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ACOUSTICS BULLETIN

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Institute of Acoustics

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The UK Pavilion at the Milan Expo

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Institute of Acoustics

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.

Conference programme 2015/2016

10-12 November
Organised by the Electroacoustics Group
Reproduced Sound
Moreton-in-Marsh

26 November
Organised by the Measurement and Instrumentation and Young Members' Groups
Sound sensing in smart cities
Salford

7 December
What the numbers really mean
Watford

26 January
Organised by the Environmental Noise Group
Aviation noise
London

9 February
Organised by the Scottish Branch
Noise aspects of onshore oil and gas exploration and extraction
Glasgow

10 March
Organised by the Measurement and Instrumentation Group
BS 4142
Birmingham

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

Dear Members

We are in the midst of awards season and I am reminded how valuable these are both to the recipients and to the Institute.

I recently presented the A B Wood Medal, a medal for younger researchers whose work is associated with the sea. This year it went to Dr Ying-Tsong Lin, Associate Scientist in Applied Ocean Physics and Oceanography at Woods Hole Oceanographic Institution (WHOI), Massachusetts, USA, who was a worthy recipient. This medal, awarded to Europeans and North Americans on alternate years, continues to raise our profile outside of our domestic market.

I also presented the RWB Stephens Medal to Professor Barry Gibbs, University of Liverpool, at our Acoustics 2015 conference and enjoyed his lecture on *Structure borne noise: research informing practice and practice informing research* which drove home the need for having a practical scientific approach for practitioners in everyday use. We need to have the ability to ensure our application is science based but with the reality of identifying a practical approach in everyday use.

Acoustics 2015 was a great success and I am grateful to all the speakers, chairmen and organisers for making this a sellout, as well as the delegates and sponsors who attended from near and far. It was an opportune time to renew contacts and discuss challenges of mutual interest with our peers in a science-based debate. It was gratifying to note the agenda covered a wide range of very interesting topics and sessions, which gave opportunities for us all to extend and improve our knowledge (as well as maintaining our CPD). At the conference we launched the interactive app for smart devices to enhance the experience for our delegates, allowing them to manage their agendas, ensure they covered the topics they wanted to see, have background on the speakers and organise their meetings. We were trialling this in advance of the ICSV2017 (International Congress on Sound and Vibration) in London that we are hosting in conjunction with IIAV (International Institute of Acoustics and Vibration). The feedback on the app was tremendous and we look forward to utilising this technology going forward.

On 14 September we had our education strategy workshop day, where present we had Council and invited attendees from key groups both inside and outside the Institute. The initial findings from the education market research study were presented. These findings will be used to help formulate and shape our Learning and Development Strategy.

The final report from Market Wise Strategies was expected in early October. There is a need to maintain the momentum of the review and it was agreed to form a small working group to review the final report and present recommendations for action to Executive on 17 November.

In this Bulletin, one of the main features is the Institute's response to the Select Committee on National Policy for the Built Environment. In this detailed document the Institute draws the Committee's attention to the important role of the acoustic environment in facilitating positive health and quality of life outcomes, within the broader context of the built and natural environment.

This is our last Bulletin before Christmas and the year end. The activities during 2015 have continued to underpin the achievements of the Institute and put us in a stronger position going into 2016. To you the membership, thank you for your support and being part of an exciting discipline. To all the volunteers and staff, I express my appreciation for your unstinting support to ensure the continued success of the Institute. So as our thoughts move to the festive season, I would like to take this opportunity to wish you and your loved ones a wonderful time and wish you all a prosperous 2016.

William Egan, President

Seabed and Sediment Acoustics: Measurements and Modelling conference

By Andrew Holden and Philippe Blondel

The Underwater Acoustics Group organised the international conference *Seabed and Sediment Acoustics: Measurements and Modelling*, held at the University of Bath on 7-9 September. The scientific objectives were to bring together international experts and scientists from all around the world, encouraging greater networking, the strengthening of existing ties between international groups (most often in North America and Europe) and the initiating of future collaborations. The technical objective was to share the latest advances in seabed and sediment acoustics.

This conference was scheduled for 2015 in order to coincide with the 10th anniversary of the successful international conference *Boundary Influences in High Frequency, Shallow Water Acoustics*, organised by Nick Pace and Philippe Blondel in July 2005, also at the University of Bath. Just over 10 years before, in April 1993, the university had the privilege of hosting another Institute of Acoustics conference, *Acoustic Classification and Mapping of the Seabed*, organised by Nick Pace and Nick Langhorne (then at the Defence Research Agency). This followed the 1983 conference *Acoustics and the Sea Bed*, spearheaded by Nick Pace, which was the first large, international conference of its kind to be held at the university. All these conferences were very successful, due in no small part to the activity of their organisers and the high calibre of all contributions with 51 papers published in 1983; 52 papers in 1993; and 65 papers in 2005. A total of 54 high quality papers were presented at the 2015 conference and there were 80 plus attendees each day. *Omnia mutantur, nihil interit* (Everything changes, nothing perishes. Ovid, *Metamorphoses*). This year's conference highlighted the many changes in the field over the last decade.

For the first time, this conference had a Young Scientists' icebreaker, an informal networking event attended by around 20 people and lasting well into the (late) evening. A few delegates had also attended the 1983 and 1993 conferences, and it was a pleasure to see the interaction between generations, and between all attendees in general. The 1983 conference has long been remembered for its science, and for its social opportunities, and we aimed to preserve this spirit in the 2015 edition, with ample time for discussions at breaks in an otherwise very full programme, an icebreaker BBQ (on the lawn of The Edge, the brand new university building, with a beautiful sunset) and a conference dinner at the Roman Baths (lit by torches as the night set in).

The 2015 conference was the result of 18 months of planning by the organising committee: Philippe Blondel (University of Bath), Andrew Holden (Dstl), Linda Canty (IOA), Charles Holland (Penn State University), Gary Heald (Dstl) and Peter Thorne (NOCS). It benefited from the IOA experience in organising successful conferences, and attracted support from the Office of Naval Research Global, the Acoustical Society of America and the European Acoustical Association. The profiles of attendees covered large parts of the world (Fig. 1), with European attendees coming in equal parts from the UK and from our neighbours, and with a good spread of backgrounds (Fig. 2).

The single-track organisation had been favoured in previous Bath conferences. As several previous delegates put it: "It forces us to discover new things, and gives us new ideas". Around three full days, the following sessions were organised:

Sediment acoustics

Twelve papers were presented in two sessions, chaired respectively by Gary Heald and David Barclay (Dalhousie University, Canada). New instrumentation was presented along with results from around the world, including a welcome attempt at synthesis and highlighting of data collection priorities. The papers covered topics such as the acoustic properties of deep sediments, the gas bubble distribution in sediments and sensing seabed interface wave vibrations and sediment.

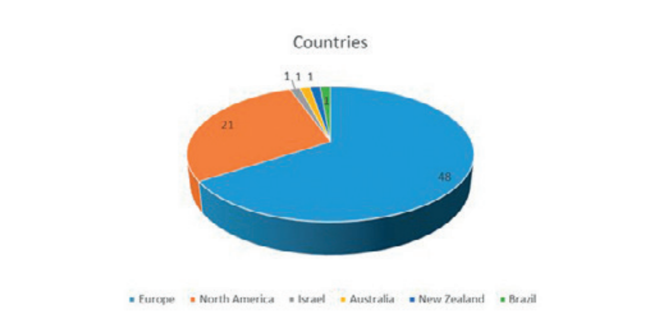


Figure 1. Most attendees to Seabed and Sediment Acoustics 2015 came from Europe and North America

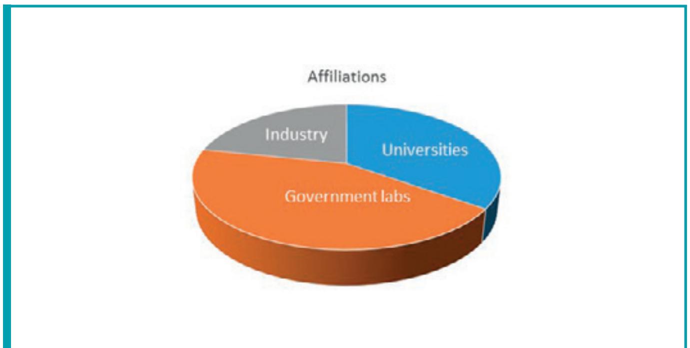


Figure 2. Delegates to the conference covered a wide spectrum of primary affiliations.

Nick Pace with a goblet to commemorate his work

Acoustic scattering from the seabed

Ten papers were presented in two sessions, chaired respectively by Brian Hefner (UW, USA) and Charles Holland. Field measurements, repeated observations in natural habitats (e.g. Kwinte Bank in Belgium) and high-level models were complemented by summaries of current calibration efforts of field instrumentation, showing the strong links between manufacturers and end users. Other papers looked at the scattering from shells, and assessing seabed ripple geometry.

Seabed influence on acoustic propagation

Michael Taroudakis (University of Crete, Greece) chaired this session, with five papers covering theoretical developments of the seabed influence on propagation modelling, the effects of seabed scattering on acoustic propagation, as well as applications in complex environments (e.g. Lake Kinneret in Israel).

Geoacoustic inversion

The next session focused on the latest acoustical processing and measurement techniques to extract information from the seabed and the water column using, in particular, signals of opportunity and impulsive sources. With five papers, this session was chaired by Adrian Jones (DSTO, Australia).

Nick Pace's contribution to seabed acoustics

A special session (see page 8) was organised to recognise the special contribution that Professor Emeritus Nick Pace (University of Bath, UK) has brought to the international underwater acoustics community in close to 50 years. Chaired by former student and long-time collaborator Jacques Guigné (visiting professor in Bath and CEO of Acoustic Zoom, Canada), this session heard a summary of Nick's research, from a first paper in *Nature* in 1967 to the latest paper in 2015, as well as many patents and earlier services to the IOA. It was nicely complemented by former students, with stories of research and personal help they got from Nick, enabling them to start very successful careers.

Synthetic aperture sonar

Alan Hunter (University of Bath) had organised this session, with six papers covering the latest developments in processing, using tools such as temporal coherence or lacunarity, estimating seafloor heights with side-looking sonars, and presenting stunning, very high-resolution images of targets on the seabed.

Bio and the seafloor

For want of a better name, this session aimed to present the bioacoustics research most relevant to seabed and sediment acoustics. Convened by Steve Simpson (University of Exeter, UK), this session was made up of three papers showing the effects of bioturbation, as well as the sensitivity of macroinvertebrates to substrate borne vibration.

Habitat mapping

This short session carried on the theme of "acoustic scattering", and it was chaired by Marc Roche (FPS Economy, Belgium). Two papers presented the best practice and recommendations from the GeoHab international community, summarising several years of effort by a large international consortium, and the application of seabed acoustics to geo-hazards offshore Malta.

Sediment transport

This last session contained six papers and was chaired by Alex Hay (Dalhousie University, Canada). Most papers showed measurements on and in the seabed, and mainly in the surf zone on beaches, highlighting how acoustics was measuring the movement of the sediment and how this was benefiting oceanography and beach management in particular.

AB Wood Medal

The AB Wood Medal and prize was presented to Ying-Tsong ("YT") Lin, of Woods Hole Oceanographic Institution (USA) by the IOA President, William Egan, and the citation was read by Peter Dobbins (Ultra Electronics, UK), chairman of the Underwater Acoustics Group. YT then gave a talk highlighting some of the fascinating work he has conducted over the years, and the challenges in balancing experiments all over the world with breaking-edge models and also a full home life. See page 16 for full details.

As mentioned earlier, several social events were organised at key stages in the conference:

P8

Dr David Barclay

Dr Louise Roberts

Colleagues reunited; left to right: Dr Charles Holland. Dr Philippe Blondel, Professor Jacques Guigné, Professor Nick Pace, Dr Tony Lyons, Dr Nicholas Chotiros and Dr Gary Heald

◂ P7

Icebreaker BBQ

This was held on the warm and sunny Sunday evening before the conference and was attended by around 50 delegates who enjoyed the BBQ and drinks provided by the University of Bath. This coincided with one of the stages of a cycling Tour of Britain, and the samba band at the end of the road provided an appreciated musical background to the beginnings of this informal event.

Young scientists' icebreaker

This was held at one of the University's newest restaurants. There were around 20 delegates evenly split between the young scientists and the "not so young" scientists. Discussions lasted for several hours, well into the starry night, and the event was very much appreciated by all.

Conference dinner at the Roman Baths

Eighty delegates enjoyed the unique atmosphere and surroundings of the Roman Baths, a UNESCO World Heritage attraction. A drinks reception allowed the delegates to wander (and wonder) around the Baths before a sit-down meal in the restaurant overlooking the Baths. Mementoes of the conference were handed out to the session chairs and Linda Canty received a bouquet of flowers in appreciation of all the hard work she did behind the scenes before the conference.

Conference feedback

At the end of the conference, the organisers received many comments both verbally and by email from delegates saying how they really appreciated and enjoyed both the conference presentations and the social events. This conference already owes its success to the high number, and the very high research level, of the presentations and papers submitted. A more formal feedback process is taking place over the next weeks, using the standard IOA procedure, and its results will be analysed at the next Underwater Acoustics Group committee meeting to plan for future conferences.

Dr Roy Edgar Hansen (left) and Dr Nicholas Chotiros study some data during a break

Conference proceedings

The abstracts of the Conference Proceedings will shortly be available on the University of Bath's OPUS open-access research repository (http://opus.bath.ac.uk/; search for Seabed and Sediment Acoustics 2015). The full proceedings can be bought from the IOA making sure the excellent research presented at the conference remains accessible to all for the years to come.

Future

Bath 2025 is already being pencilled in! But between now and then, there will no doubt be other good seabed and underwater acoustics sessions at various conferences over the world, as well as dedicated IOA conferences (all to be advertised in *Acoustics Bulletin*, of course).

A tribute to Nick Pace: Acoustics backscatter, imaging and classification on the sea floor

A special tribute was paid to Professor Nick Pace for his distinguished contribution to the field of underwater acoustics in a career spanning 45 years.

The following citation was read by Gary Heald during a special session to mark his work.

Professor Nicholas G Pace was awarded his PhD from Durham University in 1970 for his research entitled Ultrasonic propagation and binding in solids. Shortly after this he started his long career in the Department of Physics at the University of Bath. He has conducted research and development in many areas of acoustics and sonar applications. He is particularly well known for his research on the interaction of high frequency acoustics with the seabed. This has been applied in mine countermeasure applications and for the measurement, classification and mapping of seabed sediments. His research encompasses a wide range of topics including propagation of sound in shallow water and fluctuations in the ocean. He has worked on many types of sonar, including echo sounders, sidescan sonar, multibeam echo sounders and parametric sonars. In more recent years his research has included developments in synthetic aperture sonar, which offers high-resolution sidescan images from the seabed, provided the variability can be compensated, and bistatic sonar.

He is widely published in many international journals and has many conference papers in the open literature. His work is frequently cited in others papers and he holds a number of patents, particularly from his collaboration with his former student, Jacques Guigné. In1983 he organised and chaired the first in the series of Institute of Acoustics conferences on seabed and sediment acoustics and many of the papers from that conference are frequently cited. This has been followed by the seabed conferences, held at the University of Bath in 1993, 2005 and now this conference in 2015. He is a Fellow of the Acoustical Society of America. He was an active member of the IOA underwater acoustics group committee for many years.

During his years at the University of Bath he was frequently called upon to conduct research for the Admiralty Scientific branches of the MoD (AUWE, ARE, DRA, DERA) where he was well known and highly respected. This research included many studies on various aspects of sediment acoustics, over a wide range of frequencies, but also included projects investigating shallow water acoustic propagation and bubble acoustics.

In the latter part of his career he was given leave of absence from the university to take up a position Saclantcen (now CMRE) in La Spezia, Italy. During his time at the NATO centre he led teams investigating environmental acoustics (modelling, experimentation and statistical analysis), mine countermeasure sonar, force protection and seafloor mapping. He and his team also developed techniques for accurate ground truthing, including stereo photography and CT scanning of core samples. He also hosted many international scientists at the centre, as both visitors, as part of joint collaboration programmes and at the international conferences held in Lerici.

Professor Pace is now an Emeritus Professor at the University of Bath. The international underwater acoustics community, his colleagues and former students (many of whom still work the field of acoustics) are indebted to him for his excellent contribution, guidance and leadership.

Value of protection of aural environment 'woefully underestimated'

The economic value of the protection and enhancement of the aural environment is "woefully underestimated", the IOA has told the House of Lords.

In a response to a call for evidence for the Select Committee on National Policy for the Built Environment, the Institute said: "The emerging evidence of the social, environmental and economic costs of environmental noise, poor acoustics in buildings, and a failure to use sound positively, highlights the need to prioritise the proper consideration of the acoustic environment as a key component of the National Planning Policy Framework (NPPF) and of the future built and natural environment."

Here is a summary of the main points:

- The IOA is concerned at the shift to decentralize policy making. To ensure a sustainable built environment in a more decentralised policy world, robust policies capable of delivering the outcomes needed, and competent authorities to scrutinize applications and enforce those outcomes, are needed. There is a need for practitioners in planning, environmental protection and building control departments within local authorities to retain and develop the skills needed to enable them to for, good judgements on technical matters. The IOA is concerned that there is a significant disconnect between Government departments that implement policy covering the built environment. This will impair the UK's ability to meet Government aims for sustainable development.
- The IOA considers that the NPPF does not provide sufficient guidance for practitioners seeking to manage and protect the acoustic aspects of the built and natural environment. Whilst new noise policy objectives have been introduced in the Noise Policy Statement for England (NPSE) and the guidance to the NPPF (NPPG), supporting technical advice and guidance is largely missing. This omission means that the opportunity to build-in quality in an area often poorly understood by many participants is missed. Uncertainty resulting from lack of guidance may slow the operation of the planning system at a time when the rapid provision of new housing is high on the political agenda.
- The IOA encourages the Government to consider forming a policy to encourage re-use of existing buildings, making this the starting point for sustainable development. Removing the worst of the stock, and upgrading and revitalising the remaining, including decarbonizing their operation, can be an effective way to help tackle the existing housing shortfall. It is the IOA's opinion that the recent reforms will do little. We need a more radical focus on stimulation to encourage refurbishment programmes that achieve high eco standards.
- There are currently poor standards of knowledge and experience across many disciplines central to the built environment in relation to the impact of design on behavioural outcomes. There is a high level of acoustic design skill available from IOA members, many of whom have powerful environmental and economic experience. The Institute is encouraging a more holistic approach to the built environment and the realisation of the central role of acoustics in establishing social sustainability. There is therefore a training task to do internally within the IOA, which is under way. Opportunities to bring together professional institutions to encourage cross-discipline cooperation to seek holistic solutions to achieving sustainable design could be encouraged. Effort is needed to reduce the leak of skills from local authorities which is currently occurring.

The Institute's full response can be viewed under Response to Consultations in the Publications section of the IOA website.

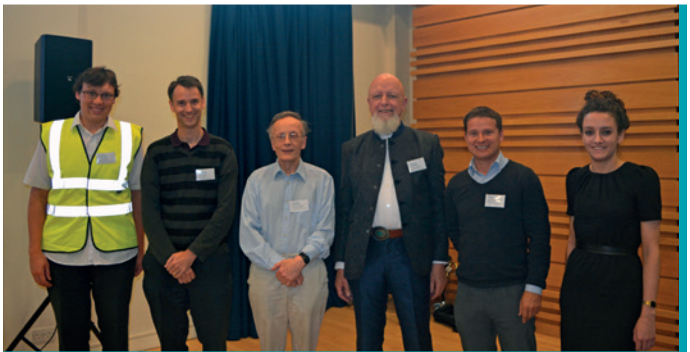
Musical instruments in science and history

By Owen Woods and Mike Wright

The Galpin Society was founded in 1946, commemorating clergyman Francis W Galpin (1858-1945), a noted scholar, collector and sometime builder of musical instruments. The society is devoted to the study of musical instruments and in association with the Institute of Acoustics, the Royal Musical Association and the University of Cambridge held their biennial 2015 conference in the glorious surroundings of the Faculty of Music on 27-30 September.

On 26th September Daniel Bangham held a most enjoyable open day and concert at the Cambridge Woodwind Makers at Stapleford Granary in memory of Sir Nicholas Shackleton, a noted clarinet collector. Sir Nicholas' wife, Ingrid Pearson, gave the first keynote paper, opening the conference on the 27th. A number of highly entertaining papers were heard on Sunday, with acknowledged highlights including the papers by Stefan Verdegem and Jamie Savan on the 19th century Oboe d 'amore and the Venetian Cornetto respectively, each of which included practical demonstrations of the instruments.

The chamber music group *Florilegium* performed a selection of music by Mozart and Haydn at Great St Mary's Church in the evening, in association with Cambridge Early Music and in memory of Christopher Hogwood CBE. Derek Adlam gave the interesting and erudite keynote paper on the 28th on Christopher's impact on the early music movement. No fewer than 13 papers were heard on the day; they included papers on musical



The MAG committee: (left to right) Owen Woods, David Sharp, Murray Campbell, Mike Wright, Stephen Dance and Jemma Jones

instrument collections, keyboard making in England and the business of organ building. The final session was on traditional instruments and culture, the assembled guests being treated to the sounds of a 2,000-year-old ocarina (thanks to David and Christa Liggins), an Italian diatonic accordion (played by Rafaelle Pinelli) and a set of Mallorcan bagpipes in full flow (Cassandre Balosso-Bardin)! During the lunch break Johan Brouwer gave a recital on the department's Rubio double harpsichord. The day was rounded off with a superb organ recital by Laurence Lyndon-Jones FRCO, assistant master of music at Chelmsford Cathedral, playing the tonally unaltered 1892 Binns organ in Queens' College Chapel.

P12

◀ P10

The 29th was devoted to the acoustics of musical instruments. The programme opened with a keynote paper entitled *Why do light gauge strings sound brighter?* by Professor Jim Woodhouse of the University of Cambridge. He explored this topic by presenting original research which complemented nicely other papers throughout the conference. Jim then chaired a session centring on the acoustics of the violin, starting with Professor Colin Gough, who described a generic model for the acoustic modes of the violin family. His paper was typically technically thorough and finely detailed.

As a complete contrast, Stewart Pollens challenged scientists who have attempted to unveil the secrets of Stradivari and other legendary instrument makers. His paper *When Science Goes Bad*, seriously questioned the validity of a number of scientific studies. A particular highlight was the presence in the room of several of the scientists concerned… the resulting question and answer session was notable for its in-depth discussion!

After a coffee break, Mike Wright, Chairman of the Musical Acoustics Group, chaired a session on plucked and bowed strings, opening with a paper by Kurijn Buys, currently a PhD student at the Open University. He examined electronic mouthpiece alternatives for wind instruments by connecting a real time computed physical model of a single reed mouthpiece to a loudspeaker with a microphone placed at the end of a clarinet type resonator. His hybrid produced convincing sounds that were close to those predicted by a complete simulation, demonstrating in a remarkable way the way that electronic and acoustic instruments can be fused together. Jack Arthur Simanjuntak of Universitas Pelita Harapan described the acoustics of a zither called the celempung, a three-string bamboo musical instrument from West Java, Indonesia. His paper was well received as few of the people present had come across this highly unusual instrument. Dr Patrick Gaydecki is Professor of DSP at the University of Manchester. His paper *Real-time digital emulation of the acoustic violin using vSound,* illustrated a self-contained system designed to filter the raw output sound from a simple non-resonant electric violin with the impulse response from a high quality instrument. His results show that a considerable enhancement can be made to the sound of an electric violin.

Lunchtime included further demonstrations of vSound and a short poster by architect Fiona Smyth who described some 1920s experiments in building acoustics and collaborations between important architects and musicians at the time.

A trilogy of post-lunch papers chaired by Professor Murray Campbell, Professor of Musical Acoustics in the School of Physics and Astronomy at the University of Edinburgh, focussed on the acoustical aspects of the bassoon. This began with bassoonist, reed maker and writer James Kopp. His paper looked at ‘embouchure’ (the use of facial muscles and the shaping of the lips to the mouthpiece). He showed the various effects of lip mass loading upon the vibrating blades of the reeds and gave interesting insights into how the embouchure has developed over the years, with clear applications for those interested in Historically Informed Performance. Matthew Dart is a well-known maker of classical and baroque bassoons. His paper explained and demonstrated the problems behind obtaining good intonation with the lower notes of these instruments. This is particularly so with one copy of a historical bassoon, where D2, the third lowest note, oscillated between sharp and flat. Using input impedance analyses, he displayed simple solutions which resulted in a quite miraculous improvement to the intonation. Finally, Bryant Hichwa, Professor Emeritus of Physics & Astronomy at Sonoma State University, described his study of acoustical performance of original baroque and classical bassoons. Measuring the physical properties and an interpretation of the non-linear acoustic properties of more than 150 bassoons has led to a detailed understanding of acoustical performance.

During the tea break, the Musical Acoustics Group held a committee meeting and this was followed by a session chaired by David Sharp on understanding the sounds of wind instruments. This started with Siobhán Culhane presenting an introductory study of the unique sonic identity of the tin whistle. She opened with some unexpected examples including traditional

The conference feast at Selwyn College

Murray Campbell

Irish music and, in contrast, Kwela street music from South Africa, displaying playing techniques well outside those normally associated with such an instrument. Professor Murray Campbell has undertaken extensive research on the different aspects of the acoustical and musical behaviour of wind instruments. His paper described the spectral enrichment in brass instruments as an approach to understanding their evolution and diversity. He described recent experimental work on bore size and shape on brass wind timbre (referring to the “brassy” sound) where the sound becomes brighter at higher dynamics. This was aptly demonstrated, along with his fine performance skills, on a historical and modern trombone. The final paper was presented by Dr Richard Smith, Managing Director of the brass instrument company Smith-Watkins. He highlighted the disparity between the harmonics of the air column and resonances of the instrument. He considered the effect of the reflection of sound from the lips in brass and dispelled the notion that higher frequency harmonics cannot be created by the performer. He also stressed that no two instruments have exactly the same musical characteristics but looked forward to the possibilities that modern technologies may present.

After this long but highly interesting programme, the conference decamped to the bar of Selwyn College and then to the fine Victorian red brick hall, where the conference feast was held with fine food and fine company.

The final day of the conference started with Daniel Bangham of Cambridge Woodwind Makers reminding us all that musical instruments are there to make noises – something which caused some consternation amongst the curators and restorers present! Other papers presented included that of Karen Loomis, on using modern technology such as CT scanning to look inside the Queen Mary and Lamont harps. The conference was amazed that the resolution was such that even the tool marks were clearly visible! As well as harps, papers featured the use and manufacture of wind instruments and the innovations of the guitar. The final session of the conference began with a demonstration of double fretting on an early guitar by Taro Takeuchi and finished with a fascinating paper by David Armitage on the Beaulieu Trophies, a superbly detailed set of carvings, which may well include the earliest visual representation of a bellows driven bagpipe in the British Isles.

Overall, the conference ran very smoothly and initial feedback has been overwhelmingly positive. The enthusiasm and interest shown by the delegates, as evidenced by the lively question and answer sessions and the animated conversation during breaks, showed that events like this can lead to very valuable intellectual collaborations. We at the Institute of Acoustics Musical Acoustics Group are delighted to have been part of it and hope that this is the first of many such collaborations, either with the Galpin Society or with any other interested party.

Boost your career prospects with Engineering Council registration

By Peter Wheeler, Engineering Manager

Over the past six months, we have held several Engineering Council (EC) professional reviews for IOA members interested in gaining Engineering Council (EC) registration through the Institute.

We offer face-to-face interviews at IOA HQ, or some other appropriate UK site, or by video-link for overseas candidates. Support and advice is available by contacting the Institute at acousticsengineering@ioa.org.uk

There are two routes: standard route for those with the appropriate EC-accredited degrees in acoustics and the individual route, which requires further preparatory work for the candidate in submitting evidence of their competence. Advice and support is offered to every candidate. The election process is overseen by the Institute's Engineering Division Committee, representing the three hundred or so members holding EC registration.

For the individual route, the Institute recognises a number of BSc courses in relevant subjects such as audio technology at certain universities as being equivalent to these BEng accredited courses for the purposes of EC registration via the individual route, without the need for further assessment.

As of 1999 graduation, the EC requires an M-level qualification for aspiring CEng candidates. The Institute recognises the IOA Diploma course and the several Masters courses linked to it as providing this evidence. Some candidates may offer a PhD qualification and these may also be accepted, depending upon the content of the associated taught element. We can also offer registration via a "technical report" route, for those who do not have relevant qualifications but who can demonstrate that they are working as a professional engineer in acoustics.

We held more interviews in October and will do so again in spring 2016. Members interested in gaining EC registration should contact acousticsengineering@ioa.org.uk

Below are profiles of some of the recent successful candidates.

Oliver Bewes

Arup, CEng

I graduated from the ISVR at the University of Southampton with a BEng in acoustical engineering. I remained at the ISVR to undertake an EngD in Transport Infrastructure Knowledge and Systems, which was sponsored by Pandrol Railway Fastenings. The project was titled *The calculation of noise from railway bridges and viaducts* and was concerned with the development of a rapid calculation model for noise from railway bridges.

I joined Arup in 2005 where I am currently a senior consultant, specialising in the prediction, assessment and control of railway noise. My recent experience includes the design of low vibration track systems for the Crossrail bored tunnels and the prediction of ground-borne noise and vibration from high speed rail.

I sought CEng registration as recognition of my senior role on projects. I have also benefited as my organisation offers staff who achieve professional status a financial incentive. This is in part because our clients recognise the value of professional status when procuring our services. I received a lot of support with my application from my colleagues who have been through the process. I feel that I perhaps could have achieved CEng a few years prior, however the additional experience I have gained in the extra years made it far easier to demonstrate that I was working at the right level. I would certainly recommend that others apply when it feels right for them.

Matthew Cassidy

Southdowns Environmental, CEng

I graduated with MEng in Aeronautical Engineering from Queen's University Belfast in 2005 and then continued in education, completing a PhD entitled *Noise reduction of an enclosed diesel generator set* at the same university. I completed the IOA Diploma in Dublin in 2008-2009 and was awarded top Irish student.

After university I began working for RES (Renewable Energy Systems) as an acoustic analyst for wind farm developments and later working as the acoustic manager at RES, with responsibility for providing global support for both development and operation of wind farms, and any other acoustic work that arose. Currently I work for Southdowns Environmental Consultants with a lead role in the management and development of its London office dealing with environmental noise, vibration and dust assessment.

CEng registration was something I had wanted to pursue for some time but had put off due to work demands and the belief that it would be too time consuming. At the start of this year, I set myself a goal to do what was necessary to gain this highly recognised professional status.

The procedure was actually very straight forward, primarily due to the Institute's guidance which set out key objectives and provided plenty of examples. The main challenge was interpreting the requirements of the UK Standard for Professional Engineering Competence to ensure I provided appropriate evidence of my relevant industry experience to support my application and fulfil all the criteria.

I would definitely encourage others to seek chartered status, especially those who believe it would be too big a time commitment. The process is challenging, but because of the support from the IOA, and provided you're suitably qualified, it's worth doing to gain the professional recognition.

Moninderjit Singh

Engineering & Acoustics Canada Inc, CEng

I achieved my diploma in mechanical engineering at a Govt. Polytechnic College in India in 1996 and started working as an engineer. Soon my interest developed in acoustics and I developed the acoustic division of my company. I did a short course in architectural acoustics from ISVR and then IOA Diploma, after which I did an MSc in applied acoustics at the University of Derby. Currently I'm president of a company in Canada and managing director of two more companies in UAE and India dealing in acoustics. Apart from management, I'm responsible for the acoustic design, reports, training and guidance for the staff as well.

I sought registration to have an edge on the competition and give more confidence to my clients. The process was quite smooth and I got full support from the IOA. I would definitely recommend others to seek registration; in fact on my recommendation, one of my colleagues has already contacted the Institute to seek registration.

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Russell Tipping

KBR, CEng

I obtained a BSc (Hons) in physics at the University of Exeter before completing the IOA Diploma and an MSc in Applied Acoustics and Noise Control, both at NESCOT College. I am a committee member of the IOA's Noise and Vibration Engineering Group.

For the past seven years I've been working as part of the noise and vibration team within KBR, a multi-disciplined engineering contractor specialising in large scale oil and gas facilities. During my time at KBR, I've been involved in the design, construction and testing of numerous projects both on and offshore in locations all around the world.

Presently I'm responsible for the commissioning and start-up noise tests of an LNG plant in Australia and helping with the acoustic design of the living quarters for a new major North Sea drilling platform.

Working within an industry and company which comprises many different engineering disciplines, I was keen to obtain chartered status as it would give me parity with, and be recognised across, the wider engineering world. Although it was a daunting task at first, the guidance material and the follow up support provided by the IOA Engineering Division made it a swift and manageable task.

Matt Torjussen

Dyson, CEng

I joined noise.co.uk Ltd for a summer internship in 2006 whilst studying for a physics degree at the University of Exeter. I enjoyed the practical application of my knowledge and joined the company full-time after completing my undergraduate studies.

I was fortunate to be supported by the company to continue studying part-time for a master's degree at the ISVR. This introduced me to a wide variety of new concepts and provided me with a strong core knowledge that I was able to apply and build on in consultancy.

I moved into noise and vibration engineering when I joined Dyson in 2012. This has introduced me to further innovative and exciting engineering and manufacturing processes whilst working with other talented engineers in a fast-paced environment for a global company.

Becoming a chartered engineer has been a key professional aim since I graduated and is an important milestone in my career. I took the individual route to registration because I don't have an accredited degree. This meant I had to provide evidence to demonstrate that I met the competencies set out by the Engineering Council. The process has allowed me to benchmark my performance and identify areas for future professional development.

Acoustic design for sustainable building

By Anthony Chilton

This was the first joint meeting by the Building Acoustics Group (BAG) and the Sustainable Design Task Force (SDTF). The half-day event was held at the suitably sustainable Coin Street Conference Centre, London which invests its profits from venue hire back into the local community through Coin Street Community Builders.

The general level of interest in this area of acoustics was evident in the high attendance, with more than 65 delegates from architectural practices, local authorities, universities, developers, suppliers and acoustic consultants.

Barry Jobling of Hoare Lea began the presentations with an appeal for balance between overheating and noise in residential design. He neatly summarised the problem presented by highly-insulated modern dwellings, built on noisy urban plots with opening windows as the only means to relieve overheating. A large number of new residential developments present occupants with an unwelcome choice between too much heat or too much noise. Barry went on to discuss the role of the acoustic engineer in striking an appropriate balance with the aim to improving future homes.

Modcell director Finlay White gave an entertaining overview of the acoustic properties of straw-bales. These are unashamedly "fat" wall constructions, whose straw core captures and stores atmospheric carbon for the building's lifespan. Finlay described a variety of building examples using their product and the results of sound insulation tests on their rendered straw bale construction. He also showed another compressed straw board product that could be used as part of dry-lining wall systems.

Anthony Chilton of Max Fordham Acoustics then tackled the design issues presented by the sustainable open-plan office. Naturally ventilated offices potentially have lower or less-consistent masking noise. Passively cooled offices with concrete soffits are at odds with providing an acoustically absorbent ceiling. Looking at Keynsham Town Hall offices as a case study, Anthony examined to what extent acoustic parameters can be relaxed to facilitate sustainable design. He promoted the use of distraction distance classifications as a way to objectively evaluate the acoustic conditions in sustainable open-plan offices.

The middle portion of the meeting was given over to a series of Pecha Kucha format presentations, with presenters challenged to cram all of their material into just six minutes 40 seconds.

First to tackle this format, complete with slides on 20 second auto-advance, was Nick Conlan of AECOM. Nick gave an informative summary of the strategy adopted for the residential element of North West Cambridge Development. The design developed made use of a bespoke acoustically lined-bend "rapid" ventilator that was detailed into the façade in distinct ways by the different architects for each lot of the development.

Staying with the subject of acoustically attenuated ventilators, Arthur van der Harten of Foster+Partners presented his work on the computer simulation and lab measurement of a bespoke ventilator for use in an office building where noise break-in was of particular concern. Arthur's COMSOL studies suggested that, whilst tempting in terms of computational speed, two-dimensional models of acoustic vents are not particularly reliable. However, three-dimensional models give a good agreement with lab measurements.

Eric Magloire of Sound Space Design presented on aspects of sustainable design in relation to performance arts spaces. He discussed the use of mixed-mode ventilation with passive extract and also looked at sustainable refurbishments to existing spaces.

Jian Kang from the University of Sheffield School of Architecture described the development of an acoustic window system that attenuates noise but allows natural ventilation and light. His impressively extensive study had considered a variety of designs based on staggered air-path and use of transparent micro-perforated absorbers. The design has already been used on residential developments in China.

Next, Jack Harvie-Clark of Apex Acoustics posed the question

Nearly 60 more applications for membership approved by IOA Council

Fifty-seven applications for membership were approved by Council in September following the recommendations of the Membership Committee. Of the total, 37 were for new membership or reinstatement, the remainder were upgrades.

FIOA

- Sean Smith

MIOA

- Paul Absolon
- Phillip Blakemore
- Victoria Bond
- Moise Coulon
- Aude Falco
- Mike Fuller
- Antony Gregson
- Gareth Hughes
- Patrick Hoyle
- Tom Leach
- Marietta McIlraith
- Robin Monaghan
- Jessica Niemann
- Richard Palmer
- Michail Pelegrinis
- Nicola Shiers
- Carl Taylor
- Paul Taylor
- Janos Tsakiris
- Richard Wilson

AMIOA

- Jalal Amine-Eddine
- Gemma Clark
- Stefan De Vito
- Joshua Dunham
- Nicholas Fry
- Alberto Fueyo Gallego
- Sam Garne
- Onur Gulen
- Christopher Holmes
- Jake Howarth
- Christina Ioannidou
- Ashley Leiper
- Laura Lopez
- Adam Mayes
- Neil Morgan
- Gavin Neilson
- Jamie Pearson
- Aaron Tomlinson
- Daniel Turner
- Erman Uzgar
- Laurence Wilmshurst

TechIOA

- Mark Boak
- Kamboyi Chibalabala
- Andrew Collins
- Christopher Conroy
- James Cousins
- Nicholas Crawford
- Boniface Hima
- Fabio Lassandro
- Samantha Liu
- Zoe Vernon
- Ryan Wilson
- Christopher Wright
- Alex Young

Affiliate

- Jamie Barratt-Gibson
- Philip Brosnan

"how loud is too loud?" when it comes to domestic mechanical ventilation. Jack presented the COST ISO NP 19488 acoustic classification scheme for dwellings, the Finnish regulations and the frighteningly quiet Swedish noise limits. He also gave an interesting explanation of the significance of low-frequency noise content and highlighted how disturbing intermittent bathroom fans can be.

In the final Pecha Kucha format presentation, Leonardo Weber from BDP described the experimental study he undertook at London South Bank University investigating the use of an acoustic meta-material for attenuated natural ventilation. He outlined the concept of resonant acoustic meta-materials, stretching the audience's technical knowledge with the idea of a negative bulk modulus. Leonardo's measurements of acoustic and airflow characteristics of his resonating cell design showed promising results worthy of further investigation.

Ze Nunes' presentation looked at the various studies that Mach Acoustics have undertaken on the acoustic performance of windows. Their work includes analysis of existing experimental data, such as that from Edinburgh Napier University, finite element, finite difference and CFD modelling of various window configurations and experimental measurements using an external free-field noise source. Ze stated the case for windows to be tested using a free-field noise source as opposed to a reverberant field as currently required by the standard.

Next, Hermann Kirchmayr gave a thorough overview of the acoustic properties of Stora Enso's cross laminated timber products. He looked at airborne and impact sound insulation before turning attention to methods of control of flanking paths, particularly where there is a desire to expose the timber to the room. Questions from the audience explored the differences between European and UK construction practices in relation to published standard acoustic details.

Bringing the event to a close, Tim Scott of Gillieron Scott Acoustic Design looked at the acoustic design of passive and mixed-mode ventilation systems. Tim described three projects in Liverpool Everyman Theatre, the Olympic Velodrome and Lauriston Primary School. The four distinctive brick chimneys that provide the "stack" ventilation at Everyman Theatre provoked particular interest as an example of acoustically attenuated ventilation informing the architectural form of the building. It was left as a matter for further investigation as to how long it would take for the in-use energy savings to offset the embodied energy of the brick chimneys.

Top underwater acoustics award goes to Ying-Tsong Lin of WHOI

A leading world expert in underwater acoustics has received an award from the Institute of Acoustics (IOA) in recognition of his outstanding work in the field.

Dr Ying-Tsong Lin, Associate Scientist in Applied Ocean Physics and Oceanography at Woods Hole Oceanographic Institution (WHOI) Massachusetts, USA, was presented with the A B Wood Medal by William Egan, IOA President, at the Institute's Seabed and Sediment Acoustics conference in Bath (see page 6).

The medal, awarded in memory of Albert Beaumont Wood, is aimed at younger researchers whose work is associated with the sea. Following his graduation from Manchester University in 1912, Albert Beaumont Wood became one of the first two research scientists at the Admiralty to work on anti-submarine defence. He designed the first directional hydrophone and was well known for the many contributions he made to the science of underwater acoustics and for the help he gave to younger colleagues.

Ying-Tsong Lin receives his award from IOA President William Egan

Below is the citation for the award:

Ying-Tsong's formal education was through the Taiwanese educational system, where he obtained his Bachelor's degree from the National Cheng Kung University, and his Master's degree and Ph.D. degree (2004) from the National Taiwan University (NTU), all in the area of ocean engineering, with a specialty in ocean acoustics. After the receipt of his Ph.D. degree, Dr Lin came to WHOI, where he was a postdoctoral scholar from 2004-2008. This rather long stay as a postdoc enabled Dr Lin to get acquainted with both the research community and funding agencies in the USA, where he wished to stay. In 2008, Dr Lin was appointed as an Assistant Scientist at WHOI, and in 2012 he was promoted to the rank of Associate Scientist.

The research work that Ying-Tsong has conducted both at WHOI and at NTU can be summarized by five topics:

1. bottom geo-acoustic property inversion
2. underwater sound propagation in complex ocean environments
3. sound propagation model development
4. marine mammal acoustics
5. passive acoustic source localisation

These five research topics concern both underwater acoustics (the forward problem) and acoustical oceanography (the inverse problem).

Though Dr Lin's contributions in all of these areas is of high quality, he is perhaps best noted for his work in complicated, three-dimensional coastal environments. This work is a combination of experiment, theory, and computation, and Dr Lin is accomplished in all three. Dr Lin is also a very interdisciplinary researcher, and his interests include physical oceanography, marine biology, and marine geology, as well as (of course) acoustics.

For distinguished contributions in the application of acoustics the Institute is proud to present its A B Wood Medal to Dr Lin.

How to write better reports for Government bodies and local authorities

By Rodger Munt

This paper is written in response to complaints received by the IOA about the standard of some acoustic reports issued to government authorities. In writing any report it is important to take full account of the target readership in order to ensure that the conclusions are clear enough to allow the authorities to make correct decisions. The nature of acoustics is such that there will normally be technical content to demonstrate that a proper study has been undertaken but its necessity and meaning should be explained in terms that non-acousticians can understand. Thus a journal paper intended for scientists will have different emphasis to one directed to local authorities. Nevertheless the technical content should be robust enough to convince an independent appraiser of the relevance and accuracy of information supplied. Some examples of technical inadequacies I have encountered when reviewing reports/papers are given in the appendix to this paper.

The following is my suggestion for the report structure, some general rules and guidance on the issues of importance in conveying information to local authorities (LAs) and to the person undertaking the technical appraisal. Comments from IOA members and LAs are invited to assist in the process of improving the standard of reporting.

1. Suggested outline of report

The report should contain the following:

- A relevant title, unique report number, author and date
- A summary which can be understood by non-experts
- An introduction briefly explaining the background, basic issues, complications and approach adopted
- Technical sections describing the measurements, analysis, results and uncertainties
- Conclusions describing the impact of results and providing recommendations
- Appendices containing in-depth analysis of measurement and detail of prediction, backing up the other sections in the report, which can be scrutinised by other professionals. References to support the technical detail should either be easily accessible in the public domain or be provided with the report.

If measurements are made to a particular BS or ISO standard then all the required reporting items pertinent to that standard must be addressed either as an appendix or in the main body of the report.

My preference is for the definitions and technical terms to be provided in an appendix as these are a distraction if left in the main section of the report.

The summary, introduction and conclusions should be in a form which can be absorbed by authorities. In many cases the authorities may not have the expertise to fully understand the technical sections which should nevertheless contain sufficient detail to allow independent technical appraisal (See the IOA Code of Conduct clause: *Ensure that primary data used in any publication or report are available in a form that would allow for independent scrutiny and that sufficient details of any experiments, by which the data were derived, are available to allow others to replicate such experiments.*)

Summary

An acoustics report should contain a brief non-technical summary, written by a competent acoustician, providing simple points that can be understood by a non-specialist. It should explain exactly the new, existing or modified features of developments and how these are affecting the noise climate and the bearing on the local situation and what measures are to be implemented to mitigate the effects. All points within the summary should be substantiated in full by way of detailed evidence provided elsewhere in the main report.

Introduction

This should describe the reasons for needing an acoustic study and, where applicable, provide a description of the industrial or commercial equipment generating the noise. Any relevant background information, including any previous study, should be explained. The environment in which the equipment is to be introduced needs to be described and shown in plans of the area, including the topography between sources and sensitive receivers. A basic description of each piece of equipment generating noise is appropriate here and, for each source of noise, general detail should be given of its characteristics, e.g. if it is a reciprocating engine exhaust explain that the sound will contain tones with directional characteristics. Indicate if the characteristics are likely to pose problems and if so what solutions will be examined in the main body of the report. The specific details of the sources, e.g. tone levels and frequencies, should be left to the technical sections.

Main technical sections

These should contain detail of measurements and their analysis and, where predictions are used, detail of the prediction method and the assumptions. Reference to the various standards is appropriate and the specifics of how the standard is applied, with diagrams of measurement locations, should be supplied. The assumptions used in any predictions should be clearly stated. In all cases an assessment of uncertainty is needed for the sound levels predicted or measured.

Full disclosure of scientific method

The evidence underpinning all advice and reports should be robust and obtained using reproducible scientific methods which allow the reliability of data to be verified.

- One of the main principles of the scientific method is the practice of full disclosure to allow someone else, working independently, to accurately replicate the scientific study or experiment. This enables careful scrutiny by other acousticians and professionals, giving them the opportunity to verify results and to analyse and interpret them independently.
- Full disclosure of the underlying data used to support conclusions helps to reduce professional scepticism and is particularly important when uncertainty or scepticism is expressed by the public or third parties over the claims sometimes made in reports.

Independent appraisal

When applying professional scepticism the decision-maker should not necessarily accept evidence at face value and should instead:

a) critically assess evidence without being overly suspicious or sceptical
b) corroborate, where necessary, methods used, data collected, proposals and recommendations made
c) identify information that brings into question the reliability of any documents and evidence
d) establish whether evidence is misleading, incomplete, incorrect,

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false, biased, exaggerated, unsubstantiated or contradictory and be prepared to challenge such information

e) consider whether the person providing the evidence or information lacks competence in key areas, and be prepared to request evidence to confirm the competency of the person(s) submitting the information, providing advice and/or making recommendations.

Appendix

Examples of technical issues with reports

In appraising reports I have encountered the following:

- Reports being issued at different times, by the same author and covering the same aspect of an acoustic study, without explanation of why a new report was necessary or why the results were different. The lack of a report number also made them difficult to identify/reference.
- A main report dominated by many pages of remotely logged acoustic data without full analysis and interpretation. The main report should have summarised the recordings in a suitable form, preferably as graphs of noise level as a function of time, whilst the tabulated data could have been made available in a separate addendum.
- On occasions there is a lack of a qualitative assessment of background noise sources that may affect a community. Specifically it is good practice to listen to and make audio recordings of the background noise at a location, to determine what noise sources are dominating, before deploying remote noise monitors. In one case two nominally similar locations produced contradictory diurnal recordings, but they were not revisited to examine why.
- The reason for measuring the meteorological conditions at the same location as acoustic recordings, as required in BS7445, seems to be misunderstood. There are many cases when the meteorological data is not analysed to establish how it might affect the recordings, e.g. wind noise or rain impact on the microphone, or how distant sources, such as a motorway, may contribute to the background noise through atmospheric refraction in particular meteorological conditions. In some cases the meteorology from a met. station several kilometres from the site is tabulated instead of the local meteorology but the latter, which will be affected by surface topography, can be significantly different.
- The effects of local meteorological conditions on the refraction of sound on recorded data are not always understood or examined. In one case a hot cloudless day with little wind was assumed to be ideal conditions in which to measure the characteristics of noise decay between a source and receiver 1km apart, not realising that these are strong lapse conditions in which acoustic shadow is experienced around a source near the ground and consequently the measured attenuation would not be representative of the average experienced by the community which, in this case, would normally be in the prevailing downwind direction.
- One study lacked an appreciation of the highly directional nature of a source, assuming a single sound level value for the source would suffice without explanation of how it was measured and what it represented. The same study did not explain how calculations were performed to account for a configuration change and for propagation over complex terrain, nor did it examine the accuracy for the estimated level of sound predicted at residential properties.

Dr Rodger Munt *(FIOA) is a retired scientist with 45 years of research experience. As a long standing employee of the former Royal Aircraft Establishment (RAE), he led successive research teams where vetting of scientific reports for non-technical customers was routine. He regularly sees the reports issued to LA planning departments in his capacity as consultee.*

Eyes down as young members play inter-professional bingo

By Ellen Harrison and Angela Lamacraft

The Young Members' Group (YMG) proudly led the organisation of an inaugural inter-institutional event aimed at young members from a diverse range of professions. More than 60 young members from the IOA, Institution of Mechanical Engineers, Landscape Institute, Chartered Institution of Building Services Engineers Young Engineers Network and the Institution of Fire Engineers came together at Baden Powell House in South Kensington in August. Attendees ranged from students to chartered engineers, and from those employed by small local start-ups through to

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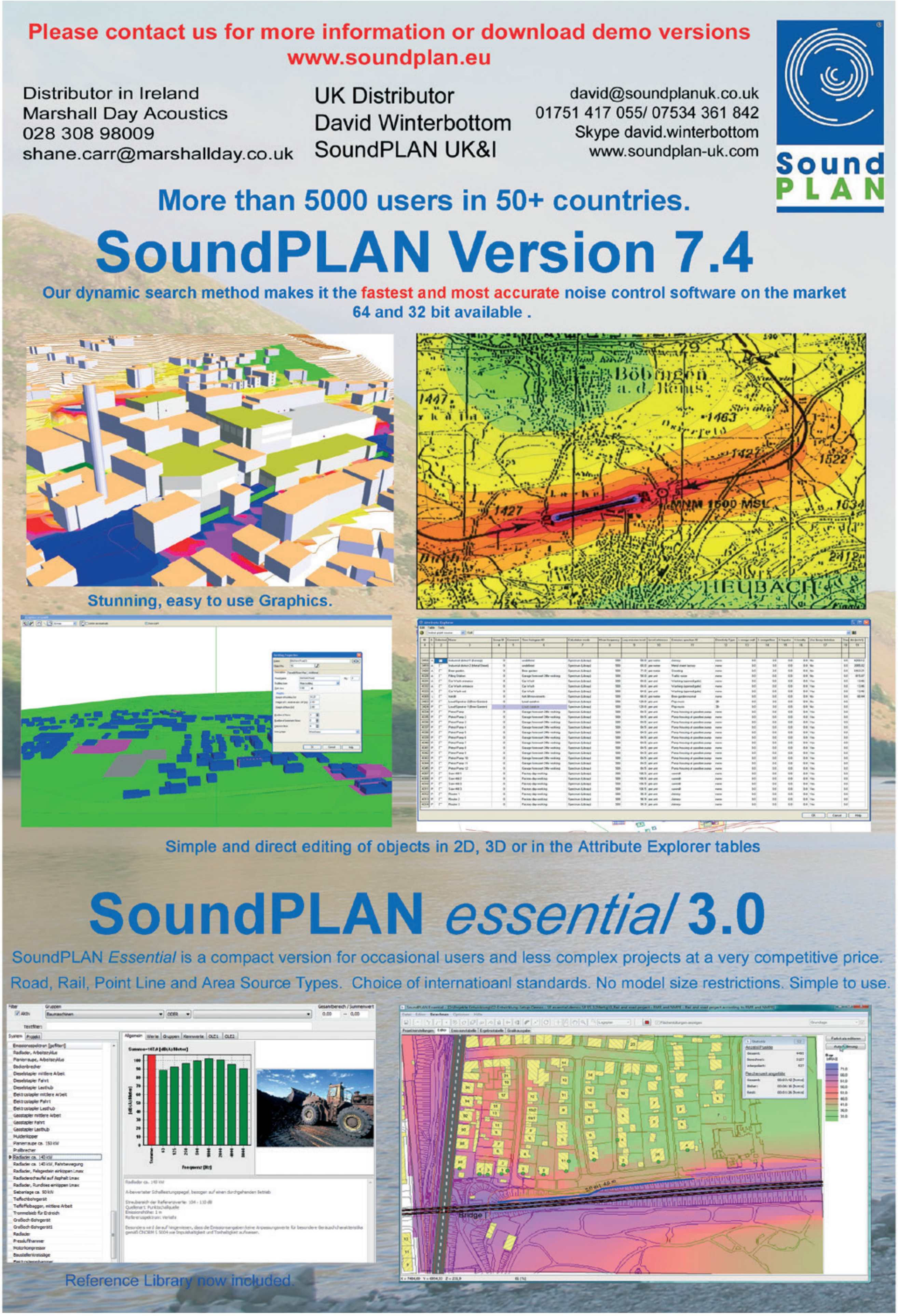
Young members get into the spirit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Reference Library now included.

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large multi-national engineering consultancies.

The YMG understands that meeting new peers can be daunting, especially for young members at the start of their career, and one of the main aims of the event was to facilitate an informal evening in which young professionals of different technical areas could come together to learn about each other in a casual environment.

This, it is hoped, will enable young professionals to become more familiar with other technical aspects of projects they are working on by understanding what other disciplines do and what is required by different disciplines in their role in a design team. Greater familiarity of associated technical fields may also help to provide a more sustainable design and can help young members in particular feel more comfortable in a room of their peers.

After a brief introduction the ice-breaker activity began: bingo! There were 20 categories (such as "Find someone who.... has worked in Asia, is chartered, speaks a foreign language") and the aim of the game was to find someone in the room for each category. Four of the completed forms were selected at random at the end of the night and the winners received a prize.

The ice-breaker provided an excellent focus for the evening, offering young members topics with which to strike up a conversation and whilst some young members focussed on completing the activity, many took the opportunity to have casual conversations or make new acquaintances. Drinks and nibbles were provided and the buzzing atmosphere of the room expressed how well attendees were taking advantage of the networking opportunities in this informal environment.

Attendees provided very positive feedback with a number requesting that we repeat it next year. It is hoped that the success will encourage more institutions to take part next year to provide an even broader representation of professions, resulting in a greater benefit to all attendees.

Senior members fly high at air sciences museum

By Ralph Weston

In October the Senior Members' Group organised a successful visit to the Farnborough Air Sciences Trust (FAST) coupled with a talk on helicopter noise by SMG member Rodger Munt. FAST is a charity dedicated to saving most of the historically important buildings and artefacts from the former Royal Aircraft Establishment (RAE) and to make them available to the public. The FAST museum, housed in one of the original HQ buildings, opened in 2003.

The visit began with an illustrated talk about the history of RAE and the museum by Dr Graham Rood, who was an employee of RAE for many years. It is a fascinating museum that shows not just old military aircraft that were used for experiments but also the many innovations that were developed at Farnborough. The trust also helps engineering students and schoolchildren appreciate the many practical aspects of aircraft design and manufacture.

Just before lunch we witnessed Tracey Curtis-Taylor, 53, setting off in her 1942 Boeing Stearman Spirit of Artemis aircraft from Farnborough on her 13,000-mile solo flight from Britain to Australia in a vintage open cockpit biplane, recreating the flight made by Amy Johnson in 1930.

Rodger Munt, a member of SMG and long standing employee of the former RAE, gave us a talk on the modelling of helicopter noise for use in environmental assessment.

After the meeting closed some members stayed on to look at even more artefacts stored at the museum. We are grateful to all the volunteer staff at FAST who contributed to a very full visit. More information on FAST at www.airsciences.org.uk

Dr Graham Rood explains the engineering involved in a helicopter


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South West Branch reports

Audiometry testing in the workplace and paranormal acoustics

By Dan Boote

Liz Terry from Insight Health Screening gave a talk on the audiometric process and interpreting results.

The presentation explained the differences in procedure and accuracy between automatic and manual tests – manual is considered more accurate. It was also noted that tests were often only for screening purposes; full diagnosis would need to be performed by an ear, nose and throat specialist. 0dB loss in all frequency bands is not considered to be normal. General retest periods were also given for each "hearing category" following a test.

Liz also covered the two types of hearing loss (conductive and sensorineural) and some of the causes of them. These causes include blockage or physical damage for conductive hearing loss and acoustic neuroma (nerve damage) for sensorineural hearing loss.

Dan Pope from Atkins followed up on his recent review of paracoustics (*Acoustics Bulletin* Vol 40 No 5) by presenting further information based on his own research into the psychoacoustics of the paranormal.

For a talk that mainly focussed on explaining apparent paranormal happenings by applying common sense and acoustic knowledge, Dan, in his orange jumper and glasses combo, bore a spooky resemblance to Scooby-Doo's Velma. He did at least manage to not lose his glasses. Jinkies!

Exploring the paranormal: Dan Pope

Fullabrook Wind Farm visit

By Dan Pope

Seventeen branch members visited Fullabrook Wind Farm in north Devon.

After an enjoyable lunch at the Broomhill sculpture garden, and an opportunity to network with fellow attendees, we wound our way through the Devon lanes towards the 22 turbines of the wind farm. The turbines are Vestas V90 each producing a maximum of 3MW.

We were met on a sunny but breezy afternoon by Rory Jordan of Magna Project Services Ltd and Ian Whitehead who is the GB Wind Farm Manager for ESB Renewables O&M.

Rory started by giving a brief history, where it was said the original proposal for a wind farm on the site was submitted 30 years ago by a local land owner. With several further submissions over the intervening years, permission was granted with the wind farm opening approximately four years ago. During its first year the farm operated at full design capacity, however this meant certain noise criteria were exceeded, and since then the output has been restricted in order to reduce noise levels.

Ian Whitehead explained how a programme of noise monitoring was set up, and on the back of recommendations from this an automated wind farm control system has been put in place to manage noise levels, tailored to specific receptors and wind conditions. For example, but not exclusively, some turbines close to receptors are switched off during certain wind conditions, and also the mode of the turbines (angle of blade) is adjusted to control noise.

There was also an opportunity to view inside the base of a turbine and admire the view out over the Atlantic and north Devon.

Branch members at Fullabrook Wind Farm

Acoustical instruments – specification standards update

By Susan Dowson

When performing any acoustical measurement, or specifying a device to use, it is important to ensure the instrument you select is suitable for the task so that reliable and traceable measurements can be performed. In many cases the instrumentation requirements will already be specified, for example if performing a particular measurement to a given standard e.g. an ISO standard, these requirements are normally included in that standard. This is usually achieved by referring to a specific specification standard and, where applicable, to a particular class of device as defined in that standard e.g. "use a class 1 sound level meter conforming to the requirements of IEC 61672-1" etc. So where do these specification standards come from?

For most acoustical instruments the specifications are given in international standard documents produced by the IEC (International Electrotechnical Commission). The relevant committee for acoustical instruments is IEC/TC29 "Electroacoustics". This is paralleled by a UK National Committee within the British Standards Institution, BSI EPL/29. It is now many years since a specific British Standard was issued by BSI for an acoustical instrument, with BSI now adopting new/revised IEC standards unchanged as BS EN documents with the same standard number as the IEC version. There are many benefits with this approach – IEC/TC29 in common with other IEC committees, has global membership, currently having 24 participating countries and 12 observer countries, and it is clearly beneficial for manufacturers, suppliers and users for discussion on the content of the documents to take place internationally. The aim is to obtain sufficient consensus such that a document can advance successfully through the various comment and voting stages and become approved as an international standard that is widely adopted.

IEC TC/29 has a broad remit and covers a wide range of instrumentation – see below. Working Groups (WGs) are set up to write new documents and these become Maintenance Teams (MTs) when they are just dealing with revisions to documents. EPL/29 provides the UK expert members for these WGs and MTs, and the national committees of other countries do likewise.

There are various well-prescribed stages in production of any IEC standard: *Preliminary Work Item* (PWI), *New Work Item Proposal* (NWIP), *Working Draft(s)* (WD), *Committee Draft(s)* (CD), *Committee Draft for Vote* (CDV), *Final Draft International Standard* (FDIS), *Publication stage* (IS). There are specific rules on format, circulation, translation, voting times, voting majorities etc. required at the various stages, and the total maximum time permitted for production of a standard or revision is ≤36 months. Further information about the various stages can be found in the ISO/IEC Directives, Part 1 'Procedures for the technical work' available at http://goo.gl/FjDHDO

Where appropriate, dependent on the instrument being specified, several standards written by IEC/TC29 are now split to cover three key areas, usually in separate Parts or Annexes of the standard. These are:

- full specifications of the instrument, which will also describe maximum permitted uncertainties of measurement for

P24 ▸

◂P23

those testing the instrument

- detailed pattern evaluation tests (previously known as type testing) - a wide range of full tests against all the specifications of the standard for a *model* of instrument. This is mandatory in some countries, although not the UK, but nonetheless it is important for manufacturers who are exporting and in general to provide a high level of confidence in the performance of the instrument. These tests are usually performed by National Metrology Institutes, with one of the main centres being at PTB, Germany.
- detailed periodic tests, often known as periodic verification tests – a limited range of tests performed on an *individual specimen* of sound level meter on a *regular* basis, to assure the user that the performance of an instrument still conforms to the applicable specifications for a limited set of key tests, for the environmental conditions under which the tests were performed. Periodic testing is normally performed by accredited laboratories – in the UK the accreditation body is the United Kingdom Accreditation Service (UKAS).

Throughout the standards documents the aim is to ensure that testing is performed in a consistent manner at all testing laboratories wherever they may be, and to ensure that all specifications and tests can be readily understood.

Areas of work for each WG/MT

There is not space to discuss in detail here all the work of the WGs and MTs, but the following table explains the *main* areas of activity, as well as mentioning examples from the current (at the time of writing) or recent work programme. See table below.

Have your say

New input into standardisation activities is always welcome, and ensures that more people have their say on draft documents. The main route is to apply to join the relevant BSI committee, EPL/29 in this case – if you are interested please contact the author or BSI directly. Documents are circulated electronically to Members and within EPL/29 most of the work is performed by email with typically only one meeting a year of about half a day, so membership is not too onerous. The IEC TC/29 Plenary meetings take place nominally every 18 months, meeting for a week at a host venue with two half-day plenary sessions and with the active WGs and MTs meeting on the other days during the week. The next plenary meeting takes place in Paris in November 2015. Some WGs and MTs also schedule additional meetings between the 18 month plenary sessions.

Another possible route for involvement is starting to emerge through the BSI Draft Review System. This involves registration on a BSI website, and within EPL/29 we have requested that IEC CD documents will be posted there as Drafts for Public Comment (DPC), as well as the ISO documents which are automatically uploaded to the site. There is then a means whereby you can make comments on the drafts, and these comments are sent to the relevant BSI committee (EPL/29 in this case), who will review and decide which of the comments will be included in the UK national comments on the document that are sent on to IEC by BSI. This Draft Review System can be accessed at is http://drafts.bsigroup.com/

It would also be useful if there was some way the IOA could flag up to its members when relevant DPCs appear on this website, and some initial discussions have taken place on this.

__Susan Dowson__ works at the National Physical Laboratory, Teddington, and is currently Chairman of both IEC/TC29 and EPL/29.

WG/MT no.	Title	Areas of activity
MT4	Sound level meters	Edition 2 of IEC 61672 was published in 2013, and currently there is no ongoing work on sound level meters. MT4 is in the very early stages of considering revision to IEC 61252 'Specifications for personal sound exposure meters'
WG5	Measurement microphones	Responsible for the IEC 61094 series of standards, including revisions. IEC 61094-3 on 'Primary method for free-field calibration of laboratory standard microphones by the reciprocity technique' is undergoing circulation to National Committees at the CDV stage, and IEC 61094-5 'Methods for pressure calibration of working standard microphones by comparison', has just been approved at CDV stage
WG10	Audiometric equipment	Responsible for the IEC 60645 series of standards, including revisions. Edition 4 'Audiometric equipment - Part 1: Equipment for pure-tone and speech audiometry (amalgamated revision of IEC 60645-1 Ed.3.0 and IEC 60645-2 Ed.1.0)' is under circulation to National Committees as a CDV
WG13	Hearing aids	Responsible for most of the IEC 60118 series of standards, including revisions. IEC 60118-0 Ed.4 – 'Hearing aids: Measurement of the performance characteristics of hearing aids' was published recently. Currently IEC 60118-13 Ed. 4.0 – 'Hearing aids: Electromagnetic compatibility (EMC)' has been approved for circulation as an FDIS. Also IEC 61669 Ed. 2.0 'Measurement of real-ear acoustical performance characteristics of hearing aids' is under circulation to National Committees as an FDIS, and IEC/TS 62886 Ed. 1.0 'Hearing aids: Method for measuring the electroacoustic performance up to 16 kHz' has been circulated and comments received at 2CD stage
MT17	Sound calibrators	Working on the revision of IEC 60942:2003 'Sound calibrators' to produce an Edition 4. Document has been circulated to National Committees as a CD and comments received
MT18	EMC requirements and updates of relevant IEC/TC 29 standards	The remit of this MT is to provide advice to all the TC29 WGs/MTs on EMC requirements as requested
MT19	Revision of IEC 61260, Filters	A full revision of IEC 61260:1995 'Octave-band and fractional-octave band filters' has taken place. Part 1 on 'Specifications' was published in 2014 and Part 2 'Pattern evaluation tests' and Part 3 'Periodic tests' have been approved for publication
MT20	Revision of IEC 60118-4, Induction loop systems	Responsible for IEC 60118-4 'Hearing aids: Induction loop systems for hearing aid purposes – System performance requirements'. Edition 3 was published in 2014
WG21	Head and ear simulators	Responsible for the IEC 60318 series of standards. IEC/TS 60318-7 'Head and torso simulator for the measurement of air-conduction hearing aids' is currently at CD stage with comments received
WG22	Audio-frequency induction-loop systems and equipment for assisted hearing	Responsible for the IEC 62489 series of standards, with the latest publication in 2014 being Edition 2 of IEC 62489-2: 'Audio-frequency induction loop systems for assisted hearing : Methods of calculating and measuring the low-frequency magnetic field emissions from the loop for assessing conformity with guidelines on limits for human exposure'
MT23	Revision of IEC 61265, Instruments for the measurement of aircraft noise certification	This MT has just been revived and is working on a revision of IEC 61265:1995 'Instruments for measurement of aircraft noise – Performance requirements for systems to measure one-third-octave-band sound pressure levels in noise certification of transport-category aeroplanes', with a WD currently available within the MT


74.2 dB
78.3 dB
53.5 dB
51.1 dB
35.5 dB
50.1 dB
01dB

Auralisation tool set to aid transport planners to cut noise

Researchers in Norway are developing a simulation tool that can generate noise similar to what might be expected from a planned road or rail line.

As well as showing nearby residents what disturbance they could be subjected to, it is predicted that the tool could be used by planners to put in noise reducing measures ahead of construction.

Erlend Viggen, a member of the project team at SINTEF research institute, said that often people living near the route of infrastructure projects were given a colour-coded noise map by planning authorities to show the predicted levels of noise.

"But this is too abstract for most people," he said. "And it's difficult to envisage what the noise will really be like. It's much better to generate an artificial noise that people can listen to before construction goes ahead."

Over the past year the team has developed an auralisation tool called MAUS, simulation software designed to recreate what it is like to be a listener in close proximity to a sound source.

The researchers have made recordings of a car using microphones located on the front and rear bumpers. The car travels at constant speeds of 30, 50 or 80 km/h, and these are the basic sounds that are input to the software.

At the moment, only researchers are listening to these traffic sounds, but the scientists believe that there are some useful applications for this tool. For example, they believe that road developers will benefit from using MAUS.

"We don't really know how this technology will be used in practice," said Mr Viggen. "One idea is that the authorities may be able to conduct thorough tests to compare alternative noise-reducing measures before a final decision is taken.

"It's also possible that they might be interested in letting residents listen to different audio simulations so that they can have their say about which scenario seems to be the least troublesome.

"In this way it may be possible to avoid conflicts and expensive, subsequent modification work," said Mr Viggen, who also insists that the tool will never be made openly available to the general public."

Workshop on numerical acoustic simulation and auralisation as built environment design consultation tools

By Jonathan Hargreaves, Yiu Lam and Paul Adams

Numerical simulation has for several decades been an important tool for acousticians. Initially it was used primarily as a complement to scale modelling on high-value prestige projects, but it is now being applied extremely widely as a standard step in the acoustic design process. A particularly valuable extension to this development is the use of auralisation, being the reproduction of the acoustic character of a space over loudspeakers or headphones, to communicate to clients the subjective effect of different acoustic design decisions. When combined with simulated or measured acoustic data, auralisation enables design teams, stakeholders and sound artists to listen to soundscapes of the natural and built environment before they are physically created. Auralisation therefore also allows a client or stakeholder, who is unlikely to be *au fait* in the language and metrics of technical acoustics, to make in informed judgement on whether an acoustic design fits their needs. Again, this process was initially limited to high-value and/or high-stakes applications, but its power to engage and communicate otherwise complex concepts to non-experts means its use is spreading to a much broader range of projects. Arup, for example, has rolled-out its SoundLab auralisation facility to 11 offices internationally, the most recent installation being in its new Manchester office, where the workshop this article reports on is based.

Auralisation however places new and intensive demands on acoustic simulation algorithms, not least that a single full-bandwidth result is required. Most commercially available room acoustics software will produce output data suitable for auralisation, however it is well known that this is unreliable in some scenarios and in particular at low frequencies because the geometric approximation of acoustic propagation which they use breaks down. Other computational methods such as Finite Element and Boundary Element are capable of capturing these low frequency effects accurately, but are typically formulated for analysing single frequency problems and do not at present interface readily with auralisation technology. Hence there is a need for hybridised or unified acoustic simulation algorithms which can process the entire audible bandwidth reliably and output that data in a format suitable for auralisation, ideally with a fast and streamlined turnaround to allow new acoustic design iterations to quickly be experienced by the client.

This was the topic of a recent Engineering and Physical Research Council (EPSRC) funded 1.5 day workshop jointly hosted by Arup and the University of Salford. The event was the culmination of a

Ian Laird delivers his presentation

Road planners will benefit from the new simulation tool

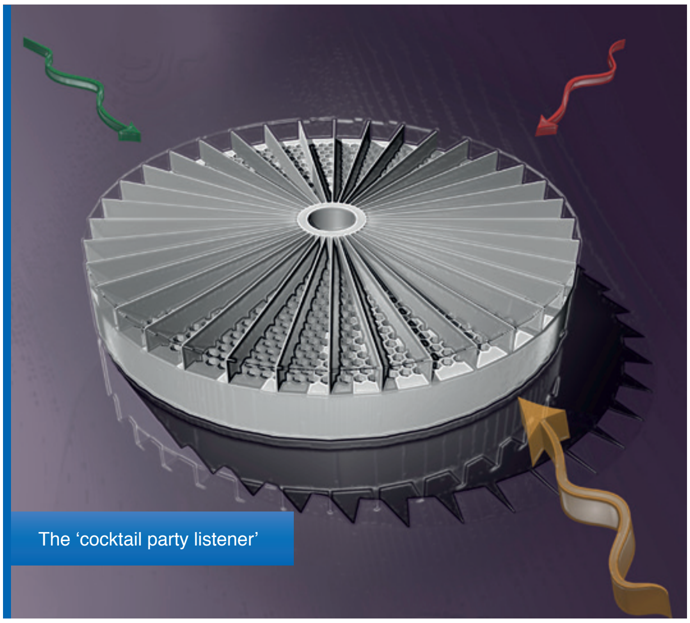
three-year interdisciplinary project, also funded by EPSRC, which saw the Acoustics Research Centre at the University of Salford collaborating with the Applied Maths department at the University of Reading, steered by industrial partners Arup and the BBC. The programme included technical talks on both theoretical and practical issues, interspersed with regular auralisation demonstrations in the on-site SoundLab facility.

Also included were structured discussion sessions aimed at promoting better mutual understanding, identifying directions for future development, and opening up possibilities for future collaborations. Plans for seeking funding to organise further such networking events are now under way. Joint publication and benchmarking initiatives were also discussed, the latter being aligned to complement the parallel work being done by the European Acoustics Association technical committee for computational acoustics and the SEACEN project in Germany.

For a full report on the workshop and videos of the technical talks visit:

http://hub.salford.ac.uk/acoustics/workshopSept2015/

Engineers solve the age old 'cocktail party problem'



The 'cocktail party listener'

Engineers have solved the age-old "cocktail party problem" that has puzzled artificial intelligence researchers for decades: picking out an individual's speech from a crowd of voices.

The single-sensor multi-speaker listening device, or "cocktail party listener", was developed by scientists at Duke University in the US and can distinguish between sounds coming from different directions with almost 97% accuracy.

The 3D-printed device is described in the *Proceedings Of The National Academy Of Sciences* (PNAS). Previous attempts to solve the cocktail party problem have involved software, not hardware solutions.

Earlier in 2015, Andrew Simpson from the University of Surrey led a team in developing a method that made use of advances in deep neural networks.

In contrast, the team from Duke University in the US mimicked the bone structure of the inner ear, creating a plastic disk with 36 passages that all lead to a microphone in the centre.

Sound waves entering one of the passages are distorted by "acoustic metamaterials" into a specific shape. The structure of the soundwaves entering the microphone can then be processed by a computer to distinguish the direction of the sound from others.

"We've invented a sensing system that can efficiently, reliably and inexpensively solve an interesting problem that modern technology has to deal with on a daily basis," said Abel Xie, a PhD student in electrical and computer engineering at Duke and lead author of the paper.

"We think this could improve the performance of voice-activated devices like smart phones and game consoles while also reducing the complexity of the system."

The proof-of-concept device looks a bit like a thick, plastic, pie-shaped honeycomb split into dozens of slices. While the honeycomb's openings may all look the same, their depth varies from hole to hole. This gives each slice of the honeycomb pie a unique pattern.

"The cavities behave like soda bottles when you blow across their tops," said Steve Cummer, professor of electrical and computer engineering at Duke. "The amount of soda left in the bottle, or the depth of the cavities in our case, affects the pitch of the sound they make, and this changes the incoming sound in a subtle but detectable way."

The researchers tested their invention in multiple trials by simultaneously sending three identical sounds at the sensor from three different directions. It was able to distinguish between them with a 96.7 percent accuracy rate.

While the prototype is six inches wide, the researchers believe it could be scaled down and incorporated into the devices we use on a regular basis. And because the sensor is made of plastic and does not have any electric or moving parts, it is extremely efficient and reliable.

"This concept may also have applications outside the world of consumer electronics," said Xie. "I think it could be combined with any medical imaging device that uses waves, such as ultrasound, to not only improve current sensing methods, but to create entirely new ones.

"With the extra information, it should also be possible to improve the sound fidelity and increase functionalities for applications like hearing aids and cochlear implants. One obvious challenge is to make the system physically small. It is challenging, but not impossible, and we are working toward that goal."

University team can 'hear' new products long before they are made

The University of Salford is helping Dyson's pioneering engineers to "listen" to products before they have even made them.

Its Acoustics Research Group is using a technique called auralisation – the simulation of sounds – making it possible to "hear" what noise sources will sounds like in varying conditions. The developed "hybrid virtual acoustic prototype" will first be applied to Dyson's range of desktop fans.

Professor Andy Moorhouse, who is leading the team, said: "It enables us to 'listen' to the design of products which don't yet exist. The technique has never before been achieved for an appliance of this type and size."

Hugh Hopper, Project Manager at Dyson, said: "The direct and obvious benefit of working towards 'zero prototyping' is that it will reduce the cost and time associated with building and testing the physical prototypes. The use of the tools developed in this project will also allow a better understanding of the acoustic behaviour of our products, so that we can quickly identify issues and simulate possible solutions.

"Professor Moorhouse and the Salford team have a long history in noise control engineering and specifically virtual acoustic prototyping. They also have a lot of involvement with industry, with the kind of practical, hands-on approach that matches really well with Dyson."

Andy Moorhouse added: "We had been talking to Dyson for some time and worked in partnership to put together a bid for funding under the 'Towards Zero Prototyping' scheme.

"The idea is to work out acoustic properties of components and their characteristics and put them together virtually by a process involving measurement and modelling. For Dyson, there are literally thousands of combinations of components, all of which have different implications for the acoustics of a manufactured product."

The university already has a string of industry collaborations under its belt having worked with Boeing and Bentley as well as on engineering quieter lawnmowers.

The university has received £130,000 in funding for the project from Innovate UK and the Research Councils UK.

Quiet please: Bradford set to have world's first 'tranquility trail'

Bradford could soon be home to the world's first "tranquility trail" which would offer people a way to escape the stresses of city life.

Using scientific formulae, Professor Greg Watts, of the University of Bradford, has mapped out a 3.5 mile trail in the city which takes advantage of the "maximum tranquility" that can be experienced within walking distance of the city centre.

He is now discussing ways to make the trail a reality with Bradford Council and announced his findings at the InterNoise 2015 conference in San Francisco.

The trail's creation follows an extensive study, led by Professor Watts and Dr Rob Pheasant, both of the University's Centre for Sustainable Environments, which analysed the relative tranquillity of urban environments, using a tranquillity rating prediction tool, previously developed at the University.

The tool combines ratings for noise levels, natural and man-made features, including historic buildings, traffic, vegetation and green space, and environment, including litter and graffiti. These factors are all given a symbol that forms part of a complex mathematical equation that predicts routes that have the optimum level of tranquillity.

Now the ideal route has been found, Professor Watts hopes as many people as possible get to benefit from his findings.

He said: "Even in a densely populated metropolitan area not noted for its abundance of open spaces it is possible to find a relatively tranquil route.

"To establish the use of the trail it would be important to provide maps of the route in attractive pocket-sized leaflets and on the city's website for easy download."

How sound can clean medical instruments

Researchers from the University of Southampton have demonstrated how a pioneering ultrasonic device can significantly improve the cleaning of medical instruments and reduce contamination and risk of infection.

StarStream, invented and patented by the University of Southampton and in commercial production by Ultrawave, makes water more efficient for cleaning by creating tiny bubbles which automatically scrub surfaces. The device supplies a gentle stream of water through a nozzle that generates ultrasound and bubbles, which dramatically improve the cleaning power of water reducing the need for additives and heating.

Using just cold water, StarStream was able to remove biological contamination, including brain tissue from surgical steel. Cleaning instruments between patients is critical to avoid transmission of agents leading to conditions such as Creutzfeldt-Jakob Disease. It was also able to remove bacterial biofilms that typically cause dental disease and was effective at removing soft tissue from bones, which is required prior to transplants to prevent rejection of the transplanted material by the recipient's immune system.

Principal Investigator Professor Tim Leighton, from the University's Institute of Sound and Vibration Research, said: "In the absence of sufficient cleaning of medical instruments, contamination and infection can result in serious consequences for the health sector and remains a significant challenge. Our highly effective cleaning device, achieved with cold water and without the need for chemical additives or the high power consumption associated with conventional strategies, has the potential to meet this challenge and transform the sector."

Professor Tim Leighton demonstrates the StarStream device

Sensor mimics bats to detect dangerous structural cracks

An ultrasound sensor for detecting dangerous cracks in structures such as aircraft engines, oil and gas pipelines and nuclear plants has been developed by researchers at the University of Strathclyde – with inspiration from the natural world.

The device, a transducer, identifies structural defects with varying ultrasonic frequencies and overcomes the limits of other, similar devices, which are based on rigid structures and have narrow ranges. It is thought to be the first device of its kind in the world.

The transducer developed at Strathclyde has a more flexible structure, based on a natural phenomenon known in mathematics as fractals. These are irregular shapes which recur repeatedly to form objects such as snowflakes, ferns and cauliflowers, making their structure appear more complex than it often actually is. The same concept also lies behind the hearing system of animals including bats, dolphins, cockroaches and moths.

Dr Tony Mulholland, a Reader in Strathclyde's Department of Mathematics and Statistics and co-researcher on the project, said: "Fractal shapes and sound waves are characterised by having geometrical features on a range of length scales. However, man-made transducers tend to have a very regular geometry, similar to a chess board, and this restricts our ability to use this technology in finding cracks and flaws in structures where safety is critical.

"The reason transducers are still made this way is mostly historical; they were usually made by an engineer cutting with a saw and their design was traditionally done by manufacturing but now, with 3D printing, computer manufacturing and more laser technology, the transducer we have designed is increasingly viable.

"We know if we can send out sound waves that are complicated and have different frequencies, we can work towards simulating what nature does. If there are defects in a nuclear plant or an oil pipeline, we would be able to detect cracks that have a range of sizes and do so at an early stage.

"This device could not only improve safety but also save a great deal of money, as early detection means inspections don't have to be carried out as often. This is something industry is telling us it needs and we are responding to that need."

Dr Mulholland was partnered in the study by Ebrahem Algehyne, a research student at Strathclyde's Centre for Ultrasonic Engineering.

The research has been published in the *IMA Journal of Applied Mathematics*.

Ebrahem Algehyne (left) and Tony Mulholland

New ultrasound sensors for improved breast cancer screening

The first prototype ultrasound sensors for a new improved breast screening technique have been developed as part of a collaboration between the National Physical Laboratory (NPL), University Hospitals Bristol (UHB), North Bristol NHS Trust (NBT), Precision Acoustics Ltd and Designworks. The team is now looking for commercial partners to translate the novel development into a clinical device.

NHS breast cancer screening in England is currently conducted using X-ray mammography, and further investigations may involve a clinical examination, more X-ray mammograms and conventional ultrasound.

During mammography, each breast is compressed between the two plates of an X-ray machine, which some women find very uncomfortable, and two X-rays are taken at different angles. However, the inability of 2D X-ray mammography to separate overlying tissue can lead to false positives and false negatives, and the hazards associated with ionising radiation limit the frequency with which X-rays can be performed. Conventional ultrasound is highly operator-dependent and suffers from imaging problems, making cancerous tissue difficult to distinguish from healthy tissue.

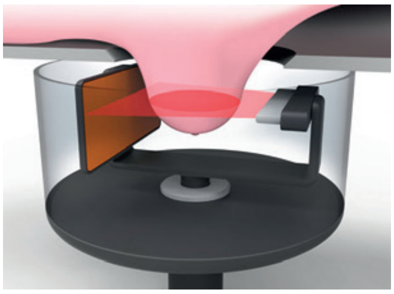
NPL, UHB, NBT, Precision Acoustics and Designworks are developing a prototype clinical system for a new breast screening technique - using ultrasound computed tomography (UCT) - that may overcome the problems of diagnosing breast disease using conventional X-ray mammography and ultrasound scans. The new ultrasound method will be safer and lower cost than currently-used screening techniques, and the results should be easier for clinicians to interpret.

NPL has developed and patented a novel detection method employing pyroelectric sensors, which convert ultrasonic energy into heat, generating electrical signals which are eventually used to form the ultrasound image. These large-area thermal sensors should generate far fewer image artefacts than conventional piezoelectric detectors, which are sensitive to the phase of the arriving ultrasound waves.

In the new procedure, the patient's breast will be placed in a warm water bath between an ultrasound transmitter and receiver. Ultrasonic waves are sent through the breast and the amount of energy emerging is measured using the prototype ultrasound sensor. The ultrasound transmitter array and the receiver are rotated around the breast, and the resulting measurements are combined to produce a 3D image of breast tissue properties. Different tissue types, including those that are cancerous, can then be identified from this image.

The first prototype pyroelectric sensors have been manufactured by Precision Acoustics and are currently being tested and optimised at NPL. Next, the team will develop a platform combining all the project components into a breast screening system ready for clinical evaluation. The system will then be deployed at the Bristol Breast Care Centre Service (NBT) for clinical evaluation on a small number of patients, providing the potential for an accurate, safe and comfortable method of screening for breast cancer.

Dr Lis Kutt and Dr Mike Shere from the Bristol Breast Care Centre Service (NBT) said: "We are evaluating this tool for imaging purposes with a view to looking at using it for screening should it prove to have the required sensitivity, specificity, patient acceptance and reproducibility of conventional mammography."



The proposed breast screening system (Image courtesy of Designworks)

Court quashes flats plan approval because of 'failure to address noise issues'

The Planning Court has quashed the grant of residential planning permission after a council failed lawfully to address issues of noise and heritage, and acted irrationally.

In Obar Camden v the London Borough of Camden Mr Justice Stewart has quashed a planning permission granted by the council for the conversion of a public house into residential flats.

Obar operates an adjacent and well-known grade II listed nightclub, live music venue and performance space on Camden High Street trading under the name KOKO (formerly known as the Camden Palace Theatre).

Obar brought a judicial review in the Planning Court seeking to quash the grant of planning permission, contending that the council had failed to assess the heritage impact of the proposal and had approached the issue of potential noise impacts on residents of the proposed flats in a way that was legally and procedurally flawed and irrational.

In his judgment that, Mr Justice Stewart held that:

- The officer report upon which the planning committee had relied had failed address matters in s.66 of the Planning (Listed Buildings and Conservation Areas) Act 1990 which required 'special regard' to be given to the desirability of preserving a listed building or its setting. He rejected a submission that members of the committee should be treated as an informed membership with an implicit working knowledge of such statutory tests. Officers had also failed to address in their report relevant sections of the National Planning Policy Framework section 12.
- The officers who drafted the report to committee had failed to relay relevant concerns of specialist noise officers to members, so that the overall effect of the report "significantly misled" the committee on material matters.
- Having resolved to grant planning permission with specific conditions identified, officers unlawfully changed the wording of the conditions without returning the matter to committee. The judge said that officers had no power in this instance to redraft the conditions which had been specified in the resolution.
- In addition, the conditions relating to noise that were imposed on the planning permission were irrational or unreasonable as they could not fulfil the aims they sought to achieve.

In light of the several errors, the claim for judicial review brought by Obar succeeded and the planning permission was quashed.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Could sound waves be used to control the brain?

For the first time, scientists have directly controlled brain cells using sound waves, in a tiny laboratory worm.

They used ultrasound to trigger activity in specific neurons, causing the worms to change direction.

As well as requiring a particular gene to be expressed in the brain cells, the technique bathes the animals in tiny bubbles to amplify the sound waves.

These complications temper the technique's promise for controlling brain activity in a non-invasive way.

Writing in the journal Nature Communications, the researchers argue that their new method for controlling brain cells could improve on "optogenetics", a technique that uses light rather than sound.

The problem with light is that it cannot penetrate through tissues - it is scattered very quickly. This means using optogenetics to control brain circuits in a mammal currently requires a fibre-optic implant.

By contrast, ultrasound travels relatively unimpeded through the body; this is the property that makes it useful for medical sonograms.

"This could be a big advantage when you want to stimulate a region deep in the brain," said the study's first author Stuart Ibsen, from the Salk Institute for Biological Studies in California.

Dr Ibsen and his colleagues hope to capitalise on this advantage, and their next aim is experiments in mice.

"The real prize will be to see whether this could work in a mammalian brain," said Dr Sreekanth Chalasani, who runs the lab behind the work.

They have dubbed the system "sonogenetics", although this term had already been applied to the idea of combining ultrasound scans with genetic tests for prenatal diagnosis.

Scientists achieve goal of almost total sound absorption

Physicists from Hong Kong University of Science and Technology have achieved the goal of almost perfect silence via almost total sound absorption.

Instead of building multi-layered gradient-index material meant to absorb all frequencies, the researchers used two resonators to come close to completely cancelling out sound waves.

In a paper published in the journal *Applied Physics Letters*, they explain their use of destructive interference to halt the scattering of sound waves, thus achieving near perfect quiet.

Researchers tuned two resonators to the same frequency, which was matched to the background sound's average impedance. The result was absolutely no audible backscattering.

They used decorated membrane resonators to complete their two experiments. The first consisted of a flat panel DMR and a pair of coupled DMRs; the second used a tube-ventilated DMR and a sidewall device backed by a cavity.

The rate of sound absorption at the end of both of these experiments came up to 99.7 percent – almost complete silence.

New £1.6 million project aims 'to make sense of sounds'

A project is to investigate how to make sense from sound data, focussing on how to convert audio recordings into understandable and actionable information. Specifically it will look at how to allow people to search, browse and interact with sounds.

The project, entitled *Making Sense of Sounds*, will be led by Professor Mark Plumbley at Surrey University and will also involve Professors Bill Davies and Trevor Cox at the University of Salford.

The work, which starts in January, is being made possible by the award of £1.6 million by the Engineering and Physical Sciences Research Council (EPSRC). It will build on work under way in an existing £6.7 million EPSRC collaboration *S3A* (Salford, Southampton and Surrey Universities and the BBC).

Bill Davies explained: "Increasing quantities of sound data are now being gathered in archives such as sound and audio-visual archives, through sound sensors such as city soundscape monitoring and as soundtracks on user-generated content. For example, the British Library Sound Archive has over a million discs and thousands of tapes; the BBC has some one million hours of digitized content; smart cities such as Santander in Spain are beginning to wire themselves up with a large number of distributed sensors; and 100 hours of video (with sound) are uploaded to YouTube every minute."

"However, the ability to understand and interact with all this sound data is hampered by a lack of tools allowing people to 'make sense of sounds' based on the audio content," continued Trevor Cox. "For example, in a sound map, users may be able to search for sound clips by geographical location, but not by 'similar sounds'. In broadcast archives, users must typically know which programme to look for, and listen through to find the section they need. Radio programme producers currently have to train themselves to listen to audio clips at up to double speed to save time in the production process.

"Clearly better tools are needed. Our new project will investigate and develop new signal processing methods to analyse sound and audio-visual files, new interaction methods to search and browse through sets of sound files, and new methods to explore and understand the criteria searchers use when searching, selecting and interacting with sounds.

"We will also investigate people's emotional response to sounds and soundscapes, assisting sound designers or producers to find audio samples with the effect they want to create, and informing the development of public policy on urban soundscapes and their impact on people."

Scientists design acoustic one-way tunnel

Scientists from Nanjing University in China have designed and built an acoustic one-way tunnel that allows sound to pass through in one direction only while blocking it from passing through in the opposite direction.

The tunnel is completely open to light and heat, which can pass through in both directions, but sound waves are blocked in one direction due to acoustic metamaterials placed on the sides of the tunnel. The acoustic one-way tunnel has potential applications for anti-noise windows and vent ducts, as well as medical ultrasound.

The tunnel takes advantage of the extraordinary reflection properties of recently developed acoustic metamaterials, which force sound waves coming from one direction to make a U-turn in the 10cm-wide tunnel and travel back out.

By strategically positioning two different acoustic metamaterials with different reflective properties along the insides of the tunnel, the researchers could asymmetrically manipulate the sound waves so that only those coming from one direction are reflected, while those coming from the other direction can pass through.

The researchers printed the acoustic metamaterials using a 3-D printer with ABS plastic, which is the same material used to make Legos. They then imprinted multiple tiny grooves into the two metamaterials with different groove periods (0.84 cm and 2.36 cm), which gives them different reflective properties. The tailored groove designs affect the sound waves differently depending on which direction they're coming from, which ultimately leads to the asymmetric wave manipulation and one-way transmission.

Although other methods have been developed for the unidirectional control of sound, all of the previous designs have relied on bulk materials. The drawback of bulk materials is that they partially block the tunnel so that it's not fully open to other entities, such as light and heat.

Because the new tunnel allows light and heat to freely pass through from both directions while blocking the transmission of sound in one direction, it could lead to anti-noise windows that are see-through and ventilated, and may inspire research into the unidirectional control of other kinds of waves.

This report is based on one that first appeared in *Phys.org*

Scientists launch new probe into underwater noise

Underwater noise in the marine environment is the focus of a new UK-wide research partnership to monitor the "soundscape" in UK waters. The University of Exeter has teamed up with The Centre for the Environment, Fisheries and Aquaculture Science (Cefas) and Marine Scotland Science to analyse underwater noise data from subsea sound recorders located around the UK coast.

Sources of noise in the ocean include shipping, seismic exploration, and construction activity, such as port extensions or offshore wind farms. There is concern that rising levels of underwater noise pollution worldwide may have an impact on marine life by interfering with communication, causing changes in behaviour, and raising stress levels.

For the first time ever, marine scientists will work together to produce an initial baseline assessment of background noise levels in UK coastal waters, including seasonal and annual patterns, as well as spatial differences. The work, funded by Defra and Marine Scotland, will help to inform the development of a UK-wide noise monitoring strategy, as part of the UK's commitment to the EU Marine Strategy Framework Directive (MSFD), which seeks to attain Good Environmental Status in European seas by 2020.

A range of government, academic and marine science organisations in the UK are being consulted to scope the potential for a partnership-based approach to establishing a noise-monitoring programme. The findings and recommendations of the project will be available early next year.

Cefas Senior Scientist and Project Lead Dr Nathan Merchant said: "This collaboration between leading UK marine science organisations enables us to share data, expertise and research findings in this increasingly important field.

"A partnership approach to marine noise monitoring will help us gain a deeper understanding of underwater noise and its impact on the marine environment, as well as providing a more cost-effective solution to establishing a UK-wide monitoring network."

How to achieve good acoustic classroom design for SEN

Consultant Adrian James has outlined a 10-step guide for achieving good acoustic design for special educational needs (SEN) classrooms.

Adrian, a member of the committee that produced the updated BB 93, unveiled his advice at a roadshow on acoustics design for schools held at Queen's University, Belfast and organised by Ecophon.

1. Keep the room size down. Reverberation naturally increases with room volume, so large rooms need more acoustic treatment. Children with special needs should generally be taught in smaller classes anyway.
2. For the same reason keep the ceiling height down. Things get difficult at more than about 2.4 m.
3. Use only "Type A" absorptive finishes – these are the most efficient and so reduce the areas required. However, the SEN standard also controls low-frequency (bass) reverberation time, so you will also need some bass absorption.
4. If possible, use dry-lined walls as these provide some useful bass absorption at no extra cost. The new standard also lets us include the effects of furniture and fittings.
5. A conventional class A suspended ceiling tile is most efficient and provides some bass absorption, especially if you use proprietary "Bass pads" on top of the tiles.
6. If for some reason you can't have a suspended ceiling, consider suspended horizontal baffles or "rafts." These are very efficient because both sides are absorptive, but they are not great at low frequencies, so you will need a lot of bass absorption from wall panels.

7. It follows that achieving the SEN standard in TABS classrooms is difficult and expensive – but not impossible.
8. Whatever the ceiling type, you will almost certainly need some acoustically absorbent wall panels as well. At least some of these should be at ear height, so they should be robust.
9. Conventional "Sabine" calculations are unreliable for this type of room. To get the design right you really need a 3-D acoustic computer model.
10. It follows that you need acoustics consultants who are experienced in this type of design. Get them involved early to advise on room shapes and sizes, and make sure that they commission the completed rooms, so that we can all learn how effective different designs are in practice.

Shane Cryer, Concept Designer- Education at Ecophon, said: "The new SEN standard requires the same reverberation time of 0.4 seconds or less but over a wider frequency range: 125 – 4000Hz. The challenge lies in absorbing the lower bass frequencies that we sometimes experience coming from cars or noisy neighbours playing their music too loudly.

"The ability of these frequencies to resonate and pass the energy through masonry walls, for instance, means that they can also pass through traditional suspended ceilings and bounce back into the room. This high energy, low frequency sound is particularly disruptive to hearing impaired, autistic and ADHD students."

Room size is important for SEN pupils

A critical assessment of sound stimuli for reverberation time measurement in acoustic performance spaces

By Kenneth Liston of the University of Derby

Introduction

Reverberation time has been widely recognised as an important measurement of an acoustic space, this is particularly important in performance spaces where critical listening is required[3,11,12]. Reverberation time data is also important for the measurement of absorption in reverberation chambers to determine coefficients[2]. There are various methods to measure reverberation time in acoustic performance spaces according to recognised standards; the two main categories are the Impulse Response and Interrupted Noise methods. The aim of this study is to compare and analyse reverberation time results derived from various sound source stimuli and spaces, in order to assess the suitability of all stimuli across various physical and acoustic characteristics.

All practical measurements were performed according to the guidelines set out in BS EN ISO 3382-1:2009 Measurement of room acoustic parameters: Part 1: Performance Spaces[4]. The reverberation times of three acoustic performance spaces (church, concert hall and lecture theatre) were measured, using three different types of sound stimuli: impulse, chirp and interrupted noise. The results were analysed in octave bands 125Hz-4000Hz and each stimulus was critically assessed. This study will present findings, which could inform the choice of sound stimuli for reverberation time measurements based on the frequency range of interest and the characteristics of the space.

ISO guidelines

The types of sound stimuli for reverberation time measurement are outlined in the official standards BS EN ISO 3382-1[4], where they are referred to as “Integrated Impulse Response” and “Interrupted Noise” methods. Both categories of stimuli are detailed in the standards, but with minimal associated guidelines and somewhat ambiguous in parts.

BS EN ISO 3382-1 does not state the type or size of the space to be measured in order to sufficiently excite, only stating that the initial sound source needs to be 35dB above the background noise of the space in a given frequency band[3]. The amount of energy to excite a church compared to a lecture theatre would be significantly different and the size of a space does not dictate the background noise level.

The frequency characteristics of the stimuli sounds are also of interest, due to the wide range of potential sources. Each stimulus source will have its own frequency characteristics, which will excite certain frequency bands more than others. For a single band frequency measurement, certain narrow band sources may suffice; however an important consideration of the stimulus sound source is that it has a broad enough band to cover the frequency range of interest[11].

Impulse Response Method

The impulse response of an acoustic system is its response to a Dirac Delta Function, where the acoustic system can be a room, cavity, plate, beam or audio device[6]. The output of the system is measured in response to the input of the Dirac pulse. This is the theory of an impulse response; however in practice a Dirac pulse is near impossible to recreate in acoustic situations, due to it requiring a pulse that is infinite at t=0 and is infinitely narrow, as expressed in Equation (1)[6].

$$\int_{-\infty}^{\infty} \delta(t)dt = 1 \qquad (1)$$

Dirac pulses may be used from loudspeakers; however their short duration and finite amplitude will result in very small amounts of energy produced and will be dependent on the signal to noise ratio of the equipment used. The response of a speaker could not possibly be fast enough to respond to an infinitely narrow pulse. In an acoustic test chamber, this may provide some result; however in a concert hall for example where background noise is present, it would not be possible if accurate results were required[1].

A common problem with impulse methods is radiating enough power with a flat frequency spectrum[13]. Some sound stimuli are used to try and closely replicate the ideal Dirac pulse with enough radiated power; these include balloons, paper bags, starter pistols or other sources, which could produce a high-energy impulse sound. An issue with such sources is that their frequency characteristics are generally not uniformed, which may not be an issue if only certain octave bands are being evaluated[13]. As well as lacking a flat frequency spectrum, the source output is generally considered non repeatable, for example balloons cannot easily be inflated to a single size and burst identically.

The relevant standards state that sound stimuli used in the integrated impulse response method will ideally be impulsive, broadband, of low directivity and produce enough sound energy in the frequency ranges of interest[4]. Starter pistols, balloons and paper bags have all been used to measure reverberation time, but with such a range of impulse sources available, each with different frequency characteristics, more specific guidelines are possibly required in the relevant standards[10].

Despite the issues with such impulse sources, a distinct benefit is the portability of the required equipment. No loudspeaker or amplifier is required unlike some alternative methods, which is why the method is still widely used; however the limitations and issues highlighted should still be considered.

Sine sweep integrated impulse response methods are not as portable and convenient as the aforementioned sources due to the requirement of a loudspeaker; however they can be identically repeated and provide a full range of frequencies. Short sine chirps or longer sine sweeps can be used and provide an improved signal to noise ratio compared to the more traditional methods and due to there being no random fluctuations in this method, it reduces the need for multiple measurements for averaging[6]. A disadvantage of sine sweep techniques is that specialist analysis software and methods are usually required, but these are generally becoming more accessible at all levels.

Interrupted Noise Method

The interrupted noise method uses a steady state level of random broadband noise, which is stopped once steady state is achieved and the subsequent sound pressure level decay is measured. The noise source most commonly used for this method is pink noise, due to its greater presence of low frequency energy when compared to a white noise signal. This method, however, lacks a smooth decay curve due to the random nature of the excitation and when below the background noise level, the curve is no longer representative of the actual decay. Due to the random nature of excitation, this method also requires multiple measurements of a space, due mainly to the effect of room modes resulting in inconsistent measurements[6]. The random fluctuations are dependent on various factors including initial amplitude and the phase angles of the normal modes at the point when the excitation signal is stopped[14]. It has been found that using the same microphone and loudspeaker positions repeatedly to measure the decay curve will result in random phases and amplitudes of room modes each time the excitation signal is stopped. The difference between the decaying modes of each measurement will result in varying decay curves to measure[2], therefore a single decay curve measured using the interrupted noise method is not useful[6].

Reverberation time measurement and room characteristics

Practical measurements of reverberation time can be somewhat effected by room modes, where certain points in a room will have increased or decreased pressure at certain frequencies; thus being detected by the microphone if in these positions. It has been found that if more than three standing waves are excited, the fluctuations will average out and the intensity will diminish uniformly; however when only two or three room modes are excited, the intensity will fluctuate in diminishing and it will depend largely on the microphone position and the frequency content of the sound source[8]. The effect of room modes on reverberation time measurements is also frequency dependent, where higher frequencies are found to be more predictable than low frequencies, this is due to the decay of the sound at low frequencies being from only a few modes; thus resulting in more accurate higher frequency reverberation times[5]. The averaging of reverberation time results from multiple source and receiver positions is important due to the effects of room modes, especially if a space is thought to be small enough for the modal distribution to lack uniformity and density. Another consideration is if there are significant parallel surfaces in the space, as this will reinforce axial modes and therefore will contribute to the modal effect on the reverberation time measurements[9]. These characteristics of small rooms can increase the decay time of modal frequencies compared to non-modal frequencies and results in individual modal frequencies being represented, as opposed to the whole room in terms of decay time[5].

Schroeder[15] determined a low frequency limit for a room; this is commonly referred to as the "Schroeder frequency". Above the limit, a room is thought to respond uniformly to bands of noise, providing increased modal overlap; thus increasing the consistency and accuracy of reverberation time measurements. The Schroeder frequency is given by,

$$f_c = 2000\sqrt{\frac{T_{60}}{V}} \qquad (2)$$

Equation (2)[15] defines the frequency where at least three modes overlap at a given frequency and shows that large rooms generally have a lower Schroeder frequency than small rooms. In large spaces, such as concert halls and churches, the Schroeder frequency will likely be too low to be of concern to the analysis of the measurements[11]. If frequencies of interest fall below the Schroeder frequency of a room, then it is thought that modal decay time should be analysed instead of reverberation time[16].

Practical studies have shown that reverberation time is less accurate in a small room at low frequencies; one particular study[7] measured various acoustic spaces, from irregular small shaped rooms to large diffuse rooms, using various stimuli to measure the reverberation time. The study found that in large diffuse rooms, there are no emphasised room modes in the frequency of interest; however in smaller absorptive rooms, the results were less consistent at low frequencies between different stimuli and more attention should be paid to positioning and sound source used[7].

In summary, small rectangular spaces are more likely to exhibit stronger axial room modes than larger and irregular shaped spaces and thus reverberation time measurements in smaller spaces can be effected by prominent room modes. BS ISO-3382-1:2009[4] does acknowledge the potential issues raised with measuring reverberation time at low frequencies, but does not provide guidance based on the size of a space to be measured.

Figure 1. Royal Concert Hall Nottingham

Performance spaces measured

Three performance spaces were chosen for reverberation time measurements, with the aim for them to provide a variety of size, absorption, purpose and acoustic characteristics. The spaces measured were:

The Royal Concert Hall, Nottingham[3] (Figure 1)

- Volume 17,510m^3, seats 2315 + 186 (choir)
- RT 1.75 seconds (500/1000Hz)
- Floor – studded rubber on concrete
- Walls – plaster on solid masonry
- Ceiling – 100mm sprayed concrete, plastered
- Stage – timber boarding
- Seating – upholstered tip-up with unperforated bases

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All Saints' Church, Nottingham (Figure 2)
- Mainly stone and concrete, with some carpeting
- Approx. 300 wooden seats covering the main floor area
- High arches and a 175ft spire
- Active tramline approx. 200m from the building

Heap Lecture Theatre, Derby University, Derby (Figure 3)
- Volume approx. 904m³. 152 soft, furnished and raked seats
- Sloping carpeted floor
- Rectangular shape
- Slatted wooden wall coverings
- Absorption is significant enough to be considered compared to the size of the space

Experimental procedure

Each space was measured using three different sound stimuli sources:
- Balloon (Impulse)
- Chirp (Impulse Log Sweep)
- Interrupted Noise (Pink Noise)

The measurements were carried out in the performance spaces stated, using the guidelines set out in BS-EN-ISO 3382-1:2009: Measurement of acoustic parameters. Part 1: Performance Spaces[4].

A summary of the guidelines:

The T_{20} measurement is a preference that has been given to the 20dB evaluation range and the sound source should be 35dB above any background noise present.

Source positions
- Positioned where the natural sound sources in the room would typically be located
- A minimum of two source positions shall be used
- The height of the acoustic centre of the source shall be 1.5m above the floor

Measurement positions
- Microphone positions a minimum of 2m apart
- Microphone at least quarter of a wavelength i.e. normally 1m from a reflecting surface (including the floor)
- Microphone positions should be representative to where the listeners would normally be located i.e. audience seats
- Microphone height should be 1.2m above the floor, corresponding to the ear height of average listeners in typical chairs
- Microphone positions to cover the seating area evenly and the results of the measurements may be averaged and the frequency range should cover 250-2000Hz in octave bands

Overall procedure

Two to three sound source positions were used in areas of each space where sound is usually generated, i.e. stage, lectern, and choir area. Multiple microphone positions were used to adequately cover the seating area for each space. The microphone was placed in positions left, centre and right of the typical sound stage of the space, in the area where the audience would usually be seated for a performance.

Equipment

The following equipment was used to measure the reverberation time of each space:
- NTi XL2 sound level meter, SNo. A2A-03293-D1, FW2.32
  – Mic Type: NTi Audio M4260, S/N: 1774, user calibrated 2012-03-04
- SLM measurement set-up
  - T_{20} ,1/3 Octave (results presented 1/1 octave)
- NTi Minirator Pro audio generator
- Dodecahedron loudspeaker (omni-directional sound source)
- Balloons and pins

Figure 2. All Saints' Church Nottingham

Figure 3. Lecture Theatre University of Derby

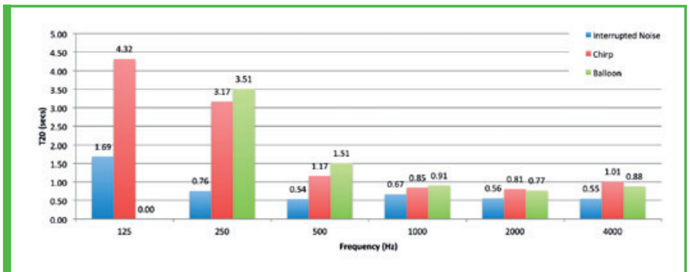

Figure 4. Lecture Theatre Reverberation Times from various stimuli

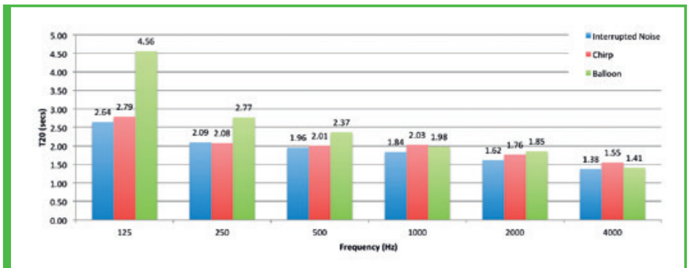

Figure 5. Concert Hall Reverberation Times from various stimuli

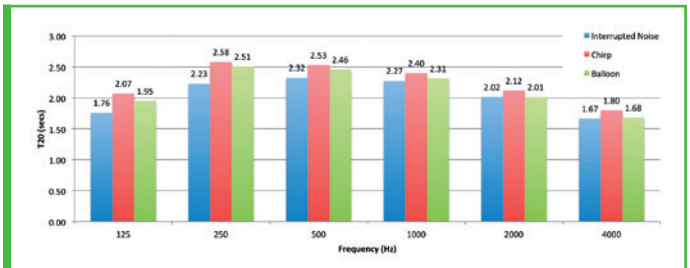

Figure 6. Church Reverberation Times from various stimuli

Results and analysis

Figures 4, 5 and 6 demonstrate the overall mean averaged T_{20} from all source and microphone positions used for each of the sound stimuli used. Although the analysis of the 125Hz octave band is not always required, it was included as an area of interest.

Lecture theatre results

Figure 4 demonstrates the average T_{20} of the lecture theatre space measured. The low frequencies (125-500Hz) exhibit large differences between the measurements, this is most apparent between the Interrupted Noise when compared with the chirp and balloon methods. The balloon impulse response method resulted in no measurements at 125Hz and the chirp method resulted in an implausible 4.32 average T_{20} measurement at 125Hz. At 250Hz the balloon and chirp methods produce higher than predicted T_{20} results. As the frequency band in question increases, there are generally less differences between the different sound stimuli methods used for measurement.

The Royal Concert Hall results

Figure 5 demonstrates the average T_{20} of the concert hall space measured.

As with the lecture theatre, the low frequency range (125-500Hz) exhibits the largest range of results when comparing stimuli. The 125Hz band for the balloon stimulus has a 4.56 second T_{20} average compared with the 2.64 and 2.79 for the interrupted noise and chirp respectively, this is a large difference and the balloon continues to exhibit higher average T_{20} times across 250-500Hz bands also. The 4.56 second measurement for the balloon is implausible if compared to an official reverberation time of the same concert hall[3], where the time is stated as 2.75 seconds, which approximately correlates with the interrupted noise and chirp method results.

The mid to high frequency bands (1-4kHz) demonstrate more parity of T20 averages for each method and the balloon is the closest method at 2000Hz to the results in Figure 7 and approximates to 1000Hz results also.

All Saints' Church results

Figure 6 demonstrates the average T_{20} of the church space measured. Compared with the other two spaces, the church did not exhibit the same extent of anomalies with low frequency reverberation time measurement. The results are more consistent across the different methods used and there are no implausible results evident. The balloon demonstrated implausible results in the concert hall and lecture theatre; however in the church the results evidenced some cohesion to the other two methods used. The chirp method produced consistently higher average T_{20} results against the other two methods as opposed to the balloon method in the other spaces measured.

Discussion of the average T_{20} results

Figure 7 demonstrates the maximum difference of average T_{20} measurements, between all stimuli methods, per frequency band and space measured. As previously stated, reverberation time measurements are more accurate at high frequencies; this supports the measurement results presented in Figure 7.

The lecture theatre exhibited the largest differences between results from the methods used. For each frequency band the differences were greatest in the lecture theatre, with as much as 2.75 seconds difference between the balloon and the interrupted noise method. It is thought that errors were the cause of large

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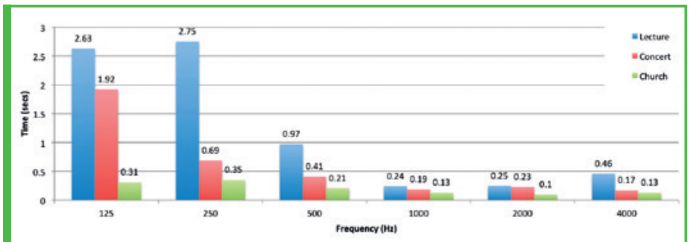

Figure 7. Maximum Reverberation Time differences between stimuli methods per space measured

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differences between methods used, in particular the frequency characteristic of each stimulus. It is thought that the balloon source does not produce enough low frequency energy[10] to excite certain rooms. However Kuttruff[11], who states that balloons can produce strong excitation of a room at low frequencies, has countered this. The lecture theatre measurement data indicates that in this relatively small and absorptive room compared with the concert hall and church measured, low frequency measurements using a balloon are inconsistent and contain errors. This could be due to inadequate levels of low frequency energy compared to the amount of absorption in the room. The interrupted noise method produces continued low frequency energy with the only limit being the response of the loudspeaker and microphone. The interrupted noise method data demonstrates more consistent results at low frequencies, compared to the other methods across all spaces measured. With the same limitations of the interrupted noise method, the chirp method does produce low frequency energy; however each frequency is represented at a single point in time during the sweep, this potentially would not excite the low frequency response of a small absorptive room enough to provide consistent and plausible results.

Examining the interrupted noise method in the 1000-4000Hz bands, the T_{20} differences in the lecture theatre were significantly reduced, with a maximum of 0.46 seconds difference at 4000Hz. 0.46 seconds is thought of as a significant difference in results and could cause errors in design and prediction if used. The church T_{20} measurements consistently produced the least differences between each method used. The low frequency bands of 125Hz and 250Hz produced the greatest differences in the church, 0.31 and 0.35 seconds respectively. 2000Hz measurements in the church presented a 0.1 second maximum difference between methods, with 1000Hz and 4000Hz bands resulting in a 0.13 second maximum difference; this is thought to be more acceptable.

The larger spaces of the concert hall and specifically the church produced the most consistent results across all methods. It is thought that any low frequency energy present in each stimulus is supported in the larger spaces, due to diffuse conditions, the amount of absorption compared to the volume and having a greater chance to develop. The church in particular has minimal absorption relative to the vast stoned surface space; this resulted in the low frequency measurements to be more consistent across all stimuli than the other spaces measured.

As previously discussed, room modes can also effect reverberation time measurements, specifically in smaller rectangular rooms[5,8]. The lecture theatre displays such characteristics; however when Equation (2) is applied to the lecture theatre, the Schroeder frequency is 86Hz, which is below the frequency band of interest and where the anomalies occur. Room modes are not thought to be a problem within significantly large and irregular shaped spaces, such as the concert hall and church spaces measured, where the Schroeder frequency would be too low to be of interest.

Conclusions

The larger differences between stimuli were dominant in the low frequencies (125-500Hz) across all rooms measured, with the smaller, more absorbent lecture theatre resulting in the most errors and differences across the types of stimuli used. These results are supported by other studies, which also indicate that reverberation time is more difficult to measure accurately at low frequencies and in smaller rooms due to increased modal influence, although the lecture theatre's Schroeder frequency should in theory result in no significant modal influence on the measurements.

The interrupted noise method performed most consistently across all spaces and positions used, but the method still displayed on average, more differences between measurements at lower frequencies than at higher frequencies.

The impulse response method using the balloon demonstrated the most errors and inconsistencies from the stimuli used, again this was more evident at the lower frequencies. Through errors and inconsistencies evidenced, it is thought that the balloon does not generate enough low frequency energy to excite a room at such frequencies, particularly where absorption is thought to be significant.

It is concluded that the choice of stimulus for low frequency measurements of reverberation time is important for accuracy and consistency of results. When the area of interest is above 500Hz, the stimulus used is thought to be less important, with more consistency in all stimuli tested. However, it is thought that from the stimuli tested, the interrupted noise method should be chosen if low frequency (<500Hz) reverberation time measurements are required, particularly in small and absorptive rooms, where the Schroeder frequency should also be found.

Further work

This study was conducted for the purpose of an MSc thesis and although the thesis has been completed, it is desired that this remains an ongoing study; therefore feedback on this study and interests in collaboration for further measurements are welcomed.

Ideas for future work are to perform further measurements, which would include the sound stimuli used in this study in various other performance spaces, with the possibility of using other types of sound stimuli measurements, in particular the integrated impulse response method. This method was not tested due to limitations with the equipment used, it has, however, been recognised that this is a popular and in some situations, desirable method to use.

Computational and formulae based prediction of spaces measured could be carried out to determine an estimated reverberation time in order to compare against practical measurements.

Finally, in addition to T_{20} measurement data, the sound decay curve could be analysed to provide further detail on a room's response, in order to improve its acoustic characteristics.

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NVH challenges in hybrid and electric vehicles

By Gaurav Kumar

As we have witnessed, the demands for greener transport in the last decade have resulted in a large variety of new powertrain and vehicle designs. Powertrain electrification is one of the key enablers for the future automobile industry in order to reach lower CO2 emission targets. This involves the use of new concepts whose inherent characteristics, performances, and constraints are completely different from the internal combustion engine (ICE) vehicles. Likewise, the same holds for the NVH behaviour. Although electric vehicles are significantly quieter than an equivalent ICE powered version, their interior noise is marked by high-frequency tonal noise components with multiple coupled and independent base frequencies, which are often perceived as annoying. The inclusion of the new power electronics, and more particularly the pulse width modulation (PWM) control, produce specific sound modulation patterns. Simultaneously, the traditional broadband noise sources like wind or tyre noise, as well as other disturbing noise radiating from various other components, such as oil pump, HVAC, alternator and transmission systems, are no longer masked by the relatively louder combustion engine noise. This lack of masking results in complex sound signatures. Moreover, with lightweight vehicle-body design stretched to its limits in order to maximise driving range and performance while moderating battery costs, achieving acceptable NVH performance becomes an even bigger challenge.

Besides the interior noise, the influence of electrification on exterior noise is of a significant concern too. On the one hand, electrification is observed as a means to reach a significant reduction in environmental noise pollution; on the other hand, there is the risk that quiet vehicles will go unnoticed by pedestrians and other vulnerable road users (blind people, etc.) as well as the ICE vehicles, creating a dangerous situation. The solution to this has resulted into engineering of vehicle approach warning sounds that can alert the pedestrians with minimal community annoyance. A brief description about the increasing complexity of the NVH problem is summarised in Figure 1.

How can we address such challenges?

One of the best approaches to address such complex NVH problems is by breaking it into source-transfer-receiver components. Using this methodology provides three individual design aspects where any improvements made will result in the global response.

Source

Since the internal combustion engine (ICE) is deemed as the major noise source in conventional vehicles, the noise levels related to an electric vehicle is significantly lower due to the missing engine. Therefore, the noise signature in electric vehicles is not only different than the conventional vehicles but generally a lot more complex. Some such striking differences can be seen in Figure 2.

Firstly, we must acknowledge that hybrid and electric vehicles feature new noise source components such as electric motor(s), power electronics, etc. These components possess different operational and noise characteristics than those encountered in conventional engines. Very characteristic as well are the modulation phenomena caused by the variable speed drive (VSD) invertor which uses a pulse width modulation (PWM) technique

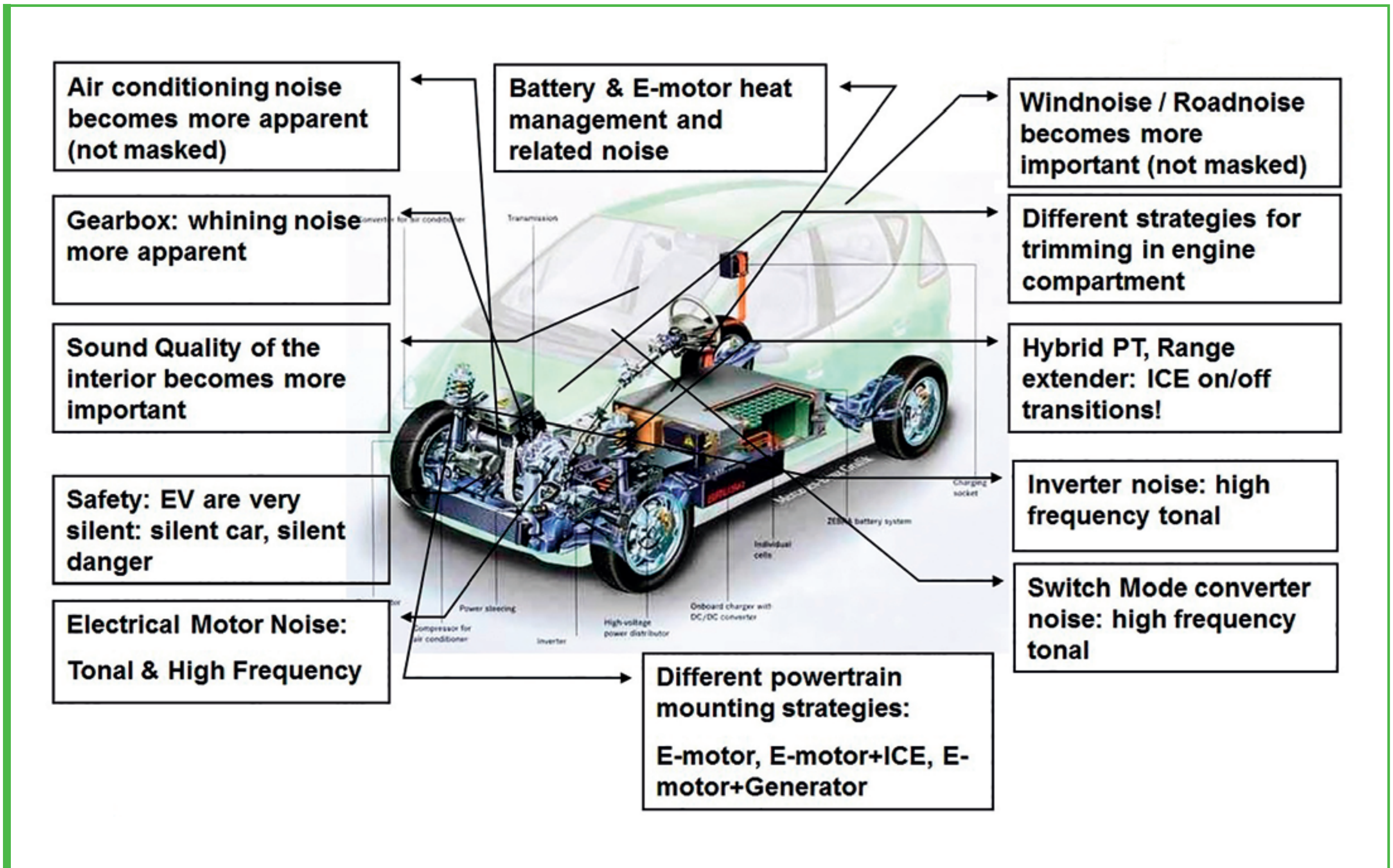

Figure 1 Summary of HEV NVH challenges

for controlling the rotational speed of the electric motor. The VSD modulations expose a typical harmonic structure in the noise footprint, composed by one or multiple central carrier frequencies surrounded by pairs of engine speed dependent side bands. In addition, there are high-frequency tonal components resulting from the magnetic fields during electric driving and regenerative braking. Such aforementioned noise characteristics are perceived as unpleasant and results in whining or whistling noise into the interior of the vehicle.

Due to the lack of masking effect coming from the ICE, the noise levels of several other source components such as the transmissions, HVAC, fan noise (from battery cooling system), oil pump, tyres etc become significantly audible. Altogether, these noise sources can be extremely disturbing and must be included in the design analysis stage.

What's equally challenging as well in the case of hybrid and electric vehicle is the transient phenomenon, such as the extremely fast, almost abrupt changes of the engine speed during full load acceleration. In addition, large amplitude variations of the electric whine noise occur during vehicle acceleration and braking – making the signature analysis even more difficult. Most common examples are the frequent start/stop operations of the combustion engine in hybrid vehicles, and the switching noise of the power cooling unit.

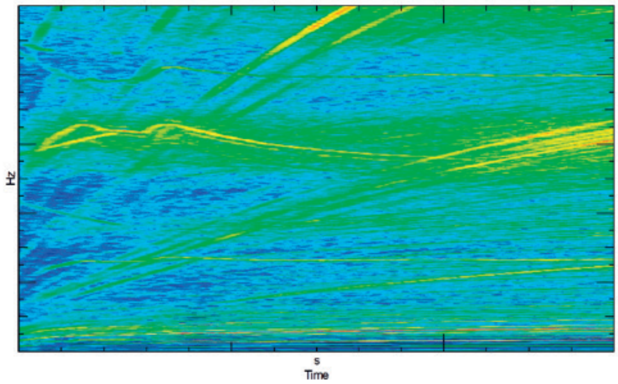

Figure 2 Complex noise signature of an HEV

Taking all these elements into account, one can clearly state that the noise signature of hybrid electric vehicle (HEV) feature a higher level of complexity that cannot be handled by the techniques developed in view of ICE engines for which the noise is dominated by a limited set of low-order harmonic components related to a single RPM. Therefore, the newly adopted methods must deal with complex harmonic structures consisting of multiple groups of order and modulation components with coupled or independent base frequency (multiple rotation speeds, secondary components), with closely-spaced and crossing orders, and with fast varying order profiles, particularly in transient operating conditions.

Transfer

The radically changed noise signatures of electric powertrains also require different techniques and models in order to describe the noise transfer from the different noise sources to the receiver point(s) – for example, the driver's ears. The main problem is related to a much higher frequency range of the sources, thereby implying reconsideration of the formulations that are used to describe and model the propagation.

The key experimental technology to be reconsidered in the view of these HEV challenges is transfer path analysis (TPA). TPA is an experimental technique that allows the identification of the structure-borne and air-borne transfer pathways from sources to receiver based on operational data and frequency response function (FRF) measurements. This method has existed since the 1980s and has focused on the lower-frequency order components

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only, which dominates in traditional ICE vehicles. Hybrid electric vehicles, however, pose new challenges. Firstly, TPA methods will have to be capable of dealing with the higher frequencies that play a prominent role in HEVs. The traditional TPA approach appears to break down at frequencies above a certain threshold, most likely because of the large variability of the FRF phase behaviour. This requires the development of energetic, power-based TPA formulations. Secondly, the complex source signatures of HEV face the pseudo-domain TPA formulations. Such time-domain approach allows auralisation and sound quality analysis of the source-path contributions to the target responses.

An example (1): EV lightweight NVH design

The fact that electric vehicles (EV) are in general quieter than their ICE counterparts provides auto manufacturers opportunities to reduce the mass of acoustic treatments and structural reinforcements on the vehicle body. A study to map out what the primary considerations might be at a concept design stage was conducted for the Future Steel Vehicle (FSV) – a lightweight steel body with an electric motor developed by World Auto Steel.[1]

Measurements were conducted on two small vehicles that both share the same body: one was equipped with an ICE and the other with an electric motor (e-motor). The outcome was used as a starting point to identify assets and pitfalls of electric motor noise and draw a set of NVH targets for the FSV. Compared to the ICE version, the e-motor vehicle showed significantly lower sound pressure levels at the driver's ear location, except for an isolated high frequency peak heard at high speeds at around 3500 Hz when the vehicle drives at top speed. Figure 3 shows the (logarithmic) frequency spectrum during run-up. From multiples of the motor orders (np) with spectral content above 2000 Hz, the order 4*np reaches the largest amplitudes. A gear box order (gp) is close to np while the other loudness during the run-up remained significantly below that of the ICE powered vehicle. The sharpness, however, was higher, as shown in Figure 4, due to the high pitched 4*np and 8*np tones. More representative than sharpness however, were tonality measures such as Tone to Noise Ratio (TTNR) and PR (Prominence Ratio).

Transfer path analysis revealed the 4*np content to be essentially air-borne in the affected frequency ranges, indicating the best solution was the use of dedicated and selective sound packaging material while there was opportunity to lower the overall body's weight, of course within the constraints of strength and safety. For this purpose, a noise target was designed based on the response spectrum, as shown in Figure 5.

As a result of this exercise, it was concluded that significant weight savings could be achieved with clever designs due to the quieter drivetrain in an electric vehicle by relaxing the NVH upper target limits in the frequency range less than 1000 Hz. For example: body noise transfer functions (NTF) between motor mounts and passenger compartment could have an upper limit raised without impairing the platform NVH targets. The high frequency pure tone noise generated by the electric motor is a problem that will need dedicated measures, e.g. by selective absorption material. It was expected that a 3 dB noise reduction from the prominent frequencies could be obtained for a penalty of around 1 kg, which is small in comparison to the weight savings elsewhere in the sound package. An in-depth discussion can be found in an SAE paper[2].

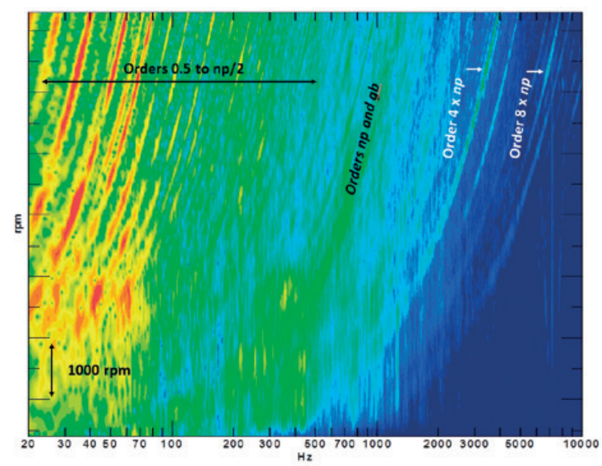

Figure 3 Electric vehicle run-up spectrum

Receiver

Perception aspects as well as specific annoyance observations constitute the requirements put on the NVH performance of HEVs. This means, despite the lower noise levels of electric powertrains, acoustic engineers will face challenging times in order to address these expectations. Because of the lack of masking effect of the combustion engine noise, multiple whistling high-frequency tones, and other subjectively unpleasant noises will emerge and create a sensation of uncontrolled harmony. Also at idle, the noise of accessories such as the air-conditioning compressor, power steering pump, vacuum pump, and fans will be quite prominent and may have a very tonal character.

Besides pleasantness, the dynamic impression of the interior noise is also an important feature in the design of a brand specific sound. Since the load dependency of the interior noise in electric vehicles is generally lower than the ICE vehicles, they may be perceived as less dynamic, which does not really fit to the well-known quick and strong torque build of the electric motor.

On the contrary to conventional vehicles, the driving condition is often decoupled from the operation state of the ICE. For example, the combustion engine can run at constant speed, while the vehicle is accelerating at full load. Even more remarkable is the frequent start/stop of the ICE and upcoming whine noise during regenerative braking. These unexpected phenomena in hybrid vehicles may cause a "disorientation" to the driver. The automotive design teams will henceforth have to face these problems and design a brand sound that satisfies the customer needs.

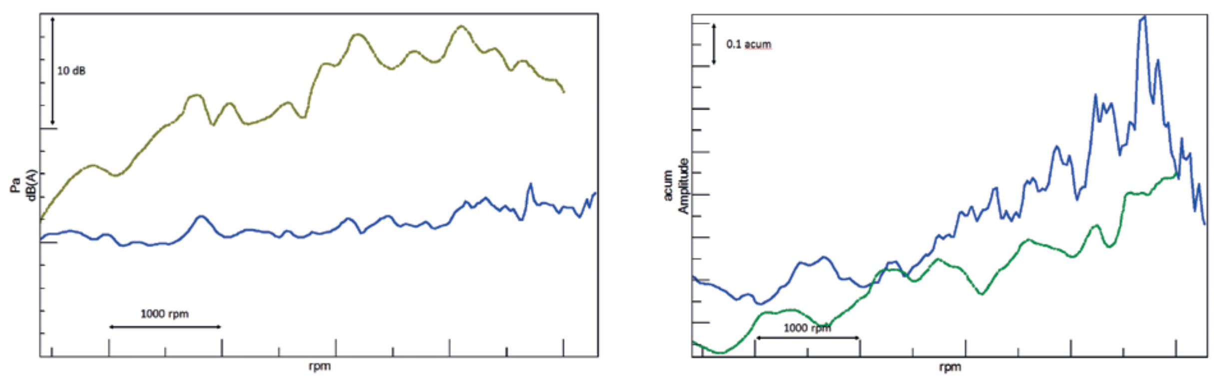

Figure 4 Run-up metrics. Left: loudness. Right: sharpness. Full line: electric vehicle. Dashed line: ICE

An example (2): Electric vehicle pedestrian alert system

An NVH topic which is increasingly considered as a critical noise issue for HEVs is the relation between the exterior sound of quieter road transport vehicles and the safety of vulnerable road users (VRU). In particular at low speeds, before the tyre noise becomes observable (less 20 km/h), the absence of any perceived engine noise, and hence the absence of any recognisable vehicle proximity warning, may cause danger to other road users.

Since this topic ultimately needs to be translated into a design requirement for a vehicle, and hence to be treated in the standard vehicle engineering process, standard software tools to enable and support such design task need to be provided. Two major challenges are addressed in this article.

The first involves the psycho-acoustic design and synthesis of a suitable warning sound for VRU that is detectable and locatable, which can be recognised as a vehicle whilst causing minimal annoyance to the community. This requires research into the exterior sound perception domain itself, the analysis, relevance assessment, modelling of the various sound components, and the synthesis of target sounds, allowing parameterized evaluation studies to be carried out. An example of the noise signature of a Nissan Leaf public dataset is shown in Figure 6.

From Figure 6, two signal contributions are clearly standing out. The first contribution component consists of broadband low frequency content with a peak at 600 Hz and an important contribution up to 100 Hz. An additional broadband group is found in the range between 2800-3500 Hz. The second contribution features a purely harmonic content with speed dependent frequencies. Two groups are found: a first dominant group with two nominal frequencies 2000-2200 Hz and a secondary group with three nominal frequencies 1100 Hz, 1350 Hz, 1600 Hz, active particularly in the first

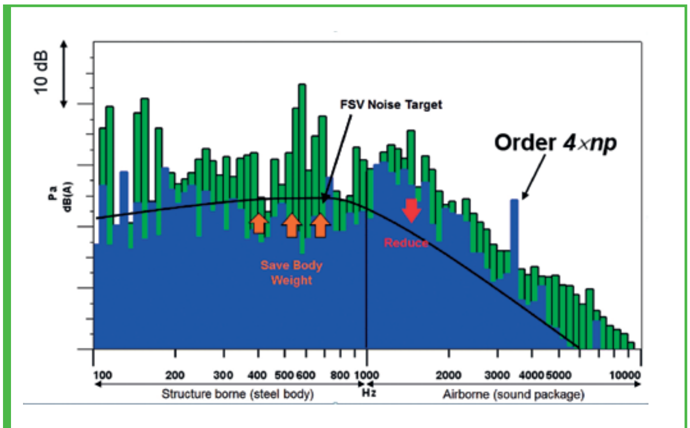

Figure 5 Comparison of EV and ICE noise responses to allow spectral target setting

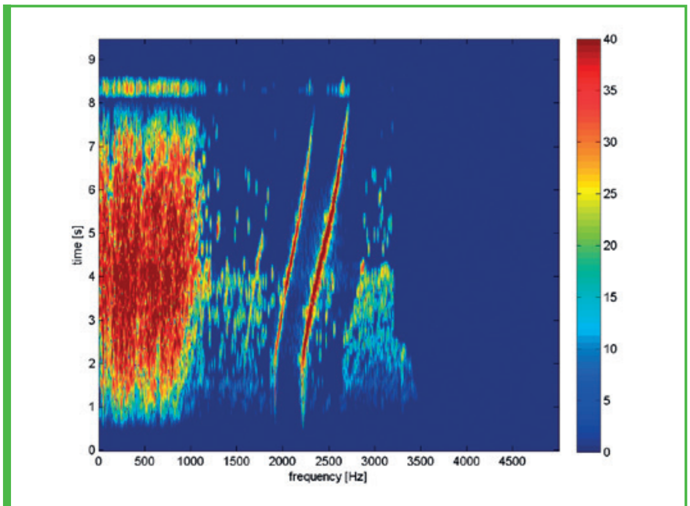

Figure 6 Electric vehicle warning sound spectrum (0-20 km/h)

part of the measurement window. For the various signal components, furthermore a modulation study was performed by means of an envelope spectral analysis diagram for amplitude modulations and some narrow-band spectral analysis for FM sidebands.[3]

The second challenge relates to the optimal configuration design of the sound source(s) on the car to reach maximal warning effect with minimal annoyance outside the danger area. Simulation methods for the sound propagation, covering a wide frequency range and taking into account vehicle and environment constraints are instrumental for this. The assessment criteria must support complex sound fields that include ambient (masking) noise (from other traffic, surrounding environment, etc.), a real vehicle environment, a real road environment, etc. This will also require making the step from numerical calculation to, ultimately, the actual sound synthesis at the receiver location for assessment studies.

In order to illustrate the above, a number of acoustic simulations have been performed at a concept stage. The directivity of the source and level of noise in the vicinity of the car can easily be assessed for different configurations, leading to optimal configuration and enabling the derivation of component and sound system specifications. Different approaches exist, including Multipole Boundary Element Method and the Ray Tracing method. In this article, the noise has been computed based on a LMS Virtual.Lab Boundary Element Method (BEM) approach where the scattering surface of the vehicle has been discretised using 2D elements. A representative car model was used. A refined microphone array was defined in front of the car to capture the emitted noise. A symmetry plane took into account the road surface reflection. A 100 dB monopole with unity amplitude has been defined to model the source. Due to the size of the acoustic mesh, an advanced BEM solver has been used, known as Fast Multipole BEM. Some typical results for two sound source positions (firewall and wheel housing at 2500Hz) are shown in Figure 7

Additionally the same technology can help make decisions as to whether sound will penetrate complex traffic situations,

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ensuring that the sound is audible in key locations where pedestrians might be expected to be present, such as between parked vehicles on the side of the road. The example in Figure 8 below shows that for a given source position noises at 650Hz and 2500Hz would not be audible to the same degree in the same location, an important consideration when designing the warning noise itself.

The simulation methodology in Figure 8 are, therefore, shown to be instrumental for a proper configuration design of the sound source(s) to reach maximal warning effect in the danger zone with minimal annoyance for the environment or other traffic users. In order to perform the study of the actual sound perception, the sound simulation has to be linked to the source signal design and interpreted in terms of subjective perception and alert/warning level by actual listening tests.

Conclusion

This article addresses some of the major elements in the hybrid and electric vehicle related NVH engineering process. It is demonstrated that a number of new challenges emerge when compared with ICE powered vehicles, thus, requiring not only specific technical solutions but also adapted and novel engineering, testing, and simulation methodologies.

In hybrid and electric vehicles, auxiliary systems such as battery cooling (fan) and transmissions generate high-pitched noises which are unmasked at low speeds. At the level of sound transfer, a major impact results from the high frequency nature of the noise sources, aggravated by the tendency for vehicle weight reduction. Classical NVH methods such as TPA and trimmed-body acoustic simulation are extended to deal with the corresponding higher frequency ranges. At the receiver end, much more emphasis is put on the subjective appreciation of the sound. In order to enable the proper identification of the sound quality problem, of the underlying sources and transfer paths, and hence the engineering of solutions through a model-based approach, a high performance and physically relevant sound synthesis approach must be developed. Another important topic that appears with the design of hybrid/electric vehicles is suitable compensation for the absence of exterior sound at low speeds. The proposed approach is to equip quiet vehicles with an artificial "warning sound", emitted during vehicle operation to alert the traffic users of the vehicle approaching, trajectory, and speed.

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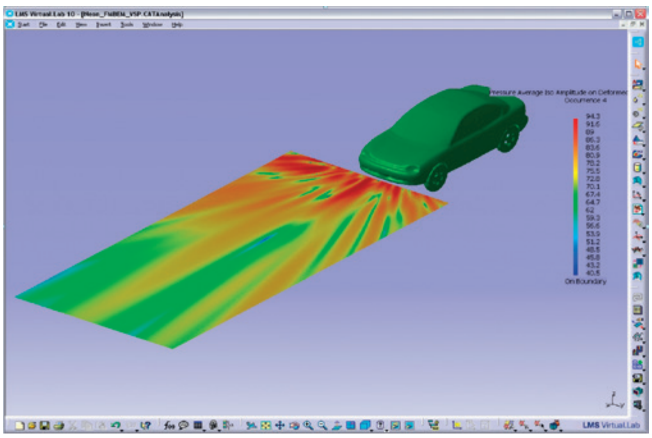


Figure 7 2500 Hz, right wheel housing and bumper extreme right source positions respectively

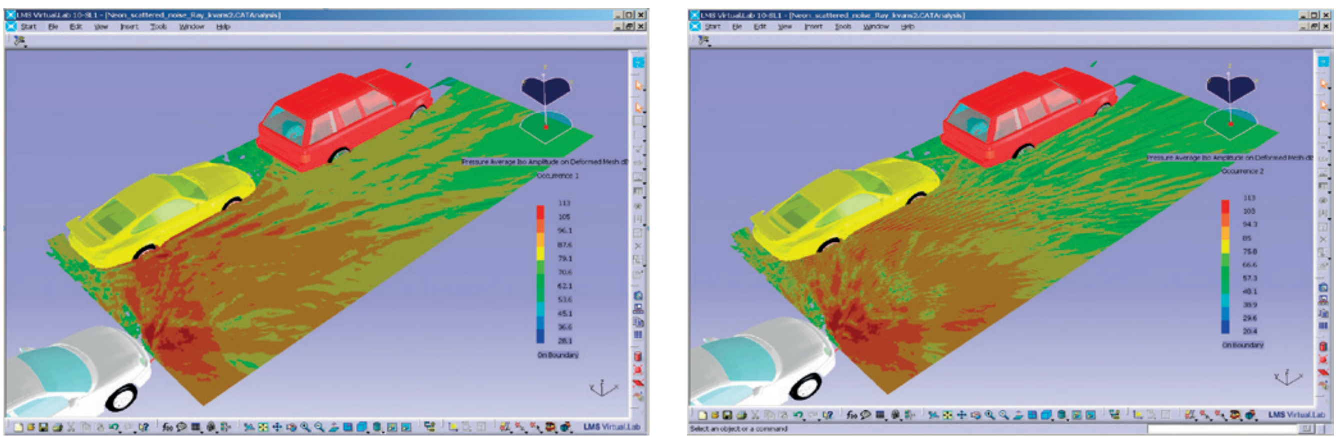
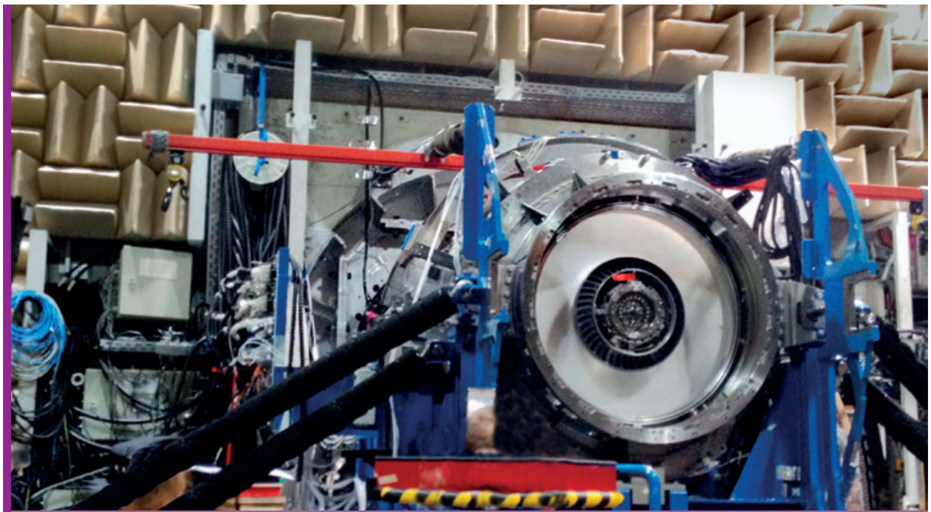


Figure 8 directivity analysis for 650Hz & 2500Hz respectively, note difference in coverage in between vehicles

Sales continue to boom for GRAS as it celebrates its first anniversary

GRAS Sound and Vibration UK has celebrated its first anniversary by announcing that it beat its first year sales target by almost 20% and that so far this year it is 10 % ahead of budget.

The Aylesbury-based company, a subsidiary of Denmark-based G.R.A.S Sound and Vibration A/S, has also achieved preferred supplier status with many UK universities which use its measurement microphones for research projects being run in conjunction with major automotive and aerospace manufacturers.



An aircraft engine being tested in an anechoic chamber

Emily Norman, GRAS UK's Sales Manager, said: "With noise development having a considerable effect on a motor vehicle or aircraft's comfort and economy, our focus for the next 12 months is to aggressively target automotive and aerospace manufacturers directly. In fact, there has already been an increase in demand from the aerospace market which has been quick to recognise the reliability, accuracy and robustness of GRAS UK microphones."

There have been several new product developments from GRAS UK recently, including the launch of a compact Flush Mount Turbulence Screen Microphone kit for improved aero-acoustic testing in wind tunnels.

Other equipment in GRAS UK's aeroacoustic toolbox include surface microphones highly suited to in-flow testing of full scale objects in wind tunnels. The company's nose cones are the result of a development project with German Dutch Wind Tunnel and offer superior in-flow noise rejection compared to existing designs.

For more information contact Emily Norman on **01296 681891** or **emilynorman@gras.co.uk** or visit **www.gras.co.uk**

Xodus wins TCO vibration contracts in Kazakhstan

Xodus Group has been awarded two contracts with TengizChevrOil (TCO) for acoustic induced vibration fatigue assessments of its Tengiz complex in Kazakhstan.

The first contract will see Xodus deliver screening assessments for the relief systems on a new high pressure steam plant, and could expand to include detailed finite element analyses of any fittings identified to be at risk of fatigue failure.

The second, larger contract follows on from similar previous work on the blowdown systems for the Tengiz plant facilities.

The three-month scope of work will be provided by Xodus' vibration engineering team and includes detailed assessments of various recommended remedial measures to improve the predicted fatigue life, as well as detailed analyses of numerous additional, potentially at risk, welded fittings.

Rob Swindell, Xodus Group's Global Vibration Engineering Lead, said: "This is a specialist service that Xodus has developed over the years which we are now providing to a number of oil and gas operators worldwide. Vibration induced failures in process systems can cause major safety, reliability and operational problems. We are able to provide assurances about the actual levels of risk, and can recommend and validate remedial measures when the level of risk is unacceptable."

Major funding boost for Acoustic Sensing Technology will create jobs

Acoustic Sensing Technology has received a £200,000 investment to help open a new office in Speke, Merseyside, to strengthen its sales team and boost its engineering capabilities.

The company, which is based at Sci-Tech Daresbury, has secured the backing from the North West Fund for Energy & Environmental managed by 350 Investment Partners. The business hopes to create up to 10 jobs over the next three years.

Acoustic Sensing Technology's SewerBatt product uses acoustic technology to assess the condition of drains and sewers.

Rob Jones, Acoustic Sensing Technology Finance Director, said: "As market awareness of acoustic technology grows, and people recognise the significant cost savings and customer service improvements available to them, it is important that we are able to continue to develop both our product and our service offering.

"The investment we have received from the North West Fund allows us to do just that and demonstrates great confidence that what we have developed is right for the market we operate in.

"We are very much at the forefront of developing this kind of technology, not only in the UK where we are working with a large number of major utility and rail companies, but on a worldwide scale where we already have significant market presence."

Extrium launches England Noise Map Viewer

Extrium has launched the England Noise Map Viewer showing the results of the second round implementation of the Environmental Noise Directive.

Extrium has worked with Defra and stakeholders over the last five years in supporting the design, production and publication of the Strategic Noise maps and Noise Action Plan Important Area maps.

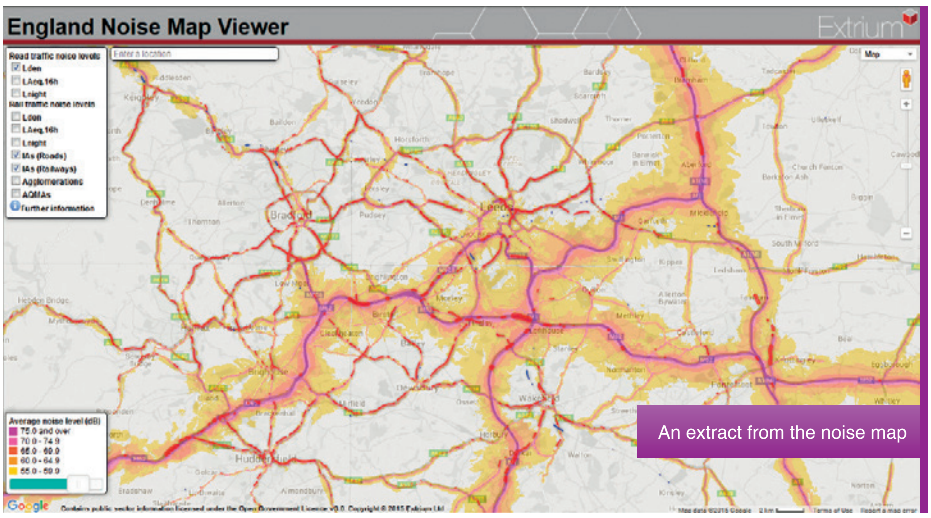
Users are able to view road and rail noise levels inside agglomerations and along major road and rail transport routes between the agglomerations. Results are shown for the Lden, Lnight and LAeq,16h noise indicators.

Users can also see the location of more than10,000 Noise Action Planning Important Areas (IAs) across the country and find out who is responsible for examining the IAs and forming a view about what measures, if any, might be taken in order to assist with the implementation of the Government's policy on noise.

The inclusion of Air Quality Management Areas (AQMAs) also enables an understanding of the relationship between noise and air quality action planning.

Nigel Jones, Managing Director of Extrium, said: "We are delighted to announce the launch of the England Noise Map Viewer. It draws upon our expert understanding of noise policy information and web technology. We look forward to the future inclusion of additional information and services to support the requirements of various users."

See the viewer at: **http://extrium.co.uk/noiseviewer.html**



An extract from the noise map

Vanguardia clinches major arena contract in Moscow

Vanguardia is providing audio and acoustic engineering services to the VTB Arena project in Moscow.

The project, which is currently under construction on the eastern side of the city, claims to be unique in its scale and architectural configuration. The development provides an underground car park underneath a ground floor shopping centre, above the retail units a stadium and an arena are located adjacent to each other on the upper levels of the building.

A polycarbonate cladding system covers the complete development to form a single building envelope. The cladding forms the stadium roof, but the arena is formed with a second independent roof underneath the external skin.

The stadium capacity is around 27,000 and the arena is 12,000. Acoustic challenges include the propagation and transfer of sound between the adjacent venues, both of which are designed to host music shows as well as sport.

The client wants to achieve high quality acoustic conditions to attract international touring acts to the complex. The design of the venue audio systems is also required to be provided at production quality and the audio system allows connectivity for links to broadcast and recording from both venues.

The project is due for completion in 2018.

Brüel & Kjær signs up to Eurofighter acoustic project

Brüel & Kjær and Airbus have entered into a cooperation to calculate the on-ground acoustic exposure of the Eurofighter.

The research project aims to perfect a complex software model of the fighter jet's acoustic emissions when landing or taking off.

The purpose of this model will be to plan take-off and landing flight paths that generate minimal acoustic disturbance for the local communities around airports used by the Eurofighter.

For a wide variety of flight configurations and operating conditions, the model will support accurate estimation of the noise radiated in all directions. This will enable Airbus Defence & Space to design low-noise flight paths, where the jet emits noise away from populated areas.

Brüel & Kjær will contribute to the project with specialist knowledge, data acquisition equipment, and software. Brüel & Kjær's personnel will characterise the individual noise sources of the Eurofighter and measure their directivity under the different thrust and flight configurations.

Airbus Defence & Space will use this detailed data to update and validate their Eurofighter noise models, and will subsequently incorporate this information into the software model to compute noise optimised take-off and landing profiles.

The Eurofighter

Picture courtesy of Airbus

dBx win acoustic consultancy of year award

dBx Acoustics has been named “Acoustic Consultancy of the Year” in the 2015 *Build* magazine Construction and Engineering Awards.

The award commends “only the most deserving firms” and recognises high levels of service and performance.

Susan Witterick, Director at dBx Acoustics, said :“We’re thrilled. We love using our experience to work on all kinds of projects, and whether it’s a multi-million pound science campus or a planning assessment for an individual house, we pride ourselves on doing a great job and being nice about it at the same time. We think this sets us apart from the competition, and it’s great to know the judges agree!”

New test lab is the largest of its kind in UK

Trescal UK’s refurbished and enlarged Manchester test facility has officially opened its doors and is now fully operational, following completion of major works.

The new facility, which has incorporated part of Trescal’s Leigh capability, is now the largest dimensional laboratory in the UK measuring 13 800 ft^2 and employing 55 people.

The laboratory is a one-stop-shop to service an extensive range of calibration requirements. This includes the following capability: high voltage, acoustics, accelerometry, mass, torque, dimensional, electrical and pressure.

The project and has included the refurbishment of existing laboratory facilities and the creation of specialist standard laboratories which operate under strict climatic conditions to within 0.5oC. In the course of the refurbishment 8.5 miles of data cabling was laid in the building and 3.5 miles of power cabling.

The Manchester facility primarily services in the north of England, as well as providing dimensional calibration support to the UK Trescal network and is also the central hub for Trescal’s logistics operation in the UK. The key industrial sectors served being aerospace, rail, pharmaceuticals, energy and automotive.

The new Manchester laboratory

Kevin Hancox, Branch Manager for Manchester, said the refurbished facility was a flagship for Trescal in the UK. “The whole build project has been designed around expansion improved workflow, from goods inward, through to calibration and then the return of equipment to customers.”

Inside the UK Pavilion

Photograph by Hufton+Crow

Hoare Lea helps visitors get a real buzz out of 'the Hive'

Hoare Lea designed the acoustics, integrated audio-visual systems and soundscape experience for the UK Pavilion at the Milan Expo. With the theme of Feeding the Planet, Energy for Life, the Expo is a platform for the exchange of ideas about food, promoting innovation for a sustainable future.

Designed by British artist Wolfgang Buttress, the UK Pavilion was developed around the concept of the beehive, with visitors following the dance of the honey bee through a series of landscapes and soundscapes – through an orchard, a wildflower meadow to "the Hive". This 14-metre-cubed aluminium structure uses light and sound to connect the visitor to the activity of a real beehive, immersing the listener in an interwoven, meditative musical composition, which represents a unique dialogue between human and honey bee.

The soundscape implements movement of sound around listeners using bespoke programmed, multi-channel space panning techniques, driven by an advanced show controller. The lattice structure of 'the Hive' integrates a 360˚ arrangement of active loudspeakers, comprising an upper ring of nine mid/high range units and a lower ring of nine mid/high range units. Low frequency sound energy is provided by six active sub-bass loudspeakers, fixed at floor level. These relay sounds and trigger musical parts in response to live behaviours of honey bees in Dr. Martin Bencsik's beehives in Nottingham, where a study is developing technology to monitor the health of bees, and so protect an important part of our food chain.

Using live accelerometer data streamed to Milan from the beehives, the design creates 'self-authoring' soundscape content and a connection between listeners and bees. The data is processed to identify particular bee activity by using live frequency and amplitude analysis. This provides a set of control signals for the soundscape system.

Mike Bedford, Hoare Lea Intelligent Buildings, explained: "The listening experience is designed with interaction of sound between the zones of the soundscape. As the listener approaches the Hive from the Meadow, for example, low frequency 'bass' sound energy from the Hive floor builds within the meadow soundscape, adding to the sense of anticipation and creating a transition."

Designing an outdoor soundscape experience within a World Expo site had the challenge of calibrating reproduced sound on the listening planes from the system, against

Nightime at the UK Pavilion

Photograph by Hufton+Crow

the ambient noise profile. A full-height, high-mass convoluted entry into the meadow from the orchard entry zone, together with landform and screening were used in the architecture to provide acoustic isolation and transition within zones. The acoustic scenario of the Hive platform (glass platform elevated 5m AFFL with acoustically transparent envelope) lent itself to the immersive 360º listening experience, with sufficient acoustic headroom above ambient level and capability of loudspeaker components to achieve required dominant level and clarity of low level intricacies within the soundscape program. Low frequency energy generated by sub-bass units within the hive had to be carefully considered with respect to risk of structure-borne transmission to the adjacent conference centre.

US company snaps up UK underwater acoustic specialist

Energy services company Proserv has acquired Nautronix, a leader in the supply of subsea digital acoustic communication products and positioning services to the oil and gas industry.

Employing 120 people, Nautronix is based in Aberdeen where the main research and development, and manufacturing facilities are located.

The company is internationally recognised for its through-water digital acoustic wireless communications and positioning systems, diver communications and vessel systems whilst also providing survey services.

The technology focussed organisation which operates across the global subsea sector provides a range of products and services including; NASNet, NASCoM, NASDrill, NASDive and Survey Services.

The transaction, which includes Nautronix Chief Operating Officer Mark Patterson joining Proserv, heightens Proserv's position as a leading player in the controls and communications market and presents the company with the opportunity to expand its offering by providing fully integrated subsea controls, communications, positioning and survey services.

David Lamont, Proserv Chief Executive Officer, said: "I am thrilled to welcome the Nautronix team to Proserv. We have been working together on bringing the two companies together for over a year, and while times in our industry are challenging, the rationale and benefits to all stakeholders including employees, shareholders and our clients remain as strong, if not stronger than ever.

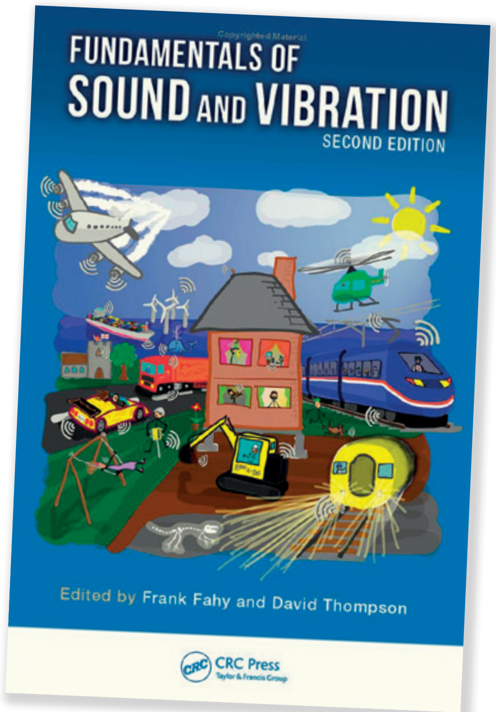
"Individually, the two companies have been doing well in these more demanding times; together, however, we are much stronger."

Mark Pattersonsaid: "It was important for us to find the right company to partner with and we are delighted that it's Proserv. Strategically, this is a fantastic opportunity for Nautronix as we can leverage from the increased exposure globally."

Fundamentals of Sound and Vibration, Second Edition

Edited by Frank Fahy and David Thompson

Review by Professor David Waddington of the University of Salford



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ISBN 9780415562102

https://www.crcpress.com/Fundamentals-of-Sound-and-Vibration-Second-Edition/Fahy-Thompson/9780415562102

This book is based on material presented during the first semester of the MSc Sound and Vibration at the University of Southampton. I am the programme leader of the MSc Acoustics at the University of Salford. This means that I'm probably well suited to review this book. And that the review could be interesting; for a given value of interesting.

Fundamentals of Sound and Vibration, Second Edition by Fahy and Thompson (2015) is actually an update of the *Fundamentals of Noise and Vibration* by Fahy and Walker (1998). *Advanced Applications in Acoustics, Noise and Vibration* by Fahy and Walker (2004) was a companion volume based partly on a selection of material covered in the second semester of the Masters and partly on material presented in the annual ISVR short course, so maybe that will be updated shortly too.

The main objective of the old *Fundamentals of Noise and Vibration* was to provide students with the skills and knowledge required to practise in the field of noise and vibration control technology. I liked that old book and so did the students, because it emphasized qualitative, physical introductions to each topic which is vital for less theoretically oriented readers. It presented acoustics, vibration, and the associated signal processing in a single volume at a level suitable for a graduate student or practising engineer having no prior formal training in the field. But it was overdue an update and that is what we have in *Fundamentals of Sound and Vibration*.

And extensively revised and updated it is too. The book includes a new introductory chapter by Frank Fahy that would serve as an excellent recruitment speech on open days at the university. Chapter 2 on the fundamentals of acoustics has been substantially revised, by the look of it by David Thompson, who has also totally rewritten chapter 5 on noise control. Chapter 3 on the fundamentals of vibration has been completely rewritten by Brian Mace, as has chapter 6 on human response to sound by Ian Flindell. Chapter 4 on signal processing has been comprehensively revised by Joe Hammond and Paul White, and Chapter 7 on human response to vibration by Michael Griffin has been updated. The book ends with new chapters on the measurement of sound and of vibration by Frank Fahy and by Tim Waters respectively. There is a lot of material here but it is all good core stuff. The writing tends toward the practical application of the fundamental principles and methods, which by and large is what the students really need to know.

On my modules I prefer *Foundations of Engineering Acoustics* by Fahy (2005), mainly because of the questions and elaborated answers. Having said that, I really like *Fundamentals of Sound and Vibration, Second Edition*. To have these introductory chapters written by leading academics, proof read, type set, and nicely bound, and available for £49.29, well it's like Christmas. You couldn't get an hour of their time for that price. I wouldn't be buying it for the acoustic consultants in my life; for them, I'd go for the *Acoustics Bulletin*. I'm safe to say that because few consultants will have had the time to read this far into a review of a text book. But as they often say at the end of book reviews, *Fundamentals of Sound and Vibration, Second Edition* will make a valuable addition to the bookshelf of any academic or student of acoustics.

Kieran Gayler new partner at Sharps Acoustics

Kieran Gayler has joined Doug and Ian Sharps as a partner at Sharps Acoustics LLP. He has moved from Sharps Redmore where he had been since 2000, the last seven years as a director.

Kieran, a member of the IOA since 1999, has a background in environmental science. He has a wealth of experience in environmental noise and planning, EIA for large projects, and as an expert witness.

He is a Chartered Environmentalist and a Chartered Scientist and is also a member of the Institution of Environmental Sciences and the Institute of Environmental Management and Assessment.

"I am really pleased to take this opportunity to fulfil a new role with the focus on pure consultancy in a highly respected independent set-up,'" he said.

"I worked with Doug in my early years at Sharps Redmore and I am excited to be picking up that relationship again and look forward to continuing with Ian into the future.

Kieran Gayler

Graham Cowling is new Technical Director at Addiscombe

Graham Cowling has joined Addiscombe Environmental Consultants as Technical Director.

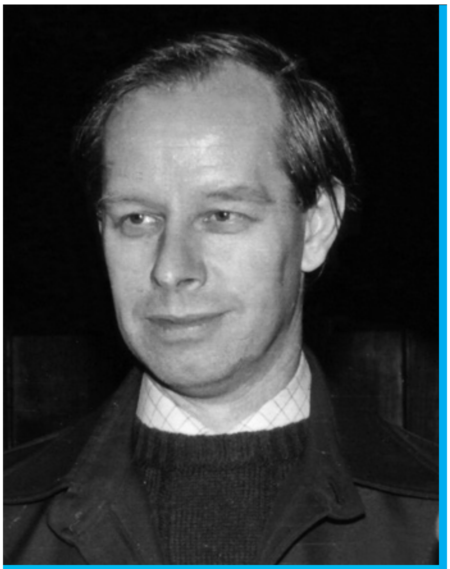
He brings with him more than 30 years' experience of noise and vibration projects including oil and gas, industrial, planning, construction, infrastructure, defence and buildings. He will have technical and commercial responsibility for projects and will head the new Southampton office.

David Nicholls, Managing Director, said: "We are delighted that Graham has accepted this position with us. His expertise and experience is a natural fit for the industries in which we operate and he will be a very positive asset for the company."

Graham Cowling

Obituary

Neil Spring (1933–2015): Distinguished acoustician who played leading role in Institute affairs



Neil Spring (1933–2015)

Neil Frederick Spring, who died on 14 August, was born on 9 February 1933. He was educated in Ealing, and went on to study at Imperial College, where he gained a BSc (Hons) in physics. After National Service in the RAF, he joined the research laboratories of BICC Ltd.

In 1959 he joined EMI to work in the Studio, Recording and Reproduction section headed by Harold Clark and later by Dr Geoffrey Dutton, where he worked on recording studio design and electro-acoustics problems associated with recording. It was here that Neil met Lilian Cracknell (Dr Dutton's secretary), and they married in 1961.

In 1964 he moved to the BBC Research Department, Engineering Division, joining the Acoustic Section at Kingswood Warren where he played a significant role in developing new techniques in studio acoustics, computer aided design and measurement methodology, and in surveys of new and existing studios. In 1970 he was moved to the Transmission Section where amongst other projects he worked on the automatic plotting of aerial radiation patterns.

Wishing to return to acoustics, he left the BBC to join Sandy Brown, the erstwhile specialist Acoustic Architect at the BBC (and better known in many circles as a jazz clarinettist), who had formed an acoustic consultancy practice with David Binns. He became a Partner in Sandy Brown Associates in 1973, being responsible for the one-eighth scale acoustic modelling of the (never built) Edinburgh Opera House. During his time at SBA he undertook the acoustic design of a wide range of buildings including the BBC's Concert Studio (Studio 7) in Manchester, TV-am, The Corn Exchange Cambridge, the specification of a multi-channel reverberation system for Limehouse Studios London, and the preparation of acoustic briefs for the National Gallery Extension and for the Third University of Hong Kong. Neil was responsible for editing the revisions to the British Standard Code of Practice CP3: Chapter III: 1972: Code of Basic data for the design of buildings Chapter III Sound insulation and noise reduction which became BS8233:1987. He also contributed to standards on sound system design. Other publications included the chapter 'Sound' in the *New Metric Handbook*, Architectural Press, 1986.

Neil was an avid attendee at IOA and AES conferences and produced a number of papers and technical articles, as well as encouraging others to do the same. He was active in the formation of the IOA Building Acoustics Group, and supported it at meetings and conferences throughout the last 40 years. His contribution to the *Acoustics Bulletin* (Jan Feb 1991) on building acoustics – 'The last six years' and prefaced 'a very personal and totally biased review' makes interesting reading of the events and progress in building acoustics at the time, and gives an insight into his measured wording and humour.

He retired from Sandy Brown Associates in 1993, but continued to consult under the name Spring Scientific Ltd. His activities also included voluntary work for the Royal National Institute of Blind People Talking Book service in the Epsom – Dorking area. He was described as "one of those who would willingly give up quite a lot of time, and drive considerable distances, to help keep the service running to maximum effectiveness".

Following a chance meeting towards the end of 2004, Bickerdike Allen and Partners learned that he was open to the possibility of some acoustic consultancy work for them on the BBC Broadcasting House project, so in January 2005, he commenced work, reviewing design team submissions, assessing construction progress and witnessing noise and vibration commissioning and testing up to completion in 2011. Thus Neil came full circle from his part in setting up the acoustic standards for studio construction during his initial time in the BBC Research Department to assessment of the satisfactory achievement of those standards in the construction of this latest addition to their studio complexes.

Neil was widely knowledgeable, not just in the field of acoustics, and his dry sense of humour often surfaced. A willing mentor, he inspired and encouraged a generation of young acousticians to become consultants. He will be missed by all who knew him. He is survived by his wife of 54 years, Lilian, and his two sons.

New appointments as Svantek restructures for growth

Andy Carling

Long-term employee Claire Fawlk has been appointed Svantek's Sales Manager for instruments for environmental monitoring, while Andy Carling has joined the company as Sales Manager for health and safety products.

The appointments stem from a major restructure to facilitate future growth and provide the platform for a series of product launches including Gilian personal air sampling pumps from US-based Sensidyne and heat shield meter from Italian company LSI Lastem.

A fully qualified occupational hygienist, Andy Carling was previously employed at Mapal Green Energy as UK Sales Manager. Earlier roles include Field Sales Engineer at Tempcon Instrumentation and Air Quality Product Manager at H20 Chemicals.

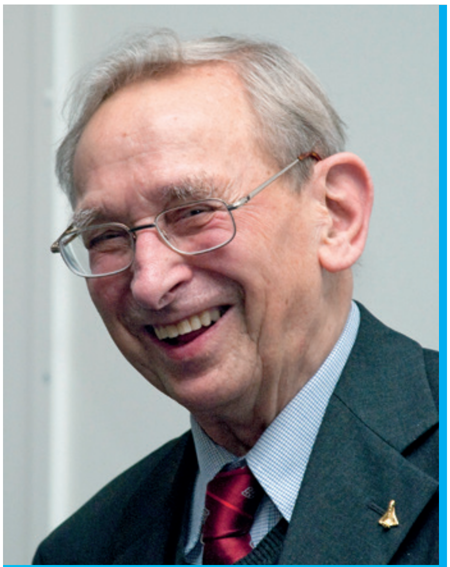
John Shelton, Managing Director, said: "The restructure is a critical next step as we implement our refreshed strategy and reinvigorate our growth momentum. It will help sharpen our focus on distinct markets and enable us to deliver increased productivity and further improvements in the quality of service and products we offer our customers."

Svantek UK is a joint venture between Svantek (Poland) and AcSoft (UK). Founded in 2011, it is already significantly increasing its share of the UK market.

For more information contact Paul Rubens on **01296 682040/07815 087905**, email: **paulrubens@svantek.co.uk** or visit **www.svantek.co.uk**

Obituary

Geoffrey Lilley (1919-2015): ‘The father of aeroacoustics’


Geoffrey Lilley (1919-2015)

Professor Geoffrey Lilley OBE, head of Aeronautics and Astronautics at the University of Southampton from 1964 to 1983, has died at the age of 95.

Known to many of his contemporaries as “the father of aeroacoustics”, Professor Lilley inspired many of today’s leading aerospace engineers. Over seven decades, he pioneered research in a number of areas such as jet engine noise reduction, sonic boom and even human-powered flight, alongside industrial partners including Rolls-Royce, British Aerospace, Lockheed, Boeing and NASA. He is one of the very few who have flown the Gossamer Condor human-powered aircraft operated by pedal power, demonstrating an impressive power-to-weight ratio.

During his time at Southampton, Professor Lilley retained his earlier connection with the Royal Aircraft Establishment at Farnborough. Through this link, he managed to obtain the large R J Mitchell wind tunnel for the university, since used extensively by Formula 1 teams to test racing car aerodynamics as well as by students and academics. He worked closely with the University’s newly-established Institute of Sound and Vibration Research (ISVR), was responsible for the development of Ship Science as a discipline and established the precursor of the Wolfson Unit for Marine Technology and Industrial Aerodynamics which now collaborates with clients from around the world including America’s Cup yachting syndicates.

Throughout his career, Professor Lilley, who joined the IOA in 1976, was directly involved in significant developments in aviation and was awarded six patents for his work. From 1955 he was a member of the UK Government’s Supersonic Transport Aircraft Committee, which led to the design of Concorde. He received an OBE in 1981 and was awarded the Gold Medal of the Royal Aeronautical Society and the Aeroacoustic Medal of the American Institute of Aeronautics and Astronautics in 1983. Although he retired from the University that year, as an Emeritus Professor he was frequently seen on campus, contributing to seminars up until a few years before his death. He was awarded an honorary degree of Doctor of Science at Southampton in 2004.

Matthew Cassidy appointed Technical Director for Southdowns in London

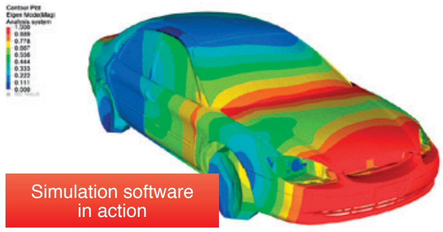

Matthew Cassidy

Dr Matthew Cassidy has been appointed by Southdowns Environmental Consultants as Technical Director in its London office in Westminster.

He has considerable experience of environmental noise assessment in the renewables sector, gained from his work at Renewable Energy Systems (RES) where he was the Acoustics Manager, responsible for wind turbine noise assessments, construction noise management and compliance monitoring for more than six years.

Patrick Williams, Southdowns Managing Director, said: “Matthew is an acknowledged expert in his field and has a track record of academic and professional achievement. With a first degree in aeronautical engineering and a PhD in the passive and active control of generator noise, he is well placed to support the on-going provision of our specialist services in aviation noise management and other specialist areas such as the monitoring and assessment of long distance noise and vibration propagation from military training grounds, as well as the development of our work on operational and construction noise and vibration from major railway and other infrastructure projects.”

Altair embeds Brüel & Kjær sound simulation in CAE



Simulation software in action

Brüel & Kjær noise, vibration and harshness (NVH) simulation software is now available to automotive designers as a module in Altair HyperWorks CAE design software.

Automotive designers using Altair CAE software can now choose a module called Insight+, which enables them to listen to the sound a vehicle would make if it featured their virtual design. This new Insight+ capability from Brüel & Kjær quickly processes CAE models into detailed sound models and allows designers to listen to them.

Because vehicle NVH characteristics affect people, subjective assessments are increasingly important to automotive designers. While data and graphs remain invaluable, virtual prototypes let designers observe and compare new component designs at a system level, which takes into account the entire vehicle and its interaction with the environment.

By enabling people to experience complex NVH data, such as source strengths and transfer functions, in a tactile manner, decisions can be made earlier in the development process with greater confidence.

During the development of vehicles, design teams often have NVH data from measurements on a real vehicle. The goal is to design new components and assess their effect on the vehicle's NVH – before a physical prototype is made. With the Insight+ module, CAE designers can 'play' the sound of a completely virtual component that has been 'inserted' into otherwise real data, recorded on a vehicle.

For more information, visit **www.bksv.com/nvhsimulator**

Software tool to aid noise propagation assessment

Applied Acoustics Ltd in conjunction with Newcastle University recently developed software called SoundPath, designed to assist noise control engineers in assessing noise propagation from source (or sources) to the receiver.

It also permits the engineer to select suitable noise mitigation measures, for example, silencers, acoustic enclosures and application of ductwork lagging/lining material to achieve the required noise limit(s).

The main feature of the software is prediction of the acoustic and aerodynamic performance of silencer configurations, including self-generated noise. Silencer designs include acoustic splitters within rectangular or circular casings, as well as pod or "bullet" type silencer designs. The prediction of acoustic performance utilises an accurate and optimised technique based on modified Beranek prediction curves and sound wave equation theory, the latter having been validated using a large pool of measured data. The acoustic performance of the silencer is presented as both static and dynamic insertion loss.

In addition SoundPath includes an extensive database of published data from recognised sources, including gas turbine intake and exhaust sound power levels (PWL), sound pressure levels (SPL), sound reduction indices (SRI) of a variety acoustic panel constructions, plus many types of external lagging materials for ductwork.

Each noise path is individually assessed, then SoundPath uses a tool, projects, to permit the user to group together selected noise paths and evaluate their resultant noise level, overall impact and compare it with the noise limit required by the project. The number of noise paths a SoundPath project can introduce and evaluate is essentially unlimited; the resulting data can be easily exported in either PDF or Excel format for use in reports.

For more details contact Kamel Rabouhi on **07714 251820** or **kamel.rabouhi@appliedacousticsltd.co.uk** or **visit www.appliedacousticsltd.co.uk**

New triaxial charge accelerometer from Brüel & Kjær

Brüel & Kjær has created a new charge accelerometer to make triaxial measurements easier for automotive and industrial engineers, enabling fast and reliable high temperature tests,

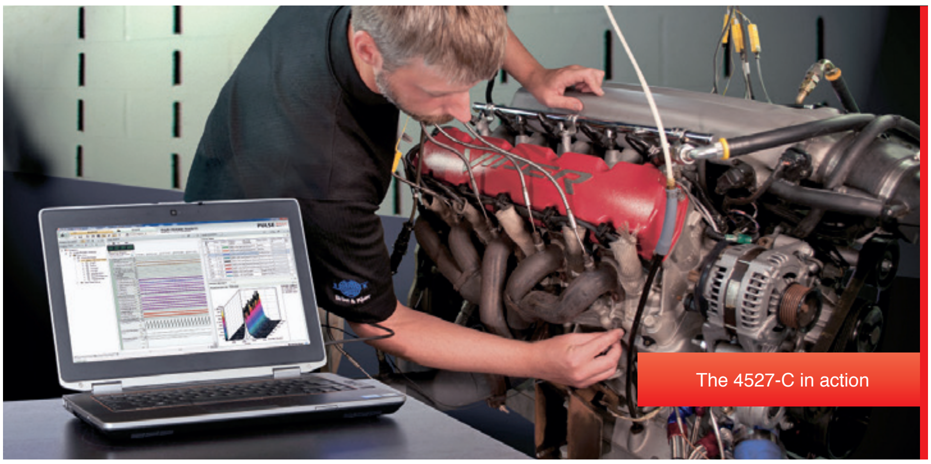
The 4527-C only needs one cable to link up with the three output channels on a data analyzer system, reducing set up time during tests. With an operational temperature up to +230°C, the accelerometer can measure within applications that generate intense heat, such as powertrains, engines, vehicle exhausts, and gas turbine equipment.

Its small size and weight also enable the user to measure in locations where there has previously only been space for single-axis accelerometers, such as the engine mounts and the exhaust.

The connector and cable have been created to avoid triboelectric noise, which originates in the connectors and affects measurement data, in order to provide maximum measurement reliability for users.

Type 4527-C has a titanium casing with a single, integrated, Microtech-compatible, 4-pin connector. A range of mounting options allows users to secure them on any surface using an M3 stud, and an adhesive pad that extends the life of the transducer.

More information is available at **www.bksv.com**



The 4527-C in action

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Committee meetings 2015/2016

DAY	DATE	TIME	MEETING
Tuesday	10 November	10.30	ASBA Examiners
Tuesday	10 November	1.30	ASBA Committee
Tuesday	17 November	10.30	Executive
Thursday	19 November	11.30	Meetings
Tuesday	**1 December**	**10.30**	**Council**
Thursday	7 January	11.30	Meetings
Thursday	21 January	10.30	Membership
Thursday	4 February	11.00	Publications
Tuesday	9 February	10.30	Medals & Awards
Tuesday	9 February	10.30	Executive
Tuesday	1 March	10.30	Diploma Tutors and Examiners
Tuesday	1 March	1.30	Education
Tuesday	8 March	10.30	Diploma Examiners (London)
Tuesday	**8 March**	**10.30**	**Council**
Wednesday	6 April	11.00	Research Co-ordination
Thursday	7 April	11.30	Meetings
Tuesday	12 April	10.30	CCWPNA Examiners
Tuesday	12 April	1.30	CCWPNA Committee
Thursday	28 April	10.30	Membership
Tuesday	10 May	10.30	CCHAV Examiners
Tuesday	10 May	1.30	CCHAV Committee
Thursday	12 May	11.00	Publications
Tuesday	24 May	10.30	Executive
Tuesday	14 June	10.30	ASBA Examiners(Edinburgh)
Tuesday	14 June	1.30	ASBA Committee (Edinburgh)
Tuesday	**14 June**	**10.30**	**Council**
Tuesday	21 June	10.30	Distance Learning Tutors WG
Tuesday	21 June	1.30	Education
Wednesday	22 June	10.30	CCENM Examiners
Wednesday	22 June	1.30	CCENM Committee
Wednesday	22 June	10.30	CCBAM
Thursday	14 July	11.30	Meetings
Tuesday	9 August	10.30	Diploma Moderators Meeting
Thursday	11 August	10.30	Membership
Tuesday	6 September	10.30	Executive
Tuesday	**13 September**	**10.30**	**Council**
Thursday	22 September	10.30	Engineering Division
Monday	26 September	11.00	Research Co-ordination
Thursday	13 October	11.30	Meetings
Thursday	20 October	11.00	Publications
Thursday	27 October	10.30	Membership

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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- User definable Amber and Red Alert Levels
- PPV, dominant frequency, and Displacement < 4 Hz shown on the website

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- Based on the on the MCERTS+ Compliant Met One ES-642
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- Temperature
- Pressure
- User selectable alerts for windspeed, direction and precipitation

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