ACOUSTICS

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Front cover photograph:

New wording has been proposed on a planning condition for noise for wind farms

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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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.

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21-23 November

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27 November

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EPSRC UK Acoustics Network
launch event
London

23-24 April 2018

Annual IOA conference
Acoustics 2018
Cardiff

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Organised by the
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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

In this edition you'll find an extensive report on ICSV24. It features an overview from the General Chair of the conference, Jian Kang, and provides summaries of the themes. It's hard to summarise so much into a few short pages but I'm confident that Jian's write-up will give you a strong flavour of the breadth of material covered.

September saw the retirement of our Publicity Officer Charles Ellis, to whom we owe thanks for his editorship of the Bulletin, production of our e-newsletter Acoustics Update, and our marketing over the last seven years. Charles is editing this copy of the Bulletin for us however to help out as we transition to a new arrangement. Happy retirement Charles!

The new editor of the Bulletin for 2018 will be looking to our members for support. Please continue to send in articles, news on what's happening in your area of acoustics, and general information on all things acoustic that you come across which might be of interest. Details of whom to contact can be found on page 20. As you may have read in Acoustics Update, our plan is to recruit a digital marketer next year - a reflection of how we see the future target area of marketing for the IOA. I'll be interested to see what our new marketer (when he or she arrives) has to say on the subject of how a President should best use Twitter as a marketing tool. Unlike a certain President, I've avoided it as a method of communication. So far, so good...

In 2015, the Institute commissioned a survey to gauge members' views on what we should provide by way of education in the future. This indicated that there was a desire for continuing professional development (CPD) material available on-line to complement our existing formal education offering. We've now taken the first step in doing this by issuing a tender for a partner to start providing the necessary IT updates to our education management system. If you'd be interested in helping draw up a priority list for CPD material, or can contribute to its development, please contact head office, as the Education and Learning Review Group would appreciate your input. While on the subject of CPD, I'd like to thank all members who've



returned their CPD plans and records for review when requested. Thanks also to those who give up their time to contribute to reviewing the information submitted, and providing encouragement and guidance to those who send in their records.

I'm writing this letter in early October, and the subject which is occupying much of Executive's attention is the search for new premises for our head office team. St Peter's House has recently been sold, and our lease expires in December 2018. We hope to have located new premises by the time this issue of the Bulletin is published.

Following a protracted discussion between Council and our Membership Committee, the Institute has started a new Professional Standards Group which met in October for the first time. The group has been set up in response to concerns from various quarters about standards within the acoustics industry. The group, which comes under the Membership Committee, is working on defining its remit so expect to see more information in a future edition of the Bulletin.

Finally, as this is the last Bulletin of 2017, I'd like to wish those celebrating the season's festivals a peaceful Hanukkah, a Merry Christmas and a Happy New Year. For those for whom the turning of the year provides a needed break, I hope you have a good rest and perhaps the luxury of time to enjoy a good book.



Jo Webb, President

London calling: world's top acousticians converge on capital for ICSV24

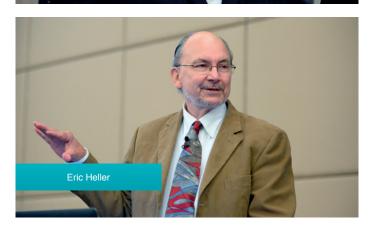
Conference round-up

By Jian Kang, ICSV24 General Chair

ointly organised by the International Institute of Acoustics and Vibration (IIAV) and the UK's Institute of Acoustics (IOA), the 24th International Congress on Sound and Vibration (ICSV24) was held in London from 23-27 July 2017. It was the first major international congress held in London covering the whole spectrum of acoustics and vibration since the 1974 International Congress on Acoustics. It was a great opportunity for scientists and engineers to share their latest research results and exchange ideas on theories, technologies, and applications in acoustics and vibration. The total registration was 1,070, including 229 IIAV and IOA members, 542 non-members, 252 students and 47 accompanying persons. In addition, there were 20 volunteers assisting the conference. The venue was the Park Plaza Westminster Bridge Hotel, which overlooks Big Ben.

In total, 1,265 abstracts from 56 countries were submitted and 932 full papers were included in the conference proceedings, including 205 papers that went through the peer review process. The scientific programme was structured into 16 themes, each containing structured sessions and regular sessions (see summaries below). The themes include: acoustical measurement and instrumentation, active noise and vibration control, aero acoustics and aviation noise, community and environmental noise, physical acoustics, industrial and occupational noise and vibration, machinery noise and vibration, materials for noise and vibration control, human response psycho-physio-bio acoustics, road and rail traffic noise and vibration, room acoustics, signal processing, simulation and numerical methods, underwater and maritime noise, building acoustics, policy, education and European projects, and musical acoustics. The papers were presented in 17 rooms and were organised in parallel sessions

road and rail traffic noise and vibration, room acoustics, signal processing, simulation and numerical methods, underwater and maritime noise, building acoustics, policy, education and European projects, and musical acoustics. The papers were presented in 17 rooms and were organised in parallel sessions



corresponding to their subject areas. As a new feature, there were also 135 e-poster presentations, which were well received.

Six distinguished plenary speakers presented recent developments in important topics of sound and vibration: Eric Heller (Harvard University, USA): The miracle of resonance and formants; Haiyan Hu (Beijing Institute of Technology, China): Advances in flutter analysis and control of aircraft structures; Jérémie Voix (Université du Québec, Canada): The ear beyond hearing: from smart earplug to in-ear brain computer interfaces; Jens Blauert (Ruhr-Universität Bochum, Germany): Reading the world with two ears; Andrei Metrikine (Delft University of Technology, Netherlands): Nonlinear dynamics offshore structures in marine currents and ice; and Timothy Leighton (University of Southampton): Climate change, dolphins, spaceships on antimicrobial resistance – the impact of bubble acoustics.

A range of social and cultural activities were arranged for and accompanying persons. The activities included:

- a visit to Cambridge on 23 July, organised by Hugh Hunt and James Talbot
- a Thames cruise chairs dinner on the 23rd
- the opening ceremony on morning of the 24th where welcome speeches were given by the ICSV24 General Chair Jian Kang, IOA President Jo Webb and IIAV President Jorge Arenas.
 These were followed by the presentation of the IIAV Honorary Fellowship by the IIAV Executive Director Malcolm Crocker and IIAV President Jorge Arenas to Professor Dame Ann Dowling and her response speech
- the welcome reception in the evening of the 24th, where the IIAV Student Award was given and there was also a Diamond Sponsor presentation by Mike Breslin, of ANV Measurement Systems







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Jian Kang, ICSV24 General Chairman

Jo Webb, IOA President

Malcolm Crocker, IIAV Executive Director

Jorge Arenas, IIAV President

Dame Ann Dowling

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- the Westminster Soundwalk on the 25th, which started and finished at the Park Plaza Hotel and which was organised by John Drever
- the Millennium Bridge visit, an IIAV Members event, also on the 25th, led by David Newland and James Talbot
- the IOA Young Members' Group social event on the 25th organised by Angela Lamacraft
- the gala dinner on the evening of the 26th at the Sheraton Park Lane Hotel, where the IOA Rayleigh Medal and the Doak Prize were presented to Juan Gallego- Juárez and Robin Langley respectively.
- the closing ceremony, which took place at the Park Plaza Hotel on the 27th when a presentation was given by the ICSV24 General Chair Jian Kang. This was followed by one from the Japanese team who are organising ICSV25, to be held in Hiroshima on 8-12 July 2018.

The technical exhibition, featuring 35 companies and centrally located in at the congress hotel, provided delegates with a wide range of products and expert services on instrumentation, software and consultancy.

We would like to express our appreciation to the members of the international scientific, local scientific, international and local organising committees, especially the technical programme coordinator and proceedings editor Barry Gibbs, and the IOA and IIAV officers Linda Canty, Allan Chesney, Malcolm Crocker, Margarita Maksotskaya and Sebastian Budzan for their hard work over the last two years. Thanks must also go to the theme chairs and session organisers and chairs, who worked very hard in preparing their sessions and inviting a large number of colleagues to take part; to the scientists and engineers worldwide who accepted the task of peer reviewing papers; and to all the volunteers during the conference for their assistance, especially Yiying Hao, Martin Lester, Zhuang Li and Bridget Shield. More importantly, the congress would not have been possible without the valuable contributions of all the authors. Last but not least, we would like to thank the many companies who sponsored this congress, and the Giardino Strings for their nice music at the opening ceremony and the gala dinner.



Acoustic materials

By Kirill Horoshenkov

This session, organised jointly by Jorge Arenas and Kirill Horoshenkov, attracted 10 papers, some of which were peer-reviewed prior to their publication in the conference proceedings. The speakers covered a very large geographical area including Europe, Japan, China and Australia. There was a range of topics from a traditional work on micro-perforated absorbers, e.g. by Okuzono Takeshi et al, to new systems for roof-top vibration pool isolation by Timothy Murray et al. The breadth of papers presented suggests that there is still strong research interest in the area of acoustics of porous media, active metamaterials for vibration isolation and composites for noise control. New work presented in this session shows that it is possible now to 3D manufacture new structures which absorb vibration and noise, e.g. by Sebastian Rothe et al. 3D printing can also be used to manufacture new types of porous media with dead-end pores to enhance the acoustic absorption of thin layers in the low- and mid-frequency ranges, e.g. Philippe Leclaire et al. The session was well attended and generated a good quality debate on the present and future of research on acoustic materials for noise control and sound field manipulation.

Active noise and vibration control

By Steve Elliott

This theme was organised by Steve Elliott and Marek Pawelczyk and comprised 11 individual sessions over a wide range of topics. These ranged from active and semi-active control of sound and vibration, with 26 papers; active structural acoustic control, three papers; applications of active control, 17 papers; and algorithms for active control, five papers, to a very well attended series of sessions on active sound field control and 3D audio, organised by Jordan Cheer and Filippo Fazi, with 18 papers. The range and variety of applications was clear, from machinery noise and vehicle noise to environmental noise transmitted through windows. The Sound field control session emphasised recent advances in zonal audio and the reproduction of spatial sound. Encouraged by a broad definition of the theme title, this series of sessions demonstrated the continuing interest in applications of active control and spatial sound reproduction.



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Aeroacoustics and aviation noise

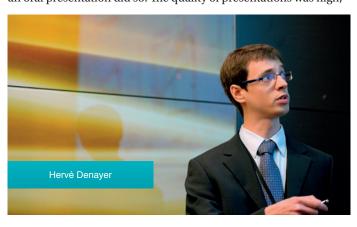
By Ricardo E Musafir

This theme area, which has featured at ICSVs since the division into areas was introduced in 2015, had 61 papers, distributed into seven sessions: two regular ones on aviation noise (interior and exterior) and five structured sessions, comprising one on spacecraft acoustics and four specifically on aeroacoustics. The aviation noise sessions had 12 papers, seven on aircraft cabin noise and vibration control, one of which one discussed cabin noise control with the use of an active window while another focused on the use of acoustic metamaterials for the same end. The five papers in aviation noise addressed legislation, noise measurements and survey of noise attitudes. The structured session on acoustic simulation, test and control in spacecraft had 10 papers covering a broad range, with emphasis on vibroacoustics. The remaining 39 papers were in the aeroacoustic sessions: experimental (11), computational (12), low mach number (four) and the general aeroacoustics (12). The low mach number session had papers on airfoils, blade design and noise and flow-acoustic interaction in ducts. The other sessions covered a very wide range, from jet noise - a theme that featured in all three, quite different aspects being considered in some eight papers, one of which discussed differences in the propagation of crackle and screech - to rotor, engine, vane and combustion noise, in a still incomplete description. A few of these included active control while others focused on the improvement or development of measuring techniques, applied for source or cabin modal structure identification. It was a very active set of sections, which attracted significant interest from the aeroacoustic community.

Building acoustics

By Barry Gibbs

This theme attracted more than 60 papers to six structured sessions, two regular sessions and the poster session. The sessions were on structure-borne and impact sound, façade sound insulation, prediction and measurement of sound insulation, acoustics of lightweight buildings, assessments of uncertainty in ground-borne vibration, and holistic approaches to architectural acoustic design. It is pleasing to report that every author scheduled to give an oral presentation did so. The quality of presentations was high,





particularly from young researchers and consultants, and the sessions were well attended. The contributions were from world-wide, including Europe, USA, Australasia, China, Japan and from the UK. There was an interesting balance of papers on research methods and findings, developments in international and national test methods, and consultancy case studies and practical experiences. Connections were made between international perspectives and UK consultative practice. This theme confirmed that building acoustics remains a strong and exciting research area, which is responding to changes in construction methods (e.g. lightweight and sustainable buildings), increased mechanical services and re-appraisals of human comfort and needs.

Community and environmental noise

By Stephen Turner

The theme chairs were Luis Bento Coelho and Stephen Turner. The theme was structured with four regular and six structured sessions and attracted more than 50 papers. The most popular was $\,$ the structured session on metastructures for noise and vibration control. Other topics included environmental noise monitoring, wind turbine noise, soundscape, sound and vibration in urban environments and outdoor noise modelling, mapping and solutions for mitigation. One of the features of such a conference is the diversity of topics and nationalities that are involved. As an example, there was short session within this theme late on the Tuesday afternoon that covered the use of sonic crystals for attenuating sound through windows; a novel noise reduction technique for an air-cooled unit; an analysis of traffic noise in Venice (land sources not water) and some observations on the current situation regarding noise management in Europe. The authors came, respectively, from Singapore, Turkey, Italy and the Netherlands. Around a dozen or so delegates attended the session and each paper provoked questions and discussions. It is that diversity that helps to make attending this type of conference so valuable.

Evaluation of acoustical quality of spaces including heritage buildings

By Joko Sarwono and Christina Higgins
This structured session consisted of seven papers, two of them invited. The papers discussed acoustical quality aspects of

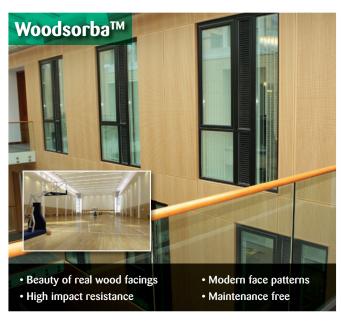




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indoor spaces, covering worship spaces, educational buildings, health care facilities, and small rooms. There was one paper that discussed modelling diffraction for general geometry.

All the papers on worship spaces discussed the acoustics performance of existing spaces, including enclosed and semi open spaces, as well as specific acoustics cues in the worship spaces. The paper on healthcare facility focused the discussion on the possibility of improving speech intelligibility and privacy, with regard to the interaction between sound sources and workers. The paper on educational space reported the impact of acoustics design on the performance of non-English speaking students, while the paper on small rooms assessed the measures of low frequency performance. The last paper discussed the improvement of ray tracing modelling on general geometry by incorporating the diffraction aspect of room surfaces.

All the presenters delivered their talks in the given time and received good feedback from the audience.

Machinery noise and vibration

By Andy Moorhouse

This theme comprised three regular sessions on condition monitoring, fault diagnosis, and machinery health monitoring, plus five special sessions dealing with end of line testing, quiet machine design, machine tool vibration and cutting dynamics, fluid machinery noise, and transfer path analysis in NVH engineering. It was a very varied theme with a very broad range of topics covered ranging from classical acoustics to mainstream mechanical engineering and from measurement based projects to numerical studies and new theory. There was a wide variety too in the nationality of the authors and it was pleasing to see presenters from all corners of the world making this a truly international conference theme. Many authors, more than a third across the theme as a whole, took up the option to have their papers peer-reviewed. The submissions confirm that some established research areas like condition and health monitoring and machine dynamics are very much alive and demonstrated the huge range of equipment and structures studied by acousticians ranging from small machine components to large ships.





Measurement and instrumentation

By John Shelton

One of the drawbacks of any instrumentation section of conferences is that the papers often describe not just the instrumentation and measurement, but also the application, which means that the papers could just as easily find themselves in any of the other theme areas. The result is that the programme is often an eclectic mix of different systems and applications, and ICSV24 was no exception.

The two main chairs, Lars Hakansson and John Shelton, shared out the session chairing duties with others, which means that I can only report on Tuesday's sessions. However, it gives a reflection of the type and flavour of the contributions.

Subject areas varied from time delay magnification of the ears of flies, in-situ absorption measurement using spherical microphone arrays, wireless measurements of lift (elevator) vibration, noise mapping using smartphones, noise contamination in windfarm measurements, a phonatory voice simulator, in-situ measurements of transmission loss using local plane waves, and a new hand-held probe for reliable vibration measurement amongst others.

For one with a very narrow focus on instrumentation, the sessions proved stimulating and varied, with some excellent presentations with lively audience feedback and discussion.

Musical acoustics

By Stephen Dance

Musical acoustics had an open theme for ICSV24 with all the papers presented on 24 July over three sessions chaired by Murray Campbell and Stephen Dance. The first session was kicked off by Stephen Dance on the subject of the hearing acuity of classical musicians after four years of study. This was followed by Gizem Okten giving a paper on the vocal load of opera singers. The third paper was on the grid array measurements of sound fields around brass instruments given by Jonathan Kemp. The final paper of the session was by Harrison Reg on FDTD simulations of brass instruments. After lunch we had a paper from Ari Kusumaningtyas on an objective and subjective acoustics comparison of guitar top plates:









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- Environmental noise and vibration
- Building acoustics
- Noise nuisance

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pine, bamboo, and spruce. The session ended early with a paper on subjective preference of electric guitars by Diego Leguizamon. The final session was kicked off by Rod Selfridge on the real time reproduction of the Aeolian harp which concluded with an impressive demonstration. The penultimate paper was on the vibro-acoustics of the South Indian drum: Mridangam and was given by Dr Sorraj. The day concluded with a paper from Bor-Tsuen Wang on the design of the curve for the chord sound plate replacing the B-spline method with a faster approximation.

Noise policy, guidance, Standards and projects

By Hilary Notley

This informative session covered a wide remit and was well attended. Perhaps given the location, the initial papers had a UK or England focus. We looked back at the effectiveness of the NPSE and considered the future of industrial noise legislation post-EU-exit. We then moved away from policy-makers and onto policy implementers. A practical toolkit for assessing the costs and benefits of mitigation measures was presented, alongside a proposal for a testing and QA procedure for assessing certain properties of noise barriers. We then considered the EU LIFE MONZA project, which is looking for synergies with the management of other pollutants and methodologies for assessing the noise benefits of conventional air quality low emission zones (LEZs) and the AQ benefits of introducing "noise-LEZs". Staying with the EU theme, we considered issues facing the Netherlands in applying the CNOSSOS-EU method to national mapping exercises. We were treated to four papers on the EU project LIFE NEREIDE. This project aims to evaluate new porous asphalt road surfaces made from crumb rubber from scrap tyres and reclaimed asphalt pavements. Novel monitoring and evaluation techniques are being developed as part of this project. Moving away from predominantly environmental noise issues, we were treated to a paper on a European Doctoral Training programme in aeroacoustics to learn how the researchers of the future are sharing knowledge and developing networks. Last, but by no means least, was an enthusiastic and interactive presentation highlighting a potential gap in traditional musicians' training, whereby an understanding of acoustics (performance space, H&S, physics of instruments,





etc) is largely missing, but research suggests would be a welcome addition to the syllabus. Food for thought for us all.

Physical acoustics

By Maria Heckl

The theme area was represented in eight structured sessions and four regular sessions. A total of 100 papers were presented.

The structured sessions featured: wave propagation application in fluids, complex solids and structures; nonlinear acoustics and vibration; sound propagation in curvilinear spacetime; thermoacoustics and combustion noise; thermoacoustics research in a gender-balanced setting; combustion dynamics and acoustics in gas turbines and furnaces; flow duct acoustics; and mufflers; and pipe vibration analysis and measurement.

The regular sessions featured: physical acoustics; ultrasound, ultrasonic measurements and their application; passive noise and vibration control; and cavitation and materials science.

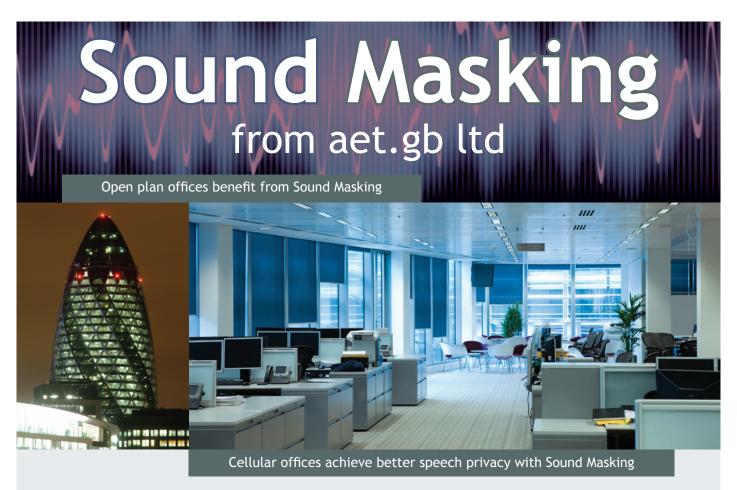
Road and rail transportation noise and vibration

By Rupert Thornely-Taylor

This theme area included a regular session on noise barriers and monitoring plus structured sessions on road and rail noise. Presentations on road vehicle NVH plus tyre-road interactions occupied all of Monday including papers on electric vehicle NVH, proton exchange membrane fuel cell dynamics, neural network modelling of magneto-rheological engine mounts, hydromounts, misfire detection, torsional vibration absorbers and isolator performance, tread design, dampers for car body micro-vibration and use of SEA for structure design as well as spherical microphone arrays and traffic noise prediction. Low noise pavements occupied Wednesday evening. Rail noise and vibration occupied the whole of Tuesday with papers on prediction models, rolling noise, monitoring and measurement, track dynamics and corrugation as well as low frequency vibration control. Effects of noise on sleep and abatement policy were also addressed. Wednesday morning's topics were light rail and high speed rail with papers on tram-track interaction and tram bogie noise, rail grinding, under-ballast plates, slab foundations along with measurement and prediction. Groundborne noise and vibration was the topic for Wednesday







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



▼P14

afternoon, with a wide range of subjects covered, from prediction methods to truck-road interaction, an audio demonstration of the loudness of low frequency noise, bearing stiffness and environmental problems.

Room acoustics

By Yiu Lam

The theme area of room acoustics had a total of nine structured and regular sessions. Together they covered all aspects of room and architectural acoustics, with special focuses, via the structured sessions, on current hot topics in both research and practice. In particular, the theme started with a memorial session on the life and work of one of the best known room acousticians, Leo Beranek, who continued to work tirelessly until he sadly passed away last year at the remarkable age of 102. Leo's works on room acoustics and noise control have inspired many generations of acousticians, and his many books and papers are de facto references for researchers and practitioners in these fields. It is a fitting tribute to host a memorial session here in this international conference. This year also saw the introduction of structured sessions on the acoustics of open plan office and health care facilities – two highly relevant topics in current acoustics practice. There were interesting discussions particularly on the difficulties in meeting noise criteria in health care facilities, and the variation of national acoustic criteria associated with open plan offices. There were also sessions dealing with the acoustics quality of spaces including heritage buildings and schools, the perception of auralised spaces, and surface materials for absorption and diffusion. Altogether they provided a wealth of knowledge that delegates will surely find useful to advance the research and practice in room acoustics.

Signal processing, simulation and numerical methods

By Jordan Cheer

The signal processing, simulation and numerical methods theme was organised by co-chairs Jordan Cheer and Jun Yang. The theme proved a great success, with a total of 80 papers spread across the duration of the conference. The presented papers included 49 invited and 31 contributed papers, with authors from around 22 different countries. The papers were divided into three regular and three structured sessions, with session topics ranging across the fields of sound and vibration reflecting the scope of the congress





as a whole. Giuseppe Miccoli and Marco Barbieri organised two structured sessions with a total of 38 papers focusing on numerical methods and simulation for acoustics and vibration. The third structured session was organised by Akira Ikuta and Zhang Haofei and focused on advanced signal processing for sound and vibration. The three regular sessions focused on modal and finite element analysis, rotor dynamics simulation and pattern recognition, all applied to various aspects of sound and vibration. These regular sessions were chaired and organised by several contributors, including Francesco Pellicano, Michal Kalkowski, Zhushi Rao, Asma Masoumi, and Antonio Zippo.

Underwater and maritime

By Adrian Brown

This theme was dominated by participants from three countries, each of which brought their particular emphasis. The Italian participants described measurement and modelling of noise from large cruise ships and its impact on Mediterranean cities, such as Venice and Naples. Their key objective is a detailed scientific approach to the gathering of evidence in support of the development of legislation to improve the acoustic environment. Some less obvious points from the Italian papers were that some ships run diesels to generate electricity for long periods whilst alongside and that tug-boats sometimes radiate more noise than the ship that they are towing. The Chinese participants provided insight into their extensive activity in the field of computational modelling with experimental validation of the vibration and noise in ships and propulsion systems. Their key objective is the development of their engineering capability leading to the manufacture of quieter ships. Two highlights from the Chinese papers were the modelling of the innovative concepts of a dynamic anti-resonant vibration isolator and a rim-driven propeller. There was also an interesting Chinese poster that showed that the re-radiation of propeller noise from a ship hull could be noisier than the direct radiation from the propeller. The UK participants had a focus on noise measurement and the impact on the marine environment. One objective is the development of more accurate methods for deriving the noise radiated by ships from measurements. One highlight was a paper that described measurement of the aspect-dependent radiated noise of a research vessel as a function of frequency. Other presentations were given by delegates from Japan, Lebanon, the Netherlands, France, Australia and Canada on a variety of topics





within the theme. A Japanese paper illustrated the consequence of detailed acoustic propagation modelling on the derivation of marine mammal Sound Exposure Level. A French paper demonstrated that that short range propagation loss is highly sensitive to changes ion input parameters such as source depth. In summary, the underwater and maritime theme was a successful interaction of ideas from different countries and multiple topics within the theme.

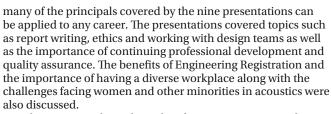
Young Members' Group

By Angela Lamacraft

The IOA Young Members' Group, in collaboration with the European Acoustics Association Young Acousticians Network (EAA YAN), provided two sessions at ICSV24.

The first was an early careers workshop, a technical session with the aim of providing young acousticians with advice for the early stages of their career. Whilst primarily focused on consulting,





A key message throughout the afternoon session was the importance of communication and professionalism and the need to understand what is required of you and your work.

Following the technical session, a social event aimed at young members was held at The Admiralty in Trafalgar Square. An ice-breaker activity based on the Radio 4 game *Just a Minute* and hosted by Jayanthiny Kangatharan (UK Representative for YAN) successfully lightened the atmosphere and an enjoyable evening of drinks, nibbles and chatting followed.















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Drywall construction workshop for acousticians

By Eugénie Sainte Cluque and Luis Gomez-Agustina

ondon Branch delivered a pilot one-day workshop in September to give acousticians a better appreciation of drywall construction issues and their impact on sound insulation performance.

The idea came from the observation that acoustic consultants to the building industry seldom have experience of practical issues of on-site installations. Eugénie Sainte Cluque's training in architecture included hands-on building work, which she felt valuable in her role as an acoustician. She wanted to give her peers their own opportunity to physically build partitions in order to understand builders' constraints and become more proficient in reading technical drawings.

Setting this interdisciplinary event was an interesting challenge in terms of educational content, logistics and communication among a group of volunteering organisers and facilitators. A compromise was reached with the Building Research Establishment (BRE), Knauf and Assured Acoustics to do the pilot workshop described below. We are very grateful to them for offering their time, expertise and resources to make this educational event possible.

Twenty delegates attended BRE in Garston where we heard a series of presentations in the morning followed by demonstrations of construction works and details in the afternoon.

Peter Turner (Assured Acoustics) gave a talk on the principles of sound insulation in terms of mass, stiffness, resonance and coincidence. This was illustrated by field measurements and observations of reduced performance from site installations. The talk also invited us to think beyond partitions alone to see them as sub-elements within complex structures, and to also consider the behaviour of sound propagation in terms of structural distortions (e.g. shear, bending or longitudinal waves).

Gary Timmins's (BRE, Acoustics Department) talk covered aspects of laboratory sound insulation testing. We were invited to ask for lab test results from product manufacturers and to be acquainted to the content of ISO 10140 Acoustics - Laboratory measurement of sound insulation of building elements to make the most of the results supplied. The presentation detailed the important features of sound insulation test labs, which was illustrated by a step by step slide show of BRE's recently built acoustic lab facilities.

Mandeep Bansal (Knauf) presented sound insulation from the point of view of a product manufacturer and installer. This included the specific use and restrictions from a selection of products, followed by case studies demonstrating how Knauf is addressing reoccurring detailing issues. This was a good basis for the workshop activities in the afternoon.

The second part of the day was spent in BRE's newly rebuilt



acoustic sound insulation testing lab. Prior to the day, Knauf installation experts Steve Webber and Mark Thorburn had built a number of open structures so that we could see how they were formed. They used a 1:1 structure to demonstrate how to install partitions. This included correct use of C-studs, handling of plaster board and installation of mineral wool. Some delegates even dared to take part by cutting plaster boards, C-studs and fixing the partitions to the structure. Another section of the workshop featured penetration details, corner isolation and deflection heads. The physical constructions spurred a large volume of questions which were answered in detail, accompanied with lively site stories and counter examples.

The event was a great success overall, as best demonstrated by delegates and speakers testimonials below:

"I found this event very interesting. We saw models of penetrations, junctions and other bits as they should be done in reality. The trainers demonstrated how to build a drywall partition from scratch, which was interesting to see. I would have liked to have built a mini wall myself, in line with the details presented in the workshop, but perhaps it would have taken a long time. I would also have liked that there had been more time for a debate following the presentations, but the presenters were open for informal discussions during the tea breaks." Reena Mahtani delegate.

"The practical part of the drywall workshop was excellent. It is rare that we get to see so much detail during a site visit so seeing the partitions built stage-by-stage really helped me to understand some of the more subtle details that need to be observed. There were also some really great hints on how to forensically investigate a complete partition for faults." Matt Torjussen, delegate.

"I was enthused by the prospect of this 'hands-on' workshop meeting and the opportunity to present some of my own knowledge and experience. There wasn't a dull moment, despite the late arrival of a delicious lunch! Although my presentation time was understandably limited for this one-day meeting, I was encouraged by the feedback and discussions from some of the delegates, who seemed keen to see similar workshops or seminars in the future. It was useful to hear a manufacturer speaking from direct experience, about site issues, practicalities and design solutions. I also enjoyed hearing about the construction of new acoustic labs - a rare event. Overall I enjoyed the day, but it was over much too soon." Peter Turner, speaker.

The enthusiasm showed by our delegates, speakers and demonstrators clearly suggests there is room to expand the concept. It would be interesting to see this event format replicated and developed over the years and being applied to other relevant engineering disciplines such as mechanical engineering, thermal insulation or architectural design, etc.



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Farewell to Bulletin Editor Charles Ellis after six years

harles Ellis is stepping down as editor of the Bulletin with this issue after six years at the helm. Your new editorial contact is Juliet Loiselle, of Warners Group Publishing, a specialist magazine publisher based in Bourne, Lincolnshire. She can be contacted at julietl@warnersgroup.co.uk or 07786 336606.

Said Charles: "I have thoroughly enjoyed my time and I want to thank members for their tremendous support, particularly those who have supplied technical contributions, Instrumentation Corner articles and event and meeting reports. I would urge everyone to help Juliet in the same way as she steers the magazine towards the next stage of its development."

It's 'eyes down' again at the Inter-**Professional Networking Event**

By Angela Lamacraft, Young Members' Group Chair

OA young members again took part in the annual Inter-Professional Networking Event in London - the third and biggest one yet.

They joined fellow professionals from nine other bodies - IMechÉ, IStructE, Forum for Tomorrow, RAeS, Institute of Fire Engineers, the Landscape Institute, CIBSE, RIBA and the Chartered Institute of Ecology and Environmental Management - for an evening of refreshments and informal networking.

As with previous years, the "ice-breaker" activity was networking bingo: participants were required to search the room for people matching various descriptions (e.g. a mechanical engineer, someone who has worked on a project in Asia, someone who speaks a foreign language). There was a range of effort put into the activity with some people's competitive streak appearing and others preferring to focus on more traditional networking, but after a couple of hours of chatting, drinking and nibbling the winners (Jessica Becher from Thames 21 and Phoebe Cross from The Ecology Consultancy) collected their prizes.

The aim of the event is to facilitate young members of different disciples to come together to learn about each other's work and perhaps make some important connections. We believe this helps young professionals feel more confident when discussing a variety of technical matters within project teams



which may even help creative and sustainable design. The event was held in a different venue to previous years and the Forge on Cornhill in London worked brilliantly: the atmosphere was electric! This event will be happening at roughly the same time next year so keep an eye out for advertisements.

Many thanks to Chris Turner and Ellen Harrison (IOA), Tristram Bushby (LI), Alex Logan (CIBSE), Ashley Theakstone (IFE), Rosie Whicheloe (CIEEM), Ali Cairncross and Zoe Rines (FFT), Jeff Blaylock (IStructE), Laura Hoang (RAeS), Adam Mayall (IMechE) and Vinesh Pomal (RIBA) for helping with the organisation and promotion and on the night.

Sixty four more applications for membership approved by Council

ixty four applications for membership were approved by Council at its September meeting following the

MIOA

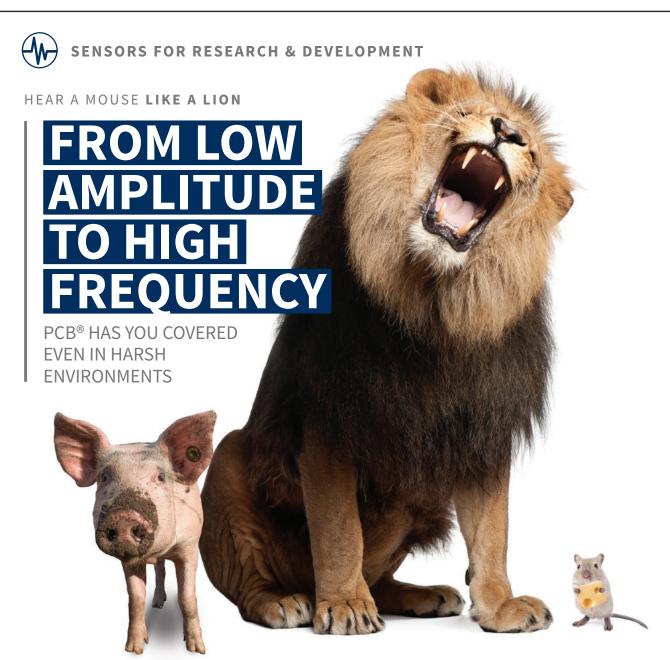
Luis Abreu	Mick Goodfellow	Luke Rendell
Daniele Albanese	Onur Gulen	Jack Richardson
Nicolas Auckland	Brian Hamilton	Patrick Shuttleworth
Steven Barry	Christopher Hunt	Michael Simms
Morgan Cheng	Kumara Jayasinghe	Lewis Stonehouse
Chun Hin Cheung	Fabio Lassandro	Jenefer Taylor
Lewis Crabtree	Christopher McCollin	Adam Thomas
Lee Denson	Jake Mroz	Martin Tonner
Nicholas Dobbs	Matthew Ottley	Sarah Whydle
Alex Foster	Joshua Palmer	Ming Yang
Timothy Fox	Eulalia Peris	Alex Young
Edward Goldsmith	Andrew Pickup	Daniel Ziemianski

recommendations of the Membership Committee. Of the total, 35 were new applications and reinstatements, the rest upgrades.

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Ian Baxter	Hortense Lecouffe	Philip Setton
Mingsan Boulter	Claire McKeown	Leonard Terry
Bernard Brincat	Jack Marriott	Krishnakumar Thirupathi
Thomas Citrine	Katarzyna Matoga	Christopher Wilson
Steffan Davies	Martyn Parker	
David Fink	Miriam Pratap	

Tech		Affiliate
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It's a proud 50 not out for Instrumentation Corner as it looks to complete the ton

By John Shelton

t doesn't seem possible that this is the 50th Instrumentation Corner article for the Bulletin. Over the years, the Measurement and Instrumentation Committee has covered many subject areas in the field, to help practitioners to improve the quality of their noise and vibration measurements, and to inform on latest instrumentation trends and standards.

The original founding committee, ably chaired by Richard Tyler, consisted of the great and sometimes good in the instrumentation field, including manufacturers, laboratories and standards bodies. That mix continues to this day, providing an excellent source of advice and comments on all things related

Although measurement and instrumentation covers all fields in acoustics, which means there's always a danger of overlap with other specialist groups, we strive to highlights areas where there is sometimes bad practice, or a lack of current thinking in outdated standards.

The first IC article appeared in January 2009, with Martin Armstrong setting the scene. Martin is our resident vibration expert and he has since contributed on subjects such as human vibration (he sits on the ISO8041 committee), measurement uncertainty, and "serious" vibration measurements. He recently updated us all on the newly published ISO8041-1 for human vibration instrumentation.

An early member of the committee, Ken Brown, also expanded on the subject by covering what was then the newly released

Richard Tyler has always had a bee in his bonnet about calibration, and his first article looked at the common problem of mixing and matching sound level meters and calibrators, a practice that I'm afraid I still see in the field. Richard has also contributed on standards updates and measurement uncertainty.

Ian Campbell has a wealth of knowledge and experience in sound level meter development, and he has covered aspects of high and low-level measurements, evaluation of sound level meter limits using dummy microphones, and extremes of high and low frequency measurements.

With a similar background, Daren Wallis has written on subjects including the effects of weather on windscreens, electret microphones, and routine verification of sound level meters.

Sue Dowson is our resident standards expert (as well as committee secretary), and has kept us abreast of developments in new standards, and activities on standards committees, on several of which she is a member. Since 2009 we have of course seen the update of the sound level meter standards to BS EN 61672, and Sue has written a clear guide to the changes.

Liz Brueck has a deep knowledge of all things Health & Safety, and in her time at HSL Buxton, she has provided some stimulating articles on the effect of jumping up and down on dosemeter measurements, measuring impulsive noise and Control of Noise at Work regulations.

Simon Bull is another sound level meter buff, and has a tendency to find some esoteric issues, one of his titles being "What you can get away with for 90% of the time"! Simon also has had some interesting views of tool timers for vibration assessment, and as far back as 2010, he was describing developments in web-based noise monitoring.

For my sins, I have banged on about subjects that have exercised me at the time, such as Ln's in 1/3 octaves, internet noise monitoring, geophones & accelerometers, and an historical overview of sound level meter developments.

Our contributors from the ANC, including Steve Cawser, have provided some clear practical advice on digital acquisition and vibration measurements, and our more recent members

such as Mark Dowie, Tony Higgins, Ben Piper and Giles Parker have covered areas as diverse as BS 4142, noise barriers, noise & planning, and ultrasound.

We recently reviewed all the IC articles, and converted as many as we could to PDF for posting on the IOA website. You can now find them by logging into your member's area, and go to the committees, groups and branches page, where you will find a link to the M&I committee. All the articles we could find are listed there, and we hope this will provide you with a useful resource.

Measurement and instrumentation never stands still, so we will continue to publish Instrumentation Corner, with both review and update articles. If you think there is a burning issue that needs to be addressed, please let us know, as the subject matter can tend to reflect what we think is important within the committee. We are there to help members improve their measurement practices and inform on new developments.

Finally, I'd like to thank all our contributors, past and present, as the articles do take some time to research and write, and we hope to continue with our M&I theme of weird and wonderful titles (Ian Campbell wins that prize with "Are old timers past their peaks (Lcpk that is)?") □

John Shelton is Chairman of the Measurement and Instrumentation Committee.



Vol34 No3: Ian Campbell Let's get down and dirty: the measurement of low sound levels

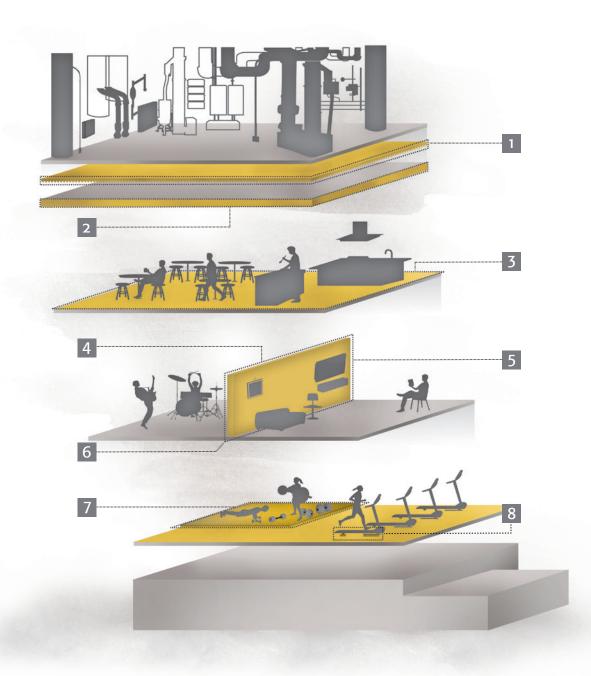




Vol40 No5: Mark Dowie. BS 4142:2014 Measurement planning and practice



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New technique to suppress sound waves from disorder to improve optical fibre communication

research collaboration in the US has revealed a new technique by which scattering of sound waves from disorder in a material can be suppressed on demand.

All of this can be simply achieved by illuminating with the appropriate colour of laser light. The result, which is published in Nature Communications, could have a wide-ranging impact on sensors and communication systems.

Gaurav Bahl, an assistant professor of mechanical science and engineering at the University of Illinois at Urbana-Champaign, and his research team have been studying the interaction of light with sound in solid state micro-resonators.

This new result is the culmination of a series of experiments pursued by his team over the past several years, and a new scientific question posed in the right place.

"Resonators can be thought of as echo chambers for sound and light, and can be as simple as micro-spherical balls of glass like those we used in our study," said Professor Bahl.

"Our research community has long understood that light can be used to create and amplify sound waves in resonators through a variety of optical forces. The resonant echoes help to increase the interaction time between sound, light, and material disorder, making these subtle effects much easier to observe and control. Since interactions within resonators are fundamentally no different from those taking place in any other system, these can be a really compact platform for exploring the underlying physics."

The key to suppressing scattering from disorder is to induce a mismatch in the propagation between the original and scattered directions. This idea is similar to how an electric current prefers to flow along the path of least resistance, or how water prefers to flow through a wider pipe rather than a constricted one.

To suppress back-scattering of forward-moving sound waves, one must create a large acoustic impedance in the backward direction. This asymmetry for forward and backward propagating waves is termed as chirality of the medium. Most solid-state systems do not have chiral properties, but these properties can be induced through magnetic fields or through space-time variation of the medium.

'A few years ago, we discovered that chirality can be induced for light using an opto-mechanical phenomenon, in which light couples with propagating sound waves and renders the medium transparent. Our experiments at that time showed that the induced optical transparency only allows light to move unidirectionally, that is, it creates a preferentially low optical impedance in one direction," Professor Bahl said. "It is then that we met our collaborator Jacob Taylor, a physicist at NIST, who asked us a simple question. What happens to the sound waves in such a system?"

"Our theoretical modelling predicted that having a chiral system for sound propagation could suppress any back-scattering that may have been induced by disorder," explained Professor Taylor. "This concept arose from work we've been doing in the past few years investigating topological protection for light, where chiral propagation is a key feature for improving the performance of devices. Initially the plan with Professor Bahl's team was just to show a difference between the forward and backward propagating sound waves, using a cooling effect created by light. But the system surprised us with an even stronger practical effect than expected."

That simple question launched a new multi-year research effort in a direction that had not been explored previously. Working in close collaboration, the team discovered that Brillouin light scattering, a specific kind of opto-mechanical interaction, could also induce chirality for sound waves. Between the experimental tools in Professor Bahl's lab, and the theoretical advancements in Professor Taylor's lab, the pieces of the puzzle were already in place.

Practical applications of this result may not be too many years off. Reduction of mechanical losses could also directly improve mechanics-based inertial navigation sensors that we use today. Examples that we encounter in daily life are accelerometers and gyroscopes, without which our mobile phones would be a lot less capable, and our cars and airplanes a lot less safe.

How acoustics can be an early warning system for bridges

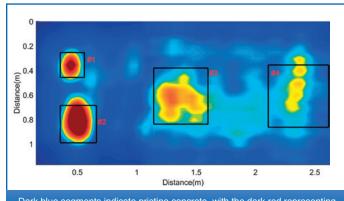
civil engineer in the US has designed and refined an acoustic approach to detecting defects in concrete bridge decks that is much faster and accurate than conventional methods of identifying delamination.

The system devised by Jinying Zhu, assistant professor of civil engineering at the University of Nebraska-Lincoln, consists of a push-cart that drags multiple strings of metallic balls along

The balls produce different acoustic frequencies when striking delaminated versus pristine concrete. Small, low-cost microphones attached to the cart then record the sound, sending it to a laptop that collects and processes the signals. All the while, a specialised GPS unit tracks the cart's location down to the centimetre.

By correlating acoustic signals with the cart's position, the system's software can automatically generate a colour-coded map that illustrates the location and dimensions of a bridge's defects. Deep-blue segments indicate pristine concrete, with dark red representing the most severe delaminations.

"Every year, you see lots of construction," Professor Zhu



Dark blue segments indicate pristine concrete, with the dark red representing areas where the concrete's layers have begun separating and might pose threats to structural integrity

said. "Bridges need to be repaired. But before (agencies) decide how many resources should be allocated for repair, they need to



▼P24

understand the condition of the bridge. This technology provides a very quick way to get that information."

Bridge inspectors have traditionally hunted for delaminations by dragging chains across a bridge deck, listening for hollow spots and marking them with chalk or paint.

"It's a very slow process, and it's subjective," Professor Zhu said. "Some delaminations are difficult to check."

A more systematic but even slower approach, known as an impact-echo test, involves tapping concrete with a steel ball and recording the acoustic signatures with a contact sensor.

Professor Zhu wondered: How could she meld the relative efficiency of the chain-drag approach with the accuracy of the impactecho method? After writing an algorithm that would help differentiate between the acoustic signals of delaminated and intact concrete, she used microphones to record the sound generated by nearly a dozen different types of chains. But no matter which she tried, the delamination-specific signals she sought were being lost amid a sea of other acoustic waves that arose from the links clattering together.

That is when she and doctoral student Hongbin Sun decided to replace chain links with metallic balls connected by nylon string. As they hoped, the ball-and-string combo enhanced the desired signals while reducing the noise.

They also found that the balls produced more data points. Slow-motion video revealed the reason: Unlike the chain links, which mostly slid along the concrete while being dragged, the balls hopped into the air when encountering even slight rough patches. Each time they landed, they produced another signal – lessening the chances of missing a potential delamination.

After varying the size and number of balls, Professor Zhu's team determined that four per string – two larger, two smaller – captured a broad range of delamination frequencies and maximized the



number of impacts per second. The team also found an ideal speed – about two feet per second – for balancing how often the balls struck the concrete with how much force they produced when landing.

Professor Zhu estimates it takes her team about 20 minutes to assess a stretch of bridge that the traditional chain-drag method requires roughly two hours to complete.

Life-cycle assessments can help decide the best measures for reducing railway noise and vibration

Researchers say the most appropriate mitigation to reduce train noise and vibration should be determined on a case-by-case basis and life-cycle assessments can help analyse the economic costs and carbon footprint of different methods.

Ground vibration from trains produces a different effect and in extreme cases can damage structures around the track. Both rolling noise and ground vibration can cause considerable disturbance to residents around railway lines, whereas, for rural rail networks, disturbance mainly affects nearby ecosystems and pasture growth/production. The effectiveness of methods to reduce railway noise and vibration should be balanced with installation and maintenance costs. It is, therefore, important for the railway industry to consider whole-of-life costs when implementing measures. Railways can extend for long distances, meaning mitigation methods must also be practicable over many kilometres of track.

In a new study, carried out at the University of Birmingham's School of Engineering, key mitigation measures are outlined for rolling noise and ground vibration and their life-cycle performance. Information from worldwide field-based scientific studies was assessed and a life-cycle analysis was also carried out in terms of economic costs and the carbon footprint. Economic costs were based on cash-flow analysis and the carbon footprint assessed materials and emissions from fuel and energy used for construction and the maintenance of different mitigation measures.

Rolling noise, measured by using microphones at certain distances from the track, is influenced by train speed and design, track conditions and weather (indirectly: flooding of the track can lead to its oxidation, causing wheel noise; increased damping due to higher moisture could suppress overall sound radiation). Mitigation

measures to reduce rolling noise include reducing track roughness, noise barriers and structural modifications or damping systems. The connection between train wheels and rails is one major source of noise and vibration; for example, deteriorating tracks are often rougher, which increases the sound pressure by up to 20 decibels



(dB). Roughness can be reduced by grinding tracks to remove corrugated edges and by lubricating tracks. Walls and other barriers can reduce noise by between 5 dB and 15 dB, depending on the height, length and distance from the track.

The researchers say that making life-cycle comparisons for rolling-noise reduction is difficult, as some interventions comprise annual maintenance (e.g. rail lubrication), whereas others are single investments (e.g. barriers). However, noise barriers had higher carbon footprints and costs due to the materials used (e.g. high-density concrete), whereas track grinding and lubrication had lower costs. Grinding had the lowest carbon footprint of around 1.52 kilograms (kg) of CO2 per kilometre (km).

Ground conditions, including the materials that provide the base of the railways, are a major source of vibration disturbance. Ground vibration can be in low frequencies on the surface (below 10 hertz (Hz)) or at higher frequencies (30-250 Hz) underground. Sleeper soffits, fixed to sleepers to absorb vibration, and ballast mats, which restrain the movement of the track, can both be used to reduce ground vibration. Ballast mats are much more expensive to install than sleeper soffits due to their size. However, they are better at reducing vibration.

Surface vibration is harder and more costly to mitigate, and technologies used include sleeper and ballast mats, trenches, buried walls and wave-impeding blocks. Wave-impeding blocks consist of soil that is compacted to reduce vibration. These are used where surrounding buildings or infrastructure prevents the construction of buried walls. Cost and carbon footprint are only incurred as a result of the fuel used when carrying out the work. It costs almost twice as much to install buried walls than trenches and the former also have a much higher carbon footprint. However, they are more effective at reducing vibration and require less maintenance.

The mitigation methods outlined show trade-offs between their effectiveness and economic and environmental costs, demonstrating how measures should be considered on a case-by-case basis. More expensive measures with a higher carbon footprint are often more effective (e.g. noise barriers and buried walls) and should, therefore, only be used in areas where noise and vibration is higher or where more people live near the train track. Less effective but cheaper and more environmentally friendly measures (e.g. trenches and wave impeding blocks) should be used in areas where train vibration does not cause large disturbance.

The researchers say the information summarised in this study may help engineers and managers to improve the environmental management of railways. They say the life-cycle assessment undertaken in this study is useful, as it considers both costs and carbon footprint, which is increasingly important to improve the sustainability of transport.

This report is based on one that first appeared in Science for Environment Policy.





Vibration-powered fault sensors installed on UK train fleet

Vibration sensors installed on the UK's Great Northern Railway can email engineers if wheel bearings or gearboxes develop a problem.

In a UK first, Govia Thameslink Railway (GTR) has installed the sensors on all 40 of its class 365 trains that run between Cambridge, Peterborough and London King's Cross.

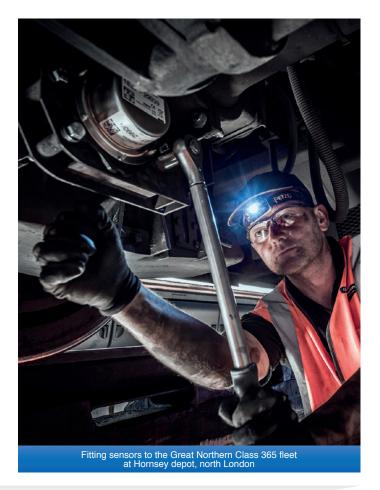
"This significant investment in state-of-the-art technology will improve the reliability of trains on the route, giving our passengers better journeys," said GTR engineering director Gerry McFadden. "Problems will be highlighted months in advance before these vital components have a chance to break down, avoiding further damage and delays."

The devices were developed by Perpetuum, a start-up firm that was spun-out from the University of Southampton. They are powered by the vibrations of the trains themselves.

"If a defect is developing, it will create a specific vibration signature which our technology can isolate and email an alert to Great Northern's engineers at their depot in Hornsey," said Perpetuum Chief Executive Steve Turley. "Looking at other train operators, we've never had a failure in service for the components our sensors monitor."

It is hoped that these kinds of sensors will become commonplace, said Farouk Balouchi of the University of Huddersfield's Institute of Railway Research. "In the railway industry they'll be used in places where the workforce is in danger, and eliminate the need to use people where sensors or instrumentation can be used autonomously," he said.

Where previously faults would be detected by simply "eyeballing the problem", sensors can allow railway operators to track degradation over time. While Perpetuum's sensor is primarily focused on monitoring the health of the train, Mr Balouchi and colleagues have been working with Siemens to develop a three-axis accelerometer that sits inside a train, and can be used to monitor the condition of the track.



Major new research project into sound barrier development

ngineers at the University of Pittsburgh have begun a two-year research project that aims to create new sound barriers to mitigate noise nuisance.

It follows the receipt of a \$200,000 grant from the US National Science Federation under its Early-concept Grants for Exploratory Research (EAGER) funding programme.

The research into Acoustic Diode as Architectural Material (ADAM) is being led by Piervincenzo (Piero) Rizzo, associate professor of civil and environmental engineering at the university's Swanson School of Engineering.

"Engineers and architects strive to create effective and fine solutions to mitigate indoor- and outdoor- generated noise in order to enhance the comfort of the occupants, improve personnel efficiency in the workplace, guarantee privacy, and to provide distraction-free spaces," he said.

"However, traditional building materials have limits, whether structurally or economically. Through this award we'll explore a new architectural system based on the concept of acoustic



diodes acting as a sound barrier that impedes unwanted noise in an environment."

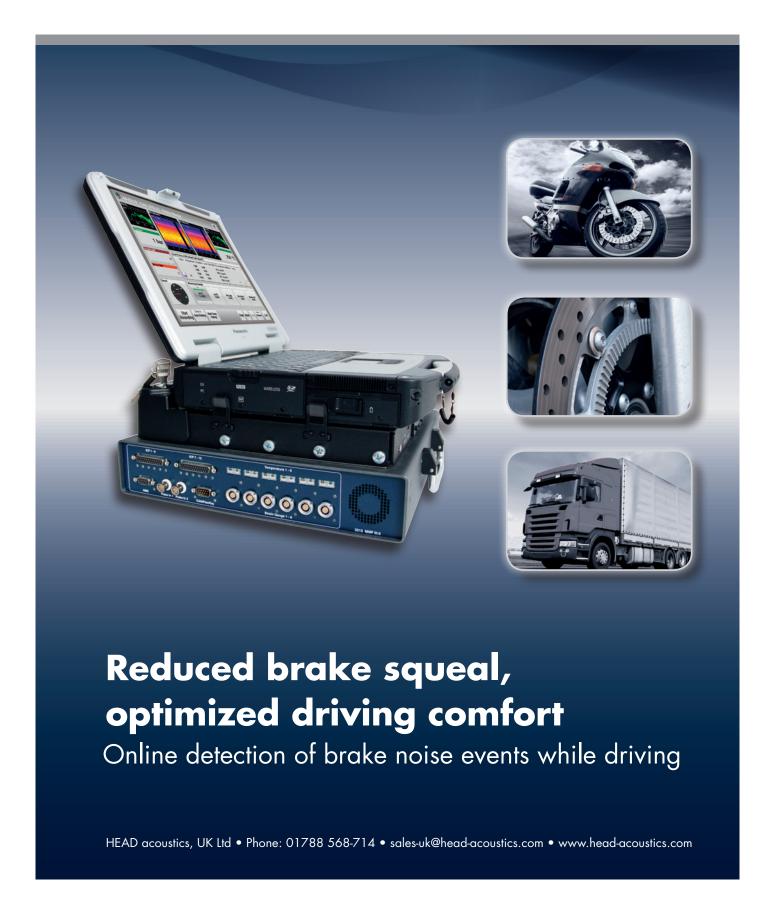
According to Dr Rizzo, acoustic diodes offer low resistance to sound in one direction and high resistance in the opposite direction, which cancels out sound transmission along one direction.

His hypothesis is that a diode, embedded in novel architectural material, can be scaled at multiple lengths to shield indoor noise and eventually transit-generated noise.

"Our research will explore 'trapping' acoustic noise in building materials via acoustic diodes, where they would reflect and decay," Dr Rizzo said. "By integrating several disciplines including acoustics, nonlinear dynamics, and architectural engineering, we hope to determine the feasibility of this potential technology."



Brake OBSERVER



Acoustics-based detection system will identify threats to marine infrastructures

Researchers are working on a NATO-funded research project to develop an acoustics-based detection system for securing marine infrastructures from external threats such as divers or mines.

Currently, the monitoring, securing and maintenance of such infrastructures are performed manually, which requires investing considerable manpower, and limits operational capabilities to the establishment of secure marine areas of limited size.

Known as ThreatDetect, the project will involve the design of a novel autonomous detection system for divers and mines, and the development of a prototype for the demonstration of the system's capabilities.

In the specific case of a detected mine, the system combines active acoustic remote detection with detection verification through target recognition by an approaching Autonomous Underwater Vehicle (AUV).

Potential users for such technology are operators of gas and oil rigs, owners of infrastructure for international communications, sea explorers, and navies. The developed technology will make it possible for such users to significantly reduce maintenance and security costs, and to provide better coverage and much faster response to catastrophic events.

The project consortium, which is receiving €340,000 from the NATO Science for Peace and Security Programme, comprises two members from two NATO member countries (IMDEA Networks from Madrid and the University of British Columbia, Vancouver)

and one member from a NATO partner country (University of Haifa)

"The main concern in the design of an autonomous system for the protection of marine infrastructures is the need for adaptation to different environments. In the cases of diver detection or mine identification, this translates into the detection of objects of unknown shape and size", said Dr Paolo Casari of IMDEA Networks, the principal investigator.

"Since divers and mines are expected to be on the surface or close to the surface, it may be hard to distinguish between the desired target and unwanted noise or signals created by waves or passing fish."

Co-directors Roee Diamant (University of Haifa) and Lutz Lampe (University of British Columbia) continued: "Considering the above challenges and opportunities, we believe that a proper solution is to apply acoustic detection for identification of a diver, and a combination of acoustic and image-based target detection to detect a submerged mine.

"In the latter case, acoustic signal processing provides detection and target localisation, and the imagery data is obtained by sending an AUV at a safe distance from the suspected mine, in order to inspect the object using optical cameras or sonar imaging. This serves as a detection verification. The communication with the AUV is based on underwater acoustic signals. This way, the system can send the AUV the approximated coordinates of the target, and can receive back the processed target image."

Underwater piling and drilling noise stresses and confuses fish

Researchers at Newcastle University have found that European sea bass experienced higher stress levels when exposed to the types of piling and drilling sounds made during the construction of offshore structures.

The fish also showed signs of being confused when they encountered a potential predator while exposed to these underwater noises. When researchers played recordings of piling sounds and mimicked an approaching predator, the seabass made more turns and failed to move away from the predator.

When exposed to drilling sounds the sea bass actively avoided these areas, spending more time in what the research team called the "safe zone".

The fish also took longer to recover from exposure to the underwater sounds.

Lead researcher Ilaria Spigad said: "Over the last few decades, the sea has become a very noisy place. The effects we saw were subtle changes, which may well have the potential to disrupt the seabass's ability to remain 'in tune' with its environment.

"Sea bass, along with other bony fishes, rely on a characteristic 'startle and response' mechanism to get away from predators. Exposure to underwater noises can make it harder for fishes to detect and react to predators. It could also impair their own ability to detect food.

"Man-made marine noise could potentially have an adverse effect on reproduction also. If fish actively avoid areas where these sounds are present it could prevent them from entering spawning grounds, or affect communication between individuals."

The researchers played recordings of drilling from the English Channel made during the installation of a new tidal barrage, while the sound of piling was taken from the construction of a new lifeboat station at Swansea Bay.

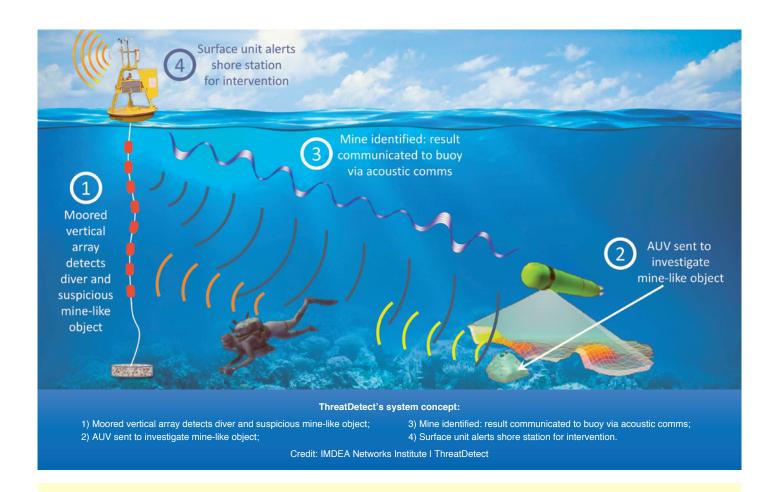
The piling was characterised by intense pulses of low frequency sound whereas the drilling was continuous noise. Both piling and drilling sounds overlap with the hearing range of sea bass and many other species of fish of $100-1000\,\mathrm{Hz}$.

Offshore construction, shipping, and even some onshore activities can all add to ambient noise levels underwater.

Although noise is recognised as a pollutant by the European Union's Marine Strategy Framework Directive (MSFD), currently only applications for larger or more complex projects have to be registered with the UK government's Marine Noise Registry.

Now, the research team are calling for this to be expanded by proposing limits on the length of time that underwater drilling and piling can take place, or replacing piling with drilling, to give fish time to recover from the physiological changes that these noises induce.



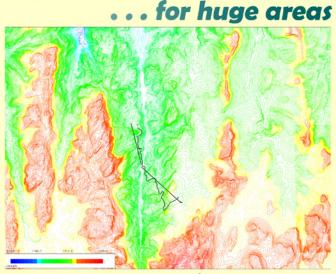


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Terrain and workings model of a 900 sq km noise assessment area for minerals development in Africa



Could this strategy bring high-speed communications to the deep sea?

A new approach to sending acoustic waves through water could potentially open up the world of high-speed communications to activities underwater, including scuba diving, remote ocean monitoring, and deep-sea exploration.

By taking advantage of the dynamic rotation generated as acoustic waves travel, or the orbital angular momentum, researchers at the Department of Energy's Lawrence Berkeley National Laboratory (Berkeley Lab) in the US were able to pack more channels onto a single frequency, effectively increasing the amount of information capable of being transmitted.

They demonstrated this by encoding in binary form the letters that make up the word "Berkeley," and transmitting the information along an acoustic signal that would normally carry less data. They describe their findings in the *Proceedings of the National Academy of Sciences*.

"It's comparable to going from a single-lane side road to a multi-lane highway," said study corresponding author Xiang Zhang, senior faculty scientist at Berkeley Lab's Materials Sciences Division and a professor at UC Berkeley. "This work has huge potential in high-speed acoustic communications."

While human activity below the surface of the sea increases, the ability to communicate underwater has not kept pace, limited in large part by physics. Microwaves are quickly absorbed in water, so transmissions cannot get far. Optical communication is no better since light gets scattered by underwater microparticles when travelling over long distances.

Low frequency acoustics is the option that remains for longrange underwater communication. Applications for sonar abound, including navigation, seafloor mapping, fishing, offshore oil surveying, and vessel detection.

However, the trade off with acoustic communication, particularly with distances of 200 metres or more, is that the available bandwidth is limited to a frequency range within 20 kilohertz. Frequency that low limits the rate of data transmission to tens of kilobits per second, a speed that harkens back to the days of dialup internet connections and 56-kilobit-per-second modems, the researchers said.

"The way we communicate underwater is still quite primitive," said Professor Zhang. "There's a huge appetite for a better solution to this."

The researchers adopted the idea of multiplexing, or combining different channels together over a shared signal. It is a technique widely used in telecommunications and computer networks, but multiplexing orbital angular momentum is an approach that had not been applied to acoustics until this study, the researchers said.

As sound propagates, the acoustic wavefront forms a helical pattern, or vortex beam. The orbital angular momentum of this wave provides a spatial degree of freedom and independent channels upon which the researchers could encode data.

"The rotation occurs at different speeds for channels with

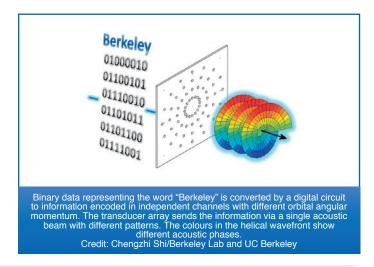
different orbital angular momenta, even while the frequency of the wave itself stays the same, making these channels independent of each other," said study co-lead author Chengzhi Shi, a graduate student in Professor Zhang's lab. "That is why we could encode different bits of data in the same acoustic beam or pulse. We then used algorithms to decode the information from the different channels because they're independent of each other."

The experimental setup, located at Berkeley Lab, consisted of a digital control circuit with an array of 64 transducers, together generating helical wavefronts to form different channels. The signals were sent out simultaneously via independent channels of the orbital angular momentum. They used a frequency of 16 kilohertz, which is within the range currently used in sonar. A receiver array with 32 sensors measured the acoustic waves, and algorithms were used to decode the different patterns.

"We modulated the amplitude and phase of each transducer to form different patterns and to generate different channels on the orbital angular momentum," said Mr Shi. "For our experiment we used eight channels, so instead of sending just 1 bit of data, we can send 8 bits simultaneously. In theory, however, the number of channels provided by orbital angular momentum can be much larger."

The researchers noted that while the experiment was done in air, the physics of the acoustic waves is very similar for water and air at this frequency range.

Expanding the capacity of underwater communications could open up new avenues for exploration, the researchers said. This added capacity could eventually make the difference between sending a text-only message and transmitting a high-definition feature film from below the ocean's surface. Remote probes in the oceans could send data without the need to surface.



Microphones in stratosphere detect low frequency sea sounds

A new study shows microphones suspended from helium balloons in the stratosphere can detect low-frequency sounds from ocean waves.

The new method shows promise for detecting acoustic signals from natural disasters and nuclear explosions that cannot always be reliably detected by sensors on the ground, according to the study's authors.

They say that while scientists can use infrasound sensors on the ground to pinpoint the location and size of avalanches, meteorite strikes and nuclear explosions, such networks often experience interference from wind and human sources like nearby machinery, dams or bridges, making it difficult to accurately detect faint infrasound signals from faraway sources.

The new study's results show sensors in the stratosphere may

reliably detect infrasound signals without this interference. This could help scientists better detect the origin of infrasound signals, according to the study's authors.

"With a sensor on the ground, the wind is blowing past and creating turbulence and causing distortion, but when you're being pushed by the wind, that doesn't create any noise at all since you're travelling at the same speed as the air around you," said Daniel Bowman, a geophysicist at Sandia National Laboratories in Albuquerque, New Mexico, and lead author of the new study in the *Journal of Geophysical Research: Atmospheres*, a journal of the American Geophysical Union.

"Even if you do get a wind gust, the air in the stratosphere is about 100 times less dense, so the force that it imposes is much less. Those two things combined basically eradicate [wind] noise in the stratosphere, as far as we can tell."

In the new study, Dr Bowman and his colleagues contributed infrasound payloads to the NASA High Altitude Student Platform (HASP), a yearly programme that gives student teams the opportunity to perform experiments on long-duration flights in the stratosphere.

During the flights over Arizona and New Mexico, in which HASP balloons were outfitted with microphones, they detected microbarom signals in the stratosphere for the first time, Dr Bowman said.

The study's authors compared microbaroms detected by their stratospheric sensors with signals from ground-based sensors. They found the stratospheric sensors could detect additional microbaroms and picked up less background noise than ground sensors. While the new study only examined the recordings from a handful of flights, the results indicate balloon-borne sensors are a promising method for detecting other infrasound, like those from natural disasters or nuclear explosions, Dr Bowman said.

The detectors could be used to monitor infrasound generated by nuclear weapons and could help enforce nuclear weapons

bans, Dr Bowman said. Balloon-borne infrasound sensors could also be used to detect infrasound in a gaseous planet's atmosphere that could help scientists learn about that planet's interior and phenomena in the atmosphere such as meteor strikes and thunder, he said.

In stating that further research was needed to improve the airborne sensors in order to determine the exact direction an infrasound was coming from and resolve other issues, Dr Bowman said: "We'll never replace ground networks, but I think we can greatly augment them. I also think this really brings the possibility of planetary acoustics to realisation, which is extremely exciting. I think we're going to see some really exciting stuff in the future."





Riding the wave: controlling high frequency sound waves

Researchers from the University of Exeter have pioneered a new technique to control high frequency sound waves, commonly found within everyday devices such as mobile phones.

The research team, led by Professor Geoff Nash, has created a new structure that can manipulate the extreme frequency sound waves – also known as surface acoustic waves or "nanoquakes" – as they run across the surface of a solid material in a similar manner to earthquake tremors on land.

Although surface acoustic waves (SAWs) form a key component of a host of technologies, they have proved extremely difficult to control with any degree of accuracy. Now, the team from the Natural Sciences department at the university have developed a new type of structure, known as a "phononic crystal", which when patterned into a device, can be used to steer and guide the nanoquakes,

Their research has been published in science journal *Nature Communications*.

Professor Nash, lead author of the research, said: "Surface acoustic wave devices are already found in a myriad of technologies, including radar systems and chemical sensing, but are increasingly being developed for applications such as lab-on-a-chip.

"Lab-on-a-chip approaches shrink conventional chemistry and biology laboratories to the size of a few millimetres, and SAWs in these systems can be used to transport and mix chemicals, or to carry out biological functions such as cell sorting.

"Yet until now, it has been extremely hard to make a structure such as ours that can be used to easily direct surface acoustic waves. Our new phononic crystal design is able to control the nanoquakes with just a handful of crystal elements, making it much easier to produce than those previously demonstrated.

"We are confident that these results will pave the way for the next generation of novel SAW device concepts, such as lab-on-a-chip biosensors, that rely on the control and manipulation of SAW nanoquakes. Even more remarkably, it has also been proposed that these structures could be scaled-up to provide protection from earth quakes."



Revolutionary approach brings 3D sound into the living room

omputer vision and sound experts at the University of Surrey have demonstrated "Media Device Orchestration" – an innovative home audio concept which enables users to enjoy immersive audio experiences by using all available devices in a typical living room.

The Media Device Orchestration (MDO) concept has been developed at Surrey in collaboration with the Universities of Salford and Southampton, and BBC Research & Development.

Using the MDO concept, researchers have demonstrated that a 3D or "spatial audio" experience can be achieved by employing everyday home devices in the living room such as a laptop, smartphone or wireless mini-speaker. The technology works by isolating different "objects" within audio content (such as a particular voice), and connecting them to separate speakers available around the room.

The concept could enable consumers to enjoy films, games, programmes and music in a far more immersive, multi-layered and exciting way, they say.

While it is possible to create 3D listening experiences using current spatial audio technology, this requires a complex set-up involving a multitude of speakers located at exact points in relation to the listener. Because of these limitations, the technology cannot easily be replicated in a domestic situation and is generally limited to specialist environments such as cinemas and theme park experiences.

The MDO research is part of the £5.4 million five-year S3A project, funded by EPSRC (Engineering and Physical Sciences Research Council), which is aimed at delivering a step-change in the quality of audio consumed by the general public.

The development of immersive spatial audio systems has become a major focus for the audio research community and home audio industry in recent years for a number of reasons. With the advent of advanced home video technology such as 3D TV, there is a need for audio technology to "catch up" in order to match the visual

experience. At the same time, the growth of virtual reality for video games and other applications is creating demand for a sense of sound which is all around the user.

In addition to "channel-based" sound production (in which the reproduction system is fixed before the content is broadcast), "object-based" audio has recently emerged on the commercial market with the launch of technologies such as Dolby Atmos. The object-based audio technology has enabled the S3A researchers to access each separate part of an audio scene, intelligently routing them to improve the listener experience.

Leading the S3A project, the University of Surrey combines expertise in both computer vision and machine listening (within its Centre for Vision, Speech and Signal Processing) and sound perception (within its Institute of Sound Recording), which has enabled a user-focused solution rather than a purely lab-based approach.

Dr Philip Jackson, Senior Lecturer in Machine Audition at Surrey, said: "Most consumer audio transmitted into our homes is in the form of two-channel stereo which uses basic principles that have been around for over 130 years. To date, sophisticated multi-channel audio techniques have not helped to improve the listening experience for the general public. Our aim is to take spatial audio out of the lab and into people's homes, and give users the impression of being at the heart of the action while in their living room."

Dr Jon Francombe, Research Fellow in spatial audio in Surrey's Institute of Sound Recording, commented: "New spatial audio methods have often required consumers to buy and install specific systems. We're trying to make immersive listening experiences available to anyone by intelligently re-purposing content for whatever devices they already have available."

Transport noise increases risk for cardiovascular diseases and diabetes

ransport noise increases risk for cardiovascular diseases and diabetes. This is shown by the first results of a study under the lead of Swiss Tropical and Public Health Institute (TPH) which was presented at the ICBEN Congress (International Commission on Biological Effects of Noise) in Zurich in June.

How transportation noise affects the health of people remains in many aspects unexplained. Since 2014, an interdisciplinary Swiss consortium has been studying the short- and long-term effects of transportation noise for the population in Switzerland in the frame of the Sirene (Short and Long Term Effects of Transportation Noise Exposure) study of the Swiss National Science Foundation (SNSF).

The results published so far show that aircraft, rail and road traffic noise in Switzerland leads to adverse health effects. For cardiovascular disease mortality, the most distinct association was found for road noise. The risk of dying of a myocardial infarction increases by four per cent per 10 decibel increase in road noise at home. Also the risk of hypertension and heart failure increases with transportation noise. "Particularly critical are most likely noise events at night regularly disturbing sleep," said Martin Röösli, principal investigator of SiRENE and professor of environmental epidemiology at Swiss TPH and the University of Basel. "The threshold for negative health impact is lower than previously suspected."

In addition to cardiovascular diseases, transportation noise also increases the risk of developing diabetes. This is shown by an examination of 2,631 people exposed to different degrees of noise pollution. "Two mechanisms play a role," said Nicole

Probst-Hensch, Head of the Department of Epidemiology and Public Health at Swiss TPH. "On the one hand, the chronic release of stress hormones influences insulin metabolism. On the other hand, sleep problems are known to negatively affect metabolism in the long term."

The results that were published in the frame of the SiRENE study will provide important information for the Swiss authorities with regard to improving noise protection and to potentially adjusting the noise limits in the Noise Abatement Ordinance (NAO). The health impact of transportation noise is substantial when considering the entire population in Switzerland, causing external costs of an estimated CHF 1.8 billion each year.



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Noisy cities disrupt heartbeat and could trigger disease, study suggests

he din of noise in town centres could trigger heart problems, a new study suggests, after scientists found that fluctuating sounds on busy high streets disturb normalcardiac rhythms.

Researchers from Nottingham Trent University found that constant changes in noise – even at low levels – had an immediate and disruptive effect on the patterns of participants' normal heart rates.

The team says their findings add to a growing body of research which shows how our everyday surroundings could have wider implications for long-term health.

For the study, shoppers were asked to wear mobile body sensors to monitor their heart rates as they moved about Nottingham city centre for 45 minutes.

"We found that rapid changes in noise resulted in rapid disturbance to the normal rhythm of participants' hearts," said researcher Dr Eiman Kanjo of Nottingham Trent's School of Science and Technology.

"If this pattern is repeated regularly then there is a danger it might lead to cardiovascular problems."

The study is the first to use sensors to attempt to model the short-term impact that city environments can have upon the human body.

The researchers also found that air pressure had an effect on heart rate as well as an impact upon body temperature.

Environmental data including noise, air pressure and light levels were compared with data from participants relating to heart rate, body temperature and movement and changes in the electrodermal activities of the skin.

None of the participants had heart problems, but the researchers say it would be useful to study whether people with heart conditions suffered a greater impact.

The team are also calling for decision-makers to develop, implement and improve guidelines and standards to protect public health around urban spaces.

"Repeated human exposure to environmental pollutants such as noise, air pollution, traffic or even crowded areas can cause severe health problems ranging from headaches and sleep disturbance to heart disease," added Dr Kanjo.

"Many people live in and around urban areas and every day will walk along city streets and get around by cars, trains or buses.

"It's important that the issue of noise is considered when designing city landscapes. Most importantly, local authorities should look at the multiple environmental factors that might affect our health at street level."

The research was published in the journal *Information Fusion*.



'Government must do more to mitigate road traffic noise'

strong call has been made to the Government to improve its approach to dealing with road traffic noise. In a new report entitled *Rising to the Challenge*, the Campaign for Better Transport says Highways England is "failing to address the wider impacts of noise" through its programme of double glazing and other noise insulation in homes in Noise Important Areas.

"Barriers, while effective and essential in some locations, can be visually intrusive," it states. "Greater use could be made of natural barriers such as tree screening or use of traditional materials in man-made barriers, at visually sensitive locations.

"Dense planting can achieve a reduction of 3-5 dBA road noise per 100 feet according to the US Department of Transportation. The priority for addressing noise pollution in RIS2 (Second Road Investment Strategy) should move beyond mitigating the impact to seeking to reduce the noise at source.

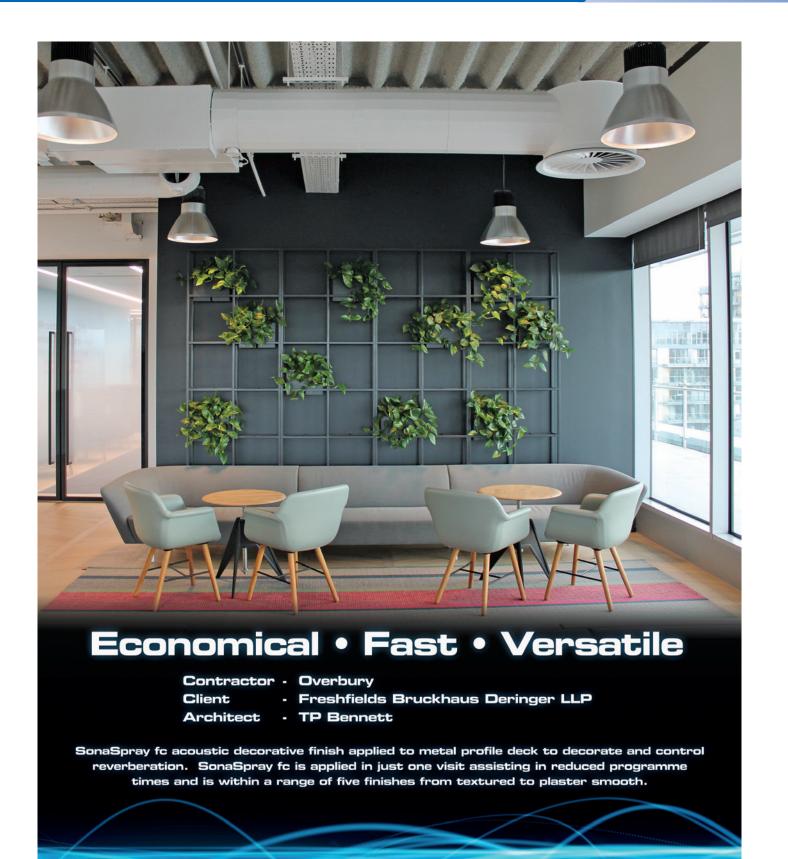
"This should include ensuring as much as possible of the SRN (Strategic Road Network) is resurfaced with noise reducing surfacing with priority being given to areas such as National Parks and AONBs (Areas of Outstanding Natural Beauty) that are valued for their tranquillity and wildlife as well as those areas where noise affects high numbers of people."

In pointing out that the World Health Organization (WHO) states that noise is second only to air pollution in the impact it has on human health, the report states: "It is a major cause, not only

of hearing loss, but also of increased stress, annoyance and sleep disturbance, leading to increased risk of heart disease, stroke, and poor mental health. This can particularly affect densely populated urban areas and many low-income communities.

"Noise from traffic on the SRN not only has adverse impacts on human health: it also undermines the tranquillity of the countryside and has damaging effects on wildlife. Highways England could contribute to mapping areas of tranquillity by publishing open data on the noise contours of all new and existing SRN infrastructure."





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Wind turbine noise: the search for an alternative truth

By Dick Bowdler FIOA

September 2017. Organised by some objectors in Scotland, it sought to counter the "misinformation" put out by governments, health services, acousticians and the wind industry worldwide. The misinformation we were told they disseminate is that there no evidence that infrasound causes a wide range of illnesses in humans and animals and, what is more, the probability of there being any causal effect is vanishingly small. The seminar was started by Melvin Grosvenor of the Independent Noise Working Group explaining how members of the Establishment all over the world tell us that there are no health effects from infrasound from wind turbines. People here, he said, will tell you differently because they are ill from infrasound. There was a conspiracy to hide the real facts which he likened to cover-ups in the past of asbestos, the radium girls, tobacco, Thalidomide and Primodos.

He then introduced Patrick Dugast, a French acoustician, who told us about the French wind farm scene. He said the French authorities' response was, like the British, to deny any connection between turbine infrasound and ill health. He described the work of Alec Salt in the US who showed that a 5Hz tone of infrasound triggers hair cells in guinea pigs.

John Yelland, a physicist and electrical engineer, then explained how turbine infrasound affects animals. Mink in Denmark fight with each other and the abortion rate goes up. The abortion rate in sheep goes up. Turbine infrasound affects pigs and geese in Poland, goats in Taiwan, beached whales (though he admitted there was no firm evidence of this). It explodes the lungs of bats and halves cow's milk yield. John also told us about Alec Salt's work and that of Paul Schomer who had pointed to research into sea sickness. This showed that maximum sea sickness risk was at a frequency of 0.2 Hz and that might explain nausea brought on by wind turbine infrasound.

Finally, Mariana Alvez-Pereira, a specialist in vibro-acoustic

disease, explained how in a sound field we were bombarded with mechanical forces, and she demonstrated this by punching her body with her fist. She explained in some detail, sometimes lurid, the damage caused to the human body by the extremely high sound levels, including infrasound, to which aircraft mechanics are exposed when close to jet engines. She also explained how industrial environmental noise appeared to produce some of the same symptoms. This included a family who lived near wind turbines.

Readers of this publication will have noticed that certain basic technical details had been glossed over during the meeting. There was no evidence that dead animals were killed by infrasound – no post mortems. Neither Patrick nor John told us why Alec Salt's findings had any relevance to the issue. The infrasound from turbines in the Paul Schomer example would only make people sick if it physically lifted them up and down one metre over a period of five seconds. There were no reports of that happening. Mariana's example of mechanical forces pounding the body is right in principle though the fist is something of an exaggeration. In reality, it is more like a gentle fanning of the face with a sheet of paper – much like the video example of infrasound shown to us by John which slightly disturbed a lighted candle. Mariana also failed to tell us how the infrasound from turbines relates to infrasound to which the aircraft mechanics were exposed.

It is a fact that turbines, like most mechanical things, produce infrasound. It is also a fact that some people living near turbines are ill. The biggest scientific flaw to the evening was that not one shred of evidence was put forward to show any causal link between the two.

Fortunately, most objectors in Scotland are more concerned about audible noise and were not at the meeting. But it is of great concern that those members of the audience who live near wind turbines and are ill will now go home believing that their illness has a direct physiological cause, that it will certainly get worse and probably escalate into something much more serious.

'Good acoustics must be incorporated in all new buildings'

s it possible to design an aesthetically beautiful building while achieving good acoustics?

☐ This was the question posed by Peter Rogers of Sustainable Acoustics at the start of a round table discussion organised by Rockfon on topics influencing aesthetics and acoustics in architecture today.

Joining him at the Word in South Shields were Jack Harvie-Clark and Richard Hinton of Apex Acoustics, Colin Falconer of Welsh Slate, Joao Esteves from Magres Ceramics, Nick Heyward of FaulknerBrowns architects and Rockfon Technical Manager Tim Spencer.

Colin Falconer and Joao Esteves discussed the lack of acoustic consideration with their industry, with aesthetics taking priority when it came to slate and tiling.

However, Nick Heyward pointed out that the correct balance between hard surfaces and acoustic elements could enable architects to achieve acoustically successful interiors. "It's about allowing for hard surfaces within certain areas and mitigating their impact with your design," he said.

The group discussed how the industry could work to improve the awareness of acoustics across the board. Ideas suggested included: encompassing acoustics in CPDs, increasing the acoustic learning module within the seven-year architecture study, and nurturing collaboration between hard surface manufacturers and acousticians.

Nick said: "More often than not acoustics are not the first thing architects consider – they almost come as a secondary system. Today's acoustic solutions, however, are more versatile – with more designs, colours and shapes, providing acoustic and aesthetically-pleasing solutions that complement the architect's vision."

Jack Harvie-Clark said buildings with a good acoustic environment enable end-users to understand what is being said efficiently which in turn helps improve productivity in workplaces and teaching and learning in schools, for example. Acoustic regulations in schools were only introduced in the UK in 2003 but did not cover universities or higher education establishments. "We're miles behind other countries within the EU when it comes to acoustics, and we can use their regulations as guidance within the UK," he said.

Richard Hinton said all buildings were different and required tailored project solutions. He gave as an example how sports stadiums desired a stimulating atmosphere whilst schools required near-silent environments. That was why architects must design acoustics that were appropriate for the function of the building, he said.

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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.

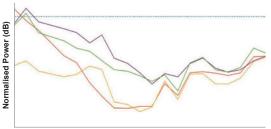
We have long experience of installing effective floating floor systems for a wide range of applications but there are a number of design variables which can be utilised for customers with limited space or budgets.

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.





Frequency (Hz)

Mason UK regularly test our elastomers and other products in independent laboratories. As part of the Mason Industries group, we also have access to extensive testing facilities. As well as taking responsibility for our own design and engineering, we often have to fabricate bespoke solutions, some of which require very specific testing and certification.

Whether a standard solution or a problem never tackled before, Mason UK can help.



Bearing creep testing and results chart

About Mason

A world leader in noise & vibration control products for over fifty years setting the standard for consultants & architects. In addition to a comp lete range of mounts, our floating floors, walls & suspended ceilings provide total acoustic isolation

Typical Applications:

- Music Rooms Night Clubs Plant Rooms Recording Studios Bowling Alleys Building Isolation
 - Cinemas Gymnasia Microscopes M+E Isolation Suspended Ceilings Industrial

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Nick said: "It's all about understanding the needs of those who will be using the building, as well as the activities that will be taking place within a space. That understanding comes from having a good dialogue between the architect, the client, the product manufacturer and the acoustician. If an architect, or anyone else in the decision-making process, is concerned about the acoustics of a particular space within a building, those concerns should be discussed early on with an acoustician."

There were commercial gains to be made from good acoustics, as the group illustrated using restaurants as an example: "It is

disappointing to visit a restaurant that's uncomfortably noisy. Acoustics could well have a monetary impact on a business," said Tim Spencer in pointing out that acoustic issues were relatively easy to resolve.

The group concluded that, by recognising the client's aspiration for a space, the architect and design team could be sympathetic to acoustics and deliver a building fit for purpose. It was time for the industry to take a holistic approach towards acoustics and work together to ensure all buildings were acoustically "sound".

Cognitive hearing aid filters out the noise

ngineers have made a major advance in helping the hearing impaired follow a conversation in a noisy environment.

Using deep neural network models, they have made a breakthrough in auditory attention decoding (AAD) methods and are coming closer to making cognitively controlled hearing aids a reality.

The study, led by Nima Mesgarani, associate professor of electrical engineering at Columbia Engineering in New York, is published in the *Journal of Neural Engineering*.

Professor Mesgarani's team developed an end-to-end system that receives a single audio channel containing a mixture of speakers by a listener along with the listener's neural signals, automatically separates the individual speakers in the mixture, determines which speaker is being listened to, and then amplifies the attended speaker's voice to assist the listener – all in under 10 seconds.

"This work combines the state-of-the-art from two disciplines: speech engineering and auditory attention decoding," said Professor Mesgarani. "We were able to develop this system once we made the breakthrough in using deep neural network models to separate speech."

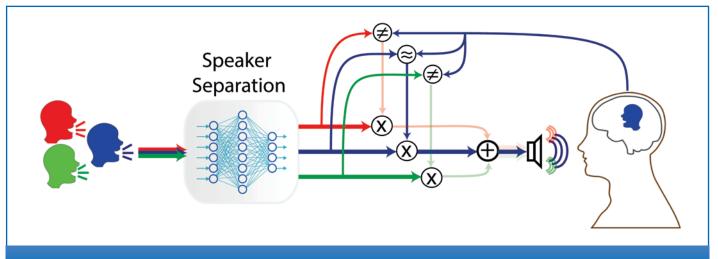
His team came up with the idea of a cognitively controlled hearing aid after they demonstrated it was possible to decode the attended target of a listener using neural responses in the listener's brain using invasive neural recordings in humans. Two years later, they showed they could decode attention with non-invasive methods as well.

"Translating these findings to real-world applications poses many challenges," said James O'Sullivan, a postdoctoral research scientist working with Professor Mesgarani and lead author of the study. In a typical implementation of auditory attention decoding, researchers compare the neural responses recorded from a subject's brain with the clean speech uttered by different speakers; the speaker who produces the maximum similarity with the neural data is determined to be the target and is subsequently amplified. However, in the real world, researchers have access only to the mixture, not the individual speakers.

"Our study takes a significant step towards automatically separating an attended speaker from the mixture," Dr O'Sullivan continued. "To do so, we built deep neural network models that can automatically separate specific speakers from a mixture. We then compare each of these separated speakers with the neural signals to determine which voice the subject is listening to, and then amplify that specific voice for the listener."

The team tested the efficacy of their system using invasive electrocorticography recordings from neurological subjects undergoing epilepsy surgery. They identified the regions of the auditory cortex that contribute to AAD and found that the system decoded the attention of the listener and amplified the voice he or she wanted to listen to, using only the mixed audio.

"Our system demonstrates a significant improvement in both subjective and objective speech quality measures – almost all of our subjects said they wanted to continue to use it," said Professor Mesgarani. "Our novel framework for AAD bridges the gap between the most recent advancements in speech processing technologies and speech prosthesis research and moves us closer to the development of realistic hearing aid devices that can automatically and dynamically track a user's direction of attention and amplify an attended speaker."



A cognitively controlled assistive hearing device can automatically amplify one speaker among many. To do so, a deep neural network automatically separates each of the speakers from the mixture, and compares each speaker with the neural data from the user's brain. The speaker that best matches the neural data is then amplified to assist the user. Credit: Nima Mesgarani/Columbia Engineering

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Welsh council fined £150,000 after worker contracted HAVS

Welsh local authority has been fined £150,000 and ordered to pay nearly £11,000 in costs after a 57-year old employee was diagnosed with Hand Arm Vibration Syndrome (HAVS). Mold Magistrates' Court heard how the man who worked in the Wrexham County Borough Council's StreetScene department had been diagnosed with HAVS in September 2015.

An investigation by the Health and Safety Executive (HSE) found the council failed to address the issue of HAVS following an audit in February 2011 which identified a failure to assess the risk to employees from vibration. The council had developed a number of policies dating back to 2004 to tackle the risk of HAVS, however it was found these policies were not implemented.

Following the introduction of HAVS occupational health surveillance for users of vibrating tools a further 11 diagnoses of HAVS or Carpal tunnel syndrome have been reported.

The council pleaded guilty to breaching Section 2 (1) of the Health and Safety at Work Act 1974.

Speaking after the hearing HSE inspector Mhairi Duffy said: "This employee now suffers from a long term, life changing illness.

The council should have implemented the policy they devised following the audit in 2011.

"Workers' health should not be made worse by the work they do; all employees have the right to go home healthy at the end of the working day."

And in another court case, an engineering company has been fined £20,000 and ordered to pay costs of £1,171 after a 29-year-old worker was diagnosed with HAVS.

Greater Manchester Magistrates' Court heard how the employee, who was working in the trimming department at Taylor Engineering and Plastics Limited, was exposed to vibration from tools used to sand components. Health surveillance implemented at the company in 2014 showed that the employee had developed HAVS through exposure to vibration while working at the company.

The company of Molesworth Street, Rochdale, pleaded guilty to breaching Section 2(1) of the Health and Safety at Work Act 1974.

Restaurants far too noisy: Good Food Guide editor

growing number of restaurants are putting off customers by deafening them with "Glastonbury-force" songs, says the Good Food Guide.

This year's guide warns of an "unprecedented" trend for noisy restaurants, which is leading to a spike in complaints from sensitive eared customers.

Elizabeth Carter, editor of the guide, said: "Restaurants are getting noisier – that's what our readers, this year in unprecedented numbers, are telling us. Noise levels, already amplified by bare-bones design, are being raised by music played at Glastonbury force.

"Everyone loves a restaurant that has a buzzing, vibrant atmosphere, but it becomes exhausting and self-defeating when, as one old hand told us: 'I have never heard such loudly amplified music in an eating place. It was so loud that I couldn't hear a word the waitress was saying, and vice versa. We had to gesture and point'."

An interior trend for minimal concrete walls and floors, which according to Ms Carter is "not just in hipster places", is also affecting the acoustics in restaurants and making it difficult for people to hear each other.

Ms Carter revealed that a number of the guide's inspectors had to ask top restaurants to turn music down, with one reporting inappropriate Simon and Garfunkel songs being played on full blast in an exclusive country retreat.

When it came to the restaurant awarded the top spot in this year's guide (Cornwall-based Restaurant Nathan Outlaw), she admitted that she was unable remember what music was playing, claiming this is a sign that it was perfectly chosen.

And in another report, the national charity Action on Hearing Loss says diners are fed up with having to compete with restaurant noise on their nights out and are increasingly turning to takeaways according to new figures released

With noise levels in some popular restaurants topping more than 90db on busy nights, a survey of 1,200 people revealed that more than 43 per cent of potential diners have opted to get a takeaway instead of going out for a meal. Ninety-one per cent stated that they would not return to a noisy place.

As part of its Speak Easy campaign the charity is now urging members of the public to take decibel readings at restaurants using a free app (Decibel 10 for iPhone and Android) and proactively give feedback to restaurants on their noise levels, either by contacting them directly or by leaving reviews on sites such as Trip Advisor to help others decide if the venue is suitable for them.



Noise control measures for activation of a fifth generation aircraft

By Craig Clayson

Introduction

RAF Marham is home to the fast jet frontline squadrons of the RAF's Tornado GR4 Force which currently focuses on operations in the Middle East, alongside holding a high readiness state for contingency operations across the globe. Following the 2013 announcement that RAF Marham will be the future home of the Lightning Force, the base is now undergoing extensive changes in preparation for the UK's first ever fifth generation, multi-role, stealth fighter.

The Noise and Vibration Division (NVD) within the Centre of Aviation Medicine (CAM) at RAF Henlow has been advising on the infrastructure planning stage and has provided specialist advice regarding the non-steady state, high noise level airfield environment. The division has also been providing advice for the application of the Environmental Impact Assessment to the LPA and occupational noise assessments of the personnel operating with, or within the vicinity of the new Lightning aircraft. Aircraft noise and airfield environments need careful consideration, both at land and sea; therefore it is essential that in-depth planning and research, future predictions, and assessments are performed. High profile acoustic companies and multinational government agencies / organisations such as Lockheed Martin, Joint project office, United States Air Force Research Laboratories, BAE Systems, Atkins, AECOM, RAF CAM NVD have all participated in the project, offering a large volume of resources and specialist knowledge.

The new UK Lightning aircraft has exceptional agility and

manoeuvrability alongside fifth generation fighter characteristics, including advanced stealth, avionics, network-enabled operations, sensor fusion and advanced logistics support. It is designed to operate from established land bases, short runway strips and the new UK Queen Elizabeth Class aircraft carriers. It consists of a Pratt & Whitney F-135-600 engine which is capable of 40,000lbs thrust and a max speed of 1.6 Mach. All Lightnings are operated by single aircrew and the UK have purchased the B configuration (this includes a lift system that consists of a lift fan behind the pilot's crew station and roll post ducts, giving it short take off and vertical landing (STOVL) capabilities) and a 3-bearing swivel main engine duct.

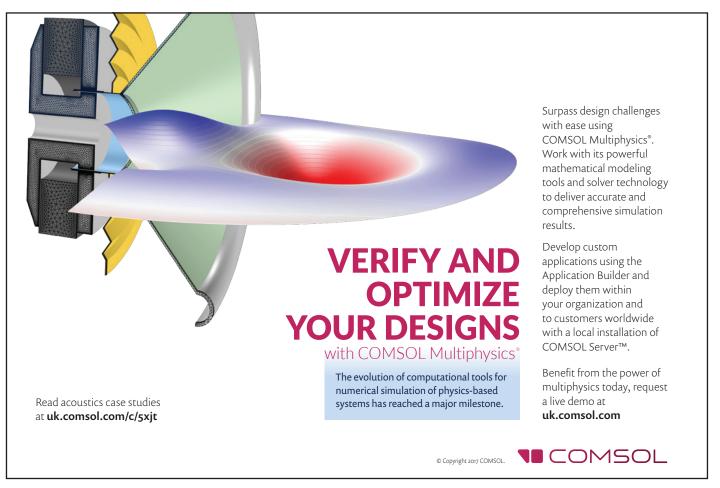
Multiple actions have been and are continuing to be undertaken by the RAF ahead of the planned introduction of the aircraft. This includes a full assessment on the environmental noise change for the local community, accurate noise prediction planning for existing and new infrastructure at RAF Marham, and assessments of associated occupational noise for military personnel.

Noise measurements at source of the Lightning

The area of military fast jet noise in recent decades has come to be a highlighted issue with reference to the environmental noise impact it can produce. The European Union Directive 2002 states that aircraft environmental noise needs to be assessed via strategic noise maps.

Fast jet noise emissions are due largely to the engines being

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built for performance, not noise abatement, which results in higher noise outputs compared to civil aircraft.

MOD greatly values the support of local communities and is acutely aware of the potential impact that aircraft operations can have upon them. The potential effects of introducing Lightning into service at RAF Marham as the Tornado GR4 is taken out of service are, thus, fully recognised.

The F-35 Joint Project Office programme has been proactive and very successful in collecting UK Lightning aircraft noise data. In Oct 2008, F-35AA1, a pre-production prototype aircraft, was used to collect initial ground run-up and flyover noise data for environmental assessments and impact statements. The American National Standards Institute (ANSI) created a noise working group which identified the need for a common approach for the measurement of military fast jet noise. The group published noise measurement procedures to allow for reliable, repeatable and accurate data collection. The methodologies produced by the working group resulted in the production of ANSI standard S12.75.2012. NVD, RAF CAM, has adopted a very similar approach to measuring new platforms.

The F35 programme organised and completed a large multi-national measurement Engine Ground Run and overhead flight noise trial surveys at Edwards Air Force Base in conjunction with take-off and vertical landings for noise trials at Marine Corps Air Station in Yuma, in the USA during 2013. The large scale trials used more than 350 off-aircraft microphone positions in array formats. Microphones heights varied from 0ft to 300ft above ground level, via stands, tripods, and cranes in all three axis for all types of manoeuvres. Separate arrays were designed for the ground run-up, flyover, and vertical landing measurements.

The output of the trial resulted in the successful capture of representative ground run-up and flyover noise data. It provides the most robust noise data currently available for occupational and environmental impact assessment for a UK military fast jet to date.

The 2013 measurements generally corroborated the 2008 results. For security reasons, exact levels cannot be released publicly; however on the ground the UK Lightning is similar in overall noise level to the F18's, F22's under similar flight profiles.

The Lightning has a high sound power level but operates in a unique manner, therefore uses a different profile setting, often resulting in less thrust required. The on-board clever computer system of the aircraft utilises a high speed low thrust operation which minimises the noise; this coupled with the reduced occurrence for this operation in comparison with older jets reduces the noise further. There is a noticeable difference in spectral content compared to other military fast jets. Whilst in flight, the UK Lightning linear is approximately 2 dB $\rm L_{MAX}$ louder on take-off and around 10 dB $\rm L_{MAX}$ quieter on approach compared with the F18; and approximately 4 dB $\rm L_{MAX}$ louder on take-off and around 8 dB $\rm L_{MAX}$ quieter on approach compared to the GR4 under conventional fight profiles.

The collected and verified data was presented in several formats to each nation partner to aide them in calculating not only the noise footprints, but occupational noise assessments.

Environmental footprint

At present, the noise footprint affecting the local community arises mainly from the arrival and departure of Tornado GR4 using the main runway at RAF Marham. Current procedures assist in mitigating the effects of noise on local residents, livestock and wildlife. These practices include avoiding over flight of sensitive receptors, the routing, speed and height of aircraft, reduced throttle settings after take-off, and restrictions on the operating hours of the airfield for both flying activity and the ground running of engines. With the introduction of the Lightning, a shorter secondary runway is being re-activated and the addition of three new vertical landing pads on the airfield.



Aircraft operations in military training airspace generate a unique noise environment. Flights are sporadic, occurring at random times and vary each day, depending on a number of factors such as training schedules, weather, wind direction and aircraft availability. This situation differs from most community noise environments, in which noise tends to be continuous or patterned. Individual military flight events (noise from a low-altitude, high-airspeed flyover) can have a rather sudden onset effect.

NVD RAF CAM calculated the noise emitted from military aircraft at RAF Marham prior to the arrival of Lightning (GR4's flying). Predictions were conducted (arrival of the Lightning) to aide in the assessment of the change via the Noise software Integrated Noise Model 7d. SAE AIR 1845 standard is utilised via noise-power-distance (NPD) data to estimate noise accounting for specific operation modes, thrust settings, speed, altitude, source-receiver geometry, acoustic directivity, and other environmental factors. The noise output could be exposure-based, maximum-level-based, or time-based. Whilst detailed assessments of community noise have been undertaken, to a good level of accuracy, they are only prediction and based on evolving assumptions. NVD will continue to work with the Lightning Basing Team to ensure the most up to date and correct data is presented.

In addition, NVD RAF CAM requested the assistance of the Air Force Research Laboratory, USA, in predicting the 1/3rd octave, two minute average to assess the event noise level and also they calculated a worst hour airfield operations scenario to aide in the assessment of infrastructure intrusion with regards to the environmental noise, allowing the analysis of the worst case scenario. This data aided in calculating the noise at facades of the immediate infrastructure in 1/3rd octave bands to allow for calculation of mitigation requirements.

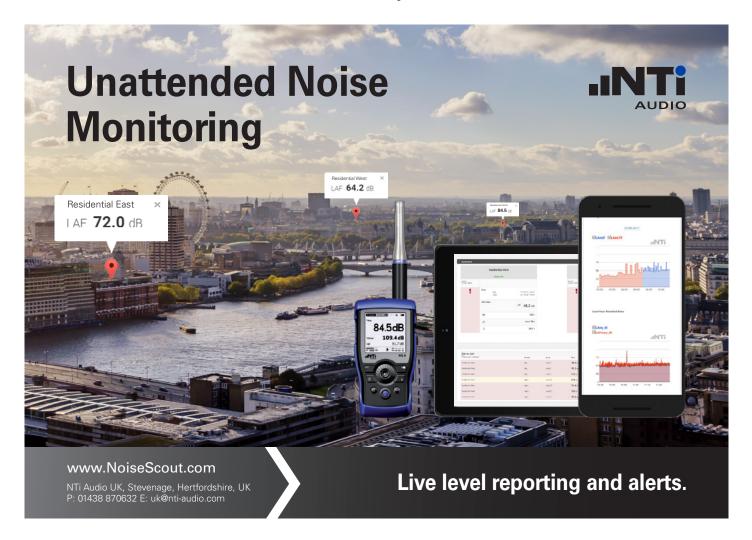
Building acoustics

To house the Lightning at RAF Marham new infrastructure is required. Atkins developed building designs with noise mitigation in mind. Noise metrics were decided upon to represent short events in the form of two minute averages and worst case scenario airfield operations over a one hour average. The noise metrics capture the predicted characterisation of the environmental noise and egress into the proposed buildings, which were applied to the drawing designs for building services, sound insulation, and reverberation times, in reference with British Standards and relevant guidances. However, many of these are not wholly appropriate for the type of environment the airfield represents; therefore using the louder event levels rather than longer averaging times is preferred to create the most appropriate noise mitigation designs. Different proposed areas were assessed against the agree criteria such as Hangar – 70 dB LAeq,1hr, Open Plan Office 45dB LAeq,1hr etc.

Existing infrastructure is currently being assessed by AECOM during GR4 operations and future predicted levels with assistance from NVD RAF CAM. Assessments to WHO Night noise guidelines 2009, WHO community noise guide, 1999, British Council for offices Guide 2009 and BS 8223:2014 are being undertaken. The assessment methodology aligns with new proposed infrastructure, but includes accommodation buildings assessments.

Pilot

Noise attenuation performance tests were executed with the Lightning II Generation II and Generation III Helmet Mounted Display. Tests were undertaken with survival equipment additions, to assist in providing accurate attenuation data for noise exposure calculations within the cockpit. Pilots of the 5th Generation aircraft also have the benefit of 50:50 synthetic / real training for this aircraft which aides with training costs, but also less noise exposure due to the simulated environment.



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Maintainer hearing protection

A variety of hearing protection systems for those maintaining the aircraft was reviewed for the suitability within this niche working environment. With both transmit and receive capability an essential factor, Lockheed Martin identified a potential solution for hearing protection for the maintainers. This comprises a double hearing protection system with the addition of digital active noise reduction custom-moulded ear plugs, supported by a hearing protection headset. ANSI tests conducted by Aegisound have shown this provides hearing protection in noise fields up to and exceeding 140 dB.

NVD and the Lightning project team tasked the Health and Safety Laboratory to review the potential options of hearing protection for DANR DHP dual earmuff and Active Noise Reduction (ANR) earplug as there is no UK standard for ANR earplugs or an EN standard test procedure to determine the ANR element of the attenuation. While the ANSI is a thorough document, it has slight differences to the UK British Standards. For example, UK methodology uses a 4dB reduction to allow for real world factors, in accordance with Health and Safety Executive guidance (i.e. APV-4dB values used).

Conformance to the Noise at Work Regulations 2005 is essential whilst any personnel, including maintainers, are aboard the QEC.

BAE has cleverly developed a spread sheet tool-based on near field noise predictions. The empirical data utilised within this tool was attained from BAE subscale modelling and data from static engine ground runs at Edwards AFB, and vertical landing operations at Marine Corps Air Station in Yuma, in September 2013. This prediction model is currently planned to be validated with real life testing to ensure everything that can be done, has been in order to fully protect the personnel.

All of this is at the fore front of all minds in the anticipation of the Lightning's integration to the UK. A project of this scale has produced many exciting challenges as an NVD acoustician, but with the support of other government organisations and contractors, successful on-going work in the three areas of environmental impact, infrastructure assessments and occupational noise are progressing to an excellent standard. This will allow for minimal disruption to the public and military personnel, and ultimately protect and preserve the hearing capabilities for all affected.

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Craig Clayson is Deputy Head of the Noise and Vibration Department at RAF Henlow. A mix of qualified civilian and military personnel, the division's main aim is to provide specialist scientific support on all aspects of noise and vibration to the RAF and the MOD.

Toolkit for assessing costs and benefits of noise mitigation measures

By Adam Lawrence

Introduction

Atkins undertook work for Defra in 2008-2009 which was published in late 2015, Project NANR201 http://randd.defra.gov.uk. The work focussed on providing a toolkit assessment process for "management areas" determined from Action Plans prepared under the Environmental Noise Directive (END). Although the work pre-dates several key noise guidance documents the approach remains valid and valuable. This article presents the appraisal and evaluation framework from the report, which is compatible with Government policy.

Assessing costs and benefits

As part of Action Plans submitted to the European Commission, the END requires "cost-effectiveness" and "cost-benefit" information for proposals on measures and strategies. Therefore an action plan has to balance the "cost of noise" against the "cost of tackling noise". A robust way of evaluating the cost of noise on society provides a useful tool for prioritising cases, helping decision makers compare various actions against one another and justify noise mitigation.

In the *Green Book* Her Majesty's Treasury provides a best practice guide to the conduct of assessments of projects, policies and programmes. This guidance is binding for government departments and executive agencies. The purpose of the Green Book "is to ensure that no policy, programme, or project is adopted without first having the answers to the following questions:

- Are there better ways to achieve this objective?
- Are there better uses for these resources?"

The essential technique advocated by the *Green Book* is option appraisal, and Cost Benefit Analysis (CBA) is the recommended approach, although the approach should be proportionate.

The assessment framework

An appropriate assessment is needed to determine the cost-effectiveness of noise control measures for noise management areas. Such an assessment could be carried out in two stages. A scoping exercise would broadly consider suitable types of noise control

measures. A more detailed assessment would subsequently quantify noise reductions and assist the decision-making process.

Design targets

The Action Planning guidance in the UK does not set specific design targets for controlling noise. However, when noise control measures are being assessed, and design options are being selected, it is useful to think about potential noise reductions, and take a view on whether:

- These measures would be suitable for the noise management area; and
- The benefit offered would be significant (i.e. that reductions would be at least perceptible).

For the person assessing the potential noise control options, it is often useful to have a design target in mind, so that they can iteratively adjust the noise control measures to aim towards that target. This also allows demonstration of the overall performance of the control measures and that they serve the purpose for which they were intended. Noise control design targets are not suggested, but such targets would broadly either:

- · Aim to reduce noise levels below an absolute noise level or
- Aim to achieve a reduction in noise levels of at least a certain amount.

The design target is simply a tool to determine if the proposed noise control measures are 'fit for purpose' or not. The person assessing effectiveness of the noise control measures needs to have a clear idea of what reductions in noise would be "acceptable".

Assessment years

The TAG methodology for noise uses the concepts of Opening Year (year 0 or the year in which the benefits of the intervention come on line) and future Forecast Year (usually 15 years after opening). For noise remediation measures, it is reasonable to assume that the "noise changes'" beyond the baseline year will remain constant, unless traffic models are used to predict changes in traffic flows as a result of the noise control measure.

Scoping

The first step is to undertake a scoping exercise to become familiar with the area, and to identify constraints which may limit options for noise control measures. This approach subsequently enables an accurate assessment of the potential benefits of noise control measures.

Noise source identification

Strategic noise maps include noise sources at a suitable level of detail for the requirements of the END. In certain situations there may be additional noise sources affecting the local community which have not been included in the strategic noise maps.

The noise control design process should consider these noise sources and their effect on the community. If there are two or more different sources which contribute similar noise levels at a location, then the overall improvement in noise levels will be limited if only one source is mitigated.

An assessment should be made of the relative importance of all noise sources in the noise management area, and a decision made about which ones to include in the noise modelling process.

Noise sensitive receiver identification

When designing noise control measures for a noise management area it is important to consider the sensitive receptors. This will include residential properties and may include non-residential properties which are noise sensitive. Separate design targets may be set for residential and non-residential receptors.

Constraints on mitigation measures

At an early stage of the assessment it is necessary to identify suitable mitigation measures which can be meaningfully taken forward for a detailed option assessment. Examples of constraints on mitigation options could include:

 Noise barriers – possibly impractical with access or space restrictions.

- Lower noise road surfaces typically only beneficial when traffic is moving at higher speeds.
- Improvements to building façade unlikely to be practicable where there is already non-openable windows and alternative ventilation.

It is important to note that TAG methodology does not directly support the valuation of changes in internal noise levels.

Scenarios

When assessing potential noise reductions, different scenarios should be considered, so that the noise control measures can be optimised.

Do-minimum scenario

The first scenario should be a "do-minimum" scenario. Here, the noise management area should be reviewed in light of programmed maintenance activities and planned schemes or developments affecting the area.

Noise control scenarios

To identify suitable noise control measures, it is useful to consider at least two different noise control scenarios. The first scenario could have a tightly focussed design target, perhaps to offer a small reduction in noise at a few properties. The second scenario could have wider aims to offer greater reductions in noise or to consider greater benefits at a number of properties. By adopting two scenarios in this manner, it is possible to compare two different levels of spend on noise control measures and to compare them with their relevant benefits.

Focussed noise control scenario example

For a focussed scenario example, the design target could be to reduce the noise levels by a small amount at the worst affected properties. The noise control measures could be designed to give



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at least a 3dB reduction in noise levels at those buildings with the highest noise levels. Specifying a reduction in noise greater than 3dB would be desirable.

Broader noise control scenario example

For a broader scenario example, the aim could be to reduce noise levels to below a specific noise level at all properties within the noise management area. The scenario should recognise that in some places this may not be easy to achieve, and in these situations the aim should be to provide as large a reduction in noise as practical.

Study area

Once the scenarios and targets have been defined, it is important to ensure that an appropriate study area is defined. The study area should include all properties where changes in noise of 1dB or greater are expected. In practice, the study area should be extended slightly further than this to include properties where the change in noise is less than 1dB and to positively demonstrate the extent of the study area.

Costs of noise control measures

It is necessary to estimate the costs of each noise control measure being considered. The toolkit provides advice on the steps that need to be undertaken. Chapter 6 of the NANR201 report gives a description of methods available for controlling noise and approaches for assessing potential benefits. Chapter 7 provides indicative costs for key noise control measures:

- · Rail grinding and wheel turning (rail)
- Rail pad replacement (rail)
- Alternative road surfaces (road)
- Altering traffic flow (road)
- Imposing vehicle restrictions (road)
- Speed restrictions (road)
- Noise barriers (road and rail)
- Building envelope improvements (road and rail).

Costs were identified based on Atkins project experience and selected references. For noise barriers costs were principally found in TRL report PPR047 and costs for road surfaces were principally from SPON's Price Book, which is updated annually.

Cost allowances were made in percentage terms for design, approvals, traffic management, risk, and other costs, and the process includes for routine maintenance and replacement costs over the 60 year appraisal period.

Value of noise changes

Suitable monetary values of noise changes are needed for the cost benefit analysis. The recommendation in chapter 8 of The NANR201 report is to monetise changes in noise at residential receptors using the TAG guidance.

Non-acoustic assessments

The toolkit also provides advice on what other assessments may be required for the noise control measures. These would need to be undertaken, and the results summarised for the cost benefit analysis. Chapter 9 of the NANR201 report gives advice on other assessments that may be required including: air quality, ecology, cultural heritage, landscape and visual effects, community effects, flood risk and drainage, water quality and, geology and soils. Advice also covers requirements for planning and building control.

Cost benefit analysis

The results of the noise assessment need to be brought together with the costs of the noise control measures being considered, and the results of any non-acoustic assessments undertaken. Overall, the process should optimise the net benefits, and each scenario should be examined individually to ensure that this is the case. It may be appropriate to undertake a number of iterative calculations so that the optimum benefits can be determined, within the constraints of the scenario. Iterations may involve changing the scale or type of noise control measure, re-defining the study area or selecting a different design target for the scenario.

Valuation and discounting

The guidance in TAG explains in detail the steps required to value a change in noise. An example valuation calculation is given below to illustrate the main steps. Further details of this calculation are provided in NANR201, Chapter 8, with supplementary data in Appendix C of the report. It is noted that the NANR201 report uses an earlier version of the TAG monetisation than shown here:

Noise benefits calculation

Step	Details
1	Work out the willingness to pay for the change in noise in the opening year. Example: As the result of a noise control measure road traffic noise in 2020 levels drop outside a property from 71dB $L_{\rm Aeq}$ to 67dB $L_{\rm Aeq}$, a reduction of 4dB. Night time levels are assumed to be 6dB lower than daytime levels. The monetary value of this change, including sleep disturbance, in 2014 prices, is $\mathfrak{L}553.31$.
2	Repeat this for any other future assessment years being considered. For this example, we suppose that an assessment has been carried out 10 years after the measure, showing traffic growth giving rise to a 1dB increase irrespective of the scheme. Therefore, in the 10th year, the assessment of the measure would show a 4dB reduction of noise from 72dB L _{Aeq} to 68dB L _{Aeq} . The monetary value of this change, in 2014 prices, is £581.92.
3	Use linear interpolation to value changes in noise between the assessment years. In this example, the benefit in Year 0 is $\pounds 553.31$, and the benefit in Year 10 is $\pounds 581.92$.
4	Assume that noise levels do not change after the last assessment year. Therefore the monetary value in 2014 prices, is £581.92 in Year 11 through to Year 60.
5	Identify growth factors for the actual years. For each year this is the multiplication of all growth factors for all years between 2014 and the year in question.
6	Discount the benefits in line with the values in the Green Book. No discount is applied in the first year of the assessment, but each subsequent year is discounted by the appropriate discount rate, so after 1 year the discount factor is 1 minus 3.5%, and after 2 years the discount factor is 1 minus 3.5% twice.
7	Overall, the benefits must be growthed and discounted, so the benefit in each year is multiplied by both the growth factor and the discount factor for that year. Sum the results over the appraisal period. The total over the 60 year appraisal period for this example is £22,117. This figure is the economic benefit for one household, and the process would need to be repeated for all of the other residential properties being considered.
	Table 1: Calculation of Noise Benefits

The 2015 version of TAG provides the distribution of the different health benefits arising from the changes in noise. The analysis for this example shows that over half of the benefit comes from reduction in sleep disturbance, and over a quarter comes from reduction in annoyance. Reductions in health impacts: acute myocardial infarction, stroke and dementia comprise the remaining 15% of the benefit.

Valuing costs of mitigation measures

The following steps are required to identify the costs associated with noise mitigation measures.

Step 1: identify the costs of the noise control measure and identify the maintenance schedule. Let us suppose that a 200m long, 3m high timber barrier is being considered beside a road.

Item	Cost allowance	Cost	
Timber barrier (£210/m from Table 7.3)	N/A	£42,000	
Highway Authority Approvals	10%	£4,200	
Design Costs	12%	£5,040	
Traffic management	20%	£8,400	
Protection	10%	£4,200	
Risk/Contingency	10%	£4,200	
Total Costs		£68,040	
Table 2: Costs of the noise control measure			

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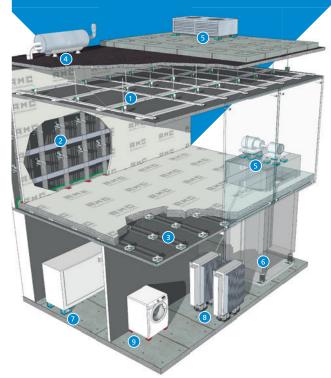
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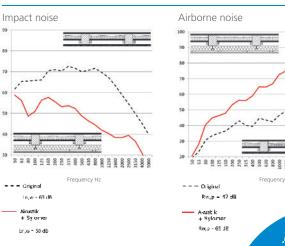








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Let us suppose that maintenance is required every 10 years at 10% of the supply costs, and that the barrier requires replacement every 20 years. The replacement barrier would not require planning approvals or design costs, but it has been assumed that traffic management and replacement barrier protection was required.

Item	Cost allowance	Cost	
Maintenance Costs (Every 10 year)	10%	£4,200	
Replacement timber barrier (Every 20 years)	N/A	£42,000	
Traffic management for replacement works	20%	£8,400	
Replacement protection (Every 20 years)	10%	£4,200	
Total Costs - Maintenance (Every 10 year)		£4,200	
Total Costs - Replacement (Every 20 years)		£54,600	
Table 3: Costs of the maintenance activities			

Step 2: Set out the costs of the noise control measure.
Step 3: Discount the costs in line with the values in the Green Book.

Year	Activity	Cost	Discount factor	Discounted Cost
0	New Barrier	£68,040	1.00000	£68,040
10	Maintenance	£4,200	0.70892	£2,977
20	Replacement	£54,600	0.50257	£27,440
30	Maintenance	£4,200	0.35628	£1,496
40	Replacement	£54,600	0.26510	£14,474
50	Maintenance	£4,200	0.19726	£828

Table 4: Discounted maintenance costs

Step 4: Sum the discounted costs over the appraisal period to give the economic cost. The total economic cost of this noise control measure is £115,257. For this maintenance and replacement programme, the economic cost is seen to be approximately three times the initial cost of £42,000.



Cost benefit analysis

With the two examples above, it is possible to undertake a comparison of the costs and benefits. If we assume that the barrier is required at roadside, then the economic costs of the measure are £115k. The economic benefits for this measure were shown to be £22k for one property, and therefore, if the measure were providing the same benefits at more than 5 properties, and assuming that no other costs or benefits were incurred, then the benefits of the measure would outweigh the costs. This comparison provides the Net Present Value (NPV) of the measure, as shown in the following table.

Measure provided at number of properties	Economic benefits from reduction in noise	Economic cost of noise control measure	Net Present Value
1	£22,117	£115,257	-£93,158
5	£110,585	£115,257	-£4,690
6	£132,702	£115,257	£17,427
10	£221,170	£115,257	£105,895
Table 5: Example Net Present Value			

The costs of noise barriers depends on the situation. If the barrier can be installed during other routine maintenance works in the area then the initial costs may be reduced, whereas if it were installed on a structure rather than at roadside the initial costs would be higher.

Road surfaces

A similar approach can be followed for the use of quieter road surfacing. However, since roads need to be re-surfaced as part of routine maintenance, the cost of the measure is the difference between the cost of maintaining the existing road surface compared with the cost of maintaining the new road surface. A Thin Wearing Course has a shorter design life than a Hot Rolled Asphalt (HRA) surface, and therefore resurfacing would be required more frequently.

The NANR201 report shows that if a HRA surface has a 15 year design life and a Thin Wearing Course has a design life of 12 years, the economic cost of resurfacing would be approximately equal to the cost of the initial cost, including planing the existing road surface during works.

Guidance updates

The process described in this article is in line with new documents and revisions to existing documents published since the publication of NANR201. New documents include the 2010 Noise Policy Statement for England, and the 2011 World Health Organisation Burden of Disease from Environmental Noise. Updates include the 2011 noise chapter of the Design Manual for Roads and Bridges, and the 2015 Transport Appraisal Guidance Unit A3. There have been subsequent rounds of strategic noise maps and action plans, and more assessment consideration of lower noise surfaces.

Conclusions

This article has described an appraisal and evaluation framework for noise control measures compatible with current UK Government policy. The article is derived from work undertaken by Atkins for Defra and published in report NANR201 where more detail, examples and a toolkit for assessment can be found. The method described gives a consistent approach for assessing the costs and benefits of noise control measures, allowing prioritisation of funds and robust decisions to be made on noise control measures.

Adam Lawrence has been an Associate Acoustician at Atkins since 2009, specialising in transport infrastructure projects.



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Evaluating uncertainty in the prediction of the performance of base-isolation systems designed to reduce groundborne noise in buildings

By Rupert Thornely-Taylor

ith increasing shortage of land for development in major cities it is becoming increasingly common for high quality residential development to be planned on sites above or near to urban rail systems, many of them constructed without resilient track support. In order to achieve high quality internal acoustical conditions, it is necessary to construct the buildings on base-isolation systems consisting of polymer bearings or springs. In such circumstances it is necessary to predict the future internal noise levels due to groundborne noise from the passage of trains, and practitioners currently use a range of methods, often involving classical vibration isolation theory. This paper will review the underlying physics involved in placing a dynamic system such as a building on resilient bearings, and will identify the principal causes and magnitudes of uncertainty or error in methods used for the calculation of the insert gain of the bearings. A case study is described involving the numerical prediction of the performance of bearings installed to support a tower block directly above a railway tunnel.

Introduction

Predicting the performance of base-isolation systems for buildings for the control of groundborne noise requires the use of a model of the dynamic behaviour of the building. Frequently the model used is that of a single-degree-of-freedom (SDOF) system consisting of a mass on a spring, and the classical equation for the transmissibility of the spring foundation is used as a means of predicting the behaviour of the base isolation system. Such a model necessitates an assumption that the building is a lumped mass m, and the input excitation for all the bearings of stiffness k is equal in magnitude and phase so that only the vertical motion need be considered. The classical equation leads to the conclusion that above a frequency of $\sqrt{2}f_n$ where f_n is the bearing natural frequency $\sqrt{(k/m)/2\pi}$, there is a reduction in the vibration amplitude of the isolated mass, which decreases at the rate of 6 dB per octave for a viscously damped system with critical damping and up to 12 dB per octave for an undamped system, with no upper frequency limit.

In practice no real building satisfies these assumptions. It is common practice to derive the values for the mass supported by each bearing from the structural engineer's load calculations and divide the load in Newtons by the gravitational acceleration g. This does not necessarily give the correct value for the mass above the bearing, as the load force can be due in part to strain in structural members and not simply to the weight of the supported mass. Even a building which approximates a lumped mass may rock, pitch or roll at one of the coupled natural frequencies associated

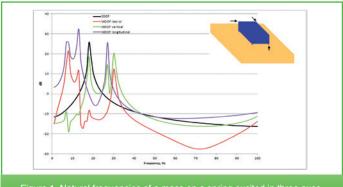


Figure 1. Natural frequencies of a mass on a spring excited in three axes.

with those degrees of freedom. Few, if any, buildings approximate a lumped mass, and almost all have internal natural frequencies of columns, floorplates and other structures. Tall buildings, which are increasingly the subject of base-isolation designs, may behave as a stack of mass-spring systems with the floors as masses and the columns as springs.

The dynamic behaviour of buildings

The equation commonly used for calculating the performance of a base-isolation system using a SDOF model is [1]

$$T = \sqrt{\frac{1 + \left[2\left(\frac{f}{f_n}\right)\left(\frac{b}{b_c}\right)\right]^2}{\left[1 - \left(\frac{f}{f_n}\right)^2\right]^2 + \left[2\left(\frac{f}{f_n}\right)\left(\frac{b}{b_c}\right)\right]^2}}$$
(1)

where f is the forcing frequency, $f_n = \sqrt{(k/m)/2\pi}$ is the natural frequency of the mass-spring system and b/b_c is the fraction of critical damping. This equation is identical [1] to the equation for the force transmissibility of a vibrating mass mounted on a spring, except that for a case of base-isolation the transmissibility, T, is of displacement, velocity or acceleration and not force. Since groundborne noise is broadly a function of the vibration velocity of radiating surfaces, equation 1 will be regarded as a velocity transmissibility equation in this article.

It follows that even in a case where a building behaves like a lumped mass and is excited only vertically by an input in-phase at all mountings, the velocity transmissibility is not necessarily the insertion loss of the bearings. The velocity of the bearing foundation will not be the same as it is with rigid blocks in place of bearings. For a given input force, the effect of inserting a low impedance element in the transmission path may be to increase the velocity, reducing the isolation calculated using equation 1. However, this assumes that the source has constant force characteristics. The driving point impedance of the base of a masson-a-spring system, at resonance, is infinite for zero damping. Consequently, the velocity of the base is zero at resonance, because it cannot move against an infinite impedance. The steadystate transmissibility is infinite, however, because there will be some excitation of the mass at the start of the excitation and its velocity divided by that of its foundation involves division by zero to give infinite transmissibility.

In almost all real cases, in addition to vertical movement, a supported mass will also be excited asymmetrically causing it to rock or pitch. These modes will have their own natural frequencies, each coupled to the vertical SDOF natural frequency. The effect of the coupling is to cause two new coupled frequencies in each case, one lower than the SDOF frequency and one higher. Lateral components in the foundation vibration will excite either or both the two lateral natural frequencies of the mass, and may also excite the yawing mode (rotation about a vertical axis). Thus there are potentially six natural frequencies associated with a lumped mass on bearings. To illustrate this effect, a finite-difference-time domain model was created consisting of a monolithic block supported on four springs, which was excited by the application of an impulse on three different locations in each of the three axes as illustrated in Figure 1. The responses of the block are illustrated in figure 1 and show natural frequencies either side of the classical single-degree-of-freedom result.

Most buildings are constructed as assemblies of plates and beams, including beams forming columns to support floor plates.

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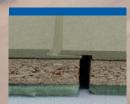
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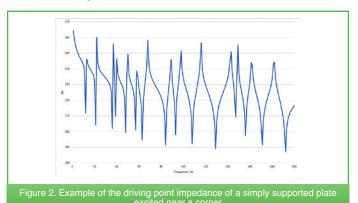
The bearings are likely to be placed beneath columns. The transmissibility of the bearing system will be dependent on the driving point impedance of the structure "seen" by the top of the bearing. An infinitely long column standing on end on a bearing has a driving point impedance of $\rho C_L S$ where ρ is the mass density of the column, C_L is the longitudinal compression wave speed and S is the cross-sectional area of the column.

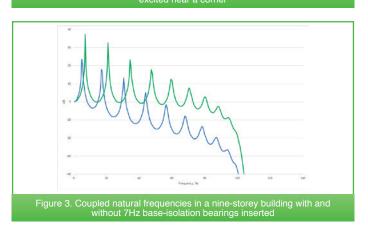
Vibration is not only transmitted through columns by means of longitudinal compression waves, but also by means of bending waves if the motion of the foundation is not in-phase across the base of the foundation. Plates supported by columns will be excited in one or more of their plate modes as a result of both vertical and bending wave inputs from columns. An example of the driving point impedance of a simply supported, undamped, plate excited near its corner [2] is shown in Figure 2. This shows excursions of the order of 60dB between resonances and anti-resonance at frequencies quite closely spaced.

The consequence of the existence of the significant number of mechanisms that cause a building to depart from the lumped mass assumption is that whereas the impedance of a mass is simply $i\omega m$ (where ω is the angular frequency, m is the mass in kilograms and i is $\sqrt{-1}$), the impedance of a building contains many resonances at which the transmissibility of the bearings will be significantly above the SDOF value, and anti-resonances at which it is greater.

The precise behaviour of a base-isolated building is dependent on the source impedance. This is a function not only of the nature of the foundations below the bearings, but also on the coupling between the building and the soil or rock supporting it. A finite plate resting on the top of an elastic halfspace behaves itself like a mass on a spring [3][4], with the mass being not only the building foundation structure, but also a volume of soil near it and the spring constant being a function of the dimensions and the soil dynamic properties. In these circumstances, the SDOF mass-spring system becomes a mass-spring-mass-spring system, possessing two coupled natural frequencies, one below the foundation natural frequency and the other above the supported mass-spring combination.

In contrast to the simple case of a rigid body resting on a halfspace is a tall building with many floors supported on columns. Such a case has interesting dynamic properties [5]. For example, if the load on the ground floor columns is summed and considered





as a single degree-of-freedom system with the ground floor columns treated as springs based on the compressive stiffness of the columns, it can be the case that the natural frequency of system is in single figures. Should it be necessary to consider base-isolation of such a building, the effect of inserting bearings below the columns would seem intuitively to be somewhat nugatory. However, the actual situation is much more complex than that of a single-degree-of-freedom system, as illustrated in figure 3. The figure is a plot of the velocity transmissibility between the foundation and the first floor of a nine-storey building, showing the peaks caused by the SDOF resonances of the all the columns and masses of the slabs above. The upper curve is for an unisolated building, and the lower curve shows the effect of inserting resilient bearings below the lower floor level, having a natural frequency of 7Hz calculated using the total mass of all the floors as if they were a lumped mass. Although the improvement in transmissibility is much less than the SDOF equation predicts, there is nonetheless an improvement of 10-15 d $\bar{\text{B}}$. It is notable, however, that there is already a significant reduction in transmissibility in the unisolated case at frequencies above the natural frequency of the top floor on its columns, in this case above 80 Hz.

Numerical modelling

The stack of springs and masses considered in Figure 3 is a major oversimplification, particularly in an asymmetric building structure. In order to study the effect of introducing resilient bearings in a tall building, a numerical model has been created using a 3D finite-difference-time-domain (FDTD) software package known as FINDWAVE [6]. The building in question is situated over an underground railway and has a number of deep basements and podium structures, above which is an 18-storey residential tower with irregularly shaped floors. An isometric view of the model is shown in figure 4. In order to control groundborne noise from the underground railway in the residential apartments the building is designed with resilient bearings at the heads of the columns and in the cores just below first floor level, being the first of the eighteen floors of the tower. The bearings were assigned stiffnesses based on a SDOF calculation taking the entire mass of the building above the bearings such that they would have a natural frequency of 10Hz.

Many of the dynamic properties of a building are very difficult if not impossible to measure in-situ, and the advantage of a numerical model is that information can be output that would be unavailable for the actual building.

The driving point impedance was output from the model at the top of a bearing underneath a column line, defined as $F\{F(f)\}^*/F\{v(f)\}^*$ where F signifies the Fourier transform of the force, F(f)

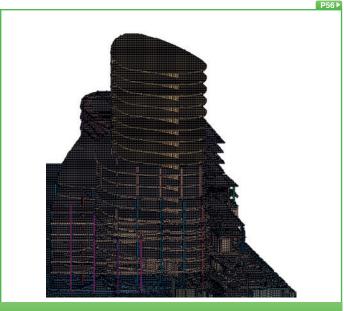


Figure 4. Isometric view of the FINDWAVE 3D Finite-difference-time-domain model





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and velocity, v(f) and * signifies the complex conjugate. It is plotted in dB in figure 5 along with the two idealised lumped-parameter impedances of $i\omega m$ and $\rho c_L S$. It can be seen that while peaks in the spectrum reach the upper $i\omega m$ curve, at most frequencies the curve is closer to the lower $\rho c_T S$.

Figure 6 shows the velocity transmissibility of the bearings along with the SDOF transmissibility curve. Figure 6 shows, in 1/3 octave bands, the velocity transmissibility relative to the base velocity of the building with the bearings in place, and Figure 7 is the velocity transmissibility relative to the base velocity of the building with rigid support so that it takes account of the effect of the bearings on the source below as well as the structure above. Of particular note is the absence of a peak at the SDOF bearing natural frequency, and the presence of two coupled peaks, one above and the other below the SDOF natural frequency, resulting from the coupling between the structure above the bearings and the foundations below. Comparison of Figure 7 with Figure 6 shows that when the change in the foundation velocity is taken into account, the actual transmissibility more closely resembles that predicted using the driving point impedance of an infinite column than a lumped mass.

Conclusions

It can be concluded the predicting the performance of a base-iso-lation system over the frequency range relevant to the reduction of groundborne noise using a SDOF model is likely to lead to an over-optimistic result is the base of large, tall or complex buildings. The reasons for this have been discussed and primarily relate to the dynamic response of such buildings which will limit the driving point impedance of the structure "seen" by the top of the bearings. The additional degrees of freedom of a lumped mass are only a partial explanation. Additionally, the use of a simple velocity transmissibility equation can be misleading, as the velocity of the base is affected by the insertion of the bearings. The SDOF model also fails to allow for coupling between the mass-on-a-spring of the building and its bearings and the mass and spring system which exists in the foundation.

Numerical modelling is capable of taking all these matters into account, and provides the most detailed method of predicting the performance of base isolation systems.

Rupert Thornely-Taylor began working in acoustics in 1964 and has run his own practice since 1968. A former member of the Noise Advisory Council, he was also a member of the Scott Committee which drafted the basis of the noise section of the Control of Pollution Act 1974.

References are available from the Editor at ioa@ioa.org.uk

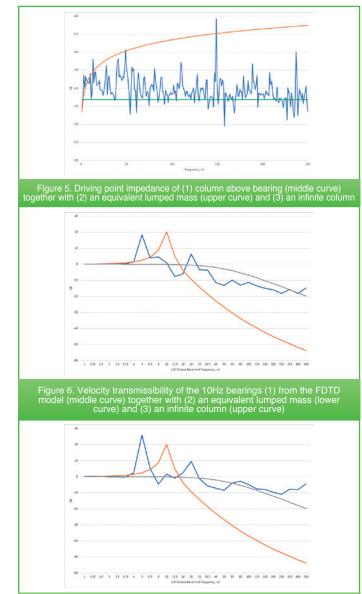


Figure 7. Velocity transmissibility of the 10Hz bearings relative to the base in the unisolated building(1) from the FDTD model (middle curve) together with (2) an equivalent lumped mass (lower curve) and (3) an infinite column (upper curve)

A planning condition for wind turbines

This article has been contributed to by Andy McKenzie, Matthew Cand, Dick Bowdler, Mark Jiggins, Gavin Irvine, Michael Reid, Richard Perkins, Michael Lotinga, Malcolm Hayes and Andrew Bullmore

Introduction

This article sets out a proposed wording for a planning condition on noise for wind farms or individual wind turbines.

Whilst local authorities and developers have waited for a planning condition that could be applied to newly consented wind farms, or to those already consented but with a suspensive condition, the report Wind Turbine AM Review (WTAMR) by WSP/Parsons Brinckerhoff for DECC arguably did not provide that. In addition there have been a number of comments on WTAMR that we consider should be addressed. The introductory sections and the conditions text represent the broad consensus view of those whose names appear below, following a period of discussion, compromise and agreement. This approach is proposed based on the current state of understanding, but may be subject to modification in light of new research and further robust information.

Copies of the condition only in Word format are available from the following websites:

- www.hayesmckenzie.co.uk/uploads/A_Planning_Condition_for_ Wind_Turbines_Sept_2017.docx
- www.dickbowdler.co.uk/content/publications/

Proposed wording condition

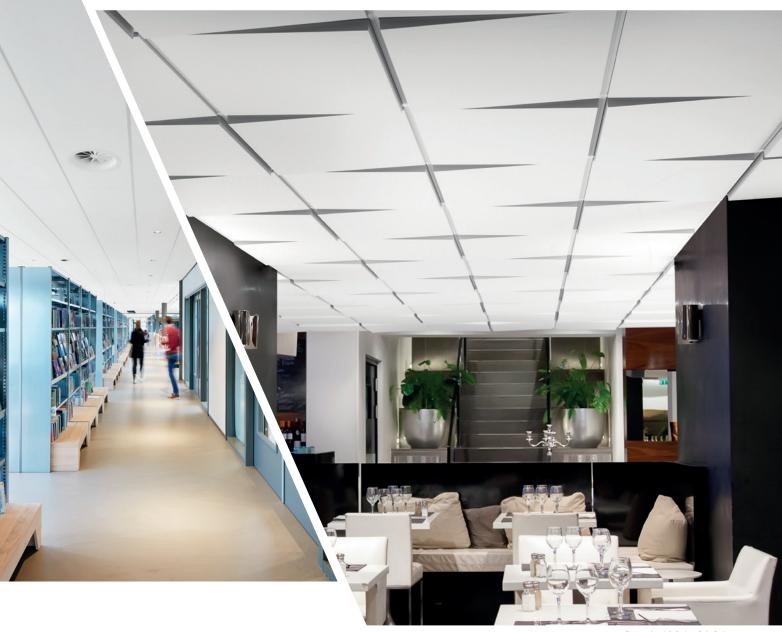
The annex contains the condition wording which takes fairly typical wording for a planning condition on wind farm noise, including adjustments for tonal penalties if relevant, and adds a mechanism for adding a penalty for AM. Consistent with the recommendations of the WTAMR, the AM penalty is applied in addition to the tonality penalty. But how to calculate an AM penalty in practice is not clear from the WTAMR report.

WSP researchers in their subsequent *Acoustic Bulletin* article have discussed this aspect further: the penalty "should be applied to each

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individual 10-minute period assessed, and the rated levels separated into wind speed integer 'bins' for the purposes of comparison with the condition limits". They explain that to "aggregate the AM penalty" values would give an equivalent result to adding the penalty to each 10 minute period and then averaging the resulting "rated" levels, which is our experience in practice. In contrast, as they note, averaging the AM ratings and deriving an AM penalty on that basis would in many cases lead to different results.

The proposed condition has therefore been drafted on the basis of aggregating the AM penalties obtained, and applying this to the overall noise levels. This is considered to be a pragmatic way to represent the frequency/intensity of AM typically observed in relevant weather conditions. The condition explains that this averaging should only be done in relevant subsets of conditions which are determined in each case based on the observed complaints (if relevant), data analysis results or practitioner judgment. Analysis in wind direction bins, or plotting the amplitude modulation as a polar plot may be important in determining the appropriate subset. An example is shown in Fig 1 which is a polar plot of AM values as a function of wind direction and speed.

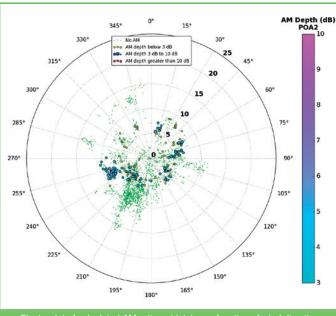


Fig 1 - plot of calculated AM ratings (dots) as a function of wind direction (circular direction) and wind speed (radial direction).

AM penalty - general aspects

As various people before us have discovered, the derivation of a penalty is not easy. There is not sufficient reliable research to be confident that a penalty system would always provide a fair indication of the impact of AM. However, to do nothing would be unfair on those wind farm neighbours adversely affected by AM and, in any case, there seems to be general agreement amongst many stakeholders on all sides of the debate that a robust condition including AM is required.

There are a significant number of people who have reservations about the penalty scheme proposed in the WTAMR report and this has been discussed in some detail by interested parties. The conclusion is that the penalty graph needs further research to establish whether it should be amended to take account of rotational speed and the difference between Leq and L90 (which increases as AM increases) and that this should be progressed as soon as possible. Meanwhile we have included the WTAMR graph in this condition. It is intended for medium to large scale turbines with a rotational speed up to 32 rpm.

A note on the night time limit

There has been criticism from some quarters of the method the WTAMR report proposed for an additional penalty to be applied at night to take account of the difference between the night-time and day-time limits; specifically where the night-time limits are higher. With a few exceptions (where suspensive conditions for AM have been applied, typically as a scheme to be agreed) the condition we are discussing here applies only to new consents. That means that, in the majority of cases, it will

be applied as part of a complete set of noise limits. In such cases, the night-time and day-time limits can be set appropriately in accordance with the circumstances of the case. It should be noted that, if the night time limit is higher than the day time limit this could mean that an AM penalty would take the wind farm over the limit during the day but not at night. Where a suspensive condition for AM has been applied, the AM penalty would have to be tailored to the individual case unless an application were made to amend the conditions as a whole.

Annex

Proposed planning conditions on noise for **** Wind Farm

The rating level of noise immissions from the combined effects of the wind turbines hereby permitted (including the application of any tonal penalty and amplitude modulation (AM) penalty), when determined in accordance with the attached guidance notes, shall not exceed the values for the relevant integer wind speed set out in or derived from Table 1 attached to these conditions and:

- A) Within 21 days from receipt of a written request of the planning authority, following a complaint to it alleging noise disturbance at a dwelling, the wind farm operator shall, at its expense, employ an independent consultant and provide a written protocol to be approved by the planning authority. The protocol shall describe the procedure to assess the level and character of noise immissions from the wind farm at the complainant's property in accordance with the procedures described in the attached guidance notes. The written request from the planning authority shall set out as far as possible the time or meteorological conditions to which the complaint relates and time or conditions relating to tonal noise or AM if applicable. Measurements to assess compliance with the noise limits shall be undertaken in accordance with the assessment protocol which shall be approved in writing by the planning authority.
- B) The wind farm operator shall provide to the planning authority the independent consultant's assessment of the rating level of noise immissions undertaken in accordance with the protocol within two months of the date of the approval of the protocol by the local authority unless otherwise agreed by the planning authority. The assessment shall include all data collected for the purposes of undertaking the compliance measurements and analysis, such data to be provided in a format to be agreed with the planning authority. Certificates of calibration of the equipment shall be submitted to the planning authority with the report.
- C) Where a further assessment of the rating level of noise immissions from the wind farm is required pursuant to Guidance Note 5 of the attached Guidance Notes, the wind farm operator shall submit a copy of the further assessment within 21 days of submission of the independent consultant's initial assessment unless otherwise agreed by the Planning Authority.

[It is acknowledged that there may be other parts of the current IOAGPG conditions which require inclusion here, such as the clause discussing limits which apply at non named locations etc. The text included above aims to show how rating of AM scheme fits within the normal WF compliance approach.]

(Insert here the table or tables relevant to the specific planning condition) $\,$

Guidance notes for noise condition

These notes are to be read with and form part of the planning condition on noise. The measured data is to be split into bins as described below. The rating level in each bin is the arithmetic sum of the wind farm noise level, any tonal penalty applied in accordance with Note 3 and any AM penalty applied in accordance with Note 4. Reference to ETSU-R-97 refers to the publication entitled "The Assessment and Rating of Noise from Wind Farms" (1997) published by the Energy Technology Support unit (ETSU) for the Department of Trade and Industry (DTI). IOAGPG is "A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise" or any update of that report current at the time of measurement. The IOA Metric is "A Method for Rating Amplitude Modulation in Wind Turbine Noise" dated 9th August 2016 or any update of that current at the time of measurement.

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▼P58

Note 1 - Data collection

- A) Values of the LA90,10-minute noise index should be measured in accordance with the IOAGPG. Measurements shall be undertaken in such a manner to enable a tonal penalty to be calculated and to allow an AM penalty to be calculated for selected periods where a tonal or AM assessment is required.
- To enable compliance with the conditions to be evaluated, the wind farm operator shall continuously log arithmetic mean wind speed in metres per second (m/s) and arithmetic mean wind direction in degrees from north in each successive 10-minutes period in a manner to be agreed in writing with the planning authority. The wind speed at turbine hub height shall be "standardised" to a reference height of 10 metres as described in ETSU-R-97 at page 120 using a reference roughness length of 0.05 metres. It is this standardised 10 metre height wind speed data which are correlated with the noise measurements determined as valid. The wind farm operator shall continuously log arithmetic mean nacelle anemometer wind speed, arithmetic mean nacelle orientation, arithmetic mean wind direction as measured at the nacelle, arithmetic mean rotor RPM and whether each wind turbine is running normally during each successive 10-minutes period for each wind turbine on the wind farm. All 10-minute periods shall commence on the hour and in 10-minute increments thereafter synchronised with Universal Time (UT).

Note 2 - Data analysis

- A) The independent consultant shall identify a sub set of data having had regard to:-
 - the conditions (including time of day and corresponding wind directions and speeds) at times in which complaints were recorded:
 - the nature/description recorded in the complaints if available;
 - information contained in the written request from the local planning authority;
 - likely propagation effects (downwind conditions or otherwise);
 - the results of the tonality/AM analysis where relevant.
 In cases where it is possible to identify patterns of clearly different conditions in which complaints have arisen additional sub sets may be considered provided this does not introduce unreasonable complexity in the analysis and can be justified by the independent consultant.
- B) Within each of the sub set(s) of data identified, data shall be placed into separate 1 m/s wide wind speed bins.

Note 3 - Tonal penalty

- A) Where, in accordance with the protocol, the noise contains or is likely to contain a tonal component, a tonal audibility shall be calculated for each ten-minute period using the following procedure.
- B) For each 10-minute period for which a tonal assessment is required this shall be performed on noise immissions during two minutes of each 10-minute period. The two-minute periods should be spaced at 10-minute intervals provided that uninterrupted uncorrupted data are available ("the standard procedure").
- C) For each of the two-minute samples the tone level above audibility shall be calculated by comparison with the audibility criterion given in Section 2.1 on pages 104-109 of ETSU-R-97. Samples for which the tones were below the audibility criterion or no tone was identified, a value of zero audibility shall be substituted. Where data for a ten-minute period are corrupted, that period shall be removed from the tonal analysis.
- D) The tone level above audibility for each 10-minute period shall be placed in the appropriate data sub set and wind speed bin.

Note 4 - AM penalty

- A) Where, in accordance with the protocol, the noise contains or is likely to contain AM, an AM penalty shall be calculated for each ten-minute period using the following procedure.
- B) For each 10-minute interval for which an AM assessment is required this shall be performed in accordance with the IOA Metric. The value of AM for each ten-minute period shall be converted to a penalty in decibels in accordance with the graph below and the penalty shall be placed in the appropriate data sub set and wind speed bin. Where a penalty is zero it should be placed in the bin in the same way.



Note 5 - Calculation of rating level

- A) The LA90 sound pressure level for each data sub set and wind speed bin is the arithmetic mean of all the 10 minute sound pressure levels within that data sub set and wind speed bin except where data has been excluded for reasons which should be clearly identified by the independent consultant. The tonal penalty for each bin is the arithmetic mean of the separate 10 minute tonal audibility levels in the bin converted to a penalty in accordance with Fig 17 on page 104 of ETSU-R-97. The AM penalty for each bin is the arithmetic mean of the AM penalties in the bin. The assessment level in each bin is normally the arithmetic sum of the bin LA90, the bin tonal penalty and the bin AM penalty except where the AM penalty and the tonal penalty relate to the same characteristic (e.g. amplitude modulated tones) when the sum of both penalties may overly penalise the characteristics of the noise. Such cases should be identified and only the larger of the AM or tonal penalty should be applied.
- B) If the assessment level in every bin lies at or below the values set out in the table(s) attached to the conditions then no further action is necessary. In the event that the assessment level is above the limit(s) set out in the tables attached to the noise conditions in any bin, the independent consultant shall undertake a further assessment of the rating level to correct for background noise so that the rating level relates to wind turbine noise immission only. Correction for background noise need only be undertaken for those wind speed bins where the assessment level is above the limit.
- C) The wind farm operator shall ensure that all the wind turbines in the development are turned off for such periods as the independent consultant requires to undertake the further assessment. The further assessment shall be undertaken in accordance with the following steps:
 - i. Repeating the steps in Note 1, with the wind farm switched off, and determining the background noise (L_3) in each bin as required in the protocol. At the discretion of the consultant and provided there is no reason to believe background noise would vary with wind direction, background noise in bins where there is insufficient data can be assumed to be the same as that in other bins at the same wind speed.
 - ii. The wind farm noise (L_1) in each bin shall then be calculated as follows where L_2 is the measured level with turbines running but without the addition of any tonal nor AM penalty:

$$L_1 = 10\log\left|10^{L_2/10} - 10^{L_3/10}\right|$$

- iii. The rating level shall be calculated by adding the tonal and AM penalties to the derived wind farm noise L1 in that bin.
- iv. If the rating level after adjustment for background noise contribution and adjustment for tonal and AM penalties in every bin lies at or below the values set out in the Tables attached to the condition at all wind speeds then no further action is necessary. If the rating level at any integer wind speed exceeds the values set out in the Table(s) attached to the condition then the development fails to comply with the planning condition in the circumstances represented by that bin.



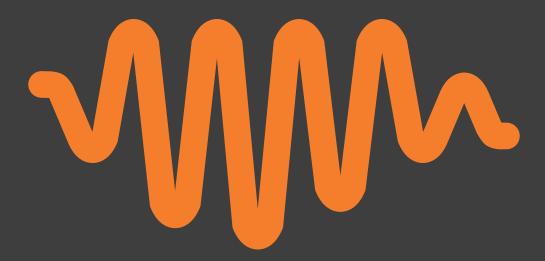
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Arup gives teenagers a taste of acoustic engineering

By Yuliya Smyrnova

rup has hosted Engineering Awareness Week for the first time in Manchester. It involved a work placement initiative which saw a group of 20 15 to 17year-old pupils from schools across Greater Manchester visit the Manchester office for a week. Their aim: to design a music festival on one of the proposed Arup sites.

On the first day, the pupils were divided into four groups and introduced to four potential festival sites from which each group had to select one. Our planning consultants presented the pupils with the potential problems they could encounter in each of the disciplines, including planning, geotechnics, structures, energy, sustainability, transport, health and safety, digital and acoustics; afterwards each discipline was presented in greater detail by the consultants and engineers.

In the case of acoustics, we demonstrated how sound propagates outdoors, how to

consider noise breaking out into the residential and sensitive buildings, how noise can be mitigated, where to locate the main and secondary stages of a music festival, and what constraints the local authorities may impose on the event.

We taught the pupils how to calculate sound attenuation from the source based on distance correction. Another task included the prediction of the effectiveness of a noise barrier. It was great to hear from one of the group's presenters - during their final design presentations - that an acoustic barrier would not screen much noise if it was located far away from a sound source.

On the last day each group had to prepare a presentation of their design work and present it to a judging panel. Even though three groups had chosen the same site (which was a ground near Salford airport), each design was unique and distinctive.

While working on their acoustic tasks,



the pupils also asked us about our roles as acoustic consultants. To bring them closer to the subject, we presented them some 3D audio-visual demos in our SoundLab, which left most of them speechless.

The event was a time-consuming but rewarding experience. It was great to show how rewarding it can to be an acoustician and explain the many things we could do. We would strongly recommend anyone to join similar movements next or in the following years.

Two CEOs for Marshall Day Acoustics as Peter Fearnside steps aside

eter Fearnside has stepped down as Chief Executive Officer at Marshall Day Acoustics in Australia and been replaced by co-CEOs Christophe Delaire and Amanda Robinson.

He will continue to work with the Melbourne-based firm as a consultant, particularly for the China market, and in a mentoring capacity for the in-house theatre design team while also supporting his successors through a transition period.

He said his decision came at a time

when he believed that Marshall Day, which celebrates its 30th anniversary this year, needed to change and diversify, to strengthen and expand.

Christophe Delaire, who has a Master's degree in Engineering from Ecole Supérieure d'Ingénieurs de Poitiers (France), joined Marshall Day in 2002. He specialises in environmental acoustics, in particular wind farm noise. He has also been responsible for coordinating Marshall Day's relationship with 01dB, introducing its range of

smart noise monitoring equipment to the Australian market.

Amanda Robinson, who has a Bachelor of Mechanical Engineering degree from the University of Adelaide, joined Marshall Day in 2005 after almost a decade of extensive building acoustics experience with multidisciplinary practices in Australia and the UK.

With more 50 staff in offices that span across Australia, Hong Kong and Shanghai, Marshall Day is is one of the world's leading independent acoustic consulting firms.



ICAN launches noise complaint logging website for Ireland

Acoustics to enable people in Ireland to log noise complaints.

Complaints will be classified under headings such as road traffic noise, rail traffic noise, air traffic noise, wind farm noise and neighbourhood noise.

ICAN says the purpose of the website – www.noisecomplaint.ie – is to compile information on noise complaints from the

public, providing statistics for government departments, data for decision makers, local authorities, ministers, councillors and key influencers. It is proposed that the data will be published every six months and that it will be publicly available via a results page.

Diarmuid Keaney, Acoustic Consultant at ICAN, said: "The data will also be used to create awareness on noise matters, to induce change, to recognise and quantify the extent of noise and how it affects the public as an environmental pollutant.

"By logging their noise complaints members of the public can make a difference and provide decision makers with real data about the impact of noise on public wellbeing, reducing the potential of long-term damage to human health."

□

AcSoft supplies advanced acoustic camera to Cardiff University

cSoft Sound & Vibration has supplied an acoustic camera for Cardiff University's Structural Performance (CUSP) Laboratory to help it in its aim to establish itself as internationally recognised facility for audible acoustic and damage detection research.

The Gfai GmbH Fibonacci 96-channel acoustic camera system with associated NoiseImage software will be primarily used for the research and development of non-contact damage detection techniques using Audible Acoustics (AA) for composite materials within the aerospace industry.

Available in 72, 96 and 120 channel versions, the camera utilises an array of microphones and optical camera to identify and locate sound in 2D and 3D spaces in a remote and non-contact manner by overlaying the audible source location on still or video images of the object.

The camera can be used for a variety of sound analysis and source localisation applications across a range of industrial sectors including aerospace, automotive, consumer products, psychoacoustics, environmental, musical instrument design, railway and zoological industries.

The Cardiff University version system offers dual functionality and is capable of locating audible sources at low and high frequencies using holography and beamforming respectively.

For further information contact Emily Norman on **01234 639550** or visit **www.acsoft.co.uk**

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BSRIA wins UKAS accreditation for sound absorption testing

B SRIA has extended its scope of UKAS (United Kingdom Accreditation Service) accreditation to include sound absorption testing in accordance with BS EN ISO 354:2003 and BS EN 11654:1997.

BSRIA provides acoustic testing to determine the sound absorption coefficient and rating of sound absorption for a range of materials including insulation, carpets, wall panels, ceiling tiles and office screens.

The sound absorption testing further extends BSRIA's UKAS accredited acoustic testing services, which also include determination of sound power levels in accordance with BS EN ISO 3741:2010 and BS EN 12102:2013. Testing is carried out in the BSRIA thermally controlled acoustic facility, which is a 210m³ reverberation chamber.

Rebecca Hogg, Acoustic Consultant, who manages the acoustic test facility, said: "The

UKAS accredited sound absorption testing extends our existing acoustic services and provides customers with the assurance they are getting internationally recognised quality test data. With an increased importance placed on acoustics in the built environment, it is essential that manufacturers, designers and installers have confidence in the acoustic performance data of sound absorbing materials."

UKAS is the sole national accreditation body recognised by government to assess, against internationally agreed standards, organisations that provide certification, testing, inspection and calibration services. Accreditation by UKAS, says BSRIA, "demonstrates the competence, impartiality and performance capability of these evaluators".

For more information ring **01344 465664** or email **test@bsria.co.uk**



MedaPhor agrees to buy Intelligent Ultrasound in £3.6 million deal

edaPhor, the AIM-listed advanced ultrasound training systems developer, has agreed to acquire University of Oxford spin-out company Intelligent Ultrasound.

Founded in 2004, MedaPhor develops advanced ultrasound skills training simulators for medical professionals. The Cardiffbased company has more than 200 customers in more than 30 countries around the world.

Intelligent Ultrasound, described as a leader in imaging analytics, develops products and services that make ultrasound imaging a more effective diagnostic tool.

MedaPhor will acquire Intelligent Ultrasound for up to £3.6 million. The deal is subject to shareholder approval.

"This is a strategic acquisition that will expand our existing ultrasound training simulator business into the larger clinical ultrasound software market," said MedaPhor chief executive Stuart Gall.

"Combining Intelligent Ultrasound's exciting deep learning image analysis software with our existing management, R&D and sales networks, will speed up the

commercialisation of the IUL products currently in development and we look forward to working with their excellent team to realise this objective."

MedaPhor has, alongside the transaction, has raised £5.5 million through a share placing.

The funds will be used to develop Intelligent Ultrasound's suite of products, further develop MedaPhor's existing simulator and training division and finance the working capital requirement of the group.

Wakefield Acoustics scoops six-figure contract with UK energy farm

Takefield Acoustics has won a six-figure contract to supply a package of acoustic equipment for the new gas-fired power plant at Creyke Beck Power Station in east Yorkshire.

As part of the contract, the company will supply 11 high specification inlet ventilation modules, 11 outlet ventilation modules, as well as a series of acoustic doors to support the expansion of the Creyke Beck Power Station.

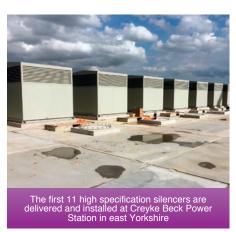
The new plant is one of the first of its kind in the region and is expected to provide back-up power for as many as 50,000 homes at short notice. These "peaking" plants are being built all over the UK to provide instantaneous back up power to the grid as

unreliable renewables such as wind become increasingly part of the energy mix.

Wakefield Acoustics has been working with its client to design a series of high specification noise control acoustic modules to meet the requirements of the project. The modules have been designed to attenuate noise generated by the gas engines down to 70dB (A).

Each module is fabricated from corrosion resistant materials taking into consideration the requirements of the client and incorporates dampers and filtration systems.

Lee Nicholson, Managing Director of Wakefield Acoustics, said: "This project is the latest in our growing portfolio of power generation plants."



Ultrasonics firm secures £1.1 million funding to develop products

Inductosense, a spin-out from the University of Bristol, has secured £1.1million in funding from a consortium of investors to help it develop novel ultrasonic sensors for monitoring corrosion, cracks or defects.

The technology is known as the WAND – Wireless and Non Destructive – system and it works by bringing a measurement probe near to a compact, battery-free sensor installed on a structure.

What makes the technology unique is that the sensors are small, passive and wireless and can therefore be permanently attached to structures, even if the structures are beneath a layer of material or coating. The benefits to customers are a significant reduction in cost and downtime associated with conventional monitoring.

The technology was developed over several years by Dr Chenghuan Zhong, Dr Anthony Croxford and Professor Paul Wilcox from the Ultrasonics and Non-Destructive Testing Group at the University of Bristol.

In late 2015 the company was formed with funding from InnovateUK alongside angel investment. Since then the team has launched its first product (a system for measuring internal corrosion on pipework) and secured orders.

It is now working with a number of major

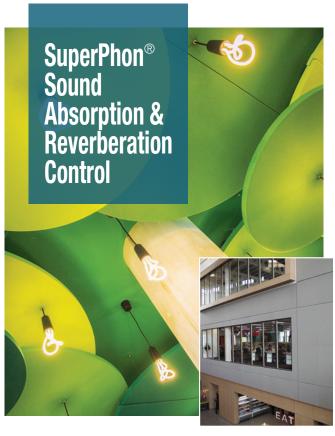
companies on trials with an initial focus on monitoring assets across oil and gas and nuclear.

The investment consortium consists of Perivoli Innovations, the University of Bristol Enterprise Fund (managed by Parkwalk Advisors Ltd), IP Group, the Institution of Mechanical Engineers' Stephenson LP Fund, and a number of angel investors.

Dr Matt Butcher, Chief Executive at Inductosense, said: "Over the past year we have had great success in development of the technology and commercial traction. With the investment we want to accelerate our pace and progress from trials to commercial deployment of sensors. We are also commercialising some exciting new products."

Stephen Tetlow, Chief Executive of the Institution of Mechanical Engineers, said announcing the investment: "It is exciting that we can support cutting-edge technologies, like those being developed by Inductosense that are, in George Stephenson's words, 'likely to be useful to the world'."





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Obituary

John Bowsher (1933-2017): 'True Renaissance man' who played major role in the development of IOA education activities over many years

By Keith Attenborough

ohn was educated at Haberdashers' Aske's in north London and won an Exhibition, at the age of 17, to Imperial College (IC). He stayed at IC for six years, leaving with a PhD in Physics. He had to rush to get his thesis typed up before Christmas in the year before leaving for Canada by ship on 2 January to take up a Canadian Government award and he arranged to meet his PhD examiner in a pub halfway between London and Wales where Viva was conducted.

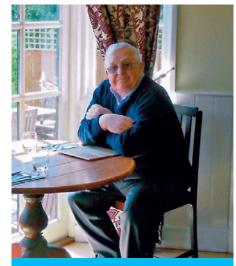
He spent two years with the National Research Council in Ottawa and became a member of the Ottawa Symphony Orchestra, playing with them as a professional trombonist.

When John returned to England, he worked in the Acoustics Division at the National Physical Laboratory, from where he was head-hunted by Surrey University, where, as Lecturer, he started his involvement with acoustics education. He played a major part in the establishment of the physics with modern acoustics degree, the famous 'Tonmeister' MSc course and supervised many excellent PhD students.

John supported the IOA for many years, being a member of Council from 1978 to 1986, Vice President and Chairman of the Membership Committee and Education Committee and organiser of several IOA conferences. In 1986, the IOA awarded him an Honorary Fellowship for contributions to musical acoustics. John gave the RWB Stephens lecture in 1990. In 2014 he was presented with an Award for Services to the Institute

John made major and important

contributions to the educational activities of the Institute. He was Deputy Chief Examiner for the Diploma in 1986 and Chief Examiner from 1988 from 2000. During his period as Chief Examiner, work started on a tutored distance learning version of the Diploma and



John Bowsher (1933-2017)

an Education Review, initiated by Council, resulted in 12 recommendations including the appointment of an Education Manager, Peter Wheeler being the first incumbent in 2000. After retiring as Chief Examiner and, until prevented from continuing through ill health in 2015, John was responsible

for the typesetting, proofing, printing and distribution of IOA examination papers. His meticulous reign in this capacity included devising rubrics, font types and conventions and formula sheets. He provided an important final check on technical contents and consistency between questions and answers at proof stage. He used 'Papyrus' desk-top publishing software for preparing pdfs of examinations proofs and hated MS Word with a passion. Despite many battles with computers and software, particularly after his cataract operations, he set standards for examination production that are proving hard to follow.

Apart from his world-wide reputation for research into musical acoustics, John was known for award-winning photography. Later in life he took up croquet at which he showed considerable prowess also. Many conversations with John on IOA education business were peppered with accounts of his latest croquet exploits and telephone calls had to be made at times that avoided TV screening of Formula 1 grand prix races – one of his other passions. But his quirky sense of humour and kindness were always to the fore.

John is survived by Sylvia, whom he married in 1967, and their daughter, Hilary. Sylvia was a cellist and they played together for many years in Chelsea Opera Group under Sir Colin Davis.

He will be missed by professional acousticians and musicians who will mourn the passing of a truly "Renaissance man".

Philippa Wolfarth comes aboard sales team at AcSoft

hilippa Wolfarth has joined AcSoft Group as Internal Sales Executive where she will provide support across all divisions of the business – AcSoft Sound & Vibration, Svantek UK, G.R.A.S UK and AcSoft Health & Safety.

She was previously Sales Agent at Integral Resource Group in Melbourne, Australia, Business Development Manager at Cromwell Tools and has worked in advertising sales for local newspapers and magazines.

In her role at AcSoft, Philippa will be responsible for helping increase sales of the full portfolio of products, including

G.R.A.S. microphone sets and accessories, Svantek dosimeters, GilAir sampling pumps and high level data acquisition solutions. She will also provide administrative support to the field / direct sales teams where required.

Paul Rubens, General Manager at AcSoft Group, said: "I'm delighted to welcome Philippa on board during a significant period of growth for all businesses in the group. As well as a proven track record in tough sales environments, she brings enthusiasm and vibrancy to the team."



Philippa Wolfarth

Fabrizio Filippi and Simon Perigot join acoustics teams at Theatre Projects

abrizio Filippi and Simon Perigot have joined Theatre Projects' acoustics teams in London and Paris respectively.

Fabrizio Filippi has worked in acoustics, noise and vibration control for 10 years, gaining experience on performing arts and public buildings, studios and museums. His experience also includes groundborne noise and vibration predictions for noise sensitive buildings near railway and underground lines.

He obtained a BSc in aerospace engineering and a master's in sound engineering from the University of Rome. He also obtained a graduate diploma from the University of Cambridge in interdisciplinary design for the built environment (IDBE). He is a Chartered Engineer (CEng) and a Member of the Institute of Acoustics (MIOA).

At Theatre Projects, he is taking a key role consulting on all aspects of theatre and auditorium acoustic design. With a mission to grow the London acoustics team, he will work closely with Seb Jouan and the team based in Paris, Rob Harris in the UK, and with TP's theatre designers on projects in the UK and throughout the globe.

Before joining Theatre Projects, Simon Perigot worked at LASA, a leading acoustic and vibration engineering firm in Paris.

His responsibilities there included acoustic design and acoustic modelling, noise and vibration measurement campaigns, room acoustics, sound insulation, and acoustic testing.

He received his associate degree with a strong focus on practical applications of mechanical engineering principles from the Université Pierre et Marie Curie in Paris. He also holds a bachelor of engineering in

acoustics and vibration from Université du Maine in Le Mans.

Since joining Theatre Projects, he has been working on the LG Arts Centre in Seoul, a concert hall with Tadao Ando, Tunbridge Wells Theatre in the UK with Allies and Morrison, and in France, the Centre des Congrès in Angers, the Paris Villa M with Philippe Starck and the new Paris Parc building with BIG.





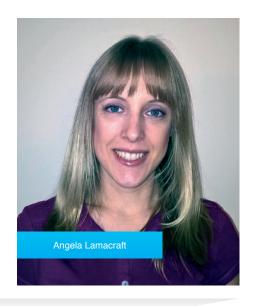
ACCON UK welcomes Angela Lamacraft as Senior Acoustic Consultant

ngela Lamacraft has joined ACCON UK as Senior Acoustic Consultant based in its Reading office.

Previously with Amec Foster Wheeler, she specialises in environmental noise, transportation noise and vibration and industrial noise control across a range of sectors (including retail, commercial, scientific, technical, residential and industrial). She brings major consultancy experience of

managing stand-alone acoustic assessments and multi-disciplinary projects. She is also Chairman of the IOA Young Members' Group.

Graham Parry, ACCON UK Managing Director, said: "This is a key appointment which further strengthens our acoustic team and I am sure that Angela's contribution will enable us to continue to offer a very high standard of technical capability and support our many clients."



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'Revolutionary' new simulation technique will aid micro-crack detection

wo scientists have devised a new modelling tool for micro-crack detection which can model both linear and non-linear ultrasonic behaviour.

Known as Peri-Ultrasound, it was developed by PhD student Hadi Hafezi and his advisor, Professor Tribikram Kundu of the University of Arizona.

Dr Hafezi, who will present his findings at the Smart Structure/NDE symposium in

Denver in March 2018, said: "Engineering simulation can play a major role predicting even the approximate time of failure of machines. It allows us to study the behaviour of material under various scenarios (e.g. when they are in real life service). These simulation tools not only avoid costly physical testing regimes, but also speed up the design process.

"However, although computer simulations up to now have shown tremendous

improvement, nonetheless these tools are based on analytical methods that show inherent drawbacks for explaining material behaviour.

"This is where our new tool can take the next great leap forward in failure prediction and detection. It is a fast computational tool, and could integrate both crack propagation and detection in the simulation of material behaviours."

New solution from NTi Audio for determination of sound power

Ti Audio is offering a new solution for determining sound power from sound level measurements. This allows a manufacturer to determine the sound power level LWA of a product, using ISO 3744 standards, according to the Machinery Directive 2006/42/EC and the Outdoor Noise Directive 2000/14/EC.

The measurement data is recorded using the portable XL2 Sound Level Meter, while the evaluation and creation of the measurement report are carried out with the new Sound Power Reporter PC software.

NTi says the software completes the essential tools needed for sound power measurements by evaluating and reporting on the measured data recorded with the XL2. This includes all necessary corrections (background

noise and room correction) as well as the creation of an extensive measurement report according to the ISO 3744 standard, including a description of the measuring environment and the object under test. The measurement report is available within seconds of taking the measurement data from the XL2 Sound Level Meter.

With the optional Extended Acoustic Pack, the reverberation measurement can also be carried out in third-octave resolution. The software is freely available for all users to download. The import of data into the PC software is enabled by the Sound Power Option being installed on the XL2 Sound Level Meter. As an alternative to purchasing this option, NTi says the annual subscription service Sound Power Reporter 365 offers a way for the data import into the PC software. This allows the



processing of the measurement data from a licensed XL2 at several workstations as well as the transfer of the data within a team or to a customer.

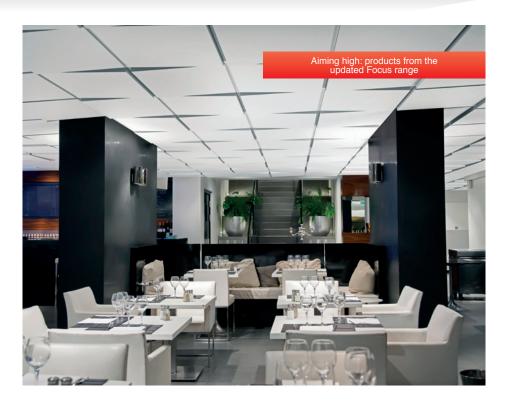
For more information go to http://www.nti-audio.com/en/news/sound-power-testing---a-professional-solution-with-the-x12.aspx

Ecophon offers new Focus on acoustic range

cophon has updated and expanded its Focus acoustic ceiling range. It has now a range of 16 Akutex colours, with11 standard sizes, 10 edge details and six design solutions addressing locations such as level changes and wall transitions.

New to the range is Focus Ez: an asymmetric tegular tile, which can be installed in different orientations to create angles and forms across the ceiling. Ez also integrates with any of the three different lighting solutions available to enhance a ceiling installation.

For more information, **visit www.ecophon.com**/**uk**



Better hearing protection available with Cirrus doseBadge⁵ update



he Cirrus doseBadge⁵noise dosimeter is now available with octave bands filters allowing for effective and accurate selection that it says enhances employee hearing protection.

This new function runs alongside the doseBadge⁵'s ongoing assessment of noise exposure but, says Cirrus, allows for more detailed analysis of noise sources with the additional data helping H&S managers select hearing protection or review noise control measures.

The new feature follows a number of upgrades to the doseBadge⁵ which was launched in 2016. Additional features include: wireless Bluetooth connectivity, scheduled measurement timers, tamper detection as well as extensive data logging and analysis.

James Tingay, Cirrus Research Marketing Manager, said: "Having insight into the frequency content of measured noise levels can be critical when there's a need to select appropriate PPE."

A new version of the NoiseTools software will also be released alongside the new version of the doseBadge⁵ to support the new features.



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Committee meetings 2017/18

DAY	DATE	TIME	MEETING
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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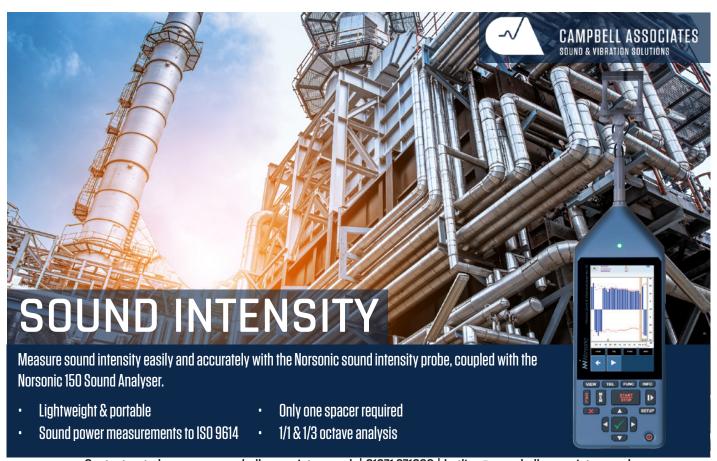
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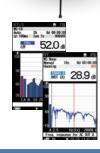
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