple dimensions of engineering practices, such as safety concerns, sustainability, commercial issues etc, which will also be very useful in the future

CEng not only gives me professional recognition, but, by working through the CEng process, I demonstrated a career path towards professional registration to my colleagues, many of whom are young graduates with just a few years of experience and uncertain about career development as an acoustician. They were ecstatic to hear the news and we had a celebration dinner together.

A discussion of the use of app-based noise measurement tools

By James Tingay

There has been a growing awareness in the acoustics community as to the availability and application of apps that can provide noise measurement functions.

Some of these apps have been designed to meet, when used with a suitable external microphone, compliance with the relevant instrumentation standards.

The vast majority of apps are available as free downloads from the Google Play Store or the Apple App Store giving users a vast selection to choose from, and when combined with the range of devices available, there is potential for significant variations in the accuracy, function and performance of the measurement chain.

The purpose of this discussion is not to identify individual apps or to recommend one platform (iOS or Android) over another but to give an overview of the current usage of apps and to highlight whether users of these apps are considering the potential areas of measurement uncertainty that may arise when doing so.

How widely used are apps for noise measurements?

A significant proportion of the noise measurement equipment sold both in the UK and overseas is used for compliance with occupational noise regulations such as the Control of Noise at Work Regulations 2005 and it is within this area that we see the most widespread use of apps.

To estimate the usage, a brief survey was carried out using current users of Cirrus noise measurement equipment to see if they are using apps and whether they have considered any of the aspects raised above.

The users have been identified as Noise at Work where the primary use of noise measurement equipment is for the measurement of occupational noise and environmental where the primary use is for environmental noise measurements. There is some crossover between these two groups so to remove duplication, the primary usage was used.

Are you or have you used a noise measurement app for work purposes?	Yes	No
Noise at Work	40%	60%
Environmental	17%	73%

Within the Noise at Work arena, users are often implementing apps as a way of making an initial assessment of noise levels or to give other stakeholders a simple way to raise concerns about changes in noise levels.

Environmental users are seeking levels and recordings of sounds that are of concern to them, or populating complaint management apps issued by councils or others.

Internal or external microphone?

There are plenty of online discussions, including within the IOA LinkedIn group, as to the use of apps using external microphones and there are a number of manufacturers who have developed microphone systems that can be used, primarily with iOS-based devices, to provide an external input to the measurement system.

The question of how accurate, for want of a better description, a noise measurement app could be using an internal microphone has been discussed at length previously in a number of papers[1].

One showed that using the same app across a number of different devices and in a controlled environment gave

P18

P17

differences of between -28dB(A) and +10dB(A) when compared with a reference sound level meter.

The most significant differences were shown when the noise contained a high proportion of low frequency content or where the measured noise contained a significant impulsive component (not uncommon within a manufacturing environment).

The chart below shows the differences, relative to measurements made with a calibrated class one sound level meter, for different combinations of device, app and noise content.

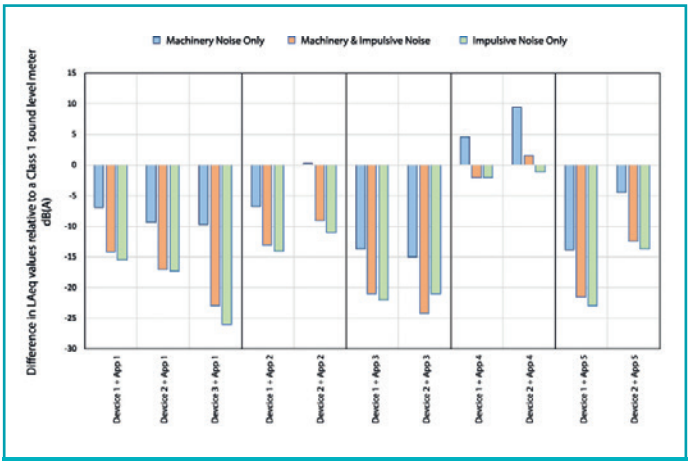


Figure 1 Comparison of same app running on different similar form devices, relative to IEC61672 Class 1 SLM

It is clear from this data that the more impulsive content there is within the noise source, the larger the difference from the reference measurement can be.

A second example below shows the relative difference in readings between a single device running three different apps, relative to data recorded by a calibrated class one sound level meter.

The measurements were made using a microphone on the supplied headphone cable, the internal microphone (or microphones) and an external microphone/preamplifier.

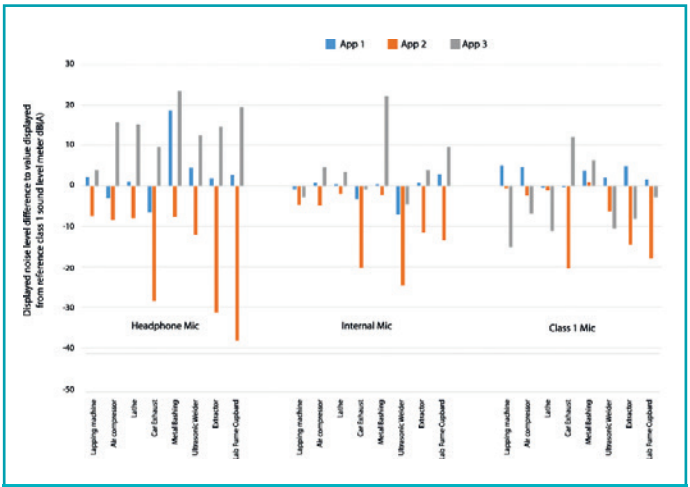


Figure 2 Difference in readings for a single iPad device, measuring different workplace noise with three different apps

Again, as with the test of the same app on different devices, the relative difference between the measurements made with a calibrated class 1 sound level meter has a wide spread with readings between -38dB(A) and +24dB(A) being recorded.

A recent test of an app using a new iPad showed a discrepancy of up to 10dB between measurements. This appeared to be caused by the use of multiple microphones on a device, especially where one or more of the microphones is being used automatically for noise cancellation.

This effect was more pronounced at low levels below 40dB(A) where this could significantly impact upon environmental noise measurements and calculations where the statistical distribution of the noise is an important metric.

It is possible to disable the automatic noise cancellation but it does seem unlikely that the more casual user would delve into the accessibility settings to do this, especially if the device were to be used for other voice enabled applications such as Skype or Facetime.

Calibration of the measurement chain

In this instance, the question of calibration refers to verification that the device is displaying an accurate value at a single frequency and level, rather than to periodic verification to IEC 61672-3 for example.

Users who had used an external microphone were generally aware of the need to calibrate their device before taking measurements. However, the majority who were relying on the internal microphone had not considered that calibration would be required.

A comment from one user was that they had assumed that the developer of the app would have ensured that the level was correct, questioning why they would need to take any calibration into account. They were using the same app on two different devices and were seeing significant differences between the two configurations.

Another comment was that they had tried to use a standard acoustic calibrator as a reference but the calibrator kept switching off as it did not detect that a microphone had been inserted into the cavity.

Positioning of the device

The orientation or positioning of the device has been shown in previous studies to be a significant factor that can have a significant affect upon the frequency response of the measurements.

Most smart phones use a microphone that is positioned at the lower edge of the device in the space where the designers would expect the user's mouth to be. Some devices now use multiple microphone capsules spread over the body of the device to allow for noise cancellation, enhancing the quality of speech.

The location of the microphone on tablets is more variable as these are not intended to be used for calls.

Most modern devices will auto-rotate the display as the user moves the phone with the result that the microphone could possibly be in one of four different positions. A quick sample of users of smart phones and tablets showed that unless that were made aware of the position of the microphone they would hold the device with the microphone typically facing their body, sometimes with the body of the device touching their clothing, further affecting the frequency response of the device.

The technical requirements of the current sound level meter standards have dictated that the microphone capsule is located at the top of the instrument.

One interesting point that appeared from this simple survey was that those who had used (or were frequently using) a handheld sound level meter were often putting the microphone close into their body. When questioned as to why this was, the feedback was that they were unaware of or had not considered where the microphone on the device was located.

Standards, consistency and repeatability

One question that is often discussed is whether this type of app could, or should, be used where there is a requirement to meet a standard or regulation.

Most sound level meters currently being manufactured comply with IEC 61672-1, often with the subsequent Type Approval to IEC 61672-2 and then periodic verification to IEC 61672-3. The standards, regulations and guidelines to which most of us are working will specify that an instrument should meet class one or class two of this standard.

The user instructions for the NIOSH sound level meter app contain a disclaimer that "...we want to emphasize that smartphones and smartphone sound apps were not designed to meet such rigorous standards and that this app does not meet

P20

P18

type 2/class 2 standards and should not be used for compliance purposes". Other apps have similar statements or none at all!

What is being measured?

A further question to be asked is to what the apps are truly measuring and displaying.

An evaluation of 25 sound level meter apps on the Google Play Store showed that only six labelled the metric being displayed correctly. Where this was not the case, the majority were using SPL, often with no indication of the frequency or time weighting being used.

Where some form of averaging was available, only eight of the apps used displayed Leq or TWA as a metric. The others used Average or Mean as a descriptor. Using a quick, visual check using a controlled noise source that stepped by +20dB, some even appeared to be using a simple linear average.

The clear risk here is that the user may not be aware of whether the app is providing the appropriate metric or whether the processing of raw data to provide those metrics is correct.

In the example below, the sound level meter is showing the current LAF, LAFmax and LAFmin values of 55.9dB(A), 90.6dB(A) and 54.5dB(A) respectively.

The app is showing 61, 76 and 39 respectively but with no indication as to the applied time and frequency weighting. This is not a judgement on a specific app but an example of how the information displayed could be misleading.

Conclusion

As stated in the introduction, the aim of this review is not to approve or disapprove of the use of apps for sound level measurements. There are plenty of apps that, when used with the appropriate microphone, can be an effective and accurate way to take measurements.

However, we should be aware that a significant proportion of the users of noise measurement equipment are not noise professionals and could be at risk of using inappropriate equipment to take what could be business critical measurements.

Education and information is key.

Figure 3 Comparison of a randomly selected app vs Class 1 sound level meter

James Tingay *is the Marketing Manager at Cirrus Research. James has more than 25 years of experience in the design, manufacture, sales and marketing of noise measurement instrumentation.*

References

1. Comparative study of the performance of smartphone-based sound level meter apps, with and without the application of a ½" IEC-61094-4 working standard microphone, to IEC-61672 standard metering equipment in the detection of various problematic workplace noise environments David P. ROBINSON; James TINGAY, Internoise 2014

High standards again at Association of Noise Consultants excellence awards

By Robert Osborne

Judges had their work cut out again at the Association of Noise Consultants' annual awards to select the overall winners from a highly impressive array of entries.

The awards were launched in 2013 to highlight the unique skills of UK-based acoustic and noise professionals, and the dynamic and diverse nature of the industry overall, to inspire the next generation of acoustic consultants.

The entries were reduced to a shortlist of 15 across the five categories and all those entrants were requested to make a brief presentation on their project immediately before the awards ceremony at the Hyatt Regency, Birmingham. An award was made for the best presentation by one of the shortlisted projects and this was determined by those attending. This went to Adrian James of Adrian James Acoustics.

The 11-strong judging panel, chaired by Sue Bird, did not visit any of the projects or hear the results and so their decisions were based on reviews of paperwork only. In a number of cases the projects had not yet been built and so it was not possible to validate the results which in some cases influenced the final decision.

The awards were presented by the guest speaker, James Woudhuysen, the broadcaster and writer.

Presentations were also made by ANC President Peter Hepworth to the best IOA Diploma student in 2015/16, Beth Paxton of Apex Acoustics, and to Charley Woodman of Birmingham City Council for the best 2015/16 Diploma project (Noise from all-weather sport pitches).

P22

Adrian James of Adrian James Acoustics with James Woudhuysen and Emily Norman of AcSoft (sponsor)

Beth Paxton is presented with the award for the best IOA Diploma performance by ANC President Peter Hepworth

Charley Woodman is presented with the award for the best IOA Diploma project by ANC President Peter Hepworth

P20

Commercial buildings

Winner: Hoare Lea

Hanover House, Reading

Conversion of this former office building to affordable private residential with minimum internal areas for living standards was only financially viable if the thickness of the Part E compliant party wall construction was kept to no more than 135mm. The consultants believe this to be an unprecedented technical brief for a residential development. They convinced the client that risks could be mitigated by use of pioneering engineering design tools and a collaborative approach.

The project features a bespoke drywall system, and through innovative design, reliable prediction software and collaboration a partition system as thin as the length of an iPhone5 was developed to meet the performance standards. As the partition construction had never been tested before, the consultants had to estimate performance and mitigate the risks associated with flanking and quality of workmanship. There was no built-in tolerance or design margin. The performance of the partition was estimated by an in-depth review of similar tested partition systems and by predictions using in-house sound insulation prediction software which is based on statistical energy analysis.

The judges were impressed that in a field where a standard method is the obvious solution, the consultants had worked with the construction side demonstrating innovation and tackling complexity. This was a very neat solution which achieved the result and must have involved flawless onsite monitoring and inspection.

Max Foster (centre) of Hoare Lea with James Woudhuysen (left) and Ian Kirby of H&H Acoustic Technologies (sponsor)

Hanover House, Reading

Highly commended: Sandy Brown Associates

YouTube Space, St Pancras, London

A project involving the reconfiguration of two floors of an office building into a specially created studio and editing space where YouTubers and vloggers can learn and connect. The consultants were at the centre of a project where an attentive working style had to be provided and the expectations from the client and design team were high. By their nature very high acoustic performance was required with the two primary studios being horizontally adjacent, creating a multi-functional space while being able to be used simultaneously for recording.

As the architect commented: "Sandy Brown Associates provided timely expert advice which helped steer the design at crucial points and kept the acoustic performance at the top of the agenda. The success of their approach is demonstrated in the performance of the completed space."

The judges recognised this was a difficult and challenging brief with skilful application of known techniques. The innovation came through putting these together and resulted in a project which not only met but exceeded expectations.

Commended: SRL Technical Services

Dubai Opera House – mechanical services

This project is one of the few world class music venues created and so acousticians rarely get the opportunity to work on them. The auditorium acousticians were Sandy Brown Associates who set all the sound insulation requirements for the building. SRL were employed by the main contractor and M&E subcontractor on this high profile, prestige project with a budget to match.

It is also acoustically special as the specification contained very onerous requirements, such as achieving NR15 within the main auditorium with all the services operating. The M&E design presented some challenges, which needed to be addressed to meet the necessary acoustic performance. An example of this was that noise data for selected products was limited and one supplier was unable to show their product could work. During regular site visits, the consultants identified issues such as ducts being rigidly fixed to the walls of a riser although the specification stipulated isolated connections. Despite the challenges faced, they were able to predict the reradiated noise within the auditorium and ensure that the very low noise criterion was met.

The judges observed that this project demonstrated complexity throughout, as well as showing a high level of consultancy in guiding the client to a successful conclusion. Commended status is recognition that the entry relates to the one element of the acoustics consultancy on this impressive project.

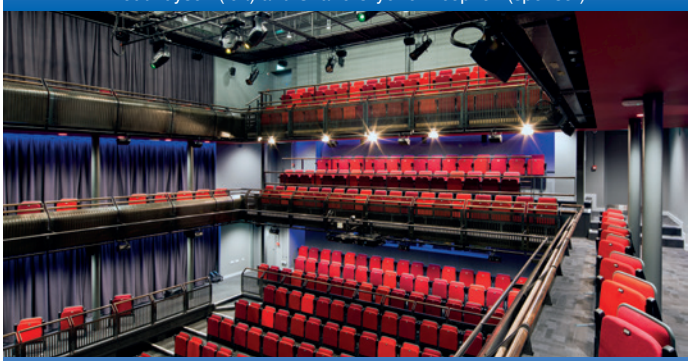
Education buildings

Winner: Sandy Brown Associates

New Adelphi Building, University of Salford

A new performing arts building, which brings many disciplines under one roof. The consultants provided design advice on all architectural acoustics, working with the design team and client to accommodate all proposed spaces within the building, while still providing high levels of sound insulation between the spaces and adequately controlling noise egress from performance and rehearsal spaces. Auralisation of airborne sound insulation for the music/drama spaces was used to demonstrate the targeted P24

Stephen Stringer (centre) of Sandy Brown Associates with James Woudhuysen (left) and Shane Cryer of Ecophon (sponsor)



Part of the New Adelphi Building, University of Salford
Credit: Tom Bright

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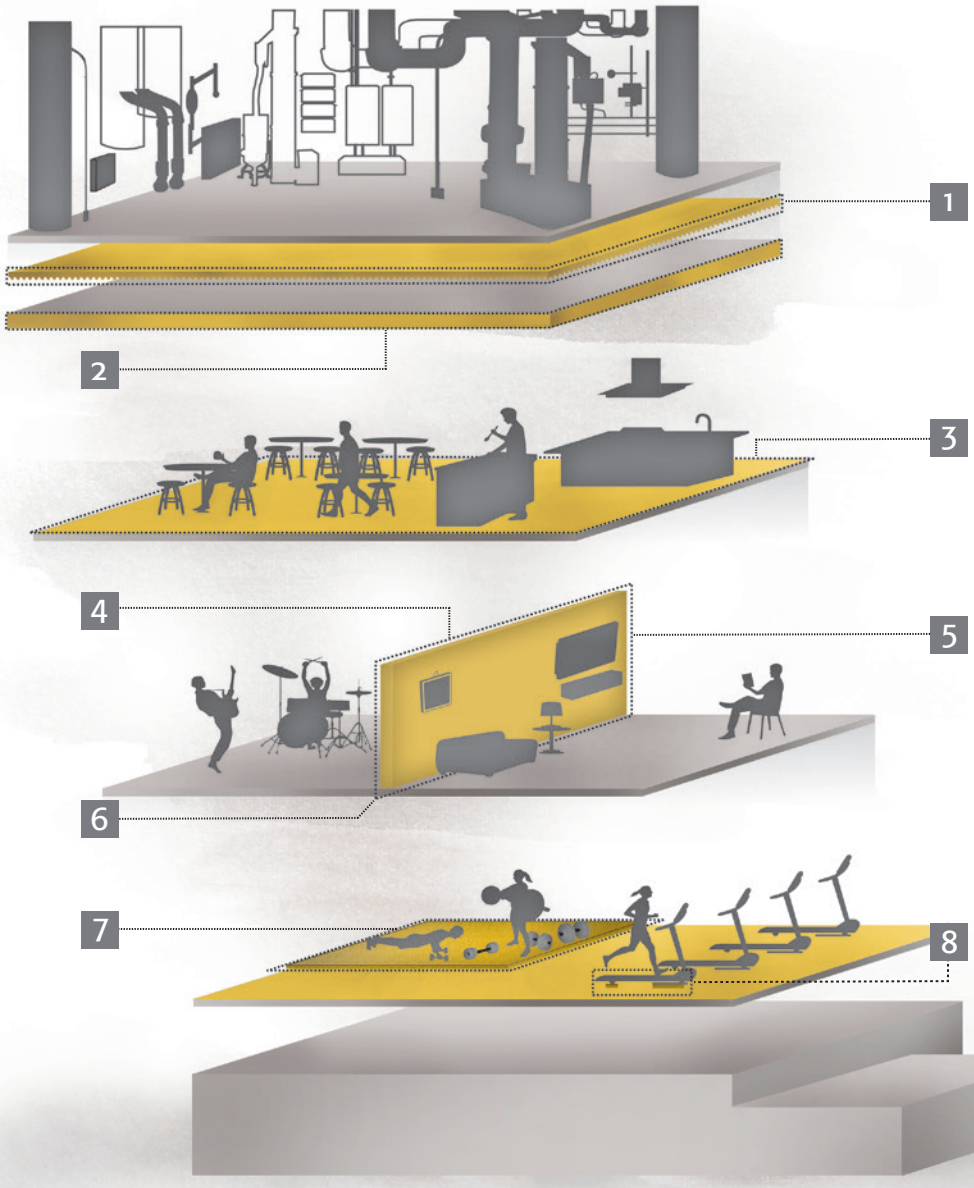
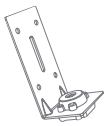


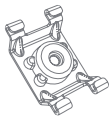
1 GenieMat™ FF

2 GenieClip™ Type LB



3 GenieMat™ RST

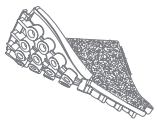
4 GenieClip™ Type RST



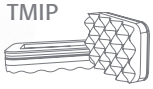
5 GenieClip™ Mount

6 GenieMat™ ISS

7 GenieMat™ Fit



8 GenieMat™ TMIP



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P22

standards to the client, using measurements from band rehearsals and music lessons at the university.

The judges noted this was a large project with complex sound insulation requirements. It had highly elegant solutions internally, complex acoustic detailing and displayed integrated architecture and acoustic design. They were impressed by the use of a box within a box design and that recording studios, music and drama spaces had been provided in a location so close to the railway.

The building houses many different performing arts spaces. The majority require low background noise levels and generate high sound levels. It also forms an entrance from the railway station into the campus and is a cut-through at lower levels. The A6 main road is 130m south of the site and Salford Crescent station is 60m west.

The architects, Stride Treglowan, said: "The acoustic consultancy worked well as part of a cross functional design team and their knowledge and experience of the other design disciplines was helpful to the development of the overall design. The acoustic design of the building enabled the multi-use building ... to function as intended."

Highly commended: Adrian James Acoustics
Britten Building, Gresham's School, Norfolk
A very high level building with excellent acoustics provided within a limited budget. It far exceeds the standards in DfE exemplar designs and building bulletins through close collaboration between the client, project manager, architect and acousticians from the start.

The consultants undertook regular site visits during the construction phase, enabling issues to be resolved early on without the need for expensive remedial work. They developed bespoke details to meet enhanced sound insulation criteria using lightweight constructions which were only possible due to their early input to the layout. Acoustically critical spaces were located on the ground floor, utilising a fully floated floor construction consisting of structural screeds on resilient bearers for use as required.

The judges were impressed by the detailing and high standards of acoustic design, and the on-site inspections and discussions held at an early stage to understand the requirements and aspirations of the teaching staff and students. The head of music stated: "This is the most flexible music recital room that I have ever worked in, and the practice and teaching rooms are the best out of any school or music conservatoire that I know."

Commended: Pace Consult
University of Warwick, The Oculus Building
An inter-disciplinary, two floor building with two lecture theatres, 12 teaching spaces, an open plan learning space under a wooden roof and a double height atrium. An important concept during the design was the use of natural light which penetrates across a double height glazed window, whilst the state of the art wooden roof gives a special character to the building. These peculiarities created different acoustic challenges.

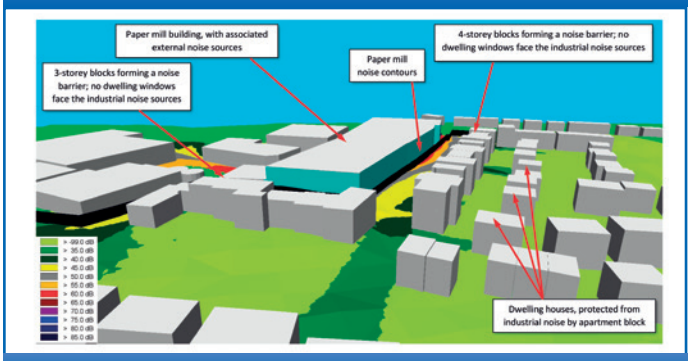
The judges observed that the consultants had produced innovative solutions whilst respecting the architectural features. They noted that control of reverberation time was a factor during the whole design process and that working closely with the architect and main contractor had helped achieve this. The extensive use of modelling to address the different challenges was recognised.

Environmental noise

Winner: Apex Acoustics
United House, Swanley, Kent
A residential site affected by noise from the adjacent paper mill as well as road and rail traffic, where the consultants worked with the design team on an innovative acoustic design to achieve planning permission. By prioritising acoustic considerations throughout the stages of the project, they developed an approach that can be applied to other sites affected by similar noise issues.

A previous application by the developer for this site had been refused so the consultants approached the project with the aim of achieving a good acoustic design, aware that this concept underlies the ProPG which had yet to be published at the time this was completed. As well as modelling and measuring, this is a complex

Rich Hinton (centre) of Apex Acoustics with James Woudhuysen (left) and Mike Breslin of ANV (sponsor)



United House, Swanley

design project and used features such as windows on the ends of the building that are cranked by extending the building envelope so they have no line of sight to the industrial noise source.

The developer commented: "Apex Acoustics took an entirely fresh approach to addressing noise issues and managed to get both the paper mill and local authority on board. Apex also advised us on the ventilation and overheating risks associated with acoustics – we will definitely take this on board for consideration as the detailed design progresses".

The judges felt this was a good example of making a site viable for residential development and showed how the two sides could work together to achieve a mutually acceptable conclusion. This was a reminder of how to approach such projects both in terms of acoustic design and working with all the parties concerned.

Highly commended: Southdowns Environmental Consultants
Ministry of Defence land ranges
There is a public perception that activities on MoD land ranges can produce noise and vibration that may be damaging to property through airborne or seismic shock waves. This investigation required the continuous monitoring of sound pressure, air overpressure and groundborne vibration at multiple locations over six months. Pioneering and innovative approaches to continuous data capture, processing and assessment were required and, in collaboration with an equipment supplier, system hardware and software capability was designed and tested and then deployed.

This project is unusually broad requiring innovative, use of and trialling of unproven measurement and telecommunications technologies and techniques; rigorous testing of bespoke systems, monitoring within highly sensitised communities; capturing high quality sound, air over pressure and groundborne vibration signals and measurement metrics.

The judges were very interested in this project which was innovative in its use of technology. They were not sure how much consultancy was involved and would have liked to know more about how the project was managed and controlled and how the results can be used.

Commended: AECOM
Thames Tideway Tunnel
This issue of environmental noise and vibration impacts P26

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P24

during the construction phase to upgrade London's sewerage system, was under intense scrutiny during the public examination and was seen as weighing against consent for the development. Noise was therefore one of the foremost environmental constraints and the consultants provided acoustic services focussing on environmental modelling and compliance management. They also volunteered as STEMNET Ambassadors including delivering an interactive session on Bringing Sound to Life.

The judges would like to have known more details about the monitoring undertaken and the consultancy provided. With the project data providing the source of a paper at Internoise 2016 on the different methods for calculation of typical sound levels from long-term monitoring data, it would have been interesting to know more about how the information was now being used.

Smaller Projects

Winner: Apex Acoustics

TupTup Palace, Newcastle

This project illustrates a ground-breaking approach to solving the problem of noise from nightclub smoking areas. The modelling techniques, solutions to controlling noise break out through doors, and control of noise from patrons in the smoking area have the potential for wide application in addressing this perpetual problem. The consultants took room acoustics modelling methods and applied them to environmental noise propagation, appreciating that understanding the limitations of using the software in this manner is key to its successful application.

A novel approach to reducing noise generated by patrons in the alley was adopted by having a walk-through attenuator in front of the doors, sound absorption on the walls and rafts above the alley. The concept is an extension of a "sound lobby", but built entirely externally within the alley due to space constraints inside the building. The smoking shelter guidelines were re-evaluated to enable design of compliant spaces capable of providing acoustic screening.

The client said: "We had tried everything we could think of to reduce the noise but could not stop the complaints from the residents. Apex Acoustics came with a scientific approach to understanding the problem, and totally out-of-the-box solutions that we would never have thought of."

The judges recognised that this addresses a current issue with an innovative approach to a significant problem. It was a clever approach to take indoor noise modelling and use it outdoors and then design sound barrier and absorption panels to cope with the noise.

Weigang Wei (centre) of Apex Acoustics with James Woudhuysen (left) and Mark Dowie of Brüel & Kjær (sponsor)

Tup Tup Palace, Newcastle – sound absorbent treatment in an alley

Highly commended: AECOM

Acoustic Shell for Theatre Royal, Glasgow

Scottish Opera wished to move their orchestra from the pit to the stage, using a collapsible orchestra shell to improve on stage acoustics. The consultants looked at developing an acoustic shell to determine the extent of the improvement, the sense of ensemble and the expected sound pressure levels on stage, as well as the change in sound quality in audience areas. They used a unique facility – the Immersive Sound Studio (ISS) – during the design process to produce auralisations and allow Scottish Opera to hear how the orchestra would sound from different locations. The ISS technology is applicable to a wider variety of acoustic projects and lets non-technical people easily and intuitively understand complex issues without complicated terminology and reports.

The judges were impressed by this technically challenging project, carried out to a high standard, and the client's involvement in reaching a decision based on how the theatre would sound. The technology is complex but it produces a very simple outcome which people clearly relate to.

Commended: Red Twin

Sound Insulation & Flanking Assessment

A new school was experiencing problems with sound insulation of a movable wall product. The consultant reviewed the design and tested the system to establish the reasons for under-performance. They used an acoustic camera to identify hot spots whilst recognising that this is an uncalibrated and arbitrary method of assessment which could not confirm if the wall met the specification. They used sound intensity measurements to establish weaknesses in the building fabric but provided specific performance for the pass door and the flank elements which it had not previously been possible to separate.

The judges liked the measurement of the performance of actual elements and the application of existing technology in a different way. This was a good technique for resolving the problem and whilst perhaps not unique it was unusual to see it applied in the field rather than in the laboratory.

Vibration

Winner: Cole Jarman

Francis Crick Institute, London

This is a unique building housing more than 1,200 scientists in a world class research facility in an unconventional location. Although well connected for rail, Eurostar, London Underground and major road routes, their proximity create significant sources of groundborne vibration. Furthermore, mechanical services plant linked to the laboratories, provide more sources of vibration.

The design team and vibration consultants collaborated with the other disciplines to consider the building to unprecedented levels of detail to address these conflicting requirements. Any process inside the building with the potential to generate vibration was reviewed and assessed, with mitigation incorporated to reduce the risk.

Impressive in its own right visually, few will realise the interior vibration environment was one of the key design drivers. This project shows how giving due credence to the discipline of vibration design can create world class facilities in what would otherwise be considered sub-prime locations. As well as the design process, there was scrutiny to ensure the full execution of design measures during construction. The end result is a low vibration environment in the building, which can easily be missed on a visit.

The architects commented: "The vibration consultants were integral to the design and realisation of an exceptional interactive, open environment, encouraging collaboration across disciplines and a highly flexible structure that will easily adapt to accommodate the rapid developments of scientific discovery"

The judges were impressed by the interlinked vibration projects which make it unique, as well as the amount of work invested in the design. It is an incredible project which had to achieve the right

Philip Hankin (centre) of Cole Jarman with James Woudhuysen (left) and Paul Downey of Pliteq (sponsor)

The Francis Crick Institute, London

outcome to enable the building to operate. The size, location and complexity make it stand out as the winner of this year's award.

Highly commended: WSP
Berkeley Hotel, London
An iconic hotel in Knightsbridge is being extended to construct a nine-storey building based on a complex lightweight structure. The development also involves excavation for four basement levels, bringing the raft foundation within approximately six metres of the Piccadilly Line tunnel. Vibration is a key concern as high end spa and treatment facilities will be accommodated in the basement.

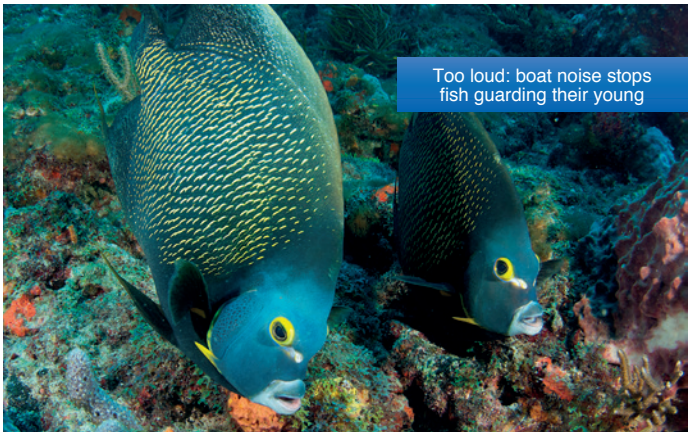
This project has helped further understanding in building isolation schemes as the consultants undertook a building vibration isolation performance detailed study, based on numerical modelling in a real case scenario. In sessions with client representatives they explained and demonstrated sources of uncertainties and isolation complexities, justifying their design and managing expectations. Academia were involved in various subject elements of the design and modelling.

The judges considered there were huge risks arising from the proximity to the Underground and complemented the consultants on their grasp of the project and alertness to possible problems. Focused on the superstructure only and dealing with the basement rooms individually, this project takes low frequency understanding to new levels and could change the approach to future projects.

Commended: RBA Acoustics
Omerara and The Flat Iron Square, London
A project involving the conversion of active railway arches into a mixed use development including a live music venue, on a site in a busy urban environment. Extensive computer modelling was used to predict noise breakout and patron noise egress, as ensuring nearby noise-sensitive areas would not be overly disturbed was vital to the planning and design stages. The two aspects of noise breakout and effects of structure-borne train noise on an intimate music venue make this an interesting project.

The judges noted that due to budget restrictions and loss of space, a box in box solution was not possible so the consultants came up with a number of construction solutions and achieved a result which markedly surpassed the target level, resulting in train passbys being mostly inaudible during performances. Innovative design and analysis were used and the final construction required high quality workmanship and regular inspections.

Motorboat noise makes fish bad parents


Too loud: boat noise stops fish guarding their young

Noise from motorboats is making fish become bad parents, and reducing the chance of their young surviving, research led by marine experts at the University of Exeter has shown.

The sound of motorboat engines disturbed coral reef fish so acutely it changed the behaviour of parents, and stopped male fish properly guarding their young, feeding and interacting with their offspring.

The research, which involved playing recordings of natural reef noise or intermittent motorboat noise around 38 fish nests over 12 days, found that the death-rates of baby fish exposed to boat engine noise increased significantly, with six of the 19 boat-noise nests suffering complete mortality.

The university-led team of marine biologists say that noise from boats is a "global pollutant", distracting fish and making them unable to properly protect their young from predators. They believe motorboat noise should be factored in when trying to protect fish stocks and manage fisheries.

Dr Steve Simpson, an expert of the impact of noise on marine life at the university, said: "This study raises important implications for managing the noise of the 100,000s of motorboats used around the world in coral reef environments. We are now considering acoustic quiet zones and corridors, and exploring how engine and propeller development can reduce the impact of this globally prevalent pollutant."

The university researchers predicted that their field research into the effect of man-made noise on coral fish could have wider implications for the survival of other marine species, and even birds and mammals. They called for more research in these areas.

Dr Sophie Nedelec, of the university's College of Life and Environmental Sciences, said she believed other species could be similarly affected by marine noise pollution.

"Parental care is widespread in the animal kingdom; from blue tits to blue whales, so there could be big implications for populations of animals affected by noise," she said.

Noise from boats has already been shown to affect the way fish, mammals, birds and invertebrates behave. It can force them to change their habitat to get away from the noise and reduce their success finding a mate. Boat noise can travel for many kilometres underwater.

This new research, carried out by the University of Exeter, University of Bristol, James Cook University, Queensland, Australia, and the Australian Institute of Marine Science, showed motorboat noise can increase death rates among juvenile fish.

Dr Nedelec, lead author on the paper published in *Proceedings of the Royal Society B* journal, added: "Parental care behaviour seems to be impaired in noisy conditions and we believe this makes it easier for predators to strike their offspring. It is likely the parents were either stressed or distracted by the noise, giving an advantage to the predators in this case."

Fish exposed to the motorboat noise spent far more time chasing and making aggressive strikes at other fish, compared to males exposed to recordings of ambient sound. The scientists believe this increase in aggressive behaviour may have been be due to "heightened stress", or distraction by the noise which led to decision-making errors, so the fish attacked or chased fish that were not a predatory threat.

Air-guns used in offshore oil exploration can kill tiny marine life


Deadly danger: microscopic animals are at risk from sound waves

Powerful sound waves created during offshore surveys for oil and gas can kill microscopic animals at the base of the ocean food chain, according to a new study. And these lethal effects travel much farther than ecologists had previously assumed. Researchers fear that damage to these animals, collectively known as zooplankton, could harm top predators and commercially important species of fish that depend on such species for food.

Seismic surveys blast compressed air to produce pulses of sound that can probe the sea floor thousands of metres down for natural resources. At 220–250 decibels, the pulses produced by these air guns are louder than a Saturn V rocket during launch. Scientists have known for decades that whales and other marine mammals that use sound to communicate change their behaviour in response to such noise. There is increasing evidence that seismic surveys also affect fish and marine invertebrates. And now, researchers have found that the noise from air-gun blasts can kill zooplankton at distances of up to 1.2 kilometres away – more than two orders of magnitude farther than previously thought. They reported their results in *Nature Ecology and Evolution*.

"We were quite gobsmacked," said lead author Jayson Semmens, a marine biologist at the University of Tasmania in Hobart, Australia.

Semmens and his team conducted their study off the south eastern coast of Tasmania in 2015. They used sonar and nets to assess populations of zooplankton, including krill larvae and tiny crustaceans called copepods, before and after firing a series of air-gun shots. The team found that zooplankton abundance dropped by 64% within one hour of the blasts. And the P30

P28

proportion of dead zooplankton increased by 200–300% as far away as 1.2 kilometres — the maximum distance the researchers sampled. This suggests that the impact of the blasts could extend well beyond such distances, Semmens says.

"Dead bodies in net tows don't lie," said Doug Nowacek, a marine ecologist at Duke University Marine Laboratory in Beaufort, North Carolina, who was not involved in the study. He suggests the next question for researchers is figuring out what this means for the ocean ecosystem. "If you start impacting the zooplankton population, that can cause a serious cascade through the food web."

The study did not pin down precisely how air-gun blasts kill zooplankton, Mr Semmens said, but the noise they produce probably damages the highly sensitive hair-like receptors that the animals use to navigate. The blast might not kill them all directly, but it could disorient them and make it harder for them to survive.

Football kings Vanguardia edge out RBA Acoustics to lift Acoustics Cup

Vanguardia lifted the annual Campbell Associates Acoustic Cup with a 1-0 victory in a thrilling final over RBA Acoustics who had to accept the runners-up slot for the second year running.

Harry Lang was the scorer, slotting into the bottom corner after picking up a great through ball.

In the second final of the evening Anderson Acoustics beat Stansted Environmental to take home the Acoustics Plate.

The other companies taking part were Bickerdike Allen, Campbell Associates, Cole Jarman and WSP.

The competition raised more than £2,000 for East Anglia's Children's Hospices (EACH), which provide an amazing service to families at a very sensitive and emotional time. In the six years of this competition, more than £6,000 has been raised for worthy causes.

John Campbell, organiser, said: "It was a great evening and many thanks to all the teams who supported this fundraising event for playing the games in such a great spirit."

Cup aces: the victorious Vanguardia team

If you are interested in entering a five-a-side team for Acoustic Cup in 2018, please contact **john@campbell-associates.co.uk**

Device remove alarm sounds in intensive care units

US engineers have created a device that removes shrill alarm sounds in hospital intensive care units while preserving patients' ability to hear human and environmental stimuli, notably speech.

It is hoped that the system, which still allows clinicians to pick up alerts, will greatly aid patient recovery.

The team's findings, *Frequency-Selective Silencing Device for Digital Filtering of Audible Medical Alarm Sounds to Enhance ICU Patient Recovery*, were presented at the International Community for Auditory Display (ICAD) in the summer.

The paper highlights how loud noises produced by clinical alarms contribute to psychological problems like delirium and PTSD and provides innovative solutions to enhance the patient experience.

Joseph J Schlesinger, assistant professor of anaesthesia assistant professor of Anaesthesia, Division of Critical Care Medicine at Vanderbilt University Medical Centre, Tennessee, said: "The shrillness and quantity of audible medical alarms are responsible for many negative consequences for patients. The noise of the alarm combined with its frequency often disturbs patients' sleep patterns, which can be very disorienting.

"We wanted to create a way that clinicians would still be alerted to necessary patient alarms, while providing a better environment for the patient's healing process," he said. "The question became: how do we filter out the alarms from the patient experience without harming the patient's ability to hear and comprehend speech as well as be in tune to other environmental sounds?"

At risk: frequent alarm noise can hinder patient recovery

Professor Schlesinger collaborated with students from Vanderbilt University Department of Biomedical Engineering to develop a device worn by the patient that eliminates alarm sounds from the patient perspective by digitally subtracting sound waves while preserving and improving speech comprehension.

The team tested the in-ear device in a simulated ICU environment. The results showed clinical and statistical improvement in alarm filtering.

Professor Schlesinger hopes his team's findings will spark collaborations across the country to further develop devices that are medical grade, affordable and reusable.

"This will need further study in large patient populations to look at patient outcomes, benefits and safety," he said. "I anticipate we will have some interest from multiple sites to investigate use in patients.

"Future directions also include a device for clinicians that would transmit the alarm signals directly to the nurse and physician caring for a particular patient."

NATO unveils JANUS, first standardised acoustic protocol for undersea systems

The NATO Science and Technology Organization's Centre for Maritime Research and Experimentation (CMRE) has developed a NATO-approved standard for underwater acoustic communications called JANUS.

The milestone, the result of 10 years' work, marks the first time that a digital underwater communication protocol has been acknowledged at international level and opens the way to develop many underwater communication applications.

"JANUS was a Roman god of openings and gateways," said John Potter, a scientist at the CMRE Strategic Development Office "That's why it is called JANUS, because this language opens the portal between two domains, two different operating paradigms, through which they can talk.

"It is a digital underwater signalling system that can be used to contact underwater devices using a common format; announce the presence of a device to reduce conflicts; and enable a group of underwater devices (that can be underwater robots, submarines, divers or any other equipment operating under the surface) to organise themselves into a network."

JANUS brings acoustic systems into sync with one another in part by defining a common frequency –11.5 kilohertz – over which all systems can announce their presence. Once two systems make contact through JANUS, they may decide to switch to a different frequency or protocol that could deliver higher data rates or travel further.

Adopted globally, JANUS can make military and civilian, NATO and non-NATO devices interoperable, providing them all with a common language with which to communicate and arrange to cooperate.

JANUS has been extensively tested at sea in exercises involving a number of partners (universities, industries and research institutions) covering a range of application scenarios. Close collaboration with NATO Allies has been particularly fruitful in developing JANUS for use in cases that may improve the safety of maritime operations.

For example, the Portuguese Navy has been working with CMRE to develop new concepts to support the exchange of crucial information with submarines (typically only available at the surface via radio) such as the location of nearby ships. Digital data exchanges to support rescue operations in case of a submarine incident are currently also being developed.

New protocol for underwater acoustics communication

University to spearhead major acoustic energy research project

The University of Exeter has received a multi-million pound research grant to pioneer new techniques and materials to control and manipulate electromagnetic and acoustic energy, with the aim of revolutionising technologies such as wireless communication and asset tracking.

The university has received £2.4 million from the Engineering and Physical Sciences Research Council (EPSRC) to lead the innovative new five-year project, in partnership with QinetiQ, a leading defence and security company who have a strong track-record of developing technology for both defence and civilian applications.

The substantial grant is part of the EPSRC's new Prosperity Partnerships scheme, which is designed to further strengthen research partnerships between universities, industry and business partners. The investment is also designed to showcase the pivotal importance of engineering and physical sciences to the UK's continued development as a global research and innovation leader.

Exeter is one of 10 universities nationwide to lead a Prosperity Partnership project. Both the university and QinetiQ will make substantial co-investments to support the research and its exploitation.

The project led by Exeter, entitled *Tailored Electromagnetic and Acoustic Materials*, seeks to develop advanced materials that can be used to control and influence electromagnetic and acoustic energy.

The project aims to develop a host of advanced and cost-effective new techniques, which would enable specialists to create compact antennae for wireless communications, improved remote safety beacons and markers, and new materials to control acoustic noise.

As part of the project, the University of Exeter will recruit eight new postdoctoral researchers and four graduate students, who benefit from the EPSRC Exeter Centre for Doctoral Training in Metamaterials, some of whom will be based with QinetiQ.

Researchers design sounds that can be recorded by microphones but inaudible to humans

Researchers at the Coordinated Science Laboratory at the University of Illinois in the US have designed a sound that is completely inaudible to humans (40 kHz or above) yet is audible to any microphone.

The sound combines multiple tones that, when interacting with the microphone's mechanics, create what researchers call a "shadow," which is a sound that the microphones can detect.

The team, which includes PhD student Nirupam Roy and CSL Professors Romit Roy Choudhury and Haitham Hassanieh, see many applications for this work. This work won Best Paper Award, titled "BackDoor: Making Microphones Hear Inaudible Sounds," at a leading conference, MobiSys 2017.

"Imagine having a private conversation with someone. You can broadcast this inaudible signal, which translates to a white noise in the microphone, to prevent any spy microphones from recording voices," said Mr Roy, a PhD student in electrical and computer engineering. "Because it's inaudible, it wouldn't interfere at all with the conversation."

According to the researchers, military and government officials could secure private and confidential meetings from electronic eavesdropping or cinemas and concerts could prevent unauthorized recording of movies and live performances.

The signal can also be used to send communication between Internet of Things (IoT) devices, such as an Amazon Echo or Google Home, which would reduce the growing load on Bluetooth, since Bluetooth is primarily how IoT devices communicate. They also foresee that this signal could protect users from unauthorized recording when communicating with voice-activated systems.

"We thought, can we design an application so that when you are actually giving a message, like to an Amazon Echo, no one can record your voice to the Amazon Echo if we're playing this sound?" said Mr Roy. "Voice-activated systems are everywhere, so now it is important to build defences against attacks that can be launched through your voice."

The sound's frequency is designed by the researchers and transmitted from ultrasonic speakers, completely inaudible to humans but able to be recorded by microphones.

The team acknowledges there may be ways to misuse this technology, though they hope that by knowing the problems that can arise, they can build measures to protect against it.


Nirupam Roy

"Inaudible sound jammers, could, for example, affect someone wearing a hearing aid because the internal microphone would pick up that sound," said Mr Roy. "Or, for example, in a bank robbery, someone might be trying to make a phone call to 911, but this sound could jam all the phones trying to make calls."

Like all techniques, inaudible sounds can be used in different ways, but "with this knowledge of how it can be used negatively, we can develop strategies to prevent it," said Professor Choudhury, an associate professor of electrical and computer engineering.

The sound's frequency is designed by the researchers and transmitted from ultrasonic speakers, but the microphone – the receiver of the signal – is not altered in anyway. Off-the-shelf microphones will react in the same way to the signal.

"Microphones are in millions of devices, including all of our smartphones," said Professor Hassanieh, an assistant professor of electrical and computer engineering. "And this signal can be received without modifying the microphone, making this technique readily available to interact with the devices around us."

Owls' wings could hold the key to beating wind turbine noise

A new study has revealed how inspiration from owls' wings could allow aircraft and wind turbines to become quieter. Researchers from Japan and China studied the serrations in the leading edge of owls' wings, gaining new insight into how they work to make the birds' flight silent.

Their results, published in the journal *Bioinspiration and Biomimetics*, point towards potential mechanisms for noise suppression in wind turbines, aircraft, multi-rotor drones and other machines.

Lead author Professor Hao Liu, from Chiba University, Japan, said: "Owls are known for silent flight, owing to their unique wing features, which are normally characterised by leading-edge serrations, trailing-edge fringes and velvet-like surfaces.

"We wanted to understand how these features affect aerodynamic force production and noise reduction, and whether they could be applied elsewhere."

The researchers analysed owl-inspired feather wing models with and without leading edge serrations, by combining large-eddy simulations — a mathematical model for turbulence used in computational fluid dynamics to simulate air flows — and Particle-Image Velocimetry (PIV) and force measurements in a low-speed wind tunnel.

They discovered leading-edge serrations can passively control the transition between laminar, or streamline air flow, and turbulent air flow over the upper wing surface, at angles of attack (AoA) between zero and 20 degrees. This means they play a crucial role in aerodynamic force and sound production.

Professor Liu said: "We found, however, that a trade-off exists between force production and sound suppression. Serrated leading-edges reduce aerodynamic performance at lower AoAs than 15° compared to clean leading-edges, but can achieve noise reduction and aerodynamic performance at AoAs above 15°, which owl wings often reach in flight.

"These owl-inspired leading edge serrations, if applied to wind turbine blades, aircraft wings or drone rotors, could provide a useful biomimetic design for flow control and noise reduction.

"At a time when issues of noise are one of the main barriers to the building of wind turbines, for example, a method for reducing the noise they generate is most welcome."

Owl wings – the secret to quieter wind turbines?

New research in Australia into health effects of wind farm noise

Two new research projects into wind farms and human health are beginning in Australia following government grant awards totalling $3.3 million.

A team led by epidemiologist Professor Guy Marks from the University of New South Wales was awarded $1.94 million to study wind turbine noise and sleep, balance, mood and cardiovascular health.

Dr Renzo Tonin, Managing Director of Renzo Tonin & Associates, is a chief investigator in the study, and will play a lead role in the development, testing and deployment of the equipment used to generate and measure infrasound.

The team will conduct two trials – one trial in the lab, and another in the study participants' homes. Both trials will measure health indicators claimed to be affected by infrasound from wind farms, sometimes referred to as "wind turbine syndrome" (WTS).

As Professor Marks has observed, there is currently "no proof that WTS actually exists, as all the research available is seriously flawed".

"On the other hand, there are several experts who firmly believe WTS symptoms are the result of a 'nocebo effect', where a person becomes certain something harmless is making them sick. In other words, their health problems are triggered by the individual's dislike of the turbines, rather than from any sound emanating from them."

The nocebo effect hypothesis is supported by a recent research paper by Dr Tonin, James Brett of the University of NSW and Dr Ben Colagiuri of the University of Sydney, published in the *Journal of Low Frequency Noise & Vibration*.

The NHMRC has cited the need for further high-quality, independent research into wind farm noise in awarding these recent grants.

Professor Marks' team will use cutting-edge research methods and materials to address this research gap, including a custom audio system to produce infrasound, which will be designed by Dr Tonin.

"The proposed audio system will be the first of its kind in the world intended to generate infrasound in people's bedrooms on a long-term basis, and builds on the pioneering work of Dr Bruce Walker in the US," said Dr Tonin.

The audio system will allow researchers to accurately measure infrasound "in the field" – in this case, people's homes and bedrooms. This will be the first time infrasound has been measured in people's homes as part of a rigorous scientific study.

A further grant of $1.36 million was awarded to sleep researcher Associate Professor Peter Catcheside from Flinders University.

Professor Marks and Dr Tonin's team acknowledge the challenges involved in a measuring sound in people's homes and bedrooms, but believe that "a pilot study is practical and possible".

"A field study is important because it allows people to experience the infrasound in their own private settings – an environment that they're comfortable in," Dr Tonin said. "Although this can make measuring infrasound more complicated, this reduces the risk of the study being biased when people are forced to sleep in unfamiliar settings like a lab."

"Our team is very much looking forward to seeing the results of our field study, and seeing how that complements our lab study."

The research findings from both teams' are expected in 2020.

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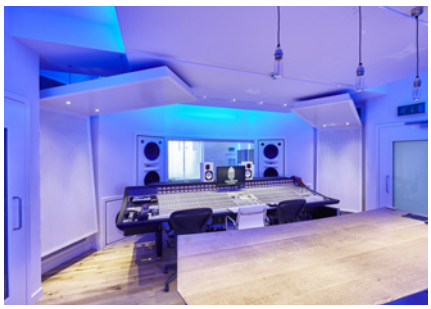

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Audio tickets: queuing for music festivals could soon be a thing of the past

A new app that uses inaudible sounds from phones to identify ticket holders could mean the end of long queues at gigs and music festivals.

The technology is currently being used by Ticketmaster at some venues, and uses a system that sends and receives audio signals from smartphones.

This allows the system to identify who is entering a venue without the need for physical tickets, potentially changing the queuing system for live events in future.

Specifically, Ticketmaster is using a system developed by Lisnr called "smart tones", trialling the technology at a handful of venues. Following this trial, the company plans to launch the system worldwide within the next four years.

All users have to do is download and install an app on their smartphone, and open it when arriving at the event. Pre-installed microphones at the venue then pick up the audio signals from the app.

Because these signals are emitted at between 18.75 kHz and 19.2 kHz, they are inaudible to 90% of people.

Using audio technology as opposed to other communication services such as NFC is, according to Lisnr, much cheaper, and comes with added benefits such as fraud prevention.

Because Lisnr tickets are linked to both the customer's account and their mobile device, the organisers will always be able to verify the right person is using the right ticket at the event.

What's more, because each tone emitted from a user's smartphone contains a unique identifier, venues will be able to track a specific customer's movements within the venue, allowing for personalised experiences.

Justin Burleigh, EVP of product at Ticketmaster, said: "We used identity as our North Star – our guiding light to develop a product that makes each individual fan experience the greatest it could be.

"This means using identity to drive customized experiences based on who you are and where you are, eliminating fraud, resulting in a safer environment, and delivering more personalisation based on the specific event you're attending."

Tory MP Nigel Adams, who has campaigned for a clampdown on touts since he was a victim of the practice last year, welcomed the move. "The touts and the ticketing industry are locked in a technological arms race and it's encouraging that Ticketmaster is deploying innovative technology to try and prevent those people who are intent on ripping off the consumer," he said.

Unique technology project to reduce New York noise pollution

New York has launched a unique experiment seeking to provide the city with the technology to dial down the volume and address noise pollution.

The five-year, $4.6 million project, the brainchild of researchers at New York University, working in concert with city residents and city hall, is using machine learning technology and sensors to build a sound library.

The idea is to record the full panoply of noises in the city of 8.5 million residents and use artificial intelligence so that machines can recognize sounds automatically, ultimately giving authorities a way to mitigate noise levels.

Juan Bello, head of the "Sounds of NYC" project and associate professor of music technology at NYU, says noise is "consistently the number one civil complaint" to the city's 311 telephone hotline for non-emergency services, instituted in 2003.

Researchers installed the first sensor boxes, which transmit data through wifi, on New York University buildings in Greenwich Village.

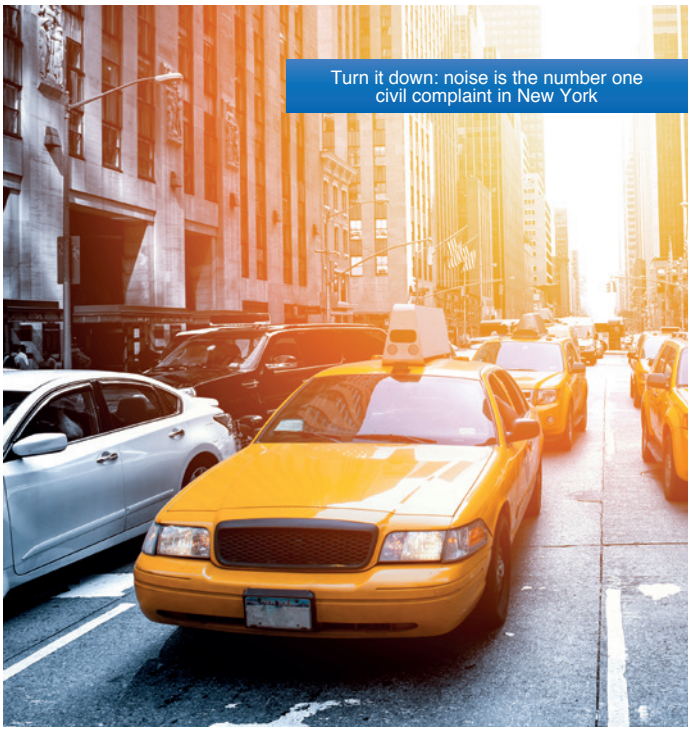
They're now installing sensors across Manhattan and Brooklyn at spots selected for their diverse sounds. By the end of the year, there should be 100 in place.

"There are plenty of studies that show that noise has a tremendous impact on health, both short-term and long-term," said Professor Bello, citing heart conditions, hearing loss and hypertension, which then have a significant economic impact.

The sensors are programmed to record no more than 10 consecutive seconds to avoid eavesdropping on conversations and posing confidentiality problems.

Researchers hope to index thousands of sounds which, with the help of New Yorkers, will be carefully annotated and help computers identify the source of nuisance sound immediately. It would then be over to the city to do what it can to limit it.

The first results gathered by Professor Bello's team tend to confirm that the problem is under-reported, that there are more noise violations than the 311 log seems to suggest, at least for sounds linked to construction.

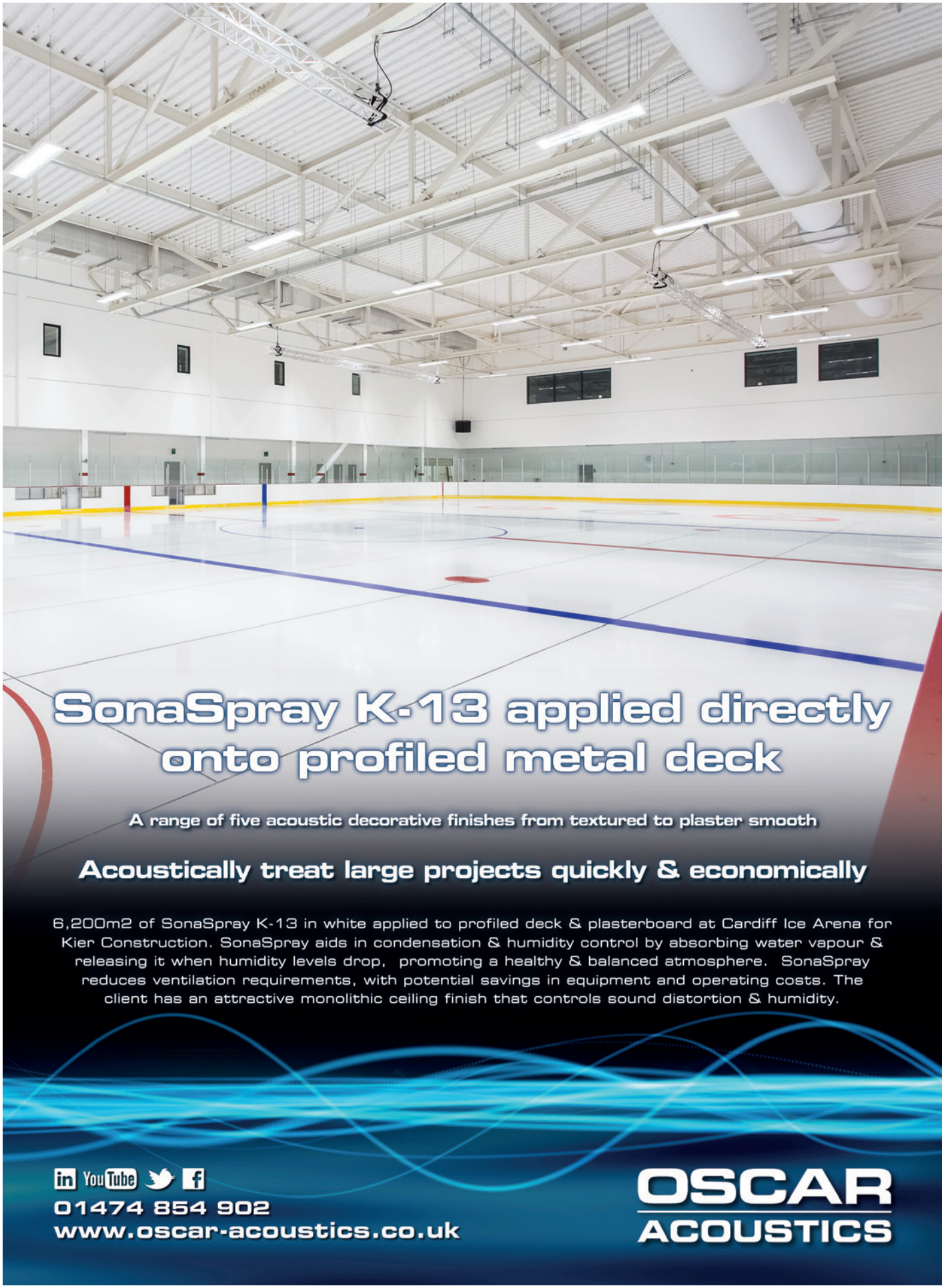


Turn it down: noise is the number one civil complaint in New York

New York may not be the only loud city in the world, but he calls it "a perfect laboratory" to test solutions that can be adopted and transferred "to many other places in the US and around the world".

"That's ultimately the objective," he said. "We will generate a core set of technologies that can be applied to this problem anywhere."

This report is based on one that first appeared on *Inquirer.net*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Breakthrough audio system that turns the car into the speaker

Technology company Continental is reinventing the car audio system – by turning the car into the speaker.

This is done by replacing conventional loudspeakers with actuators that create sound by vibrating certain surfaces in the vehicle.

In comparison with conventional speaker technology, the speaker-less audio system brings many advantages: it is much lighter, has dramatically reduced box volume, uses less electricity – and is said to deliver excellent acoustics.

Johann Hiebl, head of the Continental business unit Infotainment and connectivity, said: "In the age of electric vehicles, car manufacturers are looking for innovative solutions to drastically reduce the weight of their vehicles and gain space for passengers and new technologies.

"On the other hand, design and sound quality may not suffer from this goal. Our approach is to treat the car itself as an instrument. We use compact actuators to excite suitable surfaces to thus generate a natural, 3D sound experience."

In direct comparison with a conventional high-end vehicle audio system, a speaker-less solution can reduce the system volume by a factor of 10 or higher, while bringing down the system weight to a fraction of a speaker solution. The invisible car audio technology can be integrated into any car model from high end sedans to small electric vehicles.

The mix of tweeters (high frequency speakers), mid-range speakers and subwoofers which together make a conventional high-end car audio system frequently interrupts the original interior surfaces with the typical look of a speaker front. Designers do not always welcome this.

"Moreover, it is not necessary to integrate speakers with oscillating membranes when you have all the surfaces you need to do the job in the car already", said Dimitrios Patsouras, director competence centre NVH at Continental Engineering Services. The rationale behind this invisible audio system is to avoid this kind of duplication and utilise existing components for even better results.

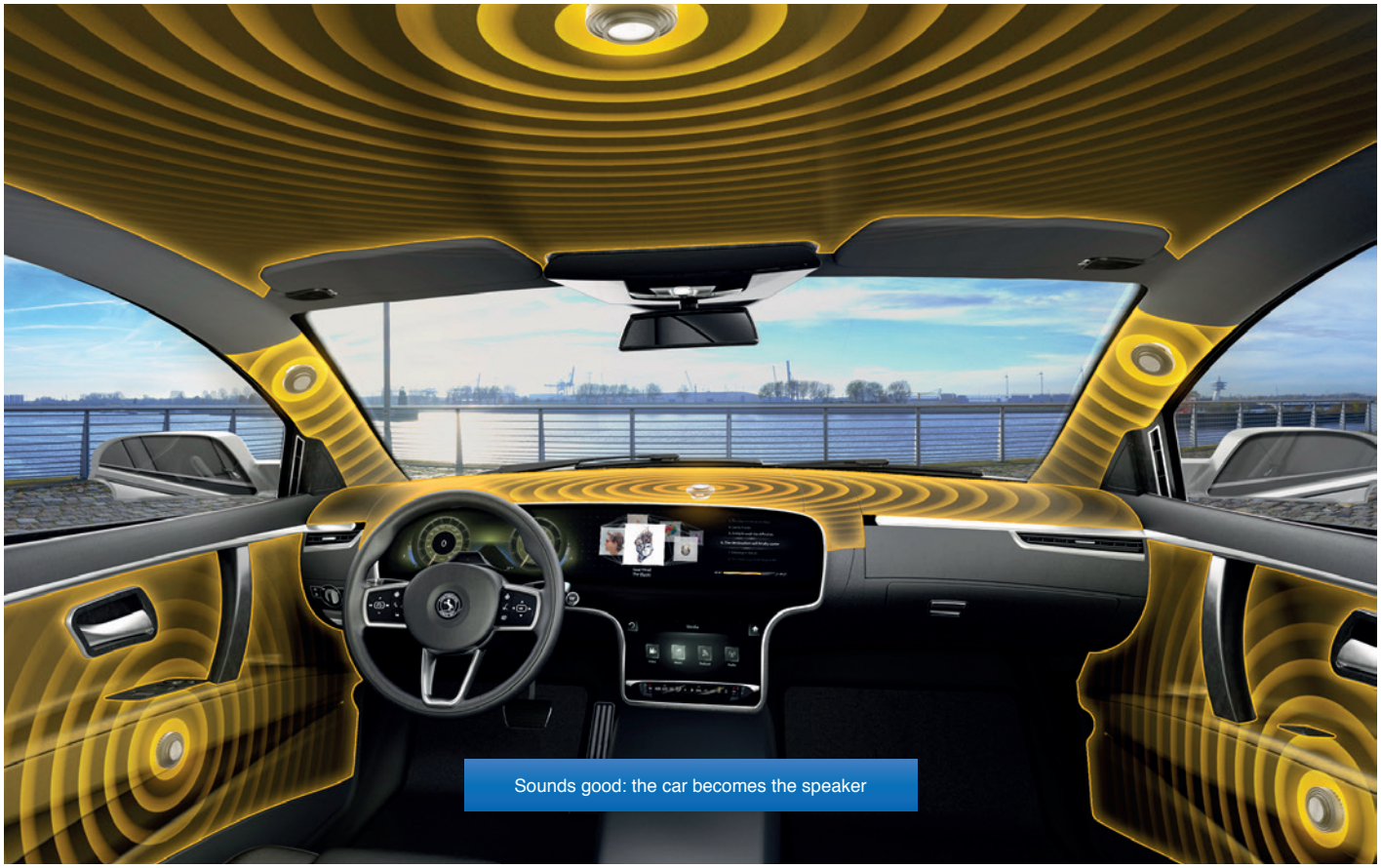
The sound waves are generated by compact actuators, which are similar to the core of a conventional speaker. These transducers consist of a magnet and a coil, which generate micro-vibrations. However, instead of an oscillating membrane which is part of a current speaker, larger existing components and surfaces in the vehicle are excited by the transducers to radiate the sound.

"If you take a violin for comparison, the bow and strings are the transducer. The violin's bridge equals the location and bonding of the transducer to the surface which equals the instrument body", said Mr Patsouras.

Specific areas in the vehicle lend themselves to each of the required three main frequency ranges. "The A-pillar is suited for high frequencies, while the door panels, for instance, have the right properties for generating medium frequencies. Similar to speaker technology, we use large components such as the roof lining or rear shelf to generate low frequencies," he explained. To achieve a good 3D sound, conventional high-end car audio systems can easily require between ten and 20 or more speakers. Owing to a conventional speaker design this gives the system a weight of up to 15 kilograms and a total box volume of 10 to 30 litres.

Continental's speaker-less audio system can weigh as little as 1 kilogram and requires as little as 1 litre of total box volume. "However, the main benefit is the quality of the sound. Even experts listening with a discerning ear have given us the highest praise for our invisible system's acoustics," Mr Patsouras said.

Continental says speaker-less technology offers further potential beyond car audio: it can also provide a sound source for human-machine interaction concepts, such as navigation instructions or the indicator sound.



Sounds good: the car becomes the speaker

Impact Testing for Gymnasia Flooring

In Partnership with Salford University

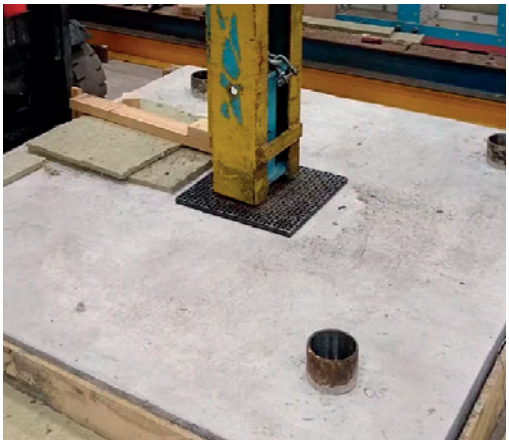
Specifying and designing an isolation system subject to heavy impact is difficult. Most commonly a problem for free weights zones and high energy activities such as CrossFit, the impact energy can be high and easily capable of causing significant disturbance.

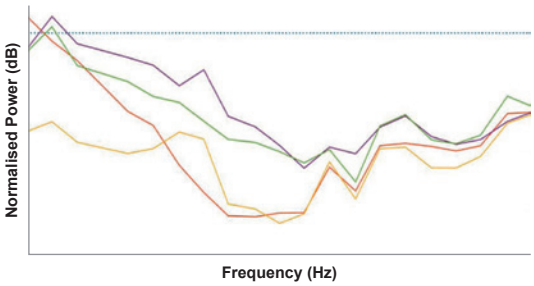
We have long experience of installing effective floating floor systems for a wide range of applications but there are a number of design variables which can be utilised for customers with limited space or budgets.

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

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

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





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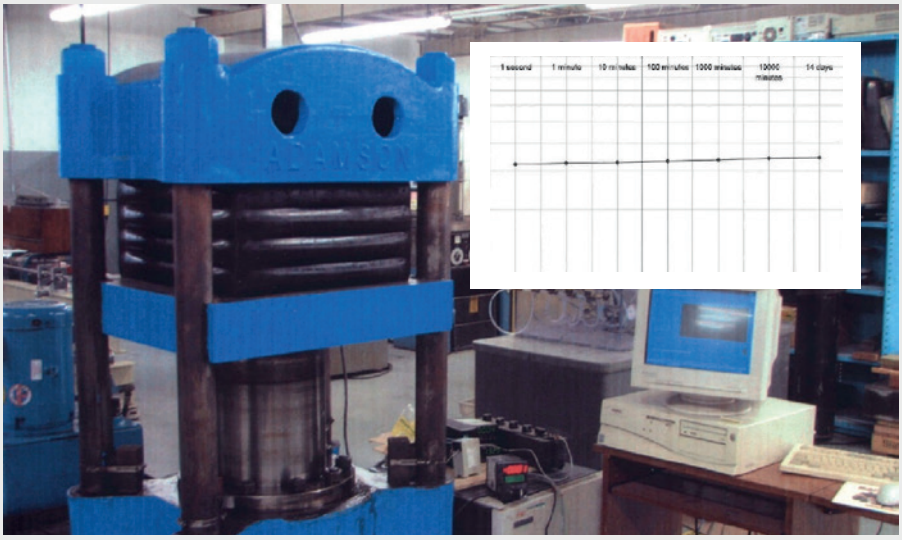

Bearing creep testing and results chart

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Noise from night flights at Heathrow, Gatwick and Stansted to be cut

Noise from night flights at Heathrow, Gatwick and Stansted will be cut in a new crackdown, Transport Secretary Chris Grayling has said.

Mr Grayling has confirmed a series of measures to reduce noise at the three London airports, including new quotas on the number of flights and a lower noise limit at Heathrow and Gatwick.

In a written statement to Parliament, Mr Grayling said: "I am fully aware that noise is a major concern for those living near these airports, and that night noise is widely regarded as the most disturbing impact of aviation.

"While advances in new technology mean that aircraft are generally getting quieter, the limits governing night noise at these airports has not kept pace with these developments.

"The new rules we are publishing today will encourage the use of quieter aircraft at all three airports by reducing the amount of noise these airports are legally allowed to make, and will give local residents a five-year guarantee about the level of noise that they will be exposed to.

"This decision strikes a balance between managing the impacts on local communities by locking in the benefits offered by recent technological developments, with the economic benefits of night flights."

The announcement comes after a consultation on measures for new flights, which was launched in January.

And in another development, more than 700 residents living near Heathrow will be able to upgrade their home's noise insulation free of charge under the airport's Quieter Homes Scheme.

The selection has been based on an assessment by an independent noise appraisal expert. The offer follows a pilot programme launched in 2014, running in three zones around Heathrow and chosen, according to the level of noise from the overflight of aircraft.

A total of 708 homes – in addition to the 474 already fitted with soundproofing insulation during the pilot scheme – will now be eligible to apply.

Long term aircraft noise exposure linked to high blood pressure

Long term exposure to aircraft noise, especially at night, is linked to an increased risk of developing high blood pressure and possibly heart flutter and stroke as well, new research suggests.

Data was taken from some 420 people living near Athens International Airport in Greece, where up to 600 planes take off and land every day. They formed one of six groups of people living near six large European airports who had taken part in a study which assessed the potential health impacts of aircraft noise in 2004-6.

"When all cases of high blood pressure were included, every additional 10 dB of night-time aircraft noise was associated with a 69 per cent heightened risk of the condition," said Professor Klea Katsouyanni, study leader, University of Athens Medical School.

"When only new cases were included, every additional 10 dB was associated with a more than doubling in risk."

The aircraft and road traffic noise exposure levels estimated for their postcodes at that time – fewer than 50 decibels to more than 60 dB – were used for the current study in 2013, published online in *Occupational & Environmental Medicine*.

Daytime aircraft noise was defined as that occurring between 7am and 11pm, and night-time noise the rest of the day.

Around half of the participants were exposed to more than 55 dB of daytime aircraft noise, while around one in four were exposed to more than 45 dB of night-time aircraft noise.

Only around one in 10 were exposed to significant road traffic noise of more than 55 dB.

Between 2004-6 and 2013, 71 people were newly diagnosed with high blood pressure and 44 were diagnosed with cardiac arrhythmia, or heart flutter. A further 18 had a heart attack.

The associations between road traffic noise and ill health were much weaker and less consistent, the findings showed.

The researchers said that they were unable to look at specific causes of death among the 78 people who died between 2004-6 and 2013. The numbers studied were also relatively small, and it was not possible to account for the potential effects of air pollution.

Nevertheless, a growing body of evidence links noise exposure to ill health, they emphasised.


At risk: people living near airports

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'Tranquility tool' aims to create oases of calm in city centres

Scientists at the University of Bradford have developed the world's first Tranquillity Rating Prediction Tool (TRAPT), a scientific process for measuring how relaxing urban environments and public spaces are.

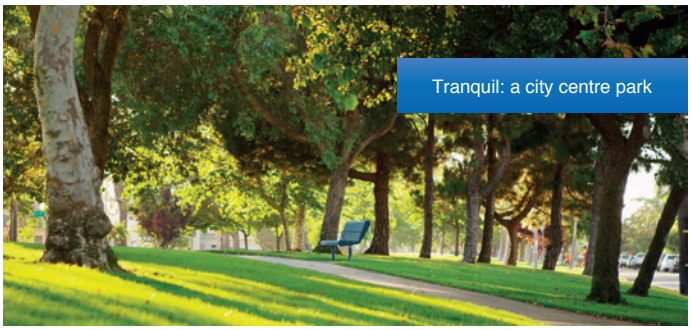
In a new paper published in the *Urban Forestry and Urban Greening* journal, lead researcher Professor Greg Watts believes that the tool could help planners, architects and environmentalists to understand what the impact of "greening" measures like introducing trees, hedges or additional vegetation could have on urban spaces. It is hoped that in time the tool could allow users to optimise green spaces as part of the property development process, all before a spade hits the ground or to rejuvenate run-down suburbs and town centres.

Studies have illustrated a clear link between tranquil environments and stress reduction, well-being and pain relief. While quiet, green spaces promote relaxation, litter, graffiti and road noise all have the potential to reduce it. Introducing vegetation into an environment to soften it — a process called "greening" — is one way to improve tranquillity, but until now architects and planners have had to make assumptions as to the impact this will have.

Professor Watts said: "Currently, architects design urban environments to provide open spaces where people can relax. While it's guided by certain principles, it's not scientific. TRAPT provides a robust and tested measure of how relaxing an environment currently is, or could be once built."

The TRAPT system uses three measures of an urban environment including soundscape, landscape and moderating factors – the amount of natural features like trees, shrubs, flowers or water in the eye-line for example. When processed, the environment is given a score between 0 and 10. As an example, an outstanding tranquil environment was Glen Etive in the Scottish Highlands that elicited a high average score of 9.1 though an urban park can exceed 7.

"TRAPT provides the user with a simple measure for understanding how tranquil and relaxing it can be. By varying different factors – the amount of greenery, or introducing noise attenuating barriers or quieter road surfaces for instance – planners can understand the impact of their decisions," Professor Watts added.



Tranquil: a city centre park

Based at the Bradford Centre for Sustainable Environments, Professor Watts and his team have spent over 10 years testing and validating the system in both laboratory and field studies.

Through the practical application of TRAPT, Professor Watts hopes that his research could help architects, planners, civic leaders and environmentalists to gain a greater understanding of the impact of decisions they take.

He said: "We're confident that our testing has helped us to create a tool that provides a realistic and reliable measure of relaxation. TRAPT could be used to help architects design rewarding and relaxing urban environments. Planners can use it to assess how tranquil new developments would be, making changes to the plans if required."

The tool could also be useful to environmentalists arguing against the removal of trees, shrubs or urban green spaces. Residents could argue for more trees, shrubs and flowers to improve the appearance of jaded town centres and suburban areas.

"These measures should also help to counter threats such as over development, tree removal or traffic densification that might threaten existing benefits."

Haptic technology is helping the visually impaired 'feel' sound waves

Researchers at Goldsmiths, University of London are using haptic technology to help visually impaired audio engineers "feel" sound waves.

The Haptic Wave prototype consists of a wooden board with a slider built into it. As the user moves the slider from left to right to scroll through time, a dial moves up and down depending on the position of the waveform at that point in time.

The louder it gets the higher the dial, and it falls to the bottom of the slider for the quiet parts. "It's an immediate, intuitive indication," said Atau Tanaka, a professor of media and computing at the university, who worked on the ESPRC-funded research.

Adam Parkinson, who co-authored the research, said that they had consulted with a number of visually impaired audio engineers about what kind of device they had been looking for before developing the Haptic Wave, which is about 30cm long and 12cm tall. "Whether you're visually impaired or not, this technology frees you up and you can take that information in through the hands," he said. In the future, the same technology could potentially be used to show whether a vocalist is in tune.

Mr Parkinson said the device, which is being trialled in music studios and recording facilities across the United States and England, could be useful for audio engineers, musicians, radio producers and voiceover artists

It was one of a number of haptic technologies on show at a Royal Academy of Engineering event. Other featured a demonstration from Bristol-based start-up Ultrahaptics whose technology uses ultrasonic waves to simulate the sensation of touch.

This article is based on one that first appeared in *Professional Engineering*.

The Haptic Wave prototype

Drilling trade body warns operators of 'complacency' over HAVS

The UK's trade body for the ground drilling industry says it is concerned about "possible complacency" among operators over Hand Arm Vibration Syndrome (HAVS).

The British Drilling Association (BDA) has issued a reminder to the sector of the need to address the issue and is supporting the initiative with a number of recommendations.

Specifically, it is urging operators to undertake written risk assessments related to rig operation, and specifically the use of vibrating hand tools. Additionally, it suggests that operation of vibrating machinery and tools be monitored closely and that detailed records of exposure are maintained on file. Exposure in the drilling sector will most likely be linked to use of hand-held hydraulic and electric breakers used to get through hardstanding together with grinding and cutting equipment. Every piece of machinery is rated by manufacturers and suppliers so that daily allowable use can be determined.

Martyn Brocklesby, BDA Vice Chairman, said: "Hand Arm Vibration Syndrome, caused by exposure to vibration in the workplace, is extremely serious resulting in permanent injury, yet it is also preventable. The BDA is reminding its members and non-members of the on-going need to address this issue P44

Caution: drilling can cause HAVS

Advertising Feature

From mysterious past to bright future - London's Iconic Lighthouse Building

Once a building at risk and on the Historic England's register deemed unsafe for use, the Grade II Listed Lighthouse building has been carefully renovated into quieter and warmer office and retail space.

Adjacent to Kings Cross, sits the iconic Flat-Iron Lighthouse building. No one knows when it was built exactly, but there are indications it was somewhere between 1875 - 1884, the purpose of the building is also unknown. Some speculate the building once sold oysters, others say the Lighthouse may have been used to spot fires or even a camera obscura; it still remains a mystery today.

Having lain derelict for over 20 years, UK Real Estate took on the task of restoring the iconic building for its new purpose as office and retail space and appointed Balfour Beatty as its main contractor. The project was challenging; with two underground tunnels running beneath, the building's restoration had to be carefully managed, including tackling the issues of noise and vibrations.

The solution to the extensive vibration issues was to isolate all internal fixtures and fittings by inserting elastomeric bearing pads at all points of contact with the external structure. Secondary glazing was an intrinsic component of this solution as a fully independent internal window system, it allows the full sealing of the internal envelope.

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P43

and to ensure the correct procedures, monitoring and long-term recording systems are in place to minimise risk."

He continued "Alternatives are available to using hydraulic or electric breakers, such as concrete coring or the use of excavator-mounted equipment, and we urge the drilling sector to consider their use where practical and feasible. Reducing exposure to vibrating equipment will reduce the number of injuries relating to their use and financially, will decrease the potential for injury claims in the future."

The warning comes after an engineering firm was fined £120,000 and ordered to pay £7,241 for failing to control the risk to employees using hand held power tools from HAVS after it admitted breaching the Control of Vibration at Work Regulations 2005.

Manchester and Salford Magistrates heard how Newfield Fabrications Co Ltd (NFCL) failed to ensure the risks to its employees from exposure was adequately controlled. The company also failed to ensure its employees were given sufficient information, instruction and training on the effects of working with vibrating hand tools.

An investigation by the Health and Safety Executive (HSE) found that a welder who had been working at the Sandbach-based company had been given a job that involved a significant amount of grinding and polishing.

After a number of hours on the task, the worker began to experience numbness and tingling. He asked to swap with another worker but was told to carry on. Whilst his symptoms continued he was told by his supervisor to carry on using vibrating tools.

A few weeks later, a 20-year-old apprentice welder also began to suffer from vibration-related symptoms from using similar tools.

Scientists say acoustics could help save dwindling bee population

A research team has developed an inexpensive acoustic listening system using data from small microphones in the field to monitor bees in flight. The study, published in *PLOS ONE*, shows how farmers could use the technology to monitor pollination and increase food production. According to recent studies, declines in wild and managed bee populations threaten the pollination of flowers in more than 85 per cent of flowering plants and 75 per cent of agricultural crops worldwide. Widespread and effective monitoring of bee populations could lead to better management; however, tracking bees is tricky and costly.

"Causes of pollinator decline are complex and include diminishing flower resources, habitat loss, climate change, increased disease incidence and exposure to pesticides, so pinpointing the driving forces remains a challenge," said Candace Galen, professor of biological science in the University of Missouri's College of Arts and Science.

"For more than 100 years, scientists have used sonic vibrations to monitor birds, bats, frogs and insects. We wanted to test the potential for remote monitoring programs that use acoustics to track bee flight activities."

First, the team analysed the characteristic frequencies of bee buzzes in the laboratory. Then, they placed small microphones attached to data storage devices in the field and collected the acoustic survey data from three locations on Pennsylvania Mountain, Colorado, to estimate bumble bee activity.

Using the data, they developed algorithms that identified and quantified the number of bee buzzes in each location and compared that data to visual surveys the team made in the field. In almost every instance, the acoustic surveys were more sensitive, picking up more buzzing bees.

"Eavesdropping on the acoustic signatures of bee flights tells the story of bee activity and pollination services," Professor Galen said. "Farmers may be able to use the exact methods to monitor pollination of their orchards and vegetable crops and head off pollination deficits. Finally, global 'citizen scientists' could get involved, monitoring bees in their backyards."

Currently, using the algorithms developed in this study, the team is developing a smartphone app that could record buzz activity as well as document the bees photographically. Future studies could determine whether bees detect competitors by sound and whether flowers have chemical responses to bee buzzes, Professor Galen said.

Creating a buzz: acoustic monitoring could stop bee decline

New hearing test to establish fitness-for-duty among military personnel

Researchers at the University of Southampton have devised a new hearing test for military personnel that they hope will better assess whether soldiers have sufficient hearing ability to be safe and effective in a combat situation.

The current measure of "auditory fitness-for-duty" used in British military medical examinations is "pure-tone audiometry", which assesses the ability to hear individual tones of different frequencies in quiet surroundings. It does not take into account the communication and the noisy environments that infantry personnel encounter on a daily basis.

Dr Daniel Rowan, who led the team that devised the test, said: "How good a soldier's hearing is can mean the difference between life and death. The problem with the pure-tone audiometry test is that it doesn't relate to the listening challenges that soldiers face in the line of duty.

"Pure-tone audiometry comprises hearing short beeps in quiet environments. This is not a true reflection of military life.

"Our new test takes into account what soldiers need to be able to hear and react to, and is based on input from them on the typical scenarios that they actually experience."

The new test – a speech-in-noise test – involves participants listening to military-style language over background noise at varying balances.

The structure of sentences, for example "Ready bravo", "go to green" and "eight now", was chosen after soldiers previously completed surveys to identify battlefield sounds and commands based on their importance, regularity and the number of soldiers who hear them in the line of duty.

The new test was developed and assessed in a study, funded by the MoD Royal Centre for Defence Medicine, and published in the International Journal of Audiology. It has since been implemented into a tablet app to make it easier and more cost-effective to deliver.

The test has been shown to accurately measure an individual's ability to recognise speech within background noise. The Royal Centre for Defence Medicine has funded a follow-up study to investigate whether the test can accurately predict soldiers' auditory fitness-for-duty.

New test can assess better soldiers' hearing in battle

People, policy, and health: assessing historic interventions in practice

By Stuart Dryden

Introduction

In January 2012 Defra commissioned a research project from Rupert Taylor Ltd to carry out *An investigation into the effect of historic noise policy interventions* to cover the period from about the early 1960s [1, 2]. Interventions in the form of primary and secondary legislation, policy advice and guidance, codes of practice and regulations, and British Standards have continued since that time and European and international guidance and regulations have also addressed various noise issues over a similar period and have influenced national policy either indirectly (e,g. by informing national guidance) or by being directly transposed into national regulations.

That research project formed the first part of Defra's consideration of the implications for noise policy of possible changes in the acoustic environment over the next 50 years and the study investigated five policy areas which:

- required compliance with increasingly stringent ICAO aircraft noise emission limits
- required compliance with increasingly stringent EC road vehicle noise emission limits
- changed the Building Regulations regarding sound insulation that aimed to reduce neighbour and neighbourhood noise
- legislated on general noise nuisance & specific noise sources (to control neighbour and neighbourhood noise), and
- legislated specifically to control construction noise (to reduce neighbourhood noise).

This paper considers the intervention to reduce aircraft noise to determine whether any health benefits of the policy can be determined.

Scope of assessment

Scope of the Defra study

The Defra study addressed a range of policies and noise sources and in the case of aircraft noise the effectiveness of the intervention was assessed by considering the change in the area within the 57dBA $L_{eq,16hr}$ noise contour (or an equivalent NNI contour). That criterion was selected primarily because historically it had been used when considering the environmental impact of airports. Consequently data on changes in the contour area were available for six airports (the first year in which data were available is shown in brackets for each airport): London Heathrow (1972), London Gatwick (1972), Manchester (1990), London Stansted (1988), London Luton (1976), and Birmingham (1993). The acquired data showed the actual areas that occurred as a result of the combined effects of several factors in addition to the policy intervention itself – *ie*, enforcing the reductions in the ICAO noise limits which led to the fleet mix changing towards quieter aircraft. There were also changes (mainly increases) in the number of Air Traffic Movements (ATMs) each year and other factors such as local operational measures. The change in the contour area is particularly influenced by the large increase in ATMs that occurred at most airports over the study period.

In order to obtain alternative estimates of the effects of the policy, a method was therefore devised to adjust the 57dBA $L_{eq,16hr}$ contour areas to take account of the change in the number of ATMs that had occurred compared to the starting year. Using this method enabled assessments of the areas within the 57dBA $L_{eq,16hr}$ contour to be made for two additional scenarios: first, assuming that the policy had been in place (i.e., aircraft noise emission levels reduced over the study period) but there had been no increase in ATMs, and secondly, assuming that the actual increase in ATMs had occurred but that there had been no policy in place (and hence no reduction from the aircraft noise emission levels at the start of the study period).

For some of the years data were also available of the population within the 57dBA $L_{eq,16hr}$ contour but for the Defra study the area enclosed was used in preference to the population enclosed principally because the population within a given contour is affected by the population density and distribution (the shape of the contour can also affect the population within it). Consequently, the contour area was considered a more direct measure of the policy effects over time than the population exposed. Furthermore, had the population been used instead of the area, the alternative assessments described above that adjusted the area to account for changes in the ATMs could not have been implemented.

Scope of the new study

For the airports and periods studied there was some information on the population within some or all of the 57, 63, and 69dBA $L_{eq,16hr}$ contours. It was therefore possible, in principle, to determine the change in the population exposed within these bands over some of the study period and hence attempt to estimate any health benefits that might have occurred. Those population figures relate to the combined effects of the reduction in aircraft noise emission limits brought about by the policy and the change (mainly increases) in ATMs over the study period. Unfortunately, the method described above that enabled the contour areas to be adjusted to take account of the changes in ATMs cannot be applied directly to population data if only the numbers within the contour bands are available. Consequently, the assessment undertaken in this new study relates to the combined effects of the policy and the actual ATM changes.

Relationship between aircraft noise exposure and effects on people

The relationship between noise from aircraft and effects on people has been studied in the UK since at least the early 1960s by conducting surveys of both aircraft noise to estimate noise exposure and related social surveys to determine the response of members of the exposed community [3].

The range of effects studied has increased from annoyance and sleep disturbance to include impacts on children's progress in reading and direct physical health effects such as cardiovascular diseases and the European Environment Agency (EEA) [4] and the World Health Organization (WHO) [5] have published guidance on estimating the effects of noise exposure in terms of annoyance and other responses, though not for all effects for all noise sources.

Health effects considered in the new study

The EEA report [4] presents relationships between exposure to aircraft noise and annoyance, sleep disturbance, hypertension, and cognitive impairment (primarily related to effects on schoolchildren). The noise indices specified in those relationships are L_{den}, L_{night}, L_{den}, and L_{dn} respectively whereas the noise exposure data from the Defra study uses the $L_{eq,16hr}$ index. Although it might be possible to derive a conversion factor between $L_{eq,16hr}$ and L_{den} or L_{dn} (see below) that is not the case for conversion to L_{night} and so sleep disturbance was not included in the review. An assessment of the effects on cognitive impairment over the study period requires information on the locations of schools and the numbers of pupils attending them in order to estimate their noise level exposure. However, only basic population data were available and so cognitive impairment was also excluded from the study. Thus the effects considered were annoyance and hypertension.

Before the relationships for these health topics could be applied to the available data a number of factors had to be considered as explained in subsequent sections of this article.

Population data and dose-response relationships

Dose-response relationship for annoyance

Both the EEA and WHO reports referred to above [4, 5] use the expressions from a European Commission (EC) position paper [6] for the dose-response relationship between the percentage of people highly annoyed (%HA) by aircraft noise and noise level in which the noise level is expressed using the index L_{den}, which is defined in an EC directive [7]. The EEA report [4] notes that that relationship has been criticised because recent survey data appeared to show an increase in peoples' sensitivity over time and that although it had not been possible to identify a single cause, there did appear to be a change in the trend around 1990. This issue is of potential significance for the analysis attempted in this paper because the population data for some airports extends from the 1970s to 2009.

A recent paper by Gelderblom et al [8] investigated the stability over time of the Community Tolerance Level (CTL), a concept introduced by Fidell et al [9], and appears to have found a satisfactory explanation for this matter. Gelderblom et al [8] reviewed 62 studies of aircraft noise annoyance from the period 1961 to 2015 and classified them as either "low-rate change" (LRC) or "high-rate change" (HRC) airports using definitions they quote from Janssen & Guski [10, submitted] who proposed this classification. In summary, Gelderblom et al [8] showed that analysing the studies as a single dataset replicated the effect of increased sensitivity over time (albeit to a lesser degree than other studies have done) but that including the LRC/HRC classification in the analysis resulted in two distributions. One of these – for the LRC category airports – was relatively stable over time and in fairly good agreement with the EEA response curve for CTL (which is equivalent to a %A of 50%). The second distribution – for the HRC airports – was also fairly stable over time but was 9dB ± 3dB lower than the first one, which indicated increased sensitivity/lower tolerance for the HRC category airports.

Gelderblom et al [8] point out that "The distribution of the two types of studies (LRC vs. HRC) explains these findings. The great majority of the HRC studies were conducted relatively recently (later than 1996). This group is therefore (overly) well represented in the past two decades". Thus the use of the EC annoyance dose-response relationship seems justified in the case of LRC airports.

Use of data from Defra study

According to the definitions quoted by Gelderblom et al [8] an airport is classified as LRC if there is "*no indication of a sustained abrupt change of [actual] aircraft movements, or the published intention of the airport to change the number of movements [ATMs] within 3 years before and after the study". The 'abrupt change' in ATMs is further defined as " … a significant deviation in the trend of aircraft movements from the trend typical for the airport. Each trend is calculated by means of total movement data during a five year period. If the typical trend is disrupted significantly and permanent, we call this a "'high-rate change airport"*".

The first of these criteria can be tested by examining the available data on annual ATMs for the airports in the Defra study [1, 2]. The second criterion is less straightforward to determine, though if the ATM trend shows an 'abrupt change' that might be an indication that public discussion of that change could have occurred in advance. Two of the airports in the original Defra study [1, 2] appear in the list of studies reviewed by Gelderblom et al [8]. They classify two studies at London Heathrow (LHR) in 1961 and 1967 as LCR and one study at Birmingham Airport (BHX) in 1997 as HCR on the basis of announced changes that from 1997 would double that airport's capacity. Janssen & Guski [11] also classified a 2003 study at LHR as being for a LRC airport.

Table 1 and Figure 1 show the five-year ATM totals for each airport normalised to the number of ATMs at the end of the first 5-year period for each airport in order to highlight the ATM trends. Table 1 shows that at London Heathrow (LHR, the shaded P48

P47

area at the bottom of the chart) the change in the 5-year ATMs is gradual over most of the 35-year period apart from an unsustained step at the 20-year point, and so it seems reasonable to regard LHR as an LRC airport. For Birmingham (BHX) the period covered by the data is rather short and the initial step (after 10 years, in 2003) is not sustained. However, Birmingham was classified as an HRC airport in the late 1990s [8]. The profiles for some other airports are less straightforward to categorise over the period for which data are available and the total period might need to be considered in separate parts, see, in particular, London Luton (LTN) comparing years 0 to 15 with years 15 to 35.

In view of the difficulty in classifying most airports as HRC/LRC, and the period for which population data were available (see below) it was decided to confine the study to Heathrow (LHR) and to assume that it was an LRC airport.

Noise scales used for data and for analysis

Change in the UK from NNI to $L_{eq,16hr}$ contours

The noise contour data collected for the Defra study for the period before 1990 used the NNI scale and thereafter the $L_{eq,16hr}$ scale (in dBA) was used. Regarding the change in 1990 from the use of noise contours using NNI values index to values of $L_{eq,16hr}$, the values used were selected so that "*the Leq contours would match the existing NNI ones* [*ie*, 35, 45, 55] *as closely as possible and thus represent the same degree of annoyance, on average, as the 1988 NNI contours*" [12]. That was the justification in the original Defra study [1, 2] for regarding the area within historic 35 NNI contours and the subsequent 57dBA $L_{eq,16hr}$ contours as representing equivalent impacts. It is therefore considered reasonable for the purposes of estimating annoyance effects in the present study to treat the 35, 45, 55 NNI contours as equivalent to the 57, 63, and 69dBA $L_{eq,16hr}$ contours respectively[1]. Thus the data have been combined using the relevant equivalent values for $L_{eq,16hr}$ in place of the actual NNI values.

Conversion from $L_{eq,16hr}$ to L_{den}

The L_{den} is a 24-hour L_{Aeq} for which the hourly L_{Aeq} values in the evening period (19:00 to 23:00) have a weighting of +5dB applied and those for the night-time period (23:00 – 07:00) have a weighting of +10dB applied and so the available noise contours, which were determined for $L_{eq,16hr}$ values, must be expressed in terms of L_{den}, the scale on which the dose-response relationships are expressed. Conversion factors between noise levels using different indices are available for road traffic [4, 5] but those references highlight the difficulty of providing factors in the case of aircraft noise and for $L_{eq,16hr}$ values. Miedema and Oudshoorn [13] provide general rules for converting between L_{den} (also referred to as DENL) and L_{dn} (also referred to as DNL) for aircraft which they derived from a review of large number of airport studies, but they did not consider conversion to L_{den} from $L_{eq,16hr}$.

The relationship between $L_{eq,16hr}$ and L_{den} is determined by the hourly noise profile over the 24 hour period which varies between airports. It can be particularly influenced by the night time noise level since that does not affect the value of $L_{eq,16hr}$ but can increase L_{den} owing to the 10dB night-time weighting applied. However, night-time airport activity might be restricted by local regulations. The range of values for the difference between $L_{eq,16hr}$ and L_{den} has therefore been investigated for LHR using potential time patterns for the noise level based on data published by the airport owners [14, 15].

The approach was to derive a series of noise level profiles in which the hourly level was varied with reference to a standard noise level; thus for the period 0700-1900 (day) the noise level for every hour was assumed to be 1 (= 0 dB). At LHR there are restrictions within the period 2330 0600 (part of night-time) [15] and the relative level for that period was estimated to be 0.1 (= –10 dB). The highest value for L_{den} therefore occurs when the noise level for the remaining periods (2300-2330 and 0600-0700) are set at the reference level use for the daytime period (ie, 1, = 0 dB). This hourly noise profile is shown in Figure 2 on which the difference between the L_{den} and the $L_{eq,16hr}$ is shown by the separate column on the right hand side. For this case the difference is 2.3dB.

A profile that would produce a smaller difference between L_{den} and $L_{eq,16hr}$ was considered having the noise levels for the periods 2200-2300, 2300-2330, and 0600-0700 set to 0.5 (= –3 dB) as shown by the dark blue shading in Figure 3. For this profile the difference between L_{den} and $L_{eq,16hr}$ is 1.3dB. Finally, changing the profile by setting the noise level for the period 0600-0700 back to the reference level (= 0 dB) results in the difference increasing to 2.0dB (Figure 4). The actual profile might well be different over the years 1972 – 2009 and so as a conservative estimate it has been assumed that L_{den} is 2dB greater than $L_{eq,16hr}$ at LHR.

Population data from the Defra study

Review of changes in exposed population over time

The data available for LHR provides the total population within each of the 57, 63, and 69dBA $L_{eq,16hr}$ contours for the years 1974 – 2009 from which the population exposed to in the range 57-63dBA and 63-69dBA $L_{eq,16hr}$ can be determined. The trend is for the P50

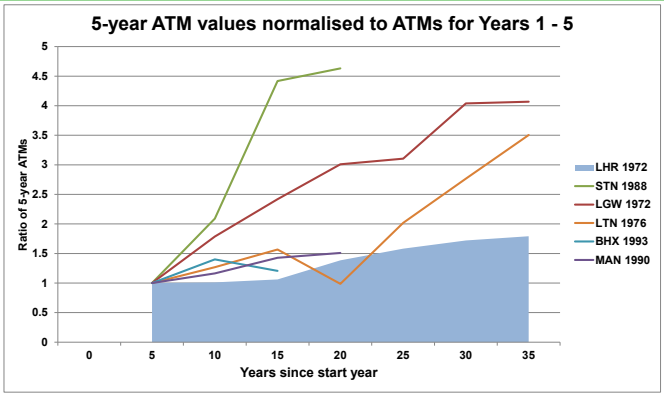

Figure 1. 5-year ATM values normalised to ATMs value for years 1 – 5

Airport Code	Start Year	Elapsed years from start of airport data						
		5	10	15	20	25	30	35
LHR	1972	1.0	1.0	1.1	1.4	1.6	1.7	1.8
LGW	1972	1.0	1.8	2.4	3.0	3.1	4.0	4.1
STN	1988	1.0	2.1	4.4	4.6			
MAN	1990	1.0	1.2	1.4	1.5			
BHX	1993	1.0	1.4	1.2				
LTN	1976	1.0	1.3	1.6	1.0	2.0	2.8	3.5

Key to Airport Codes
LHR = London Heathrow
LGW = London Gatwick
STN = London Stanstead
MAN = Manchester
BHX = Birmingham
LTN = London Luton

Table 1. 5-year ATM values normalised by airport to ATMs in years 1 to 5

1. The $L_{eq,16hr}$ values in [12] were 57, 63.5, and 70dB, but the contours produced have values of 57, 63, and 69dB.

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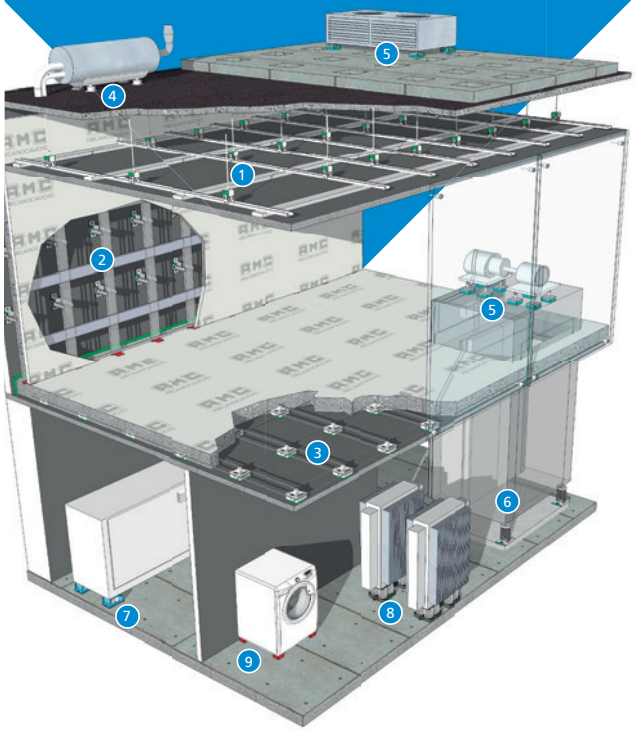

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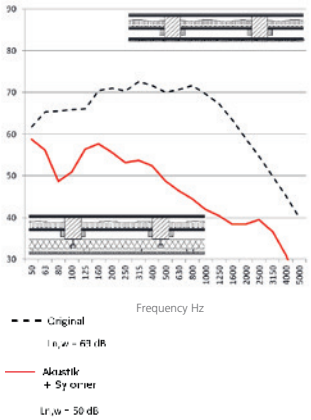

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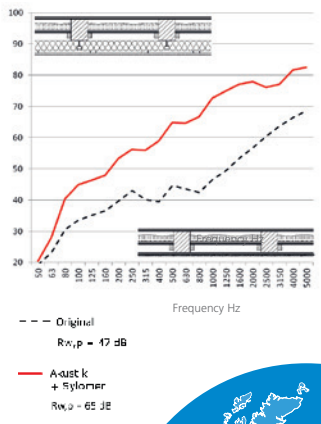

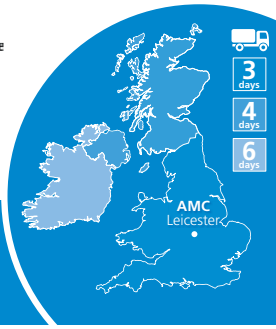

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P48

population within each of the above noise contours to reduce over time and the rate of reduction is such that the 1974 population in the 57-63dBA $L_{eq,16hr}$ band falls to half its original value after about 9 years and after a total of about 19 years has fallen to a value lower than the initial population in the 63-69dBA $L_{eq,16hr}$ band. Thus the population in a given band is not only reducing in number but the actual people within the band are changing and are eventually a different population from the people initially exposed. This raises two questions: first what the relevance of the duration of exposure to a specific noise level or band is and secondly, what rate of change occurs in exposed populations.

Role of duration of aircraft noise exposure in annoyance and hypertension effects

The noise annoyance response considered in a recent WHO review [11] is related to "*long-term exposure, i.e. related to residents who live in a more or less noisy area for at least one year, and answer noise annoyance questions related to a long time*".

In a review of studies of the cardiovascular effects of aircraft noise, Berry [16] noted that Huss et al [17] only found a statistically significant effect between L_{dn} and myocardial infarction in subjects who had lived in the same place for at least 15 years and that Floud et al report [18] that "*A statistically significant association was found between exposure to night-time aircraft noise and [self-reported] 'heart disease and stroke' in people who had lived in the same home for 20 years or more, …*". Berry [16] further observes that in relation in relation to hypertension effects Jarup et al [19] (who used data from the same study as Floud et al [18]) reported a significant exposure response relationship for night-time aircraft noise (though not for daytime aircraft noise exposure); the subjects in that study had all lived for a minimum of 5 years near one the airports in the study. However, Jarup et al [19] do not report any investigation of the effects of residence duration apart from the initial requirement for inclusion of the subjects in the study.

Although duration of exposure is considered to be a relevant factor in determining response, and some studies have found a statistically significant relationship linked to exposure duration for some health effects, there do not yet appear to be definitive conclusions in relation to annoyance or hyper-tension effects and aircraft noise assessed with the L_{den} index specified in the EEA report [4].

Factors affecting the stability of populations exposed to aircraft noise

Gelderblom et al [8] considered this issue and reported that within all OECD countries between 2% and 15% of the population

P52

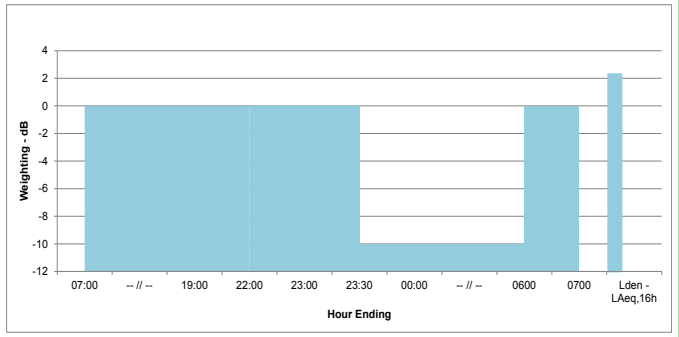

Figure 2. Relationship between Lden and $L_{Aeq,16h}$ at LHR using relative hourly noise level

Relationship between noise level and annoyance

Assume that LHR is a LRC airport and use the EC dose-response relationship [6]

Relationships between noise scales

Equate pre-1990 NNI contours with the corresponding $L_{eq,16hr}$ values
Use the conversion $L_{den} = L_{eq,16hr} + 2$ dB

Effect of changes duration of exposure to aircraft noise

No account taken of changes in exposure as a result of changes to population composition

No account taken of any effect of periods of exposure to different noise levels

Box 1. Assumptions applied for the study

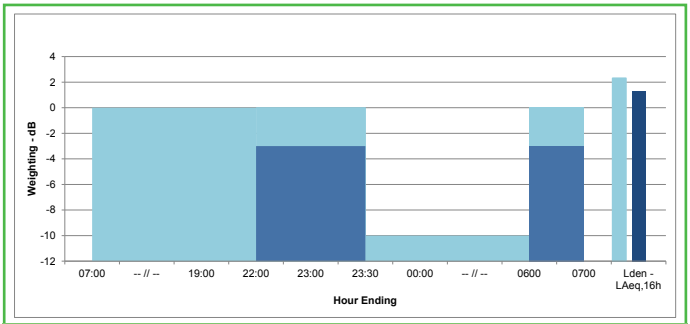

Figure 3. Relationship between L_{den} and $L_{Aeq,16h}$ at LHR using relative hourly noise level

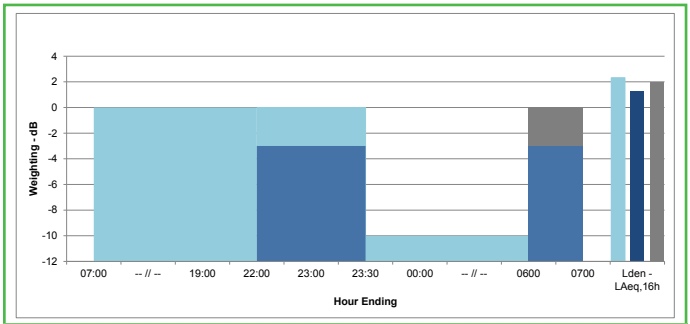

Figure 4. Relationship between L_{den} and $L_{Aeq,16h}$ at LHR using relative hourly noise level

		Elapsed years from start of airport data						
		5	10	15	20	25	30	35
Population in band		*5-year mean population – Normalised to 57-69dBA Pop in Period 1974-1978*						
$L_{eq,16hr}$	L_{den}							
57-63	62	1.00	0.57	0.32	0.21	0.15	0.13	0.13
63-69	68	0.17	0.12	0.09	0.06	0.05	0.04	0.03
Annoyance		*5-year mean population – Normalised to 57-69dBA Pop in Period 1974-1978*						
	%HA	0.27	0.16	0.10	0.06	0.05	0.04	0.04
	%A	0.51	0.31	0.19	0.12	0.09	0.08	0.07
Hypertension		*Proportion of exposed population has been normalised to starting population*						
Attributive Fraction		0.41	0.02	0	0	0	0	0

Table 2. 5-year Normalised values of Population, Annoyance, and AF for Hypertension

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P50

changes residence annually. They showed that for a percentage moving rate of 10% and a fixed population, after seven years more than half of the initial population will have moved. Thus even when the noise generation is stable the duration of exposure to a given noise band can change over a relatively short period.

A recent CAA study on population trends in the vicinity of ten UK airports [20] reports that between 1991 and 2011 the UK population grew by 10% but comments "*Since airports are large centres of activity and employment, they can stimulate population growth*". and calculates that in the area surrounding London Heathrow the population grew by 21% over the same period.

Approach to the analysis

Assumptions applied

As noted above, it has been necessary to consider several factors before attempting to estimate the health effects that might have resulted from past noise policy interventions on aircraft noise and the assumptions applied are summarised in Box 1.

Estimate of effect on annoyance

There are no firm data for aircraft noise on which to base the effects of exposure duration. However, given the rate at which it was found that the in-band population at LHR has changed, for illustrative purposes the average population in the bands 57-63dBA and 63-69dBA $L_{eq,16hr}$ at LHR has been calculated at 5-year intervals from 1974 to 2008.

The relationship in [4] provides an estimate of the percentage of people 'highly annoyed' (%HA) and 'annoyed' (%A) for exposure to a given level of L_{den}. Taking the mid-point of the bands 57-63dBA and 63-69dBA $L_{eq,16hr}$[2] as the level of exposure for the population in each band, the number of people 'highly annoyed' and 'annoyed' in the population in the band 57-69dBA $L_{eq,16hr}$ can then be determined. That process can be applied to estimate the actual number of people 'highly annoyed' and 'annoyed' in the population in the band 57-69dBA $L_{eq,16hr}$ for each of the 5-year periods. In order to illustrate the effect of the noise policy that led to the shrinking of the noise contours and the exposure of fewer people, the actual numbers of people 'highly annoyed' and 'annoyed' in each 5-year period has then been expressed as a percentage of the initial, 1974 population.

Estimate of effect on hypertension

For the hypertension analysis the approach is based on the relative risk method in [4]. The relationships in [4] have been used to estimate the relative risk from which the Attributive Fraction (AF)[3] for hypertension has been estimated for populations exposed to L_{den} values of 62dB and 68dB (*ie*, corresponding to exposures of 57-63dBA and 63-69dBA $L_{eq,16hr}$). To illustrate the effect of the reducing population in each 5-year period exposed the AF values have not been determined by using the actual population for each 5-year period. Instead the populations in the 5-year periods were first normalised to a reference population taken as the combined population in the 57-63 & 63-69 dBA $L_{eq,16hr}$ bands for the first 5 year period (1974 to1979). The AF values derived from these reducing populations therefore assume that a reducing proportion of a fixed population is exposed, whereas in fact the composition of the exposed population changes, as well as reducing in number.

Results and conclusions

The results of the foregoing analysis are shown in Table 2 and Figure 5 (for annoyance) and Figure 6 (for hypertension).

Figure 5 shows that the %HA and %A for each 5-year period (left hand scale) and, for information, the relative increase in ATMs over that period (right hand scale). It can be seen that over the 35-year period the %HA and %A fall from 51% Annoyed and 27% Highly Annoyed to 7% and 4% respectively despite the large increase in ATMs (more than 180%).

In the case of hypertension Figure 6 shows that the AF falls to almost zero after the first two 5 year periods.

In conclusion, the results presented in his paper can only be indicative since no account has been taken of the uncertainties arising from the assumptions, the published confidence limits of

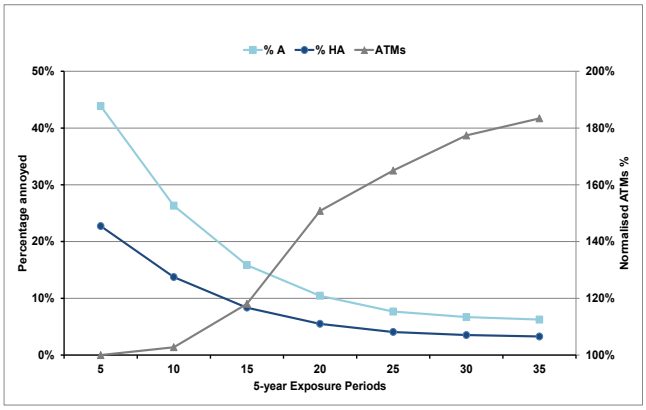

Figure 5. Percentage Annoyance in 5-year Periods Normalised to Initial Population Value (Left Hand Scale)
5-year ATMs normalised to initial value (Right Hand Scale)

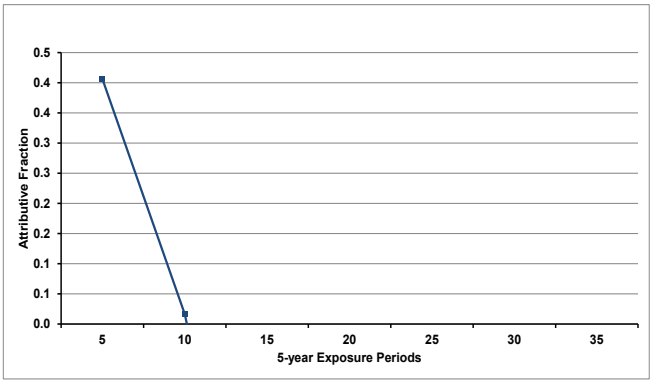

Figure 6. Hypertension Effects at LHR using AF based on initial population

the exposure-response relationships, or potential unreliability in population data [20]. Nevertheless, it illustrates some important points for the assessment of noise-related health effects in practice. It transpires that the duration of exposure of a specific 'population' to a given level can be relatively short because of changes to population composition. This can arise not only from the normal influence of occupiers moving into or out of an area, or population growth (which might be enhanced near air-ports), but by the shrinking of noise contour areas over time. Reduction in noise contour areas not only reduces the number of people exposed but changes the composition of that population since it includes people previously exposed to higher bands. The implications are that further research is required on the role of duration in dose response relationships for health effects and how the effects from periods of exposure at different levels should be combined.

Acknowledgements

The author is grateful to Defra for funding the original research, to Rupert Thornely-Taylor FIOA for supporting this study, and to Bernard Berry HonFIOA for helpful discussions and advice during the preparation of this paper.

Stuart Dryden FIOA *has recently completed 19 years as a Senior Consultant with Rupert Thornely-Taylor's practice having previously worked at EMI Central Research Labs, Southwark Council, WS Atkins and ERM where he was head of acoustics. His experience encompasses environmental noise and vibration, noise nuisance, building acoustics, and expert witness work. He has also undertaken several research projects for Defra including those on noise mapping, use of the EPA, mediation, and EIA.*

References

A full set of references can be obtained from the Editor, Charles Ellis, at **charles.ellis@ioa.org.uk**

2. Converted to L_{den} values of 62dB and 68dB respectively.
3. The Attributive Fraction is a measure the effect on the incidence of the specific health effect of removing the noise exposure.

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Uncertainty in noise modelling

By Simon Shilton

Introduction

The use of computer models for the assessment of environmental noise levels has been in wide spread use since the late 1980s. Today, computer noise modelling is used extensively to determine the level of noise impact, design of mitigation measures, extent of compensation and number of people exposed to strategic schemes on the national transport networks, and across entire countries under EC Directive 2002/49/EC (END) [1].

The computer software used for noise assessments predominantly implement calculation methodologies set out in national, or international, standards or guidelines, such as the new EC Directive 2015/996 [2] or ISO 9613-2:1996 [3]. These noise models are engineering methodologies, with the majority being developed empirically with a basis in the fundamentals of acoustic propagation, along with a series of correction factors employed to provide a best-fit to the measurement data used as the basis for validation of the method. The methods are typically most reliable when used in situations similar to the validation measurement locations, which in turn relate to the original design purpose of the method.

With an increasing focus on the re-use of calculated noise levels in health impact assessments [4], and the onset of health effects creating a call to provide results as low as 40 dB L_{den} [5] it becomes increasingly relevant to consider the factors which affect the validity of the results. This article sets out an overview of uncertainty in the noise modelling process and discusses some strategies for determining and minimising the impact of uncertainty at each stage.

Sources of uncertainty in noise modelling

Isukapalli and Georgopoulos [6] stated that there are normally four stages involved in the uncertainty analysis of a model:

- estimation of uncertainties in model inputs and parameters (characterisation of input uncertainties)
- estimation of the uncertainty in model outputs resulting from the uncertainty in model inputs and model parameters (uncertainty propagation or sensitivity)
- characterisation of uncertainties associated with different model structures and model formulations (characterisation of model uncertainty)
- characterisation of the uncertainties in model predictions resulting from uncertainties in the evaluation data (uncertainty of evaluation data).

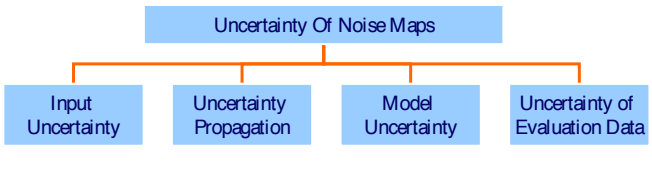

Figure 1: Four components determining the uncertainty of noise maps

Input uncertainty

Input uncertainty is determined by a combination of uncertainties in static inputs, such as the position of the sources, building geometry, ground altitude variations, and by the quality of time-varying attributes such as the traffic flow and meteorological data (Figure 2).

This input data is often captured primarily for purposes other than noise studies, and it needs to be processed, combined with other datasets and/or digitized before it can be used in a noise calculation model. Input data resolution, currency, coverage and licensing all create challenges when trying to realise a wide area model for a noise assessment.

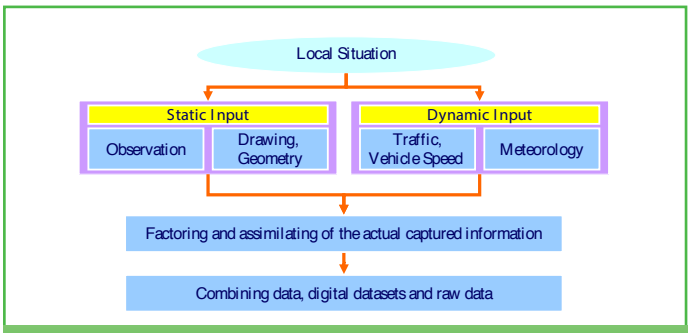

Figure 2: Input uncertainty scheme

Model uncertainty

Model uncertainties are those issues related to how well the documented calculation standard represents the real-world situation, and what uncertainties it introduces due to the (necessary) simplifications made in order to present a solution which is relatively simple to implement.

There is also the secondary issue of how the documented standard is transposed from a paper document into a 3D noise calculation tool, and how the tools additional simplifications, efficiency techniques, end-user calculation settings and assumptions introduce further uncertainties into an uncertain methodology in order to create usable real world calculation times (Figure 3).

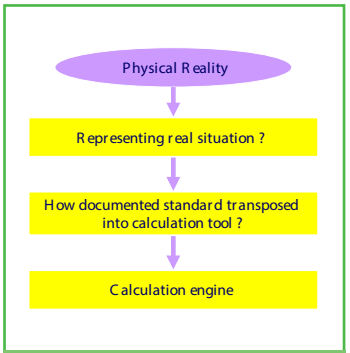

Figure 3: Model uncertainty scheme

Most of the existing methodologies were not originally developed with a software implementation in mind, and therefore are not specific enough in many situations, and have unclear phrases and ambiguous algorithms. The methods also tend to describe idealised cases, such as an infinite thin barrier, yet offer no guidance on how to interpret or use general purpose GIS datasets, such as building polygons, when interpreting barrier screening or reflection effects. These uncertainties in the documentation give rise to differing software solutions, which in turn can lead to significantly different results being obtained using the same method in different software [7] (Figure 4).

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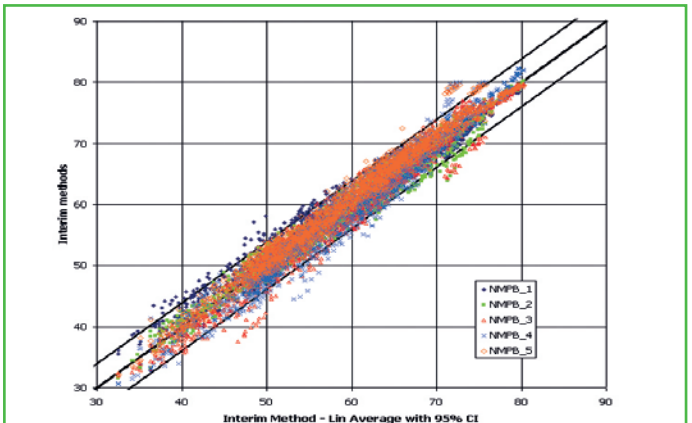

Figure 4: Linear average result from five software implementations of EC Road "Interim Method"

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P54

The sources of uncertainty do not end where the noise levels are calculated. The final result of a noise mapping project may be the number of residents and dwellings within noise level bands for reporting to the EC, or the health impact statistics, or monetized to illustrate the cost burden of noise. For this purpose, noise contours will be generated by using (different) interpolation techniques and combined with population data, health data or financial factors, each introducing further sources of uncertainty.

Propagation of uncertainty

The propagation of uncertainty, or sensitivity of the models, is an indication of how uncertainty in the input data propagates through the calculation process and produces uncertainty in the resultant. For example, how uncertainty in traffic speed generates uncertainty in the emission sound level, or how uncertainty in the calculated noise levels generates uncertainty in the number of people exposed or the health impact assessment.

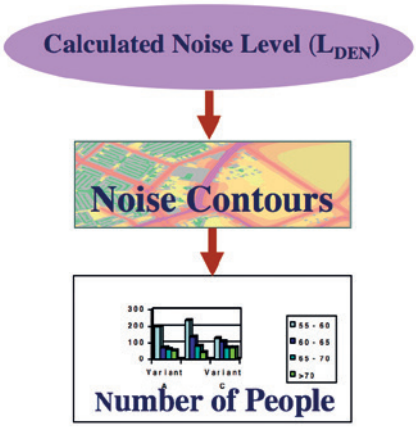

Figure 5: Uncertainty in assignment of noise levels to population data

Uncertainty of evaluation data

The evaluation data that is used to confirm the accuracy of the calculated noise level, is in itself open to uncertainty due to its means of capture. In relation to this Kragh [8] made a statement presenting the fundamental nature of this issue: "*The uncertainty of a predicted noise level is an interval in which the true value lies. It is difficult to quantify the uncertainty of a calculated noise level because the true value is unknowable…A measured noise level may deviate from the calculation result due to the influence of weather, variation in source operating conditions, background noise etc. during the measurement.*"

Figure 6 shows the interaction between uncertainties in the source operating conditions, the meteorological factors and the noise measurement itself. Corrections to the directly measured noise levels are necessary in order to compare them with the calculated, long-term noise levels.

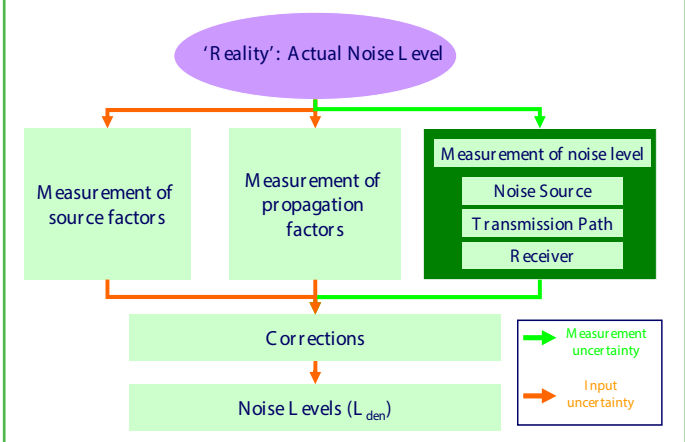

Figure 6: Uncertainty of Evaluation Data

The issue of measurement uncertainty has also been researched in detail by Craven and Kerry [9] whose work suggested that you were doing well if repeated measurements were within 5dB(A) at the same site, for the same source, on different days.

Having said that, it is also possible, as an alternative approach, to assess the uncertainty of the calculated noise level against the true value of the calculation. If one considers the situation where all the relevant input data is known with certainty and precision, this can be said to provide a true calculated result, even if it differs from a measured result. De Muer and Botteldooren [10] suggested that:"*A lack of quality and imperfection of models and input data can either be caused by uncertainty or imprecision. Uncertain information can be characterised by the partial knowledge of the true value of a statement. Imprecise information is linked to approximate information or not exact information.*"

Managing uncertainty

Input uncertainty & propagation of uncertainty

In support of EC WG-AEN and the second edition of their Good Practice Guide [11] two research projects were undertaken into uncertainty in strategic noise mapping in 2005 [12] and 2007 [13]. They focused predominantly on model input uncertainty and error propagation for the UK and EC recommended Interim calculation methods for roads and railways. The results led to quantified accuracy statements within Version 2 of the GPG, and practical advice on managing input data uncertainty. The research results help to identify the relative importance of input datasets, and quantify the level of uncertainty in the noise results which may result from uncertainty in the input datasets.

This work led to a number of studies which either validated the results of the research [14], or looked into additional aspects of data quality or results sampling [15], [16], [17], [18], [19], [20]. With the adoption of EC Directive 2015/996 moving Europe towards a common noise assessment method for strategic noise mapping from 2019 it is appropriate to review previous research in this area in order to establish the work to be undertaken in the context of this new methodology.

The data input requirements for the Common Method are broadly similar to those of the established national methods. The available input data for the geometrical aspects such as terrain, buildings, barriers etc are unlikely to change due to the appearance of this new method, so the input data uncertainty is likely to be the same. However, it is not yet established how this input data uncertainty will propagate through to results uncertainty, as there has not yet been any error propagation or sensitivity testing of the new method, except for some work on the Harmonoise road traffic source model [21], [22]. During the interim period, it is likely that the quantified accuracy statements in the WG-AEN GPGv2, and the underlying Defra research projects, will be the main guide to the influence of input data on results quality.

Model uncertainty

Directive 2015/996 came about following the six year CNOSSOS-EU process lead by DG Joint Research Council (JRC). The methods set out within Directive 2015/996 are based upon the DG JRC Reference Report published in September 2012 [23], which in turn was built from work undertaken in the Harmonoise [24] and IMAGINE [25] projects, the French NMPB2008 standard [26] and ECAC Doc 29 3rd Edition [27].

However, it is important to note that Directive 2015/996 is not exactly the same as any of the preceding methods, for this reason this paper will refer to the Common Method as set out in Directive 2015/996, which is NOT the same as CNOSSOS-EU, Harmonoise, IMAGINE, NMPB2008 or ECAC Doc 29.

As Directive 2015/996 is established as legal text there is little which may be done to affect the documented calculation methodology, and it must be assumed that the preceding CNOSSOS-EU process has been able to deliver a method which is

P58

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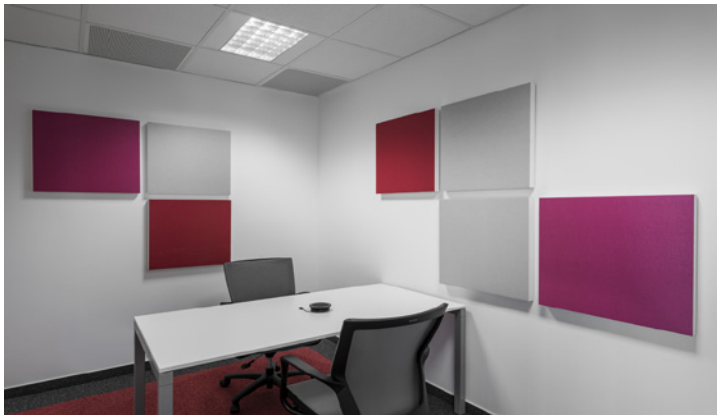

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reliable within the defined scope of application. The area which is now to be the focus of attention will be the transposition of the methodology into the noise mapping software tools which will be used to undertake the calculations. Ideally this work will be undertaken within the frame of ISO 17534-1:2015 [28].

In order for the common method to be consistently implemented in a quality assured manner in software it is necessary for there to be a set of test cases which meet the requirements of ISO 17534-2:2014 [29] and a Technical Report under the ISO17534 framework, which addresses any unclear aspects of the method as written in Directive 2015/966. This work is currently being undertaken by an ISO working group based upon research work being undertaken in Germany, Austria, France, Finland and the Netherlands.

With these two requirements met, software developers may undertake self-certification of the software they have developed which implements the Common Method, and provide a Declaration of Conformity.

The end users may then check the correct implementation of the method in software using the test cases published by the developers of the method, and the reference configuration of the software provided by the software developers. The end user will also be able to undertake analysis to assess the uncertainty in the results introduced by any software acceleration techniques or end-user calculation settings used, and report this uncertainty alongside the primary noise calculation results.

With a quality-assured implementation of the common method within noise mapping software systems, it then provides a sound basis for undertaking sensitivity analysis and error propagation testing of the new method in order to develop method specific guidance on input data quality requirements.

Uncertainty of evaluation data

Once the results of the noise calculations have been developed, it is becoming increasingly common to undertake some form of validation exercise to cross reference the calculated levels with measurements.

There is much to consider within such a comparison, and it should be undertaken with due caution in order to ensure that the assessment is valid, and that the levels have been developed on a like-for-like basis. For example, measurements may only be taken for current situations, it is not possible to measure some past or future scenario. Similarly, in most cases it is only possible to measure for a limited period of time, a few days up to a few weeks being commonly described as "long term" monitoring at one location. It is also likely that measurements may only be undertaken at a small number of specific locations within the project area, and these must be selected such that they represent locations where the calculation method is known to be valid.

As can be seen, any comparison between noise mapping results, which may represent an annual average situation for millions of receptor points across a city, against a few days of measurements at a handful of locations will be uncertain. Should such a study be required, there are methods which could be used to help reduce uncertainty and improve the reliability of the resulting comparison.

During the noise level measurement campaign the dynamic elements of the situation should be captured alongside the noise levels, namely the meteorological data and any dynamic elements which make up variations in the source emission level, such as traffic flow, traffic composition, traffic speed etc.

Based upon the results of the monitoring, the long-term noise level measurements should be analysed with reference to the source data and meteorological data in order to establish a stratified set of measurement windows. Each window should be a combination of emission (e.g. day, evening, night) and meteorological conditions, within which there was consistent emission and propagation conditions. This approach is outlined in the IMAGINE WP1 final report [30] and forms the basis of the recently revised ISO 1996-2 [31].

Meteorological window / Emission window	1	2	3	4
1				
2				
N				

Figure 7: Stratification of emission conditions and meteorological conditions during measurements.

Each stratified window is then composed of a set of noise measurement results, for which the measurement uncertainty may be determined, and the captured dynamic elements of the situation as they existing during the measurement window, i.e. the traffic flow data and the meteorology. These dynamic elements may be introduced into the calculation model, to enable the model to replicate the situation during the measurement window, creating a series of meta-models. The results from the calculations of each of these meta-models may then be compared with the noise measurement results as the basis for the validation study.

This approach was implemented within a recent project in Turkey [32] which indicated average level differences of less than 4.0 dB(A) across all the road, railway, aircraft and industry situations investigated.

Conclusions

An overview of the four main sources of uncertainty within noise modelling has been presented. Input uncertainty, error propagation, model uncertainty, and evaluation uncertainty have each been discussed in turn, with the aim of highlighting how each fit within the overall noise modelling process.

In the context of the move towards the new common noise assessment method for Europe, set out in Directive 2015/996, practical means of managing these areas of uncertainty have been discussed.

Input uncertainty will currently be informed by data requirements for the national methods previously researched, until sufficient sensitivity analysis and error propagation testing has been undertaken using the new method.

Whilst the uncertainty inherent in the documented methodology is now fixed, other elements of the overall model uncertainty may be managed under the frame of a forthcoming Technical Report under ISO 17534 standard, which will help to ensure a consistent implementation of the method into noise calculation software. This will provide end-users with a quality assured implementation, and tools to enable testing of input data quality and end-user calculation settings within the software.

Uncertainty in the evaluation data may be addressed by undertaking long term environmental noise measurements in line with ISO 1996 alongside capture of the dynamic elements within the situation, including traffic data and meteorological conditions. The captured data may then be used to establish calculation meta-models for each of the measurement windows identified, in-line with the approach set out under IMAGINE WP1 which is within the ISO 1996-2:2017.

Simon Shilton *has worked as an acoustics consultant for more than 25 years. Following 15 years with Hepworth Acoustics, he formed Acustica 12 years ago and has since worked on projects throughout Europe specialising in environmental noise; noise modelling; calculation methodologies; strategic noise mapping; environmental noise policy and noise action plans.*

References

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Going great guns: measuring high noise levels

By John Campbell MIOA

The Campbell Associates team recently went to a clay pigeon shooting range as part of an experiment to capture accurate high sound pressure levels. They took measurements from various shotguns at a distance of 0.5m from the trigger, using a sound level meter (see below). This type of measurement is sometimes required to assess the hearing protection used by individuals participating in gun-related leisure activities.

The sound level meter used was a Norsonic 140 sound Analyser and was tested in three configurations.

1. The standard meter which has a 140dB measurement limit
2. The standard meter in high level mode which boosts the measurement limit to 150dB
3. The standard meter with a quarter inch high level microphone capsule. This increases the measurement limit to 160dB.

The results

1. In the standard mode the system frequently overloaded when the microphone was positioned closer than one metre from the gun being fired. See Figure 1.
2. How does a high range option work – How do you get an extra 10dB from a standard ½" microphone?
   The sound level meter used can use 200V microphone capsules and features a high range option. When the extended measurement range is activated the standard 200v microphone has its polarization voltage lowered. This is reduced from 200 V to about 70 V. The microphone sensitivity will then be reduced by 10 dB and the instrument will be able to measure peak signals up to 150 dB. The change in the polarisation voltage will lead to a small change in the frequency response for the microphone. This change is automatically compensated when the extended measurement range is selected. Corrections are specific to each microphone type and should not be mixed.
   With this option activated in the sound level meter most measurements were achievable. See Figure 2.
   However at a distance of half a metre from the gun with heavier shot the sound level meter did see overloads with measured levels over 150dB(c) peak.
3. Using a quarter inch microphone
   With an adaptor, a ¼" microphone will fit onto a standard half inch preamplifier and you can then measure levels with a standard sound level meter. With this microphone it was possible to measure peak levels without overloads with the highest peak of 157.9dB(c). See Figure 3.

Why quarter inch microphones?

Quarter inch microphones are inherently lower in sensitivity than ½" microphones. The smaller surface area means the same sound pressure impinging on them will lead to a smaller voltage coming from the capsule. This reduced voltage is desirable for very high sound pressure measurements as it is high signal voltages that lead to overloads!

How to measure beyond 160dB?

1/8th inch microphone – This allows measurements to 175dB. With a 120V preamplifier supply it can measure to 178dB.

Preamplifier voltage – For extremely high sound pressure measurements it is important to not only have a microphone with low sensitivity; you must also have a preamplifier which can handle high signal voltages to avoid clipping of the signal. For your sound level meter (or PC analyser) to display accurately these measurements a 120V supply to the preamplifier is preferable.

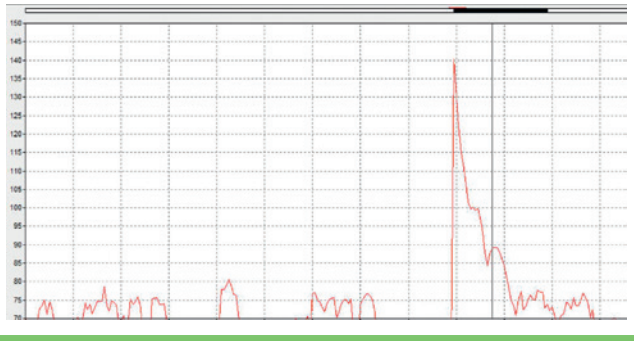


Figure 1. Overloads on standard range

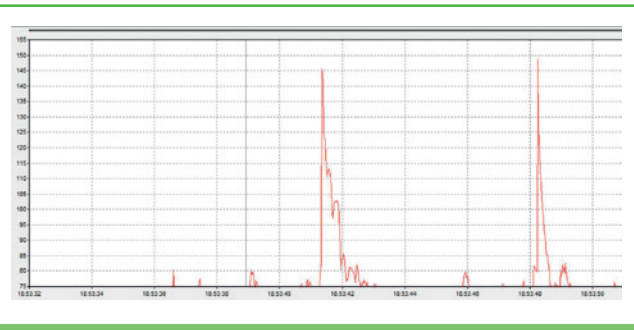


Figure 2. High range option

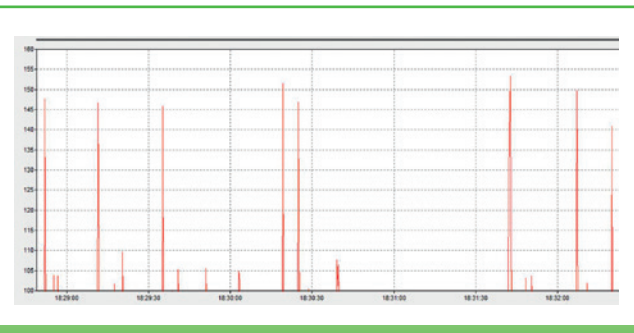
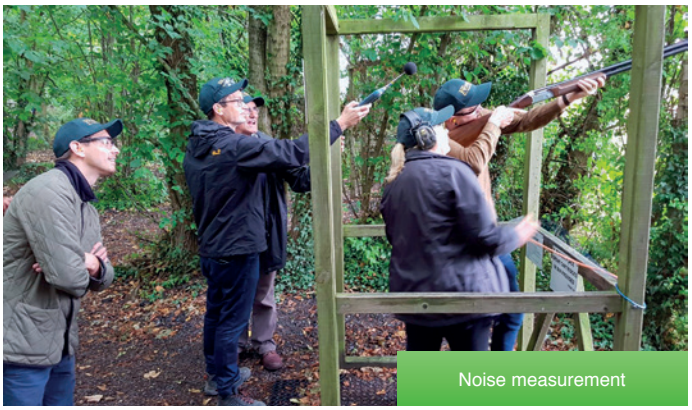


Figure 3. ¼" microphone

Ready to go



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It's 50 not out for SRL as it celebrates half a century of expansion

Leading acoustics consultancy SRL Technical Services has celebrated its fiftieth anniversary with a black tie dinner for staff and partners and ex employees followed by a family fun day.

Based in Little Waldingfield, Sudbury, the company, originally known as Sound Research Laboratory, was established in Colchester in June 1967 by Ian Woods, whose grandfather founded fan manufacturer, Woods of Colchester.

It moved to Sudbury in 1969, testing the acoustic performance of products in its new laboratory as well as providing an acoustic consultancy and design service.

Today the company works across many sectors, including education, healthcare, residential, leisure and large infrastructure projects, and employs 48 people across sites in Sudbury, Manchester, Birmingham, London and Cape Town.

Suzanne Woods, SRL Chairman and widow of Ian, said; "When Ian started the business in 1967, acoustics was almost a dark art – no one really knew what it was all about. He hired a handful of acousticians; built a laboratory and was soon testing acoustic products, fans and lawnmowers! Almost immediately he started getting enquiries about this work. It hasn't stopped growing ever since.

"Ian died five years ago but he would have been incredibly proud of the direction in which the business is moving. He enjoyed celebrating SRL's 40th anniversary and he would be delighted it is flourishing in the way it is now."

The company's success led it to open a purpose built laboratory and offices on land at Little Waldingfield and this year SRL will double its acoustic and airflow testing capacity by building a second laboratory on its Holbrook site.

The business retains its family ethos, holding regular sports and social events with staff and their families, said Suzanne. The company also has strong links with the community: students from Thomas Gainsborough School, Stour Valley and Hadleigh High Schools in Sudbury are invited for work experience each year and the company is looking to continue with its apprenticeship programme by investing in its second apprentice this year

"Ian was always focused on education at all levels and knew people to be the lifeblood of any organisation. He knew all staff within a very short time of their arrival and, on the people front, he would have been delighted that so many local residents accepted our invitation to the family fun day," said Suzanne.

Operations Director Richard Budd has worked at SRL for 23 years, starting his career with the company as a graduate acoustic consultant straight from university.

He said: "My tutor at university recommended SRL to me as it was, and still is, known as a leader in its field. Professionally I have worked on some incredibly prestigious projects and the company has invested in my development. Personally, I appreciate the family culture that surrounds everything we do. I felt part of the family from day one and for a young person of 21 that meant a great deal."

SRL Chairman Suzanne Woods (centre) with Helen Blackmore (left) and Zara Bland who were instrumental in organising the black tie dinner

In its 50 years SRL has worked on projects around the world, including the Dubai Opera House, the Bordeaux courts, the Shangri-La Hotel in Oman and oil rigs. Its biggest acoustic consultancy project to date has been a five-year contract working on the Crossrail project with a firm tasked with boring 21km of tunnel underneath some of the most densely populated parts of London.

Diversifying its services, SRL's work now includes an air quality team, noise, dust and vibration monitoring and a team of registered BREEAM (Building Research Establishment Environmental Assessment Method) assessors, who help construction professionals understand the environmental impacts of their developments, and how these can be mitigated.

The company's evolution will ensure it continues to thrive, said Suzanne.

She added: "I want us to move forward in the same way we always have done – by keeping abreast of everything that is going on around us and keeping our consultants trained and motivated. I have no doubt we can continue to flourish as a local company."

New additional guidelines for noisy hotels and soundproof products

The Quietroom Foundation has released a new, revised edition of the *Handbook Qualification Quietroom Label*.

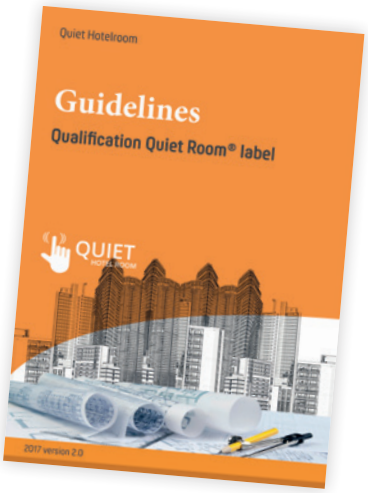
The handbook describes the certification process required to obtain the Quietroom label. It contains detailed information about the standards and measuring procedures used to certify hotel rooms.

It is aimed primarily at acoustic consultants who are engaged in the soundproofing, measurement and certification process. The handbook provides a step-by-step guide to the measurement and certification process.

In order to support architects and developers, the Quietroom Foundation, which oversees the Quiet Room label, has published the Quiet Room Guide for architects and developers. With the help of this guide, it says construction professionals can gain an understanding of the QR label, the certification requirements and the latest methods for acoustic insulation of hotel rooms.

The handbook is also a guide for hoteliers, builders and developers seeking more information on certification and demonstrates the solid and objective standards on which the Quietroom label is based.

Apart from the certification of hotel rooms, the same standards are now also applied to examine and certify soundproofing products and procedures. The Quietroom Foundation is developing a freely accessible database of manufacturers of certified products and procedures, which will help hoteliers and developers to construct hotel rooms that are guaranteed to have a high level of soundproofing.



The handbook Qualification Quietroom label may be obtained by contacting **Alice@quiethotelroom.org** or write to: Foundation Quietroom, Keizersgracht 241,1016 EA Amsterdam, The Netherlands. For more details go to **www.quiethotelroom.org/en**

Top German and US acoustic specialists announce merger

The Walters-Storyk Design Group (WSDG) and ADA-AMC (Acoustic Design Ahnert – Acoustics & Media Consultants) have agreed to merge.

The alliance will result in a new global design and acoustical consulting organisation that will aim to focus on three primary market sectors:

- media content creation, production, distribution and broadcast facilities
- corporate and governmental media installations, parliament halls and conference centres
- sports, arts and entertainment venues such as theatres and concert halls.

Partners: (left to right) John Storyk, Dirk Noy and Wolfgang Ahnert

ADA, a Berlin-based company and the predecessor of ADA-AMC, was founded in 1990 by Dr Wolfgang Ahnert, author of several books on room and electro-acoustics and an expert in technical acoustics and software development.

Since 1975 Dr Ahnert has been involved in the overall planning of numerous theatres, concert halls and further cultural buildings, while often participating in complex projects abroad.

WSDG provides architectural design, acoustic consulting and media system engineering services specialising in the implementation and integration of technology infrastructure in the built environment. It was co-founded by John Storyk in1969 and his wife/business partner Beth Walters. Jim Storyk was responsible for the design of Jimi Hendrix' Electric Lady Studios in Manhattan.

An 11-times NAMM TEC Award winner, WSDG has grown into an international organisation with a staff of more than 60 and offices and technical representation on six continents, including offices in New York, Miami, Brazil and Basel, Switzerland.

ADA-AMC will remain at its current Berlin offices while general management duties will be shared between Dr Ahnert and Dirk Noy from WSDG's Basel office.

Association of Australian Acoustical Consultants welcomes New Zealand firms

The Association of Australasian Acoustical Consultants (AAAC) has announced that it will now represent acoustical consultancies in New Zealand and welcomes seven additional consultancies as members of the organisation.

The AAAC aims to raise the standards of acoustics practice across Australasia. It helps to educate industry professionals and the public on the role that good acoustics, and the management and mitigation of noise and vibration, play in achieving good design and effective planning in the built and natural environment.

The organisation now has 65 member firms, employing approximately 400 consultants, reflecting a $90 million industry.

New Zealand firms who are now AAAC members include: Acoustic Engineering Services, AECOM (Auckland and Christchurch), Malcolm Hunt Associates, Marshall Day Acoustics, Norman Disney & Young, SLR Consulting and Styles Group.

Matthew Stead, chairman of AAAC, says, "For the first time in New Zealand, acoustic consultancies will have their own body which will give access to standardised approaches and procedures, training opportunities and a community of like-minded specialists to network with and learn from."

HEAD test equipment can help achieve logo certification for new GSMA standard

The GSM Association (GSMA) has now specified test methods to assess the minimum performance requirements for allowing manufacturers of LTE mobile terminals and network providers to make use of the HD Voice+ (High Definition Voice+) logo. HD Voice+ comprises the EVS (Enhanced Voice Services) codec operated in super-wideband or full band modes and the enhancements to terminals and networks according to the requirements defined in TS.23 Annex H. Due to newly defined requirements regarding e.g. jitter, packet loss and delay, HEAD acoustics' measurement equipment is perfectly suited for achieving HD Voice+ logo certification for 4G setups.

With the advanced communication quality analysis system ACQUA in combination with the measurement front end MFE VIII.1, EVS codec option Cod-EVS as well as the software option MFE VIII.1-IMP, HEAD acoustics says it can provide appropriate solutions for testing accordingly. Cod-EVS supports all specified bandwidths from narrowband to full band and all bit rates and modes (handset, handheld hands-free and headset). The option MFE VIII.1-IMP enables users to simulate different IP network impairments, such as delay, jitter, or packet loss, directly at the source of the signal and to apply it to the outgoing IP packets of the MFE VIII.1. The implementation of HEAD acoustics is worldwide unique: MFE VIII.1-IMP attaches the impairment information to the time signal before encoding. Thus, always the same impairments are applied to the same part of the time signal regardless of the DTX state. This way, network impairments are reproducible even with activated DTX.

The minimum performance requirements defined for HD Voice+ logo certification refer to Release 13.0 of the two standards TS 26.131 and TS 26.132 of 3GPP standardisation body. Mobile vendors, network operators and manufacturers from the automotive industry have to make sure that their devices or applications fulfill the required speech quality acoustical characteristics and speech processing in order to use the HD Voice+ logo.

The MFEVIII.1 front end

Active helicopter rotor control 'cuts noise by 30 per cent'

Tests have been conducted in Germany that have led to a 30 per cent cut in helicopter rotor noise.

The German Aerospace Centre (DLR), together with Airbus Helicopters Deutschland, tested active rotor control on a modern, five-blade rotor in a wind tunnel as part of the SKAT (Scalability and risk minimisation of technology) research project.

The main rotor, which is both the source of the lifting force and propulsion on the helicopter, creates a series of aero-elastic and aero-acoustic problems such as high levels of vibration and the generation of a great deal of noise.

While vibrations generally have a negative impact on passenger comfort and the durability of components, the rotor noise plays a particularly key role in landing approaches over populated areas. One way to reduce this noise is active rotor control.

With the use of multiple swashplates, DLR researchers were able to successfully reduce vibration and noise emissions during landing approaches with the five-blade rotor.

With individual blade control, rotor noise on the ground during the approach was reduced by up to three decibels, which corresponds to an approximately 30 per cent decrease in noise. In high-speed flight at more than 168mph, the amount of power required for the main rotor, an indicator of a real helicopter's fuel consumption, was reduced by more than five percent.

New technology can reduce helicopter noise

Researchers were able to reduce the unpleasant vibrations created by the rotor during flight by more than 80 percent with the new adaptive control system. This means, they say, helicopter flights could very soon become not only quieter, but also much more comfortable.

STO helps to keep things quiet at London library

The new look Marcus Garvey Centre

Sto's StoSilent Distance A2 110 system has been installed throughout the Marcus Garvey Centre in South Tottenham, London for Haringey Council, as part of a project which has seen the building's interior undergo a series of major improvements.

Transforming the existing building into a new integrated library and customer service centre involved the removal of many internal walls to create larger, flexible open plan areas. These included various spaces which could be adapted for different uses, and this made the installation of effective and reliable acoustic design and balance a major priority.

Sto Technical Consultant for Acoustics Mike Wallace said: "The system was able to achieve the desired acoustic performance and reduce reverberation times in the finished building to under 1 second."

The StoSilent Distance system can be installed as a suspended ceiling or as a wall covering over a cavity, and areas of up to 200m^2 can be created without the need for a break in the system, as well as curves down to a radius of 5m. This allows an effective acoustic solution to be created for many different types of installation.

For more details on visit **www.sto.com**

Royal Society engineering research award for Tim Leighton

Timothy Leighton, Professor of Ultrasonics and Underwater Acoustics at the University of Southampton, has been awarded the Royal Society's Clifford Paterson Medal "for translation of his fundamental research into acoustics and its application in many areas including anti-microbial resistance, mine detection, foetal scanning, catastrophe relief, climate change and marine life".

The medal is presented every other year to an outstanding researcher in the field of engineering.

Tim, a Fellow of the IOA, has worked at the University of Southampton since 1992, when he joined the Institute of Sound and Vibration Research (ISVR), part of the Faculty of Engineering and the Environment, as a lecturer in underwater acoustics.

Inspired by a curiosity about the babbling sound made by streams, he has translated his theoretical research about bubble acoustics and ultrasonics into multiple real-world applications, including devices for healthcare, catastrophe relief and industry.

His inventions include the world's only sonar capable of detecting mines in bubbly seawater, which he based on his theory of dolphin maths, and a cleaning system based on ultrasonically stimulating then controlling the motion of bubble walls to turn them into microscopic 'scrubbing machines', dramatically improving the cleaning power of cold water.

Tim's most recent invention uses ultrasonics to bring about accelerated wound healing, with potential to help trauma and burns victims worldwide.

He also helped develop the safety guidelines under which, to date, two billion babies in the womb have been ultrasonically imaged, while his conical bubble theories led to the invention and supply of more than a million migraine treatments. Other inventions were designed to help with osteoporosis, kidney disease and finding buried survivors in collapsed buildings.

He has also explained aspects of whale behaviour, devised sensors to measure parameters key to Earth's carbon budget, and even enabled planetaria around the world to play for their audiences the sounds that other planets will make – decades before those sounds are likely to be recorded.

Tim Leighton

As well as running his own research laboratory, he is founder and chairman of Network for Anti-Microbial Resistance and Infection Prevention (NAMRIP), which expanded to cover four continents as Global-NAMRIP, and Health Effects of Ultrasound in Air (HEFUA).

Sounds just right for acoustics student Elle at the Glastonbury Festival

IOA student member Elle Kalavsky combined her passion for audio acoustics with her love of music this summer by working at the Glastonbury Festival.

She and several fellow University of Salford undergraduates were part an Aria Acoustics team performing site audits and taking sound measurements.

In the days leading up to the main stage's opening, every loudspeaker system in every bar, stall, and stage needed to be seen and checked against a list of requirements before they got the "OK" to make some noise, she explained.

"This is an important part of the lead-up to the festival, as it helps to gauge the off-site noise levels of the occupied festival prior to the main stages running," she said. "The festival ground itself is several kilometres across, so a site audit is not an easy task.

"Following this audit, the on-site equipment is set up ready for noise propagation tests. This means that at front of house each of the main stages, and some smaller stages (the Pyramid, John Peel, Other, the Park, West Holts, Arcadia, Glade, Sonic, the Blues) either a Rion NL52, NTi XL2 or a NTi AL1 and laptop with noise measuring software are set up and ready to go ready for the weekend."

Elle spent her time at the front of house of the Park stage, and also occasionally went to check on some stages in the Silver Hayes area. Each day began by ensuring all the equipment and software were working prior to music starting at 10.30am.

"Every stage is given 15 minute L_{Aeq} limit that should not be exceeded, so maintaining communication with each sound engineer was important so they were aware of how loud they were running the show," she said.

"Occasionally there were some sound engineers who liked to keep their mix louder than needed which was always an expected problem, but with a fresh set of ears to help listen for a good mix and good rapport with every engineer, I managed to keep the noise down."

Elle, aged 20, began a BEng (Hons) Audio Acoustics course at Salford in September 2015. In addition to being a student representative for the course, she is the Salford student representative for the IOA North West Branch committee.

She is currently spending the first six months of her placement year as a lab assistant at the university's acoustic test laboratory, before moving to the university calibration laboratory for the second half of the year.

"An added bonus to working at Glastonbury was of course seeing all the bands perform live. Despite being stationed at a smaller, less-famous stage, I still got to see some class acts, including The Flaming Lips, Elbow, Sleaford Mods, and many more.

"I'm now hoping to be back at the festival when it returns in 2019 – bigger and louder than ever!"

Elle takes a temporary break between measurement duties

Acoustic Associates Sussex welcomes two new team members

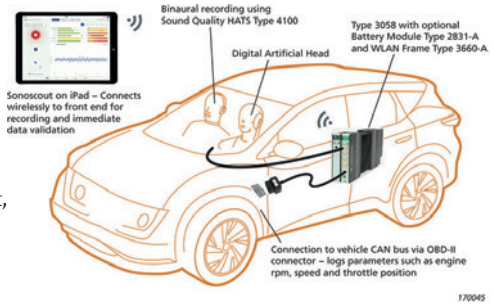
Acoustic Associates Sussex has appointed Scott Castle and Martyn Chambers to its acoustics and air tightness testing teams at its base at Shoreham Airport in response to continuing growth.

"We are delighted with these two appointments", said Peter Attwood, Managing Director. "Scott joins us as a Senior Acoustic Consultant having spent 18 years working as an Environmental Health Officer with a number of local authorities, for a number of years as a Senior EHO. He will enhance the strength of our planning and environmental acoustics team.

"Martyn starts with us as a Trainee Technician having had previous experience in a number of technical roles, most recently as a theatre technician. In addition to training in an acoustics support role, Martyn will shortly train to become an accredited air tightness tester."

Martyn Chambers (left) and Scott Castle

CAN do: Brüel & Kjær updates Sonoscout NVH recorder



The new Sonoscout portable NVH recorder

Sonoscout, Brüel & Kjær's portable NVH recorder, now includes CAN bus data which, it says, means it delivers a complete solution for validation and engineering on the go or in production testing, without the need for third-party hardware.

"Together with an even simpler and more intuitive iPad® interface, Sonoscout now offers one of the easiest and most complete real-time measurement solutions for vehicle testing," said Martin Qvist Olsen, Product Manager at Brüel & Kjær.

By continuously displaying test information such as throttle position and engine rpm from the CAN bus, Sonoscout maximises engineer confidence during testing and brings simple control and analysis to tasks such as comparing vehicles and data sets. When used with a binaural recording headset, a Sound Quality HATS Type 4100 or digital HEAD HATS, Sonoscout can capture cabin sounds in real-time.

After recording data can be quickly validated: users can replay the time history, listen to it, and explore it with simple touch controls. Exporting data uses tools that transfer to PC in five common file formats.

In addition to recording, the Sonoscout app has on-board analysis which allows users to make decisions on the spot and generate a report using Microsoft® Office apps.

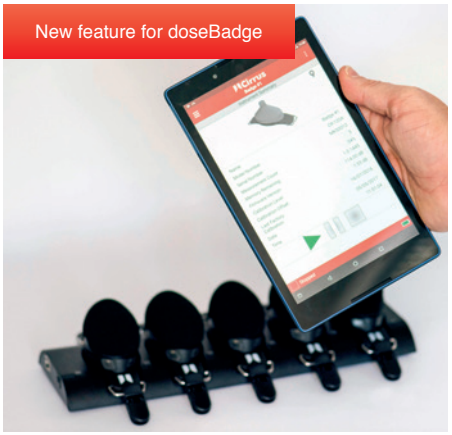
Sonoscout's capabilities now include:

- Automated calibration procedure
- TEDS support for automatic CCLD transducer recognition
- FFT, order analysis, spectrogram analysis, sound quality metrics
- Data from a vehicle's CAN bus (OBD-II or J1939)

To find out more visit **www.bksv.com/sonoscout**

Scheduled monitoring feature for Cirrus' doseBadge

New feature for doseBadge

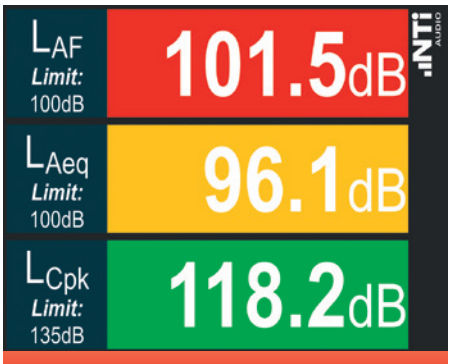


Cirrus Research has upgraded its doseBadge noise dosimeter which now has a scheduled monitoring feature that provides the ability to automatically start and stop monitoring at pre-set times. It is achievable in four steps,

"This is an excellent add-on to the doseBadge" said Cirrus Marketing Manager James Tingay. "Not only does it give real peace of mind for anyone who needs time away from their day to day job – either for training or holidays - but it is so simple to set up with no effort on anyone else's part."

For more information go to **http://www.cirrusresearch.co.uk/products/dosebadge-noise-dosimeter**

Sound level visualisation with the Projector PRO



The Projector PRO in action

NTi Audio has launched a new generation of the display projector for the XL2 Sound Level Meter.

The Projector PRO software application connects via a USB port with the XL2 measuring device and visualises its screen on a Windows or Mac computer.

Additionally, large level displays and a level predictor that looks into the future round off the functionality for live sound applications. The XL2 Projector PRO software also supports direct access to the files stored in the XL2 during a running measurement. This makes it possible to continuously measure with the XL2, and, at the same time, collect already-completed data sets from the previous day.

To ensure that level limits are not exceeded in live sound applications, the FOH engineer must monitor several levels in parallel. The new XL2 Projector PRO offers an additional large screen mode, which continuously polls three selectable levels from the XL2 and displays them on the screen together with freely-definable limits. Warnings when levels are near or exceeding the limits are clearly visualized with orange or red backgrounds.

In the so-called Predictor mode (available in a separate window) the XL2 Projector PRO visualizes the level history of the current measurement interval and indicates the headroom for the immediate future. This allows the FOH engineer to optimize dynamic passages of the band for maximum audience satisfaction while still remaining within the legal limits.

The ability to retrieve measurement data from the XL2 without interruption to the measurement process provides the user with the possibility to implement a complete cost-effective monitoring environment. The entire file system of the XL2 is available while the XL2 is measuring. The complete data records of the previous day can be transferred to a local computer with drag & drop.

The XL2 Projector PRO software is free of charge to all registered XL2 users. The large level display and the level predictor require that the Remote Measurement Option be installed on the XL2.

Armstrong Ceiling Solutions launches SonoPerf D

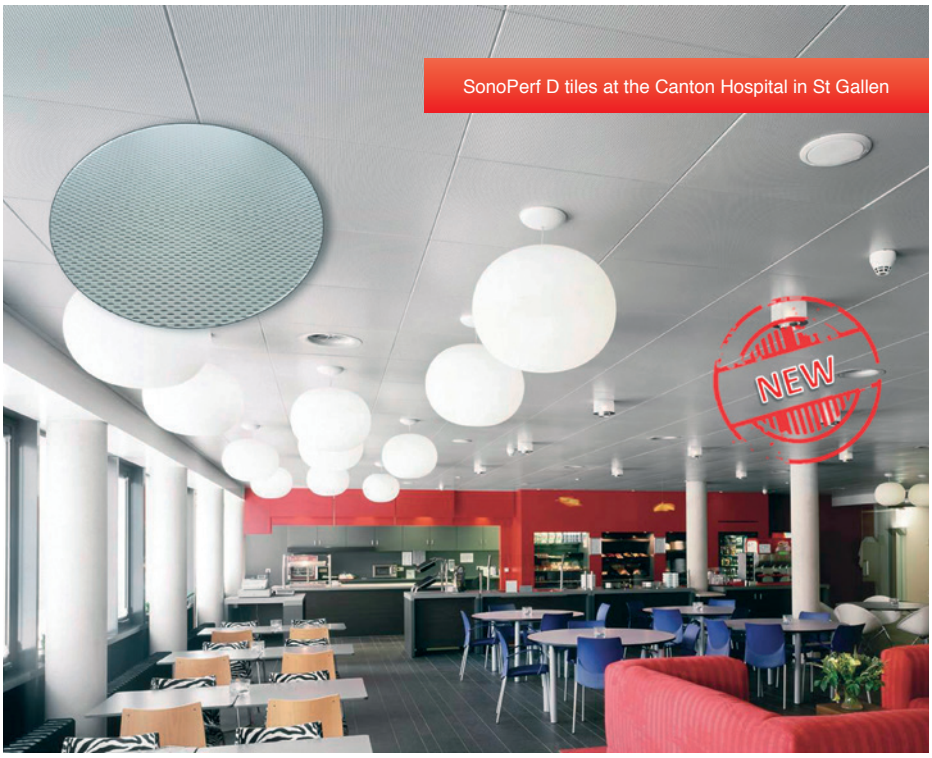
A metal tile has been launched by Armstrong Ceiling Solutions to meet the requirement for acoustics which, it says, do not come at the expense of aesthetics.

Armstrong says SonoPerf D (D for design) is particularly suitable for use with radiant chilled ceiling systems. This is due to its 3D fine micro-slotted embossing which allows for a homogenous air flow through the metal panels, improving the performance of a chilled ceiling system while also providing good flow in a deflected air stream.

Suitable for small and large rooms, as well as corridors and floating ceilings in buildings of all types, SonoPerf D features up to Class A sound absorption (1.00aw) when used with a 40mm mineral wool acoustic infill and is available in selected Clip-In, Lay-In and Hook-On systems as well as floating canopies.

Armstrong has also updated its Dune eVo ceiling tile range, which now provides a balanced acoustic performance of up to 0.65 aw, Class C sound absorption, and a sound attenuating performance of up to 39 dB. It also has fewer perforations than many standard ceiling tiles to create a uniform, smooth and contemporary finish.

More information can be found at **www.armstrongceilings.co.uk**



SonoPerf D tiles at the Canton Hospital in St Gallen

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Committee meetings 2017/18

DAY	DATE	TIME	MEETING
Wednesday	13 September	10.30	Executive
Monday	25 September	11.00	Research Co-ordination
Wednesday	**27 September**	**10.30**	**Council**
Thursday	12 October	11.30	Meetings
Thursday	19 October	11.00	Publications
Thursday	02 November	10.30	Membership
Tuesday	21 November	10.30	CCWPNA Examiners
Tuesday	21 November	1.30	CCWPNA Committee
Wednesday	22 November	10.30	Diploma Tutors and Examiners
Wednesday	22 November	1.30	Education
Thursday	23 November	10.30	CCENM Examiners
Thursday	23 November	1.30	CCENM Committee
Thursday	23 November	10.30	CCBAM Examiners
Tuesday	28 November	10.30	ASBA Examiners (*Edinburgh*)
Tuesday	28 November	1.30	ASBA Committee (*Edinburgh*)
Wednesday	29 November	10.30	Executive
Wednesday	**13 December**	**10.30**	**Council**
Thursday	11 January	11.30	Meetings
Thursday	18 January	10.30	Membership
Thursday	1 February	11.00	Publications
Thursday	1 March	10.30	Diploma Tutors and Examiners
Thursday	1 March	1.30	Education
Tuesday	6 March	10.30	Diploma Examiners (*London*)
Wednesday	8 March	10.30	Medals & Awards
Wednesday	8 March	10.30	Executive
Wednesday	**21 March**	**10.30**	**Council**
Tuesday	27 March	11.30	Meetings
Tuesday	10 April	10.30	CCWPNA Examiners
Tuesday	10 April	1.30	CCWPNA Committee
Thursday	26 April	10.30	Membership
Thursday	10 May	11.00	Publications
Tuesday	15 May	10.30	Research Co-ordination (*London*)
Thursday	17 May	10.30	CCHAV Examiners
Thursday	17 May	1.30	CCHAV Committee
Wednesday	23 May	10.30	Executive
Wednesday	**13 June**	**10.30**	**Council**
Tuesday	19 June	10.30	CCENM Examiners
Tuesday11	19 June	1.30	CCENM Committee
Tuesday	19 June	10.30	CCBAM
Wednesday	20 June	10.30	Distance Learning Tutors WG
Wednesday	20 June	1.30	Education
Tuesday	26 June	10.30	ASBA (*Edinburgh*)

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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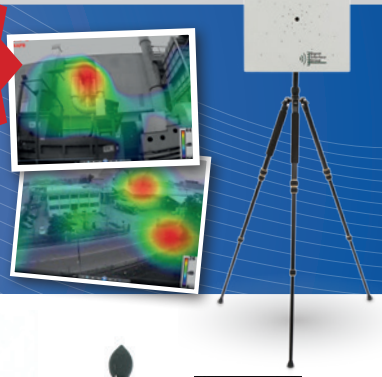
NOW AVAILABLE FOR HIRE

- Small, light, portable and easy to use
- Powered from a standard USB socket (just plug into a laptop, no separate power supply required)
- Acoustic Camera, Spectrogram and FFT can be displayed simultaneously
- Images can be stored as mp4 files to share with team members/stakeholders



RION

NL-52 the Heart of Rion's Complete Solution for Measuring Environmental and Domestic Noise

Full Support for BS 4142: 2014 Objective and Reference Methods

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