Vol 34 No 5 SEPTEMBER/OCTOBER 2009

ACOUSTICS BULLETIN

in this issue... **The impact of pile driving upon fish**

plus... **Users' preferences for passive acoustic monitoring**
How green is (PA) sound?
Noise monitoring at the Oval
Euronoise 2009 preview

Institute of Acoustics

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Contents

Front cover photograph: Underwater acoustics is an area of work of which many 'conventional' acousticians have only a hazy understanding. This issue of the Bulletin includes two Technical contributions which discuss how marine organisms react to subsea noise, and how such noise is routinely detected and measured. The cover photograph is of dolphins off the coast of Florida, USA. We also report the recent award of the IOA's A B Wood Medal to an eminent figure in the field of underwater acoustics, Prof Karim Sabra, which took place at an international conference at Nafplion, Greece.

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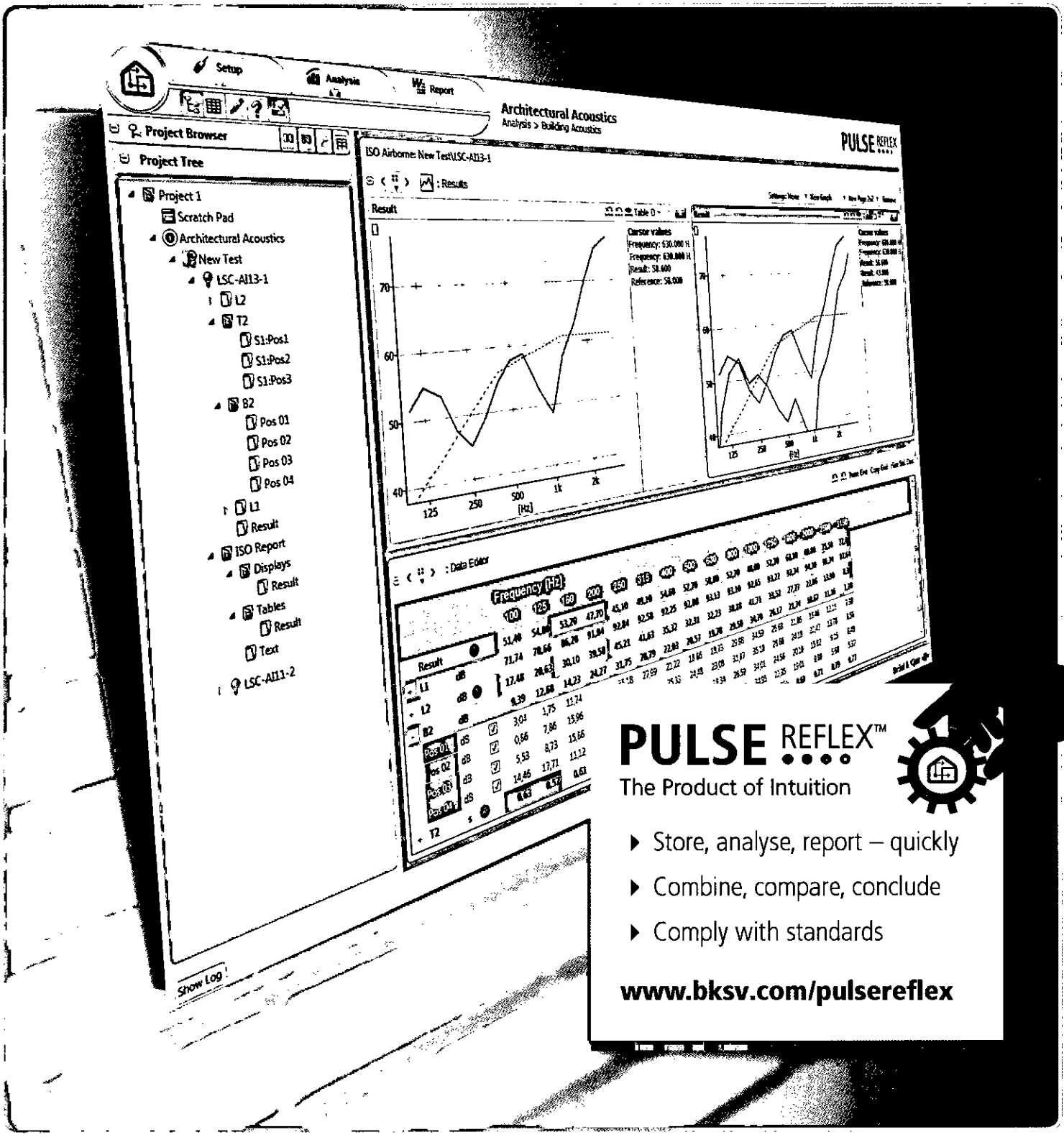

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Dear Members

I am pleased to tell you that at the June IOA Council meeting it was agreed that our membership fees would not be increased in 2010. Council also agreed that, as from January 2010, all members over the age of 70 will be eligible for a 50% reduction in their membership fees regardless of their employment status. These decisions were made in an effort to help members during the difficult financial climate we are currently experiencing.

It appears that this climate has started to have some adverse effects on the business of the Institute. In particular, we recently had to cancel a Young Acousticians' Seminar, which was to take place on 2 July, at a very late stage owing to a lack of delegates. This was the first event organised by our recently formed Young Members' group and the cancellation was most unfortunate for them and for those people who had agreed to give presentations. I hope that this event can be re-scheduled and I re-emphasise my support, and that of Council, for the group and its activities.

I would like to remind all corporate members that they are encouraged to make nominations for the Institute's medals and awards. Details are available on our re-designed website. The Institute has received a number of compliments regarding the appearance and functionality of the redesigned website. If you have not yet had the opportunity to visit www.ioa.org.uk, I would urge you to do so.

The most recent IOA medal to be awarded is the A B Wood Medal 2009. This was presented to Dr Karim Sabra from the USA at the third International Underwater Acoustics Measurements Conference that took place in Greece last June. This was a departure from the normal practice of presenting the medal at an IOA Conference but it seems to have been a great success in raising the profile of the medal itself and also that of the Institute. A short report on the event can be found on page 7 of this Bulletin.

In my last letter but one, I mentioned that the Institute had met with Lord Hunt whose portfolio at the time included environmental noise. As a result of that meeting it was hoped that the IOA would be invited to arrange a high profile event for the launch of the Government's consultations on noise action plans for agglomerations, major roads and major railways in England. However, for various reasons outside our control, the Government opted to have a relatively low profile launch. This took place on 15 July at Defra's offices in London, and the IOA was invited to attend. We are now gearing up to hold a number of workshops for our members to have their input into developing the IOA's response to these important consultations.

Finally, although I am preparing this letter in early August it is the last of my letters that you will see before Euronoise 2009. It's very encouraging for the Institute to have received already so many registrations for the conference in October, and you can find more information in this issue of the Bulletin.

I look forward to seeing you there!

John Hinton

John Hinton OBE

PRESIDENT

The 16th International Congress on Sound and Vibration (ICSV16)

Kraków, Poland, 5 - 9 July 2009

Despite the considerable economic problems around the world and the reductions in travel funding, the Sixteenth International Congress on Sound and Vibration (ICSV16), Kraków, Poland attracted over 750 participants and accompanying persons from 53 countries and was one of the largest ICSV congresses in the series to date. Students made up almost 25% of the participants. Seventy-five papers were presented by Polish authors. The next largest group was made up of sixty papers from the United Kingdom. There was a large exhibition of 21 exhibitors and sponsors. Professor Marek Pawelczyk, chair of the local organising committee, and his team of dedicated Polish colleagues are to be congratulated on the remarkable job they did in putting together a first-rate technical programme. They were helped enormously by the scientific committee comprised of leading engineers and scientists from all around the world. The ICSV16 International Scientific Committee organised 46 special structured sessions in addition to the 55 regular sessions normally held at an ICSV congress.

The congress venue was the AGH University of Science and Technology, located 15 minutes' walk from the Market Square, in the centre of Kraków. Kraków has traditionally been one of the leading centres of Polish scientific, cultural and artistic life. The intellectual potential of the city is created by 22 universities, nearly 20,000 academic lecturers and 190,000 students. As the former capital of Poland with a history encompassing over a thousand years, the city remains the spiritual heart of Poland.

The ICSV16 opening ceremony was held in the Auditorium Maximum of Jagiellonian University. After the welcome speeches, there was a recital of piano music by Frederic Chopin. The piano recital was followed by the special lecture on the *Silent flight of owls* presented by **Prof Geoffrey Lilley,** who received the IIAV Honorary Fellow award this year in Kraków.

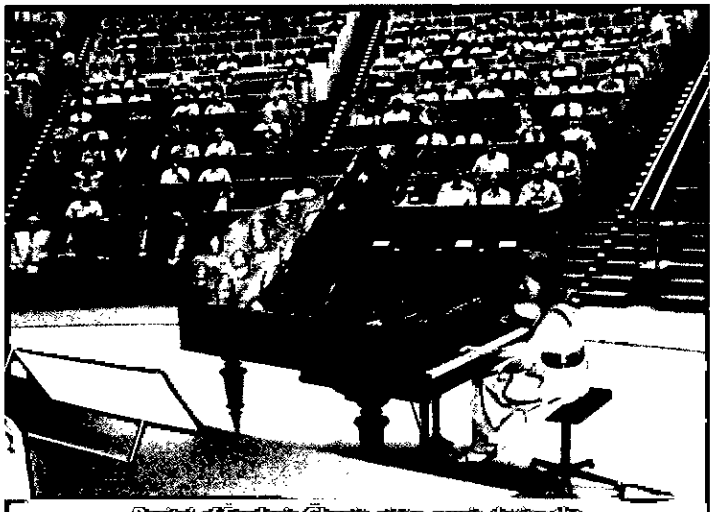
The papers at ICSV16 were given in sixteen parallel sessions. Six keynote lectures were presented by engineers and scientists from all over the globe. This year the keynote lecturers were: *Active sound control in vehicles and in the inner ear,* **Steve Elliott**, Southampton, UK; *Machinery diagnostics and machinery health monitoring,* **Bob Randall**, Sydney, Australia; *Ultrasonic imaging using multitone nonlinear coding,* **Andrzej Nowicki, Janusz Wojcik** and **Wojciech Secomski,** Warsaw, Poland; *Transmission and gearbox noise and vibration prediction and control,* **Jiri Tuma,** Ostrava, Czech Republic; *State-of-the-art beam-forming software and hardware for applications,* **Samir Gerges,** Florianopolis, Brazil and Robert **Dougherty, Bellevue,** USA; and *Acoustic and vibration exposure and comfort inside urban and extra-urban transportation systems,* **Luigi Maffei,** Naples, Italy.

On the Monday night there was a wine and cheese reception for all delegates at which many informal meetings took place.

The congress gala banquet took place on the Wednesday evening in the picturesque Archeological Gardens. The event was accompanied bya performance of famous traditional musicians, the Trebunie Tutki band. As in previous years, during ICSV banquets, participants from different countries gave impromptu group singing performances for the other guests.

IIAV makes two doctoral student awards for students to study acoustics, noise or vibration in their own countries. This year the awards were made to Tetyana Shopa and Mykhaylo Melnyk both of Lviv, Ukraine.

The next ICSV congress, ICSV17, will be held in Cairo, Egypt from 18 to 22 July 2010.



Recital of Frederic Chopin piano music during the ICSV16 Opening Ceremony

(L to r) Kevin Macan-Lind, Chief Executive, IOA, UK; Malcolm Crocker, Executive Director, IIAV, USA; Luis Bento Coelho, President, IIAV, pictured during the ICSV16 Reception

Market Square in Krakow is the second largest town square in Europe.

Professor Geoffrey Lilley

Guests Arriving at the ICSV16 Banquet held in a marquee in the grounds of the Krakow Archeological Gardens

Doctoral Student Tetyana Shopa, Lviv, Ukraine receiving her IIAV Fellowship Award from Malcolm Crocker, IIAV Executive Director

A B Wood Medal 2009

Peter Dobbins.

The A B Wood Medal for 2009 was awarded to Dr Karim Sabra of the Georgia Institute of Technology in the USA for his work on using ocean ambient noise for passive acoustic imaging. In the past, this medal has been presented at an IOA Underwater Acoustics group specialist conference in the UK, but in a break from tradition the medal lecture and the presentation were held at a major international event, the third Underwater Acoustic Measurements conference in Nafplion in the Greek Peloponnese from 21 to 26 June 2009. The idea was to give the medal a higher profile and attract more nominations from throughout Europe.

Dr Sabra gave an excellent medal lecture on the second day of the conference, explaining how ambient noise can be used for time synchronisation and localisation of unconnected acoustic receivers, and for constructing passive tomographic images of the environment.. However, in another break from tradition, the medal was actually presented by Underwater Acoustics Group Chairman, Peter Dobbins, aided by Victor Humphrey representing the Council, in a separate short ceremony held on the final Friday of the conference in the ancient 12,000 seater amphitheatre at Epidaurus.

This new venture was considered a great success by all concerned, and the occasion was made even more special by the presence of eight past winners of the medal . It seems highly likely that this is the way the A B Wood Medal will be presented from now on, although we can't always guarantee a 2,500 year old Greek amphitheatre for the ceremony.

CITATION
DR KARIM SABRA

Karim Sabra is currently an Assistant Professor in the Mechanical Engineering Department at the Georgia Institute of Technology. His research has had a significant impact in the areas of time reversal acoustics, ambient noise inversions, structural acoustics and most recently, medical acoustics.

He started his research on time reversal acoustics as a PhD student at the University of Michigan. His emphasis was on time reversal in imperfect and realistic environments - for example including the Doppler effect of currents, the effects of imperfect array geometry and noise. This work resulted in no less than 6 papers in the Journal of the Acoustical Society of America. These papers were initially theoretical or simulation based but later became experimentally based confirmations. He developed a blind deconvolution method based on waveguide physics that provided, under certain situations, a localization opportunity without detailed modelling or environmental input.

Karim then moved to Scripts Institution of Oceanology at the University of California San Diego. Here he engaged in innovative studies involving underwater noise; these explained and exploited the cross correlation of ambient noise between hydrophones. This work is valuable because it takes advantage of an omnipresent environmental nuisance (ambient noise) and simple passive listening techniques to address genuine remote sensing issues. It may have wide applicability as a means of remote sensing in the ocean.

At Scripts he honed his skills as a seagoing experimentalist and developed an uncanny ability to do real time data analysis and change experimental procedure mid course - a nontrivial accomplishment for a young scientist.

Dr Karim Sabra receiving the 2009 A B Wood Medal.

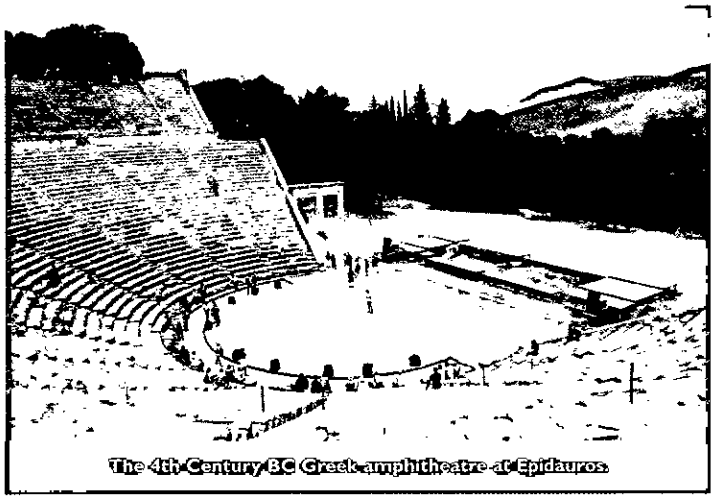
continued on page 8

A B Wood Medal 2009 - *continued from page 7*

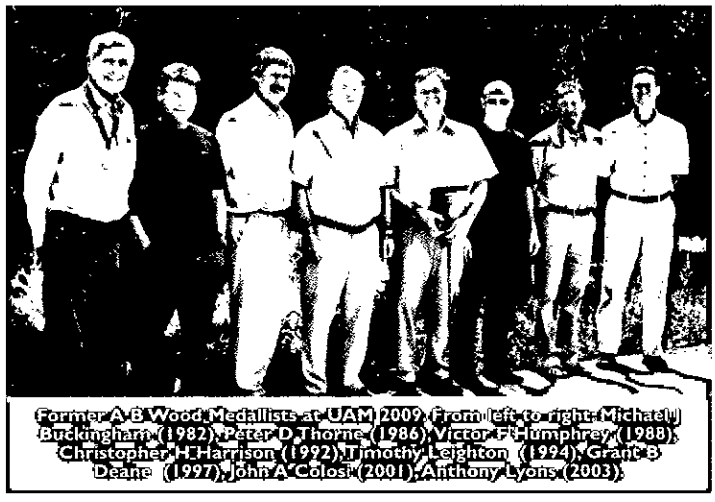
Karim Sabra has since expanded his noise correlation work to geo-acoustics in an elegant study that utilized the noise generated by breaking ocean water waves to determine surface-wave propagation speeds in the earth's crust via cross correlations between geophones. He has also introduced noise correlation techniques to the field of bio-medical elastrography.

Dr Sabra is a uniquely talented acoustician. He is most adept at moving into a new research area and quickly producing elegant, or even extraordinary, results. His intelligence, independence, and grasp of acoustics have made him an ideal researcher and his research productivity in the area of underwater acoustics has been exceptional.

The Institute of Acoustics is very proud to award the 2009 A B Wood Medal to Dr Karim Sabra for his significant contributions to the understanding of time reversal techniques in the ocean and the use of ambient noise for remote sensing.



The 4th Century BC Greek amphitheatre at Epidauros



Former A B Wood Medallists at IOA 2009. From left to right: Michael J Buckingham (1982), Peter D Thorne (1986), Victor F Humphrey (1988), Christopher H Harrison (1992), Timothy Leighton (1994), Grant B Deane (1997), John A Colosi (2001), Anthony Lyons (2003).

London branch evening meeting

The WHO guidelines and night-time noise from music events

On Wednesday 20 May 2009 David Leversedge, Technical Director at RPS, gave a presentation to the London branch on The WHO guidelines and night-time noise from music events. David began by giving the audience a brief account of how he became involved in noise control at large-scale music events and the type of events he has worked on. This was followed by an overview of the noise criteria that may be applied and examples of the type of conditions set by Local Authorities.

David became involved in large-scale music events when the dance scene became more established, starting with a few people 'in the know' turning in up in a field in the middle of nowhere, and moving onto legitimate large-scale organised events. David remembers that in the early days these type of events generally ran from 01:00h to 06:00h for one night only, but things have changed significantly with outdoor music events now running over a whole weekend. More often than not these events include numerous stages, plus other aspects such as market areas, traders and fairgrounds, all of which need to be carefully monitored and controlled in terms of noise. When the main stages finish late in the evening there is also a need to provide other on-site entertainment, which may run well into the early hours.

Some of the many events David has worked on include Global Gathering, Creamfields, Gatecrasher, Glastonbury Festival, Leeds Festival and Latitude Festival. Some of the events take place in indoor venues such as Alexandra Palace and some are outdoor venues like Glastonbury Festival near Shepton Mallet.

The Noise Council's Code of Practice on Environmental Noise Control at Concerts 1995, states that for one to three concert days per calendar year, in an urban stadia or arena, the music noise level should not exceed 75dB(A) over a 15-minute period; for one to three concert days per calendar year, in other urban stadia or rural venues, the music noise level should not exceed 65dB(A) over a 15-minute period, and for four to 12 concert days per calendar year, for all venues, the music noise level should not exceed the background noise level by more than 15dB(A) over a 15-minute period. In addition, for events continuing or held between 23:00h and 09:00h the music noise should not be audible within noise sensitive premises with windows open in a typical manner for ventilation. The term inaudible is not universally accepted, but it is still frequently used, even though it can be difficult to define and is often considered too severe.

Other relevant criteria may include the World Health Organisation Guidelines on Community Noise 2000. Although the document only refers to persons attending and employees, not off-site exposure, it does include recommended criteria to prevent sleep disturbance. David also mentioned the World Health Organisation Night Noise guidelines for Europe 2007, but the recommended noise levels seem very low and there is uncertainty as to whether the guidance will be taken forward.

Licensing conditions can vary significantly between events and Local Authorities. For example, at Turweston airfield the noise condition was 45dB LAeq,10min, at Glastonbury Festival the noise condition was 60dB LAeq,15min at the nearest noise-sensitive property during the day-time period (10:00h to 00:30h) and not 'audible and discernable' during the night-time period (00:30h to 06:00h). At Alexandra Palace the noise condition was 'not to cause a noise nuisance'.

As usual the meeting was very well-attended with a number of interesting points raised during the discussion which followed, including, measurement uncertainty, long range propagation, sub frequencies and low frequencies.

The London branch committee would like to extend thanks to David Leversedge of RPS for sparing the time to join us. In addition, the committee would also like to thank WSP for providing the venue.

Topics and speakers for the evening meetings are generally identified and organised by the London branch committee, but we always welcome new ideas and suggestions for future presentations. If you have any ideas or suggestions, or may even like to give a presentation yourself, please do not hesitate to contact Nicola Stedman: **stedmann@rpsgroup.com.**

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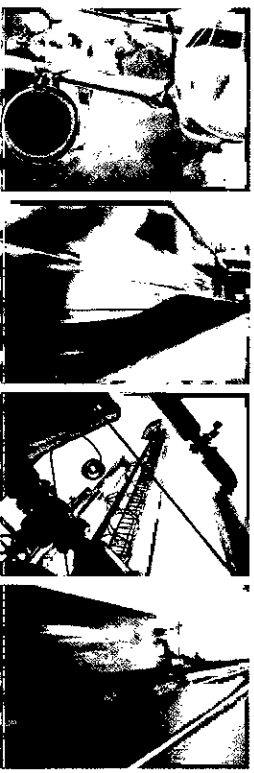

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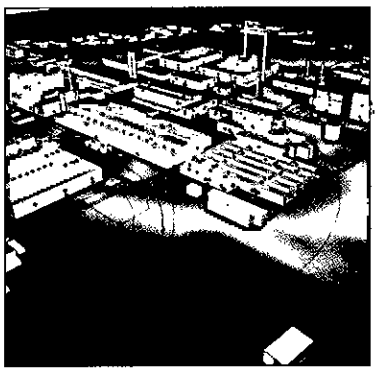
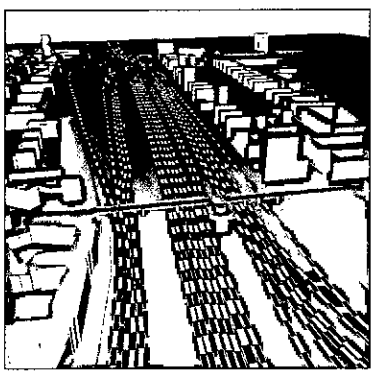
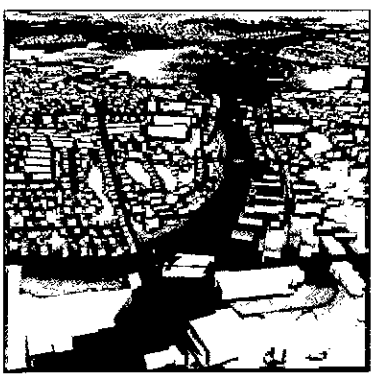


Prediction and detailed analysis of noise at industrial facilities



Optimization of building layout near roads and railway lines



Calculation of noise maps for cities of any size

IOA/ANC consultancy spotlight

Ed Clarke.

We summarise below the current hot topics within the consultancy community, as discussed at the most recent ANC company meeting, held on 20th July in London.

Building Bulletin 93

The apparent 'shelving' of the BB93 review work has been a source of some frustration, particularly among those members who put a lot of work earlier this year into the collaborative consultation and review process. At the time this was viewed by all concerned as a very positive step forward, both in terms of the technical content but also the focussed workshop approach to the joint IOA/ANC response.

Acoustics public engagement network

The ANC is keen to support this initiative, led by acousticians from the universities of Southampton and Salford. The work of this newly formed group aligns closely with one of the Association's primary objectives To inform the public of the existence of consultants concerned with noise, acoustics and vibration and the services they provide.

For more information visit
http://www.acoustics.salford.ac.uk/acoustics_info/sound_matters

LABC and noise.co.uk

A number of ANC members have raised an eyebrow or two over the relationship between these organisations. (see **http://www.noise.co.uk/**) Formal approaches to LABC and CLG have failed to produce any satisfactory explanation as to how they can prevent Local Authorities from construing this relationship as an instruction for members (Local Authorities and therefore public bodies) to recommend or even specify a specific company, which seems at best inappropriate. As fellow members of the IOA, perhaps noise.co.uk should be provided with an opportunity to respond to these concerns themselves in Acoustics Bulletin.

Online certification – ADvANCE

The ADvANCE system has been running successfully since the beginning of June, with online test result verification available for all tests undertaken by registered testers alongside the traditional printed green certificates. ANC members are being encouraged to actively engage with their local building control departments to increase awareness of the system, using an approved PowerPoint presentation.

The system is accessed through the main ANC website, which can be found at **www.theanc.co.uk** and clicking on 'building control' at the bottom left.

A specimen test dataset has been added to the database for demonstration purposes using the following access details;

Task number **23274**

Password **Q9JZD9**

Any feedback or suggestions for improvements to the system would be gratefully received.

The forgery cases which prompted the introduction of this new system are being actively pursued through local trading standards authorities.

ANC technical forum

To extend the range of services offered, the Association is surveying members on a broader range of discussion and training topics. As the Association of Noise Consultants, our focus tends to have been on technical acoustical matters, but we have also identified a demand for more general help with running consultancy businesses of our members. The very niche environment in which we operate is often understood poorly by providers of PI insurance, IT services, and so on, and we hope to help members by avoid too much re-invention of the wheel.

Market trends

On a very cautiously positive note, the consensus of those consulting firms daring to speculate is that consultancy business is starting to pick up very gradually. The ANC board has a small steering group focussed on monitoring this situation with regards to long term security. To extend the steering group analogy – it is very much steady as she goes, but we do seem to be moving forward again.

Fund for promoting the charitable aims of the Institute of Acoustics

Trevor Cox.

The Institute of Acoustics has set aside a fund to support the development of acoustics. The fund aims are to promote the advancement of acoustics by:

- Stimulating general interest, disseminating knowledge and engaging in dialogues concerning acoustics.
- Promoting education, training and advancement in knowledge in matters relating to acoustics.
- Promoting excellence and best practice in acoustics.

Each year, when funds are available, the Institute will issue an open

call for members to bid for money to fund projects.

Aims for proposed projects

The Institute does not want to be overly proscriptive about the aims of the proposed projects. A project might aim to promote excellence and best practice in acoustics: in education, the public and private sectors. However, the fund is not aimed at supporting research into acoustics per se. Projects might aim to engage practitioners outside acoustics or the general public. This might be done to raise awareness of acoustics and so improve the aural environment. Alternatively, a project might seek to address inequality of opportunity to study or practice in acoustics.

This is not an exhaustive list of potential aims for projects, and the Institute is open to other suggestions.

Criteria for judging

- There is an identified need for the project
- Success criteria have been identified
- The project meets the charitable aims of the Institute and is not aimed at commercial or financial gain of companies and organisations
- The likelihood of the project succeeding will be taken into account (considering timescales, funding available and proposed approach)
- The impact of the project in terms of the number of people reached, the quality of the interaction and the outcomes for the participants
- The legacy of the project beyond the immediate funding by the Institute (where applicable)
- Dissemination routes for project, either publicising the work or disseminating the learning gained from running the projects (where applicable)
- The ability for the project to attract additional funding during or after the Institute's funding period (where applicable)
- The ability for the applicant to deliver the project.

Applications

A brief application is required which addresses the aims and criteria given above. No more than a single page of A4 is required.

Judging

Council will determine the amount of funds available each year, which will normally be no more than the interest accrued on the fund in the previous year. Council will delegate the judging of the proposals to a small working group. The recommendations of that working group will be ratified by the Council.

Draft Noise Action Plan

Consultation

Many members will be aware that this summer sees a major consultation in environmental Noise Action Plans, as required under the Environmental Noise Directive 2002-49. The IOA is keen to make a constructive contribution to all consultations relating to acoustics. In this case, because of the importance of Noise Action Plans in setting future environmental noise policy, the Environmental Noise group is helping to ensure we respond fully. The support of members is sought in two main areas of consultation currently in progress.

1. Defra is consulting on draft Noise Action Plans for Agglomerations, Major Roads and Major Railways (responses due by 4 November 2009).
2. Major airports (up to 18 of them) are consulting on their draft Noise Action Plans (responses due by 5 October 2009 or so).

The Defra consultation documents can be downloaded from: **http://www.defra.gov.uk/environment/noise/mapping/action-plans.htm**

The airport consultation documents can be found on each airport's web site: Birmingham, Blackpool, Bournemouth, Bristol, Coventry, Leeds/Bradford, Liverpool, London City, London Gatwick, London Heathrow, London Stansted, Luton, Manchester International, Newcastle, East Midlands, Shoreham, Southampton, and Southend.

Details of IOA consultation responses are published on the IOA website **http://www.ioa.org.uk/publications/consultation-documents.asp.**

If you are involved in environmental noise, we would like you to contribute to the IOA response. The IOA Environmental Noise group committee would like to invite you to attend one of two half-day workshops, to be held in Manchester on 17 September 2009 and in London on 22 September 2009.

The committee plans to formulate the IOA responses based on all the comments we receive from members, whether at the workshops or by other means.

Anyone may, of course, send Defra or an airport his own personal comments directly. The IOA branches may, in due course, organise discussions on relevant draft Noise Action Plans, and this is being actively encouraged by the Environmental Noise group.

The Environmental Noise group committee may not be able to give every one of the 18 airports adequate attention in terms of its local detail, but it plans to comment on common and strategic issues. It is hoped that members will provide detailed responses direct to the relevant airport, or will contribute to a consensus view with the local IOA branch.

The Defra consultations includes the following three questions on the draft Noise Action Plans, and members' views are sought:

Q1. *Do you agree with the overall approach being proposed for identifying important areas and first priority locations? If not, what alternative approach would you advocate?*

Q2. *Do you agree with the overall approach being proposed for implementing the necessary procedures for identifying what further measures, if any, might be taken to mitigate the noise in the important areas? If not, what alternative approach would you advocate?*

Q3. *Do you agree with the approach being proposed for identifying and managing quiet areas in agglomerations with the aim of protecting the quietness of these areas and avoiding increases ?*

The committee is particularly interested in views on the noise levels being suggested for 'important' and 'first priority' areas, on whether it is felt that the plans are appropriately ambitious, and how they address cost-effectiveness.

In any reply, please make it clear if you are commenting on:

1 All draft Action Plans

2 Agglomerations

3 Major Roads

4 Major railways

5 Airports

If comments can all be organised around these headings it will help the committee greatly. Please reply directly to the IOA at the email address.

IOA ENG Committee

Email: linda.canty@ioa.org.uk

website: www.ioa.org.uk

Recent membership committee ruminations

Brian Tunbridge.

The Council requested that a summary of the various changes recommended by the membership committee, and approved by Council, be published in *Acoustics Bulletin*. Two of these changes required small alterations to the by-laws, and these were approved at the AGM in April 2009.

The IOA By-laws, Code of Conduct, and Articles of Association can be found on the IOA web site at **www.ioa.org.uk**

1. Application for Fellow

The By-law will now read *'A candidate applying for election or transfer to the class of Fellow of the Institute shall be proposed* ***normally*** *by one Fellow or Honorary Fellow of the Institute who personally knows the candidate and shall be supported by two other Fellows or Honorary Fellows of the Institute who also personally know the candidate'.*

The revision is normally and the interpretation of this proposal is that in exceptional circumstances it may be more appropriate for the primary sponsor to be a work colleague who is in a professional institute closely related to the IOA, such as the IET or Institute of Physics, and at the equivalent grade to Fellow. The membership committee can advise if this is acceptable.

For all applications for the grade of Fellow, the primary sponsor will be asked to provide a letter of support for the applicant outlining why they consider the candidate is suitable for election to Fellow and what significant contribution they have made in acoustics.

2. TechIOA age limit

The 21 years minimum age limit has been removed. The age limit was inconsistent with the length of experience required for the grade. The By-laws have been changed.

3. Free student membership

This will be offered to undergraduate students on a list of courses approved by the IOA. It may be extended on request to specific students on other courses with a high acoustic content, at the discretion of the membership committee. MSc and PhD students will still attract the normal student fee provided that they are in full time education and not in full time employment by a sponsor. There is no age limit for full time students, as per the By-laws.

4. Conference, overseas speakers

Overseas visitors attending an IOA conference as a contributor may be offered a complimentary one-year IOA membership at the discretion of the conference organiser and in agreement with the chairman of the membership committee. The visitor would be offered Affiliate membership at the conference with the option to complete an application form for any other suitable grade. This would also be complimentary and subject to the normal election procedures through the membership committee and Council. Organisers will be given a special joining pack which will contain a letter of explanation for the offer.

5. Incentives for new members

New members at any grade (including upgrades) will be given a letter offering an entitlement to 50% reduction in the registration fee for one Institute of Acoustics meeting or conference in the ensuing year. This would be offered until the end of 2010 when it will be reviewed.

The Council also approved that applications for Student and Affiliate grades may be reviewed by committee members outside the committee meeting by circulating the papers, in encrypted form, via the internet.

Other recent issues

Code of Conduct

Over the last three years the Institute received four or five complaints per year. Members of all grades are reminded that they have signed up to the IOA Code of Conduct. Some of the complaints relate to members' competence and a working group has been set up to review again ways of encouraging continued professional development (CPD). About 10% of the membership claim to have done some form of CPD in the last year according to the annual membership renewal returns. Any suggestions on how this percentage may be improved would be welcomed.

IOA logo and IOA member grades

The IOA logo is the property of the Institute and may only be used by Sponsor members. This was debated and confirmed at the Council meeting in June.

The Institute has also received a number of complaints from Corporate Members who find that some consultancy web sites are deliberately misleading when they fail to state clearly that they are staffed by Associate Members rather than full Corporate Members. The Institute has made requests for changes to some sites and will continue to monitor the situation.

Whilst members may be in the IOA-published Register this does not entitle any company or individual to claim they are 'registered with the IOA', as appears on some web sites.

We also note some unusual versions of the grade abbreviations. Please see the web site for the correct abbreviations (MIOA, AMIOA, TechIOA etc)

Membership officer

Now we have a full time membership officer, Ms Nezi Yusuf, please direct all queries to her at membership@ioa.co.uk.

Finally, please encourage your colleagues either to join the IOA or update their membership grade as their career progresses. All the details are under membership on the new web site. We will be looking especially for a good CPD record when we consider a move to Corporate grades in order to maintain meaningful standards within the Institute.

Local branch meetings are an excellent way to interact with other members of the Institute and to keep up to date with changes over the broad range of acoustics topics.

Euronoise preview

How Euronoise 2009 came about

Like many of the best ideas, the idea of starting the Euronoise series of conferences began with a casual conversation, in this case between Cathy MacKenzie, the powerhouse behind the early success of the Institute of Acoustics, and Geoff Leventhall, a past President of the Institute. The basic idea was - why not set up a big conference in Europe in a year when InterNoise was not being held in that region? The idea came to fruition in September 1992 at Imperial College, London. Bernard Berry had the task of organising the technical programme. The scale of the event was modest - around 200 papers - but the conference was judged a success and it was thought worth continuing with the idea.

Since then there have been six more Euronoise conferences:

1995 Lyon, France

1998 Munich, Germany

2001 Patras, Greece

2003 Naples, Italy

2006 Tampere, Finland

2008 Paris, France (as part of Acoustics '08).

At times over the years there has been some uncertainty about the 'ownership' of the Euronoise name, but it is now firmly in the hands of the European Acoustics Association (EAA) which represents the interests of 30 acoustical societies throughout Europe with more than 8500 individual members. For the 2009 event the UK Institute of Acoustics was chosen to host the event, based on a proposal submitted and discussed at the Executive Council of the EAA during Euronoise 2006 in Tampere.

In addition to a large number of structured sessions, there will be three plenary lectures selected to represent noise as a system problem: source-propagation path-receiver. The conference will be officially opened by Roseanna Cunningham MSP, Minister for the Environment in the Scottish Parliament. Owing to the system of devolved administration in the UK, there are, in fact, significant differences in approach to noise policy in the four constituent parts of the country, and significant differences in the level of progress which has been made to date.

The choice of Action on noise in Europe as the theme was made because 2009 is a critical year in European noise policy, with the implementation of the 2002 Environmental Noise Directive reaching various key milestones, and with an official review of that implementation coming to a conclusion.

The emphasise the keyword Action there will be a number of workshop discussions involving all the relevant stakeholders to try to ensure that the many words written and spoken about European noise policy do indeed become actions.

The conference is being held in the beautiful, historic and culturally exciting capital city of Scotland, and more details of the technical and social programmes are set out below.

Main programme

All papers presented at Euronoise 2009 in Edinburgh will have their abstracts published in Acta Acustica and other prestigious scientific publications.

The technical sessions at Euronoise 2009, at the Edinburgh Conference Centre, were expected to include (when Acoustics Bulletin went to press) approximately 550 papers in 47 different categories. Transportation related categories, including aircraft noise, railway noise and noise mapping, will account for at least 140 of these papers, but lively sessions on soundscapes and health-related topics are also anticipated. The categories and number of papers in each are tabulated right.

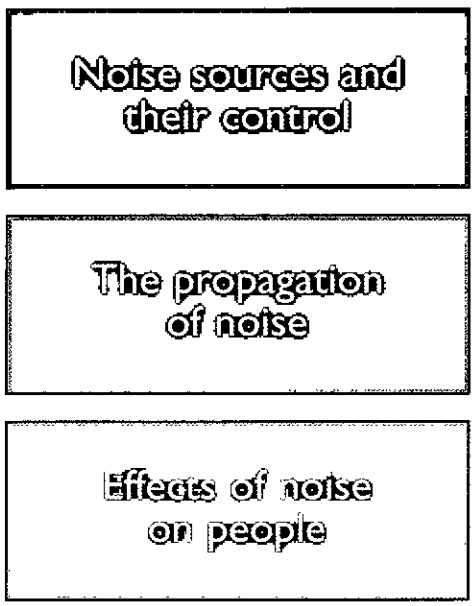
EURONOISE 2009 session	Number of papers
Acoustic comfort in architecture	6
Acoustics of enclosed spaces	17
Acoustic materials – new designs, recycled materials	13
Acoustics in Scotland – new noise legislation, action planning, quiet areas	6
Acoustical exploitation of periodic structures	9
Aircraft noise	24
Aircraft noise-interior	4
Active noise and vibration control	13
Auralisation and virtual acoustics prototyping	15
Building Services noise	5
Classroom acoustics	18
Computational acoustics	8
EN 12354 series: the state of the art	11
Future development in Building Acoustics	6
Health effects –annoyance	13
Health effects– hearing damage	5
Health effects– physiological cardiovascular	14
Health effects –sleep	9
Helicopter noise	7
Human response to vibration	7
Industrial noise	12
Measurement techniques	14
Noise barriers	7
Noise mapping	30
Noise mapping in Scotland	5
Noise policy and regulation	18
Noise valuation	7
Occupational noise	13
Ports, underwater noise	17
Propagation	13
Railway noise	32
Room acoustics – hospitals etc	6
Road traffic noise	14
Structure-borne vibration	9
Sound insulation in buildings	18
Source identification and location	8
Sound insulation standards	10
Sound quality	14
Soundscapes: tools	16
Soundscapes: urban	19
Sustainable strategy and noise solutions in urban areas	9
Tyre/road surface noise	16
Uncertainty in measurement	7
Ultrasonics	4
Vehicle noise	9
Vehicle interior noise	7
Wind turbine noise	7

continued on page 17

Euronoise preview - *continued from page 14*

Plenaries

The topics of the three plenary lectures, one on each day of Euronoise 2009, have been carefully chosen to reflect the three main parts of the 'noise problem'.



Adventures in active control by Colin Hansen will give a brief review of the work in active noise control undertaken by the author and his colleagues at the University of Adelaide during the past 20 years. Emphasis will be on practical issues associated with the implementation of real working systems, and with a special focus on fixed and moving virtual sensing.

Modelling outdoor sound propagation: a careful balance between physical rigour and engineering practice by Dick Botteldooren and Timothy van Renterghem will detail the propagation path and will illustrate the challenges imposed by the harsh conditions in the typical outdoor environment. It will also show how a number of numerical models have been developed. Future needs will be analysed for such models and the possibilities of bringing knowledge from rigorous physical modelling into engineering practice will be discussed.

New directions in noise and health research by Stephen Stansfeld will show how there have been significant achievements in recent research in Europe on the effects of noise on health, but there are also new challenges in relation to the changing noise climate and emerging sources of noise. Stephen will outline the setting up of a new European Research Network on Noise and Health - ENNAH - which will draw new researchers into the field from other relevant disciplines to invigorate the research culture. An important function of the new network will be to encourage the training of young researchers in noise and health research. It is hoped that these new developments will bring noise and health research into the European scientific mainstream.

Social programme

Opening ceremony: Monday 26 October 2009, Edinburgh International Conference Centre

A piper will signal the move to the auditorium for the start of proceedings.

There will be presentations from: Bernard Berry, Chairman, conference organising committee; Roseanna Cunningham, Minister for Environment; John Hinton, President, Institute of Acoustics; and Luigi Maffei, President, European Acoustics Association

Opening reception: Monday 26 October 2009, 6pm-7pm, exhibition area, EICC

Music, drinks and snacks will be provided, giving delegates a chance to meet up on the first evening.

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Euronoise preview - *continued from page 17*

Conference banquet: Tuesday 27 October 2009, Murrayfield

Edinburgh's iconic Murrayfield Stadium, the home of Scottish rugby, is today recognised as one of the top stadia in Europe. With a capacity of over 67000 people, it is the biggest in Scotland and has been used for rugby league, American football and association football, besides its primary function as the headquarters of the Scottish RFU. A traditional Ceilidh - pronounced 'caley', a traditional Gaelic social dance - will be held at the Murrayfield Stadium. Coaches will be provided.

Starting with a trackside reception (weather permitting), there will be a piper to lead delegates to dinner, three courses with wine followed by a Ceilidh band and highland dancer. There will be a chance to 'wear the tartan' and join in the dancing.

Closing party: Wednesday 28 October 2009, EICC

Music, whisky and shortbread will be provided before delegates are wished 'haste ye back'.

Technical visits

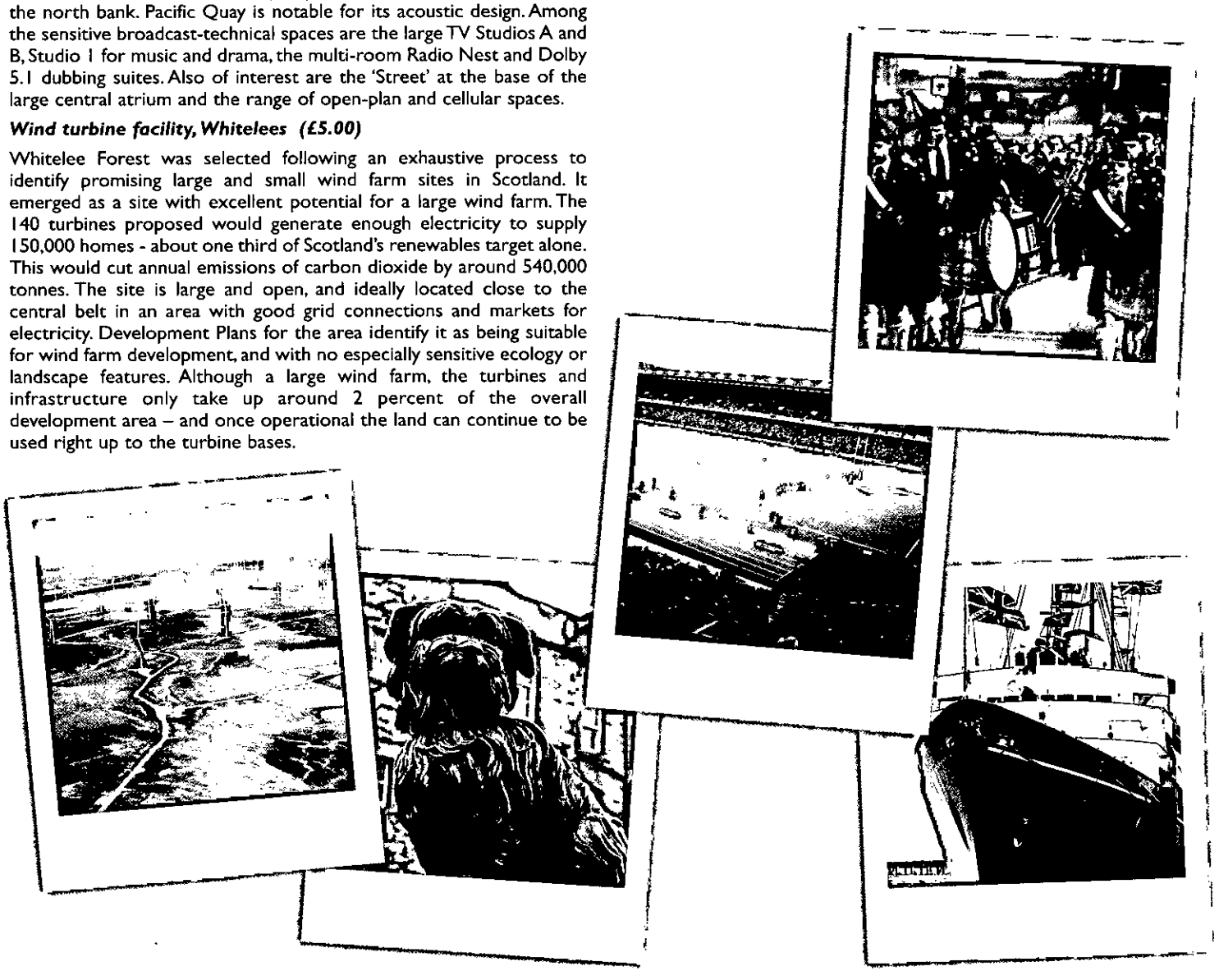
Two visits will be held on Thursday 29 October 2009 starting at 2pm.

BBC Studios (£5.00)

BBC Glasgow Pacific Quay, the headquarters of BBC Scotland, was opened in September 2007. It is located on the south bank of the River Clyde, adjacent to the Glasgow Science Centre and commercial broadcaster Scottish Televison (STV), with views of the 'Armadillo' on the north bank. Pacific Quay is notable for its acoustic design. Among the sensitive broadcast-technical spaces are the large TV Studios A and B, Studio 1 for music and drama, the multi-room Radio Nest and Dolby 5.1 dubbing suites. Also of interest are the 'Street' at the base of the large central atrium and the range of open-plan and cellular spaces.

Wind turbine facility, Whitelees (£5.00)

Whitelee Forest was selected following an exhaustive process to identify promising large and small wind farm sites in Scotland. It emerged as a site with excellent potential for a large wind farm. The 140 turbines proposed would generate enough electricity to supply 150,000 homes - about one third of Scotland's renewables target alone. This would cut annual emissions of carbon dioxide by around 540,000 tonnes. The site is large and open, and ideally located close to the central belt in an area with good grid connections and markets for electricity. Development Plans for the area identify it as being suitable for wind farm development, and with no especially sensitive ecology or landscape features. Although a large wind farm, the turbines and infrastructure only take up around 2 percent of the overall development area – and once operational the land can continue to be used right up to the turbine bases.



Apology

In Acoustics Bulletin vol.34 no.3 (May/June 2009) there appeared a press release article describing the technical systems design by Arup at the RCM's refurbished Amaryllis Fleming Concert Hall. Vol.34 no.4 (July/August 2009) included a technical contribution from Cole Jarman Associates, which described the acoustical consultancy work on the same project. This contribution included an introduction written by the Editor of Acoustics Bulletin.

The Editor accepts that the introduction did not form part of the Cole Jarman article and may easily be misconstrued by the reader. The Editor also accepts that his inference that the original press release may have been deliberately misleading was entirely unfounded. The word misled, in particular, was used in the sense of mistaken, and any inference of accusation would be incorrect. The Editor wishes to record his apology for any misunderstanding or embarrassment his words may have caused.

Instrumentation Corner

Instrumentation requirements for BS6472-1 : 2008

Guide to the evaluation of human exposure to vibration in buildings Part 1: Vibration sources other than blasting by Ken Brown.

This standard is a revision of the earlier standard introduced in 1992, which was superseded in June 2008. The older standard had come in for a lot of criticism, some of which was voiced at a recent Instrumentation and Measurement Group one-day meeting *Rumble in the (Urban) Jungle* organised by John Shelton. Most of the criticism related to assessments made using the eVDV (estimated vibration dose value), which is an optional method of estimating the VDV (vibration dose value) based on *rms* measurements. Of course VDV has the slightly unusual units of $ms^{-1.75}$, and this has never worked in its favour.

There are four major changes which affect the instrumentation to be used.

1. The frequency range is no longer in the title, but the range to be considered is now from 0.5 to 80 Hz. The standard refers to BS.6841 for mathematical definitions of the weightings. In BS.6841 (and ISO8041) the band limiting filters are 0.4 and 100 Hz (nominal frequency range of 0.5 to 80 Hz.). The change in the lower frequency to 0.5 Hz therefore makes BS.6472 consistent with other standards. Although this means that the instrumentation has to perform a full octave below the previous lowest frequency, it also means that manufacturers can, more simply, provide the same instrument for a wider range of applications.
2. The weighting filters have changed: W_b is preferred to W_g.
3. The coordinate system has changed. The basi-centric coordinate system has been changed to a geocentric coordinate system. Hence weightings for supine subjects exposed to motion in the back-to-chest and foot-to-head axes are exchanged.

continued on page 20

Instrumentation Corner - *continued from page 19*

4. The final major change is in the presentation of the frequency weighting curves. These are now presented as the modulus of the frequency weighting to be applied to the incoming acceleration signal. This is a similar presentation to the acoustic weighting curves (A, B, C, *etc*) with which we are all familiar. Previously, these had been presented as the base curves, in terms of acceleration and velocity. A factor was applied to these base curves to indicate the level of adverse comment in various situations. This led to a number of ways of measuring vibration data, and interpreting the results, which were incorrect, and never, as far as I can ascertain, intended by the authors.

So, the standard makes it perfectly clear that the quantity measured should preferably be acceleration measured in ms^{-2}. This signal should be weighted in the time domain, by one of two weighting filters, W_b or W_d, and the required VDV obtained. Modern instrumentation has made this measurement a much simpler operation than when first proposed, and in my view, it is unfortunate that other options are still allowed. I have always been of the opinion that velocity sensors (primarily geophones) are unsuitable for this type of measurement, as they only operate successfully above their natural frequency. The extension of the frequency range downwards to 0.5Hz reinforces this view.

Unfortunately, the **eVDV** is also still allowed, although the advice on when **eVDV** can be used is much clearer and more specific in the new version of the standard. Most of the intermittent or transient vibration we encounter as sources of complaint and adverse comment are non-stationary signals, and only a dose approach based on the true **VDV** is appropriate. It is for exactly the same reason that Sound Exposure Level, LAE is used in acoustics. Once again, the calculation of the fourth root of the fourth power is much easier with modern instruments - primarily because they are all things digital! Much of the disagreement has centred, in my view, on the use of an *estimated* dose value, rather than a true dose value.

Fortunately, we are now seeing dedicated instrumentation appearing on the market which will enable consultants, environmental health officers and researchers to build a database of accurate vibration dose data. This will lead to increased confidence in true VDV as a parameter; in spite of the slightly unfamiliar units!

Ken Brown BSc MIOA MIET is Associate Consultant with ISVR Consulting

European Network on Noise and Health - ENNAH

launched in September 2009

September sees the launch of the European Union funded European Network on Noise and Health – ENNAH. The network plans to create a network of experts on noise and health to establish research directions and policy needs in Europe. Over two years the network will focus on reviewing the current state of knowledge; noise assessment in health studies; the identification of effect modifiers such as air pollution and individual susceptibility factors; the measurement of health outcomes relevant to noise research; and strengthening the methodologies available for future research. One specific aim is to establish communication between researchers on noise and researchers on air pollution. The network is being co-ordinated by Stephen Stansfeld and Charlotte Clark, Queen Mary University of London.

The network is funding an exchange programme for doctoral and post-doctoral researchers, with the aim of establishing close links and partnerships among a new generation of noise researchers. Five grants for EU researchers wishing to spend up to three months in another EU research environment are available. Further information will be available on **www.ennah.eu** in September, or contact **c.clark@qmul.ac.uk**.

APPLICATION PROCESS

- Applications are sought for the EU Network on Noise & Health (ENNAH) exchange programme for doctoral and post-doctoral researchers.
- Exchanges are planned between academic disciplines and countries, with the aim of establishing close links and partnerships among a new generation of noise researchers.
- The grants will cover travel and accommodation costs during the exchange: no costs for salary will be covered.
- The exchange will take place from February 2010 to December 2010.
- Applicants should be doctoral students or to have completed their doctoral degree within the past five years.
- Applicants need to submit a grant application, following the procedure described below, in collaboration with their chosen host institute.
- Applications will be peer-reviewed by the co-ordinating committee of ENNAH.
- **DEADLINE:** Applications must be emailed to **c.clark@qmul.ac.uk** by Friday 30 October 2009.
- Applicants will be informed of the decision of the committee by Friday 11 December 2009.
- Applicants requiring to be put in contact with potential host institutes or requiring further details of the programme please contact the Deputy Network Co-ordinator: Charlotte Clark on **c.clark@qmul.ac.uk**

Environmental Noise and Health in the UK

Report by an expert group on noise and health

The ad-hoc expert group on the effects of environmental noise on health has published for comment its report on Environmental Noise and Health in the UK. The report was funded by the Department of Health and the Department of Environment, Food and Rural Affairs.

The report, prepared at the request of the Department of Health, examines the evidence linking noise and:

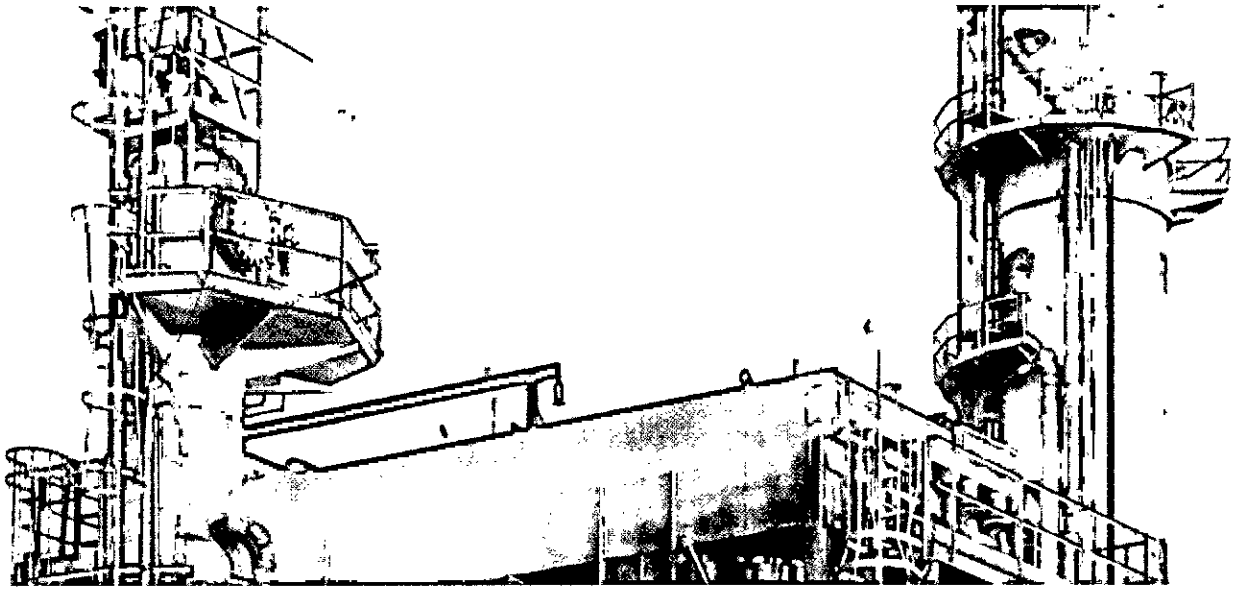
- annoyance
- cardio-vascular disease
- mental illness
- impairment of development of cognitive functions among children.

The report notes an increase in evidence showing an association between environmental noise and raised blood pressure and coronary heart disease. Evidence to show that environmental noise damages mental health remains inconclusive. The report also discusses the well-established link between exposure to noise and annoyance and suggests that public attitudes to environmental noise may be changing.

A number of research recommendations are made, and it is suggested that an Expert Advisory Committee is established to advise government on the effects of exposure to environmental noise on health.

Those wishing to comment on the report should follow the procedure given on the HPA website at **www.hpa.org.uk/noise**

The report represents the views of the authors and should not be taken as those of the Department of Health, Department of Environment, Food and Rural Affairs, or the Health Protection Agency.



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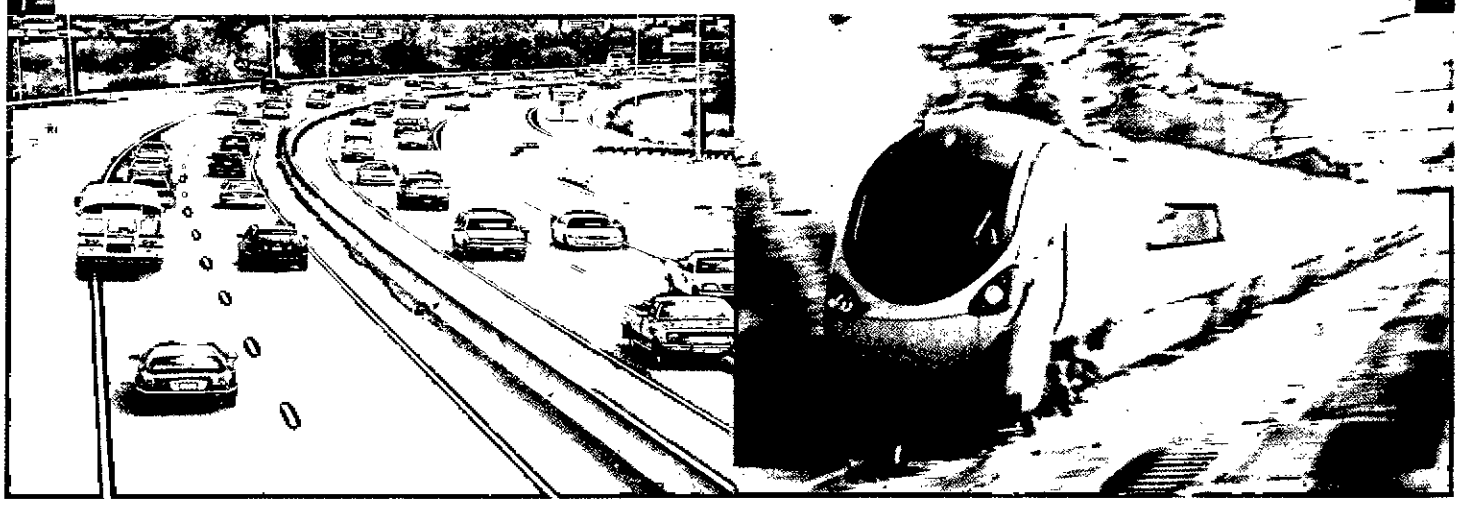

Meeting Report

Midlands branch

For the Midlands branch meeting on 22 July at the Rolls-Royce Heritage Trust Museum we were treated to something a little different. The late afternoon session was 'chaired' by Max Alderton, however he rarely sat down during the lightning tour of literally hundreds of exhibits. Max, a retired employee of Rolls-Royce plc for more years than he cared to mention had an in-depth and infectious enthusiasm for all things of an engineering nature. His anecdotes and insight brought the various exhibits to life (an idea for a *'Night at the Museum'* sequel perhaps?).

Those attending were subjected to very interesting insight into engineering and aerospace history, from one of the longest standing and biggest names synonymous with quality and heritage.

The exhibits were mainly from Coventry and Derby products but were started by a Manchester built Royce crane from the 1900s, to about the most modern exhibit, a three-shaft RB211-535 gas turbine from the 1980s.

The tour included various cars including Armstrong-Siddeley, Bentley and Rolls-Royce, and piston, rocket and jet engines from Whittle, Rover, de Havilland, Bristol, BMW, Allison and Rolls-Royce, with a Supermarine Spitfire even thrown in for good measure!

This meeting was hugely over-subscribed as we were limited on numbers. We have received some positive feedback on the content and therefore will make every effort to hold a similar event next year for those whom we unfortunately had to turn away.

In the somewhat traditional Midlands manner we again concluded the proceedings with a very good curry, with which we continued our discussion.

Paul Shields

Midlands Branch meeting

Midlands Branch meeting

ICBEN 10

Conference dates and venue announced

The next International Congress on Noise as a Public Health Problem is to be held in London in 2011. This will be the tenth international congress of ICBEN, the International Commission on the Biological Effects of Noise. The congress is being organised by the Institute of Acoustics on behalf of ICBEN, and will be held at Imperial College from 24 to 28 July 2011.

ICBEN was set up in 1968 to promote high quality scientific research into all aspects of the effects of noise on humans and animals, and to encourage communication between researchers working in these areas. Since 1968 ICBEN has held a congress every five years in order to review recent and current research on the biological effects of noise on health, with a view to informing research scientists, industry and national and international policy makers concerned with the effects of noise. Congresses have been held in the US, in Europe and in Australia. In future congresses will be held every three years, the first of these being the 2011 congress in London.

ICBEN is organised into nine international noise teams which consist of representatives of various disciplines including psychology, psychiatry, acoustics, biology and audiology. Each team focuses on a particular aspect of the effects of noise. The teams are:

Team 1: Noise-induced hearing loss

Team 2: Noise and communication

Team 3: Non-auditory effects of noise

Team 4: Influence of noise on performance and behaviour

Team 5: Effects of noise on sleep

Team 6: Community response to noise

Team 7: Noise and animals

Team 8: Interactions with other agents

Team 9: Policy and economics

As well as representing many disciplines ICBEN is a truly international organisation, with the four office holders (chair, co-chair, past chair and secretary) always coming from four different countries. The current chair is Stephen Stansfeld, Professor of Psychiatry at Queen Mary University of London, while the scientific organiser of the 2011 Congress is Bridget Shield, Professor of Acoustics at London South Bank University.

The impact of pile driving upon fish

Tony Hawkins.

Background

Pile driving is commonplace in construction work, both on land and at sea. A stake, post, sheet, tube or beam made of timber, steel or reinforced concrete is driven into the ground, the bed of a river or the seabed to support a superstructure such as a building, bridge, jetty, pier or the sub-sea foundations for a structure like an oil platform or wind turbine. Percussive or impact pile driving involves the repeated, impulsive striking of the head of the pile, either by the dropping of a weight or by the use of a hydraulic hammer. Energy is transmitted to the pile, driving it downwards. The process is repeated at strike rates of 30 to 50 times per minute until the pile has reached the required depth. The whole process may take minutes or hours, depending on the size of pile and the substrate conditions. Successive strikes have different energy levels depending on the hammer setting and the substrate material.

The energy applied to the pile is dissipated either as downward movement of the pile or as radiated wave energy. The transient wave pulses last for a fraction of a second and are usually described by changes in sound pressure with time, or as the instantaneous peak sound pressure level during the impulse. The peak pressure is the instantaneous maximum or minimum overpressure observed during each pulse and can be presented in Pascals (Pa) or decibels (dB) referenced to a sound pressure of 1 microPascal (μPa). Close to the pile the peak pressures may be very large (> 200dB re 1 μPa at one metre). The rise time, the time it takes for the waveform to reach the peak level, may be short (values of 2 to 40 ms are commonplace). Although the spectrum is dominated by low frequencies (mainly below 1 kHz) a broad range of frequencies is present.

Pile driving often takes place close to rivers, or in coastal waters, where fish are found. In some cases, those fish may be protected by law from disturbance or damage. There are several documented instances of pile driving affecting fish and in some cases causing physical harm to fish. In particular, the driving of very large steel piles associated with the construction and repair of bridges in San Francisco Bay area has resulted in the death of protected species of fish (McKee, 2005). Despite strong interest in eliminating adverse effects upon fish and other aquatic animals, however, very little is known about the characteristics of the pile-driving stimulus that are responsible for those effects, or how the physical environment may affect the impact upon fish. It has also become apparent that pile driving may affect different species of fish to a differing degree. A recent and rigorous review by Hasting & Popper (2005) has shown how poorly informed we are in terms of assessing the impact of pile driving upon fish.

If man-made sound or any other form of energy is harming aquatic animals, and especially those with legal protection, then it is important to regulate, eliminate or reduce that damage. Regulation usually involves the setting of standards or criteria defining the levels of sound which cause a specified degree of response. The response itself may vary. Individual fish may be injured or killed; their hearing may be affected; or their normal behaviour may be disrupted. Sound exposure criteria may be needed for several different levels of response.

In setting sound exposure criteria it is necessary to have regard to the particular animal or animals being exposed, and their particular sensitivity to sound. It is difficult to extrapolate from one species to another, especially for fish, which are the most diverse of vertebrate animals. It is also necessary to have some knowledge of the sounds received by the fish from the particular type of source, specified by appropriate metrics. Those metrics must themselves be related to a particular response, which in some cases may be serving as a proxy for death or risk of harm to the animal. A level is then set which, if exceeded, will constitute a breach in a regulation.

The sensitivity of fish to sounds

There is much uncertainty over the sensitivity of fish to sounds. There are two problems which must be overcome in designing suitable experiments. The first problem is in deciding whether a sound is detected by the fish. The second lies in presenting a sound with known characteristics.

Confirming sound detection

Although fish may respond spontaneously to the presentation of a sound by changing their behaviour or showing a startle reaction, such responses often diminish with time, especially with captive fish. Fish may habituate to repeated sounds (Hawkins, 1973), making it difficult to present a full range of sound stimuli and fully explore their hearing characteristics. Various training and conditioning techniques have therefore been developed to ensure that fish will always respond to sounds which they can hear. Thus, fish have been trained to press a lever, or swim through an aperture when they hear a sound, in anticipation of a subsequent reward of food. Or the electrocardiograph of the fish is monitored and fish conditioned to show a delay in the heart-beat when presented with a sound, in anticipation of a mild electric shock applied later. Once a fish is trained the sound level can be reduced progressively until the fish no longer responds. The threshold for detection may then be bracketed by raising the sound level if the fish does not respond and reducing it when the fish responds. Although application of these techniques is labour intensive, the thresholds obtained are repeatable and reliably reflect the hearing abilities of the fish. The thresholds are usually determined for pure tones and plotted against frequency to give an audiogram (Figure 1).

Physiological techniques may also be applied to examine the hearing capabilities of fish, where an electrical response is recorded from the nervous system of the fish as a sound is presented. Microphonic potentials may be detected from the auditory hair cells of the ear with an embedded electrode; or an auditory brainstem response (ABR) may be monitored by surface electrodes typically placed on the head of the fish, as done with mammals. With fish it is probably more correct to call the latter auditory evoked potentials (AEPs) rather than ABRs, as they may not be strictly from the brainstem. Thresholds at different frequencies may be determined by reducing the sound level until the potentials can no longer be detected; or frequency response curves may be prepared by comparing the sound levels which yield a given level of electrical response. Typically, the response curves show less dynamic range than those determined by behavioural techniques. Thresholds are often higher, as they may be determined by the ability of the experimenter to distinguish electrical potentials against background electrical noise rather than any limitations on the part of the fish. However, such techniques are easy to apply and may be especially valuable for registering major changes in the hearing characteristics of fish exposed to damaging levels of sound.

Sound presentation

Presentation of measured sound stimuli to fish under experimental conditions presents difficulties. Fish are generally most sensitive to low sound frequencies, where the wavelength often exceeds the dimensions of the body of water which contains them. The sounds are presented in a variety of ways, sometimes with immersed sound projectors and at other times with the projectors in air above the water. The sound signals are usually measured with hydrophones sensitive to sound pressure. Sound transmission in small bodies of water is very different to sound transmission in a free sound field. With an immersed projector in a small, open, thin-walled container very large particle motions are associated with quite low sound pressures.

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The impact of pile driving upon fish - *continued from page 23*

With an air loudspeaker above the water the sound field consists almost entirely of sound pressure. Thresholds and audiograms presented by different workers must be treated with great scepticism, especially if the sound fields have not been carefully specified.

Relatively few experiments on the hearing of fish have been carried out under appropriate acoustical conditions. The results from many of the measurements made in tanks, and expressed solely in terms of sound pressure, are unreliable and misleading.

Hearing abilities of fish

Experiments carried out under appropriate acoustic conditions; in carefully calibrated tanks or at depth in much larger bodies of water, have shown that fish hear only over a relatively narrow range of frequencies compared with mammals and birds (Figure 1). Sensitivity to measured sound pressures, even within this narrow range of frequencies, is poor for species, like the dab and salmon, but is much better for some other species. For example, the cod (Chapman and Hawkins, 1973) has a wider frequency range than either the dab (Chapman and Sand, 1974) or salmon (Hawkins and Johnstone, 1978) and at its most sensitive frequencies is limited only by the level of ambient noise in the sea. The catfish (Poggendorf, 1952) has an even wider frequency range. It has been shown that whereas the less sensitive fishes, like the dab and salmon, respond to particle motion (expressed as particle acceleration, particle velocity or particle displacement) rather than sound pressure, those fish like the catfish, which respond over a wider frequency range, are sensitive to sound pressure.

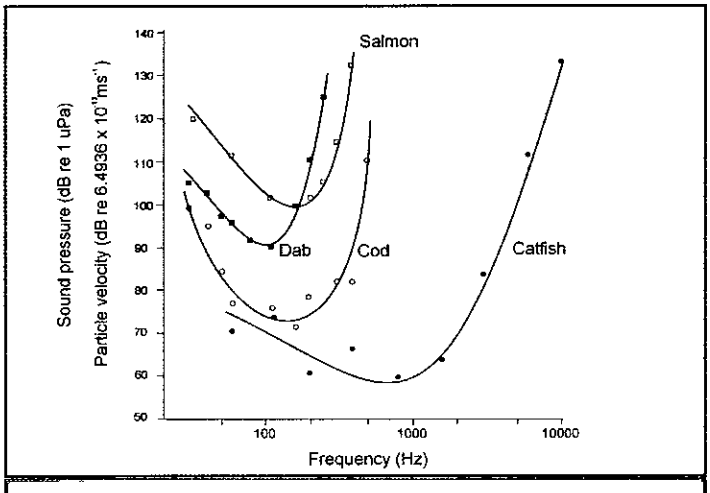

Figure 1

Fish audiograms obtained under carefully controlled acoustic conditions. The thresholds for salmon, dab and cod were obtained from a mid-water acoustic range in the sea. Those for catfish were obtained in a carefully calibrated tank

Sensitivity to sound pressure is associated with the presence in some fish of a specialised hearing apparatus which takes the form of a linkage between a gas-containing body and the ear. Thus, in the goldfish there is a chain of small bones between the gas-filled swim bladder and the ear – the Weberian ossicles. In other species, like the herring and the mormyrids, there is an ancillary bubble of gas close to or in contact with the ear. In a few species, like the cod, it appears to be sufficient for the swim bladder to be placed close to the ear (Sand and Enger, 1973).

The ear itself consists of three dense bodies – the otoliths – in contact with sensory hair cells. The principle which operates is that sound moves or vibrates the body of the fish relative to each otolith, stimulating the sensory hair cells. In species like the dab, which lack a swim-bladder, this is the main mechanism for stimulation of the ear by sound. In fish where a gas bubble is present the gas expands and contracts in response to a sound pressure wave, generating particle motions at the ear which are much greater than those in the absence of the gas. The gas bubble effectively transforms pressure into particle motion, rendering the fish more sensitive to sound than in the absence of the bubble (Sand and Hawkins, 1973). Removal of gas from the swim-bladder reduces sensitivity to sound pressure (Sand and Enger, 1973). Placing a gas-filled condom behind the head of a fish lacking a swim-bladder both increases its sensitivity and enlarges the range of frequencies to which it responds (Chapman and Sand, 1974).

There is great diversity in the structure of the ear and its connection with gas-filled bodies in fish. This is perhaps to be expected with more than 30,000 different species. Hearing abilities also vary greatly between species. Some, like the anadromous herrings and menhadens are sensitive well into the ultrasound range. Other hearing specialists can hear sounds up to 3 – 5 kHz; the cod can detect sounds up to about 400Hz; while the plaice and salmon only detect sounds at frequencies up to 200Hz.

Most audiograms for fish show sensitivity to sound pressure or particle velocity falling off at lower frequencies (below about 100Hz). Sand and Karlsen (1986) have confirmed earlier suggestions that the otolith organs behave as nearly critically damped mass-loaded accelerometers. They are inherently sensitive to particle acceleration. If the audiogram of the fish is expressed as particle velocity or sound pressure, sensitivity will fall off at lower frequencies. If the thresholds are plotted as particle acceleration there is no fall off. A range of species of fish gave a threshold value of about 10 to 5 ms-2 at 0.1Hz; a sensitivity about 10,000 higher than in humans. Knudsen et al (1997) have also confirmed that salmon show strong avoidance reactions to very low frequency sounds.

Particle motion sensitivity has been shown to be important for fish responding to sounds from different directions. With the high speed of sound propagation in water, time differences between the two ears are very small. Moreover, for animals smaller than the wavelength of a sound any sound pressure differences between the two ears will be minimal. Indeed, with a single gas bladder attached to the ear there is effectively only one receiver. Nevertheless, fish are able to discriminate between spatially separated sources, both in the horizontal (Schuijf et al 1972) and vertical (Hawkins and Sand, 1977) planes. They are also able to distinguish between sources at different distances (Schuijf and Hawkins, 1983). The ability to discriminate sounds from different directions is conveyed through the sensitivity of the otoliths to particle motion. The otolith organs are acting as vector detectors. Ambiguities in determining direction through vector weighing may be resolved by the use of a sound pressure detector as a phase reference (Schuijf, 1976).

In analysing the impact of pile driving and other anthropogenic activities upon fish, the focus has always been on propagated sound pressure, rather than particle motion. Detection of particle motion is, however, important to all fish, including those which are specialised to detect sound pressure.

The stimuli produced by pile driving

During pile driving sound or vibration propagates not only through the water but also through the ground. Indeed, most of the energy is directed towards the ground and appears either as the downward movement of the pile, or as vibration of the substrate. Three main wave types are generated: compressive, shear and surface waves (Dowding, 2000). Compressive waves, like sounds, produce particle motions parallel to the direction of propagation of the wave. Shear or distortional waves produce particle motions that are perpendicular to the direction of propagation. Surface waves, or Rayleigh waves, are transmitted along the interface between the substrate and the water (and also interfaces between different layers within the substrate) and produce particle motions in a vertical direction and also parallel to the direction of propagation.

Below-ground impacts initially produce compressive waves. These waves propagate outwards in a spherical manner until they intersect an interface or boundary where shear and interface waves are produced (Figure 2). The propagation velocities of compressive, shear and interface waves vary. The velocity is highest for compressive waves,

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The impact of pile driving upon fish - *continued from page 24*

intermediate for shear waves, and lowest for interface waves. As the waves propagate away from the pile they therefore begin to separate. In addition, the waves decay at different rates and this decay is frequency dependent. Interface waves dominate at long transmission distances, the lower frequencies showing the least attenuation. Dowding (2000) points out that interface waves begin surprisingly close to a driven pile – within a few metres. The rate of decay is dependent upon the type of substrate.

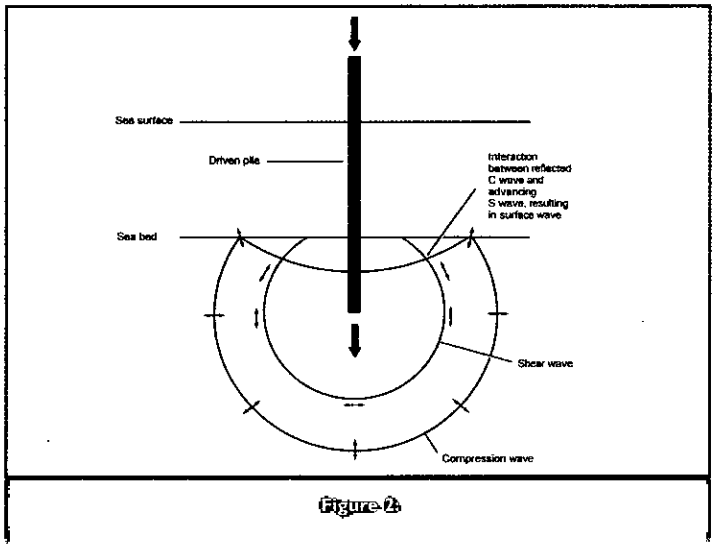

Figure 2

Particle motion generated by a pile driver, after Dowding (2000)

Although very low-frequency sound does not propagate well if it is generated in shallow water, the low frequency interface waves generated by a pile driver may travel considerable distances. Shallow water bodies overlying a substrate where pile driving is taking place will experience high amplitude low frequency particle motion from these interface waves propagating through the substrate. The motion will be transmitted several wavelengths above and below the substrate itself. Significant particle motion may therefore be evident in rivers and lakes at considerable distances from a pile driver.

Although a pelagic (mid-water) fish in a large and deep body of water, like the open ocean, may be primarily affected by the propagated sound waves generated by pile driving, in most realistic situations it is likely to be the interface waves which will have the greatest magnitude and impact upon fish. The fish most likely to be affected by pile driving are those living in shallow rivers or lakes, or in coastal waters close to the sea bed. In any event, the stimulus received by the fish will be greatly affected by the specific environmental conditions which prevail. Rarely are we dealing with simple expansion of a compressive wave-front under free field conditions. Under these more complicated conditions, and bearing in mind that the fish auditory system is primarily actuated by particle motion, it is especially important to measure particle motion directly – either as the particle velocity or particle acceleration. In practice, such measurements have rarely been performed.

Metrics

Some controversy surrounds the metrics to be applied to the stimulus received by the fish from pile driving. It is evident that both sound pressure and particle motion must be measured, and that one cannot be calculated from the other under the assumption that free field conditions prevail (except in the case of pelagic fish in a large body of water). Particle motion is a vector quantity, to be measured in three orthogonal directions, and close to the sea bed and sea surface that motion will predominately be in a vertical direction.

It is evident that pressure waves alone may damage the tissues of fish containing gas bladders. However, if damage to hearing, or to the otolith organ of fish, is being considered then shearing forces between the otolith and its sensory membrane will be especially important. Measurements of peak particle motion and sound pressure (for fish with gas-bladders), down to frequencies well below the natural frequency of the otolith structure, are necessary if clear criteria for damage are to be set. However, the potential of a given stimulus to cause damage will depend not only on its peak or rms level, but also its time-course.

In their report to Caltrans, Popper & Hastings (2005) reviewed the effects of sound (including those from pile driving activities) on fishes. They pointed out that the accumulation of energy over time may be significant in assessing the potential effects of exposure to transient sounds on fish and other aquatic animals. They considered that Sound Exposure Level (SEL) had a particular value as a metric for a single acoustic event. Because all SEL measurements are normalized to a one second time interval, SEL may be used to compare the energy content of different exposures to sound. SEL is calculated by summing the cumulative pressure squared (p2) over time and indicates the energy dose. The unit for SEL is dB re 1µPa2s. Hastings & Popper also point out, however, that the calculation of SEL inherently assumes a plane wave in which the acoustic energy flux (or intensity) is directly proportional to p2. Thus in many underwater environments, where the relationship between acoustic pressure and particle velocity is more complex, the total energy flux will not be equivalent to SEL.

Only recently has impact sound been managed with the intent of mitigating adverse effects on fish. The interim noise exposure criterion which the relevant regulatory authority in the US, NOAA's National Marine Fisheries Service, initially set for managing pile driving was a peak sound pressure of 180dB re 1µPa peak. While this value is often cited, the scientific basis for this value is not clear (see discussion in Hastings and Popper, 2005). Application of the peak pressure criterion on its own not only fails to account for the temporal characteristics of a single impulse (the rise time and the variation in peak or rms pressure within the impulse) it also fails to take account of the cumulative effects upon the animal of multiple strikes from pile driving. For these reasons a number of different metrics must be considered when setting protective criteria.

Popper et al (2006) developed new interim criteria for the onset of injury to fish from pile driving. A dual approach was adopted which included an interim single-strike criterion for SEL combined with an interim criterion for peak sound pressure level. The authors pointed out, however, that there were other characteristics of a sound which might have also an influence upon injury. The 'sharpness' of a sound (eg the ratio of peak to rms pressure, or 'crest factor') and its rise time might be especially important. In addition, the repetition of the sound and accumulation of energy over multiple exposures may have an additional effect. With multiple strikes, receipt of further sound impulses might occur before organs and tissues have recovered from the impact of the first. Popper et al (2006) proposed that interim criteria for pile driving be set at an SEL of 187dB re 1µPa2 s and a peak sound pressure level of 208dB re 1µPa for any single strike.

Concern over the cumulative effect of repeated strikes has subsequently resulted in changes to these interim criteria. Consultants to the California Department of Transport concluded that cumulative SEL criteria should govern impact conclusions and mitigation requirements for most pile driving operations. A recommended cumulative SEL criterion in the range of 183 to 189 dB was considered more stringent than a single strike criterion. An auditory tissue damage criterion of 189dB (SEL) was proposed where fish were greater than 2g in weight. Where very small fish (less than 0.5g) were present the cumulative 183dB criterion would prevail.

These interim criteria, expressed entirely in terms of sound pressure, are relevant where fish injury or damage to auditory tissues in fish with swim bladders is being considered. They are not appropriate if fish behaviour is the main concern. In many practical instances pile driving is taking place in shallow water or in other circumstances where substrate transmission will play an important role in determining the stimulus which reaches the fish. Many of the fish concerned are salmonid and other species which will be especially sensitive to low frequency particle motion. At present we do not know what levels

these particle motions reach, or what their effects upon fish will be. Further research is necessary.

Biological consequences of pile driving

It is evident that several different sound exposure criteria will be needed for fish. At its most extreme, pile driving may cause physical damage to the body tissues of fish. Damage to the auditory tissues may be monitored relatively easily (by observing damage to the sensory hair cells) and that is the criterion chosen by Popper et al (2006). Another criterion which has been put forward is hearing loss due to temporary threshold shift (TTS), which can be monitored as a diminution of auditory evoked potentials (AEPs). It can be argued that TTS may act as a proxy for change in the behaviour of the animal. In many instances, however, there will be concern that less easily observed, but nevertheless quite severe changes in behaviour may be occurring. The movements of migratory fish may be affected, preventing them reaching their spawning grounds. Fish may deterred from feeding, affecting their growth and reproductive success. There is a need to set criteria for true behavioural responses by fish. Establishing these behavioural criteria will require a more thorough knowledge of the range of responses shown by fish to sounds in the natural environment. Some responses will be transient, including startle responses or mild escape responses. They may not have a lasting impact upon the fish. Others, including cessation of feeding, disruption of migration or displacement from a preferred location affect key biological functions and may have more severe or even permanent effects both upon individual fish and upon fish populations.

Conclusions

Much of the work to date on the hearing abilities of fish has been performed under poor acoustic conditions and must be treated with great scepticism. In particular, the sensitivity of many, if not all, fish to particle motion has largely been ignored. Further investigation of the impact of large particle motions upon fish is especially important.

When pile driving is carried out, sound or vibration propagates not only through the water but also through the substrate. Compressive, shear and interface waves are generated which can result in large particle motions being generated at a great distance from the source. Conventional analysis of the pile driving stimulus as a sound pressure wave propagated through water does not adequately describe the signal which will be received by fish inhabiting lakes, rivers and shallow coastal waters. Direct measurements of these particle motions are needed.

Although much attention has been devoted to establishing criteria for auditory tissue damage in fish as a result of pile driving, those criteria have been expressed only in terms of measured sound pressures. Such criteria only apply to fish living under idealised conditions and can rarely be applied to fish exposed to real pile driving operations. Although their development has taken understanding forward in terms of considering the temporal aspects of the stimulus, and the cumulative effects of repeated strikes, they have still to address the problems experienced by the majority of fish affected by pile driving. New criteria, expressed in terms of both sound pressure and particle motion, are required.

Increasingly, regulators will be considering the impact of pile driving and other noisy activities not only in terms of injury or auditory tissue damage but also in terms of disruption to the behaviour of fish. Sound exposure criteria will be required which consider those changes in behaviour which will have a lasting impact upon individual fish and populations.

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Users' preferences for PAM systems

Peter Dobbins. Passive acoustic monitoring in the marine environment

Introduction

An online survey of users' preferences for PAM (Passive Acoustic Monitoring) systems is being conducted as part of an ongoing study to investigate the state of the art in PAM systems, and to find out where users consider the gaps in the available capability lie, and where further research and development should be aimed to meet their requirements. The survey is still online and can be accessed at **http://www.surveymonkey.com/s.aspx?sm=EpMS_2b7W2YaFypB6hbeGo9w_3d_3d.**

When the survey was initiated, it was advertised widely through mailing lists such as MARMAM [1] and Bioacoustics-L [2], Bioacoustics conferences, and personal contacts. At the time of this analysis, 113 responses had been received, mainly from researchers from academic establishments, government research organisations, and consultants and contractors providing PAM and MMO (Marine Mammal Observer) services for the oil and gas industry, as shown in Figure 1.

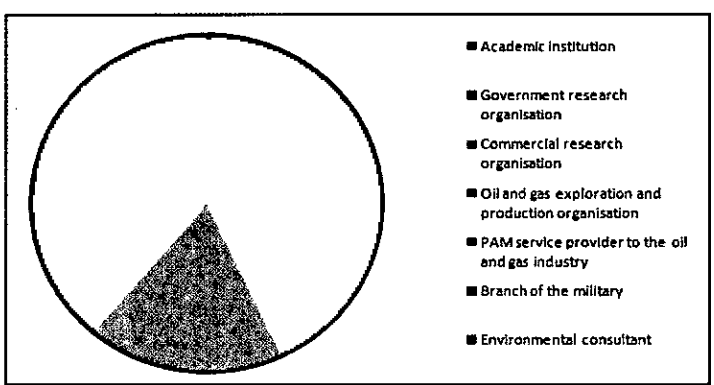

Figure 1

Affiliations of survey respondents

This article presents a brief summary of the response statistics, along with an analysis of the responders' comments, leading to conclusions regarding which directions the developers of PAM systems should take in the future.

Response statistics

The questions were divided into four main areas: PAM system applications, type of system, desirable features and general comments. The first three are considered in this section, and the comments are analysed later in the article.

PAM system applications

The questions asked under this heading were:

- What is your principal application for PAM systems?
- What sounds are you interested in monitoring?
- Which species are of most interest?

The response to the first question was mainly marine mammal research (71%), followed by environmental impact assessment and mitigation (18%), with a very few interested in fish research, data collection for information systems and population assessment (8% in total).

The answer to what sounds were of interest was essentially 'everything'. Responders were allowed to select as many of the listed sounds as they liked, and the results are shown in Figure 2. It was notable that all cetacean vocalisations were of interest, but the requirement to monitor other sounds was not insignificant and 55% wanted to monitor ambient and anthropogenic noise along with the biological sounds.

The answer to which species are of interest was overwhelmingly (96%) either 'all species' or 'all cetaceans'. The remainder tended to specify just one species or family, usually a small odontocete.

Types of system

The first two questions under this heading related to the system hardware and software and whether they were developed by the user or bought-in. The third question was about the type of deployment – towed, ship-mounted, moored and so on.

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Users' preferences for PAM systems - *continued from page 28*

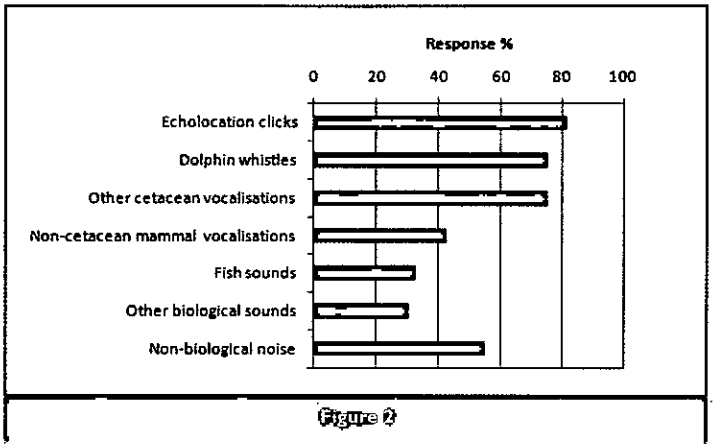

Figure 2

Sounds of interest to PAM users

System hardware was developed in-house by 33% of responders, bought in by 38%, hired by 8%, and the remainder said that the source depended on particular requirements for specific applications. The only off-the-shelf hardware mentioned by name in this answer was the T-POD produced by Chelonia Ltd (see eg [3]).

Responses for software were similar: 25% used dedicated PAM software, 15% used software that was an integral part of a bought or hired system and 29% had developed their own. Own software was mostly developed in MATLAB [4], while the specific PAM packages most frequently used were Ishmael [5], Raven [6] and RainbowClick [7]. One responder noted that PAMGUARD [8] was too unstable.

System deployment was mainly moored, tethered or anchored (69%), followed by towed (55%). Vessel mounted was just 14%, as was drifting buoys. Other methods (12%) were mostly either bottom-mounted or deployed from sea ice.

Desirable features

Responders were asked to rank a list of desirable features, and the results are presented in Table 1. The greyed cells represent the strongest response for each feature.

It is clear that the most important features, in order of importance, are ease of deployment, localisation in range, localisation in bearing, automatic detection and remote or autonomous operation. Localisation in depth, and species identification, were considered of less importance.

Of the other features suggested, robustness and reliability seemed important, along with an indication of detection validity, such as a predicted false alarm rate. There were also a number of interesting comments associated with this question: see below.

Issue	very important	important	doesn't matter much	not important
Ease of deployment	63.8	31.9	4.3	0
Automatic detection	44.7	40.4	14.9	0
Species identification	36.2	42.6	21.3	0
Localisation in range	52.2	37.0	8.7	2.2
Localisation in depth	19.6	37.0	32.6	10.9
Localisation in bearing	47.8	30.4	15.2	6.5
Remote/autonomous operation	39.1	39.1	28.3	21.7

Table 1 Important features of PAM systems: percentage rankings

General comments

The final question sought general comments, and a number of responders also added comments in their response to other questions. The most common was that much of the equipment that is currently available is of poor quality and reliability. One response summed it up quite neatly.

'If only the equipment was:

- *easy to use*
- *of high performance*
- *reliable*

...but current kit is not any of these!'

Again, the only hardware mentioned by name was the T-POD, but the user commented that these would be more useful if calibrated. Again, several responders commented on the instability of PAMGUARD.

These are sensible comments that developers should take into consideration. There were also a number of more naïve comments. One in particular was worrying.

'The hardware specs are really not that important and I would get away from calling it 'state of the art': it is not. It is a couple of analogue phones in an oil-filled tube. Apart from the difficulty in assembly, a school science student could wire it up. The really important end is the amplifier and processing software, plus the user's skill.'

This user presumably has little understanding of underwater sound or the physics associated with arrays and beamforming. If it really is so easy, it is hard to understand why the Navy uses kilometre-long towed arrays or flank arrays the size of a bus on submarines, rather than 'a couple of analogue phones'.

Among the other comments of note were a number saying that ownship noise was a problem, and more needed to be done about measuring ship noise characteristics. The answer is to look in the defence literature for ship noise characteristics or, preferably, deploy your sensor further from your vessel. There were also complaints about the lack of training available, but a brief trawl on the internet will find several PAM or PAM-related courses.

Conclusions

The main conclusions from this brief survey are that users want more reliable, robust PAM systems that are easy to deploy and preferably autonomous. They should cover the full range of sounds to be heard in the ocean and should be capable of localisation in range, localisation in bearing and automatic detection.

A secondary conclusion is that some respondents seemed to have little understanding of either acoustic propagation or the principles behind sensor arrays. Few seemed to realise that PAM is just passive sonar by another name, and that a vast body of academic research and applied development has been carried out by the defence community, much of which is equally relevant to the detection of marine mammals as well as submarines or torpedoes.

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Figure 3

Dolphins from Florida

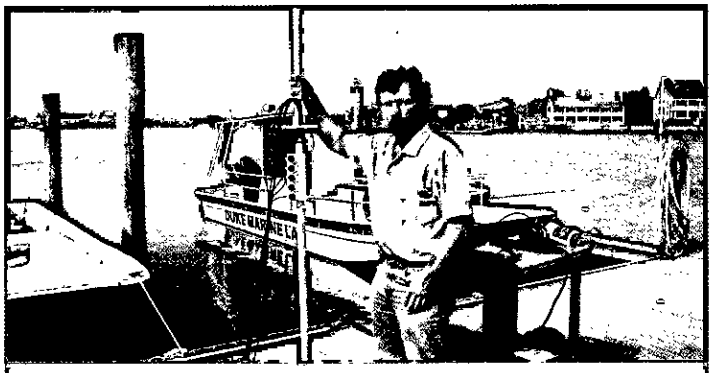

Figure 4

The author with a prototype compact PAM array

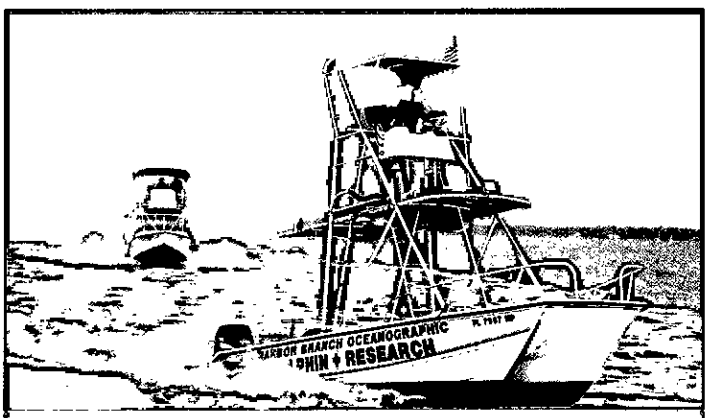

Figure 5

Harbor Branch Oceanographic Institute, Florida, marine mammal research boats

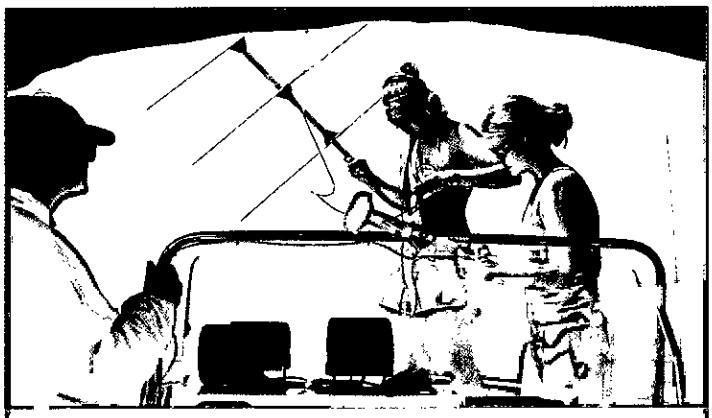

Figure 6

Students from Florida State University with marine mammal monitoring equipment

C'mon feel the noise (or, how green is my sound?)

Steve Jones.

Introduction

This article takes a fresh and pragmatic look at the traditional way of designing a sound system and its use in practice, in particular, the concept of using steady-state noise as a source for either sound pressure level (L_{pA}) or speech transmission index (STI) measurements versus real-world signals, and the impact on headroom and thus the financial and environmental costs.

Background

In the mid 1990's at Rangers Football Club, Ibrox, an HF driver blew up when trying to reach the specified maximum sound pressure level with pink noise, yet on the previous day, the system had been running at full power, broadcasting music, with no problems.

In 2006 at Bristol City Football Club, the old 'inadequate' system was measured at about 96dB(A) maximum, on axis, with pink noise. Just before to the match, the pitchside announcer was giving it his all, and a consistent 102dB(A) was measured off-axis on the outside edge of the stand with (subjectively) complete intelligibility.

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C'mon feel the noise - *continued from page 31*

In 2007 a potential upgrade to the system was proposed at Twickenham Stadium, and one possibility was to use the existing equipment rack locations and add further equipment. There was a question as to whether the mains supply had any spare capacity for the extra equipment and also how big the UPS needed to be. A current meter was inserted in the mains circuit and the current draw recorded before and during the match (for the remainder of the time the system was not used). Surprisingly, the peak figure of current draw was about one tenth of the theoretical load of the amplifiers.

So if a sound system 'measures' a certain sound pressure level in dB(A) with pink noise, is it really capable of more in reality when reproducing speech or music?

If it is:

(a) do we need all that power in the first place?

(b) if we do not, can we design for a lower level, with fewer amplifiers and less copper cable?

(c) if we can, can we also reduce the amount of secondary power (batteries)?

(d) will we save the client money?

(e) can we reduce the carbon footprint of a system by using less hardware and energy?

Design process

Perhaps, to understand where the 'over-sized' design comes from, it is necessary to look at the traditional design process. Only then will it become apparent which factors need to be taken into account to address the potential to reduce the design. In many respects it revolves around the measurement of steady-state sources in the acoustics domain.

A designer looks at a space, considers what it is to be used for, and what the likely ambient noise would be like when it is occupied. Indeed, the new BS.5839-8 actually gives the recommendation that if the space exists, then the ambient noise should be measured, but if it does not exist, then an equivalent space should be measured.

The measurement needs to be representative. For example, stadium noise should be measured as $L_{A10,t}$ during a representative event, whereas noise in a station concourse should be measured as $L_{Aeq,t}$ over a short period - say 1 minute - during rush hour.

From the noise measurements, the designer then defines and agrees the design sound pressure level to be at least 6dB above the noise (guidance in BS.7827 for stadia, and now also in BS.5839-8: 2008). The figure of 6dB above ambient has been shown to be the minimum required in order to achieve a STI of 0.5 in most cases.

Electro-acoustic design parameters

The design L_{pA} needs to be established. It is important to realise that the ambient noise is not usually consistent over time: a restaurant, for example, will be noisy when filling up with people, but quiet after they have left. The quality of the sound reproduction will also vary according to whether the reproduction is solely for messages, or is to reproduce background music or even foreground music.

The table below is taken from a hotel project where there was to be a mixture of uses of the sound system ranging from voice alarm, through background music to speech reinforcement and programme sound (as published in BS.5839-8: 2008). It shows the typical design criteria established at the initial design stage and subsequently agreed with the client.

This approach has the advantage of getting the client to 'sign-in' to the design and thus the associated costs. It is a step towards reaching the elusive goal of getting the right budget for the job. It also provides strength for any future discussions within the design team when the aesthetics or the loudspeaker locations are in danger of being compromised.

area/room	likely ambient noise dB(A)	usage noise increase dB	design L_{PA} dB	design coverage	design frequency response
Cultural centre	70	3	83	80%	300Hz to 6kHz ±3dB
Lounge	70	4	84	80%	125Hz to 12kHz ±3dB
Toilets	60	9	79	80%	300Hz to 6kHz ±3dB
Entrance lobby & lounge	73	6	89	90%	300Hz to 6kHz ±3dB
Bar lounge	65	9	84	80%	300Hz to 6kHz ±3dB
Speciality restaurant internal	65	9	84	80%	300Hz to 6kHz ±3dB
Conference room	70	6	86	95%	125Hz to 12kHz ±3dB
Meeting room	70	6	86	95%	125Hz to 12kHz ±3dB
Pavilion internal	68	6	84	80%	300Hz to 6kHz ±3dB
Health club - internal	68	6	80	80%	300Hz to 6kHz ±3dB
Health club - aerobics	75	12	97	80%	125Hz to 12kHz ±3dB

Table 1

Consideration of the available locations for loudspeakers is usually a good starting point. This then determines the type of loudspeaker which can be used. Calculations can help to prove that the desired level is achievable with the sensitivity and power rating of the devices. In addition to sound level (L_p), consideration should be given to the quality of reproduction. Is the requirement for music reproduction or just speech? The impact of music reproduction is very much that of the physical size of the loudspeaker.

CAD programmes whereby the space is modelled and the loudspeakers inserted are widely used for the bigger projects, but usually only for the bigger (and simpler spaces). The majority of designs still use the rough-and-ready 6dB loss for a doubling of distance, and a 3dB gain for a doubling of amplifier power. In either case, the power per loudspeaker comes from that calculation, and thus the amplification requirements can be defined. Add to this the desire to zone the system and the scope of the amplification is now much more granular.

It should be noted that 'zoning' may take the form of being able to address specific parts of a building separately, or it can be a large space where there is an identified focal point and the supplementary loudspeakers need to be delayed with respect to this focal source.

An example of such a requirement is at Earls Court Exhibition Centre where there is a huge 30m high hall which extends into a 7.5m high undercroft. The undercroft loudspeakers are therefore delayed with respect to the focal point loudspeaker and this means that each group has to have its own amplifiers driven from the delay line.

Secondary power

Whether using amplifiers capable of battery as well as mains power operation, or mains-only amplifiers and an uninterruptable power supply (UPS), the load will determine the amount of batteries and the size of the inverter. Secondary supplies attract some serious costs - in both economic and environmental terms - since the batteries need to be replaced about every five years.

Design of the 'front end' and the 'core'

The front end of the design will be dictated by the operational requirements. The system may be purely a voice alarm system which has message stores and maybe an emergency microphone.

Voice alarm systems will rarely be used in anger, but BS.5839-8: 2008 has been refined in respect of a greater emphasis on demonstrably acceptable intelligibility.

A system may be a combination of voice alarm and public address used for entertainment, such as in a modern football stadium, a racetrack of a cricket ground etc. The fact that it is of dual operational use does not reduce the requirement for intelligibility.

Additional sources, routing of signals to the various zones, and signal processing for operational, intelligibility, and circuit protection are all part of the systems design. Nowadays such signal processing is often done by a digital signal processor unit and custom-programmed at the time of installation.

On large sites, the amplification and signal processing is done in multiple locations, so distribution of the signals and control is usually carried out in the digital domain using computer network technology.

In the case of voice alarm systems there is also the requirement to monitor the critical signal path to ensure that any fault is flagged up immediately, and action can be taken to work around this whilst repairs are effected.

Not all projects are huge, nor are they complex, but the sources and control are integral parts of any sound system.

Financial and environmental costs

The ideal electro-acoustic system often has its critics on grounds of cost (in addition to aesthetics or loudspeaker mounting possibilities). Having explored the equipment required and put a cost to it, there is inevitably someone wanting the costs to be reduced. This leads to a re-think about how the electro-acoustic design was arrived at. That translates into the number of loudspeakers, and the amplifiers, and then the batteries for the secondary power source. At some stage the costs have to be agreed before the project can proceed. This may seem obvious, but all will soon become clear.

Nowadays the impact on the environment needs to be taken into consideration. It may not be obvious at first, but the more product that is used, the more its manufacture will 'eat' natural resources. By reducing the electro-acoustic system, fewer amplifiers would be needed and fewer batteries would be needed both immediately and through the life-cycle of the system. Indeed, if fewer loudspeakers were required in the process, then less copper cable would also be required.

COMMISSIONING THE SYSTEM

There may be a consultant involved who has specified the minimum L_{pA} and STI to be achieved. Alternatively there may be an agreed performance by another route, such as an agreed design criterion in a design-and-build contractor arrangement. At the end of the day, there are standards to be met, and proved to have been met.

Much of each space will require the same level throughout. For example it would not be acceptable for some seats in the bowl of a stadium to be much quieter than others. Indeed a lack of level will reveal a lack of signal-to-noise ratio which in turn will render those areas to be less intelligible (and possibly unacceptably so).

So how does one measure the evenness? Usually just using music and listening as one walks around the space is not specific enough, though the process is probably quite pleasant. Nevertheless, the system cannot be turned down from maximum all the time because it will not prove

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C'mon feel the noise - *continued from page 33*

that the evenness is achieved when the system is at full power. Some loudspeakers might not produce enough sound, or the amplifier for certain loudspeakers may be underpowered.

The usual method is to use pink noise as the source, turn it up to maximum and check that not only is the L_{pA} parameter met, but that there is reasonable evenness across the space.

Intelligibility measurement

There are many different ways of measuring intelligibility objectively, and these involve different sources. One of the most popular recently is that of STIPA, using a modulated noise to provide a source and measuring the modulation transfer function together with the sound pressure level.

In order to be relevant, the measurements need to be taken when the space is normally occupied and this would mean subjecting people to a horrible noise whilst asking them to act normally - an almost impossible feat.

As a result, most projects require that the measurement is carried out when there is nothing going on in the space, or at least nothing approaching normal use. However, this is what is called a 'noiseless' measurement. There are other methods which will not provide anything like sensible results if the signal-to-noise ratio is too great, such as minimum length sequence assessments (MLSSA).

For those methods which can use noiseless measurements the answer is to measure the noise and its level during normal occupation and then to 'contaminate' the intelligibility readings with the noise as part of a desktop exercise. This is known as post-processing. It is far from ideal because there is room for error and manipulation.

Another method is to measure the noise and its level during normal occupation, and then take a flat response source such as pink noise and shape it to the response measured using an equaliser. This can then be amplified and fed to a loudspeaker local to the STIPA measurement instrument. The normal occupation noise has thus been simulated, and is directly contaminating the STP reading. This is the method favoured by the author, especially in large spaces such as stadia, rail termini, racecourses and the like.

THE ISSUE OF HEADROOM

If the system reproducing the test signal has no headroom, it will clip the signal and be a form of distortion. Intelligibility measurements will then be low and even invalid. If, as one standard has in the past, a headroom of 6dB is required, this means that the electro-acoustic system has to be able to reproduce four times the sound pressure level and contains four times more equipment than the system which is on the brink of clipping. In addition, four times the equipment will require four times as much electricity to drive it on peaks and therefore four times the batteries (admittedly this is only one interpretation). Taking a more pragmatic view, 3dB headroom would seem more sensible, but this is still double the amount of equipment.

Headroom depends upon the source

What is the source operationally? Speech and music. What is our measurement source signal? Pink noise and STIPA tone. What is the difference? The energy under the curve. It is the energy which we need to look at, not the broad spectrum power handling. The energy under the curve is greater for test signals than it is for real-world signals.

The amplifier only draws the current according to the energy it needs to reproduce. Our commissioning measurements were therefore drawing ten times more energy than the real-world signals and that represented a huge amount of headroom.

Test signals and test levels

Test signals for sound systems are usually based on pink noise, a sound that contains every frequency within the range of human hearing and has been filtered to have equal energy in every octave. Whilst this may be very useful for testing equipment performance in the electrical state, it is not representative of the acoustical content of real-world sounds.

The various tests and alignments which are need to be carried out are:

- signal routing
- levels
- relative levels
- evenness of coverage
- equalisation

All of these can be carried out using pink noise. However, the maximum sound pressure level measured using pink noise will be a far more onerous requirement than for real-world sound signals, as will the STIPA intelligibility at maximum output level. This is becaue pink noise contains all the frequencies at once (constant) whereas real-world sound only contains some of the frequencies at any given time (dynamic).

IEC60268-1 recommends that pink noise shaped to the 'IEC simulated programme signal' curve, as shownin Figure 1, should be used for the measurement of temperature rise in sound equipment. This shaped noise represents continuous, somewhat compressed, music, and should be used at one-eighth of the non-clipped output power. It would

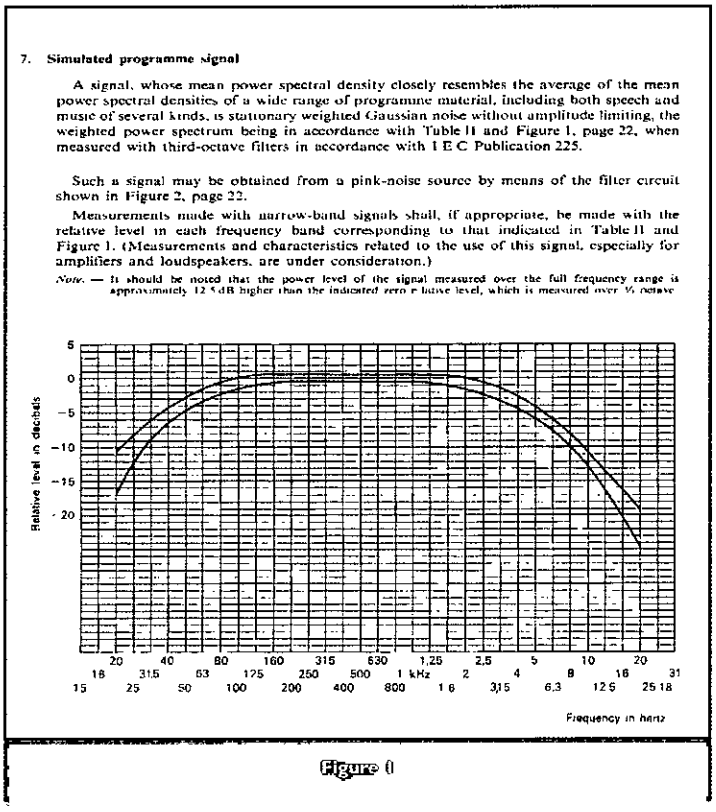

Figure 1

Power spectrum of simulated programme signal

therefore seem reasonable to carry out maximum power measurements at approximately -12.5dB of the system capability.

The curve was established from a series of tests by emininent engineers over a condiderable period, many years ago, and is still unchallenged even though it may not have been used much.

This reduction in level may have originated in the part of the Standard dealing with the temperature rise in equipment, but temperature rise is a function of energy, and it is possible that the precaution was put in place in order to allow for the difference between steady-state test signals and real-world dynamic signals.

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C'mon feel the noise - *continued from page 34*

Steady-state noise v real-world signals

The rig show in Figure 2 was set up in order to see how much difference there was between steady-state noise and speech in terms of energy consumption and system headroom.

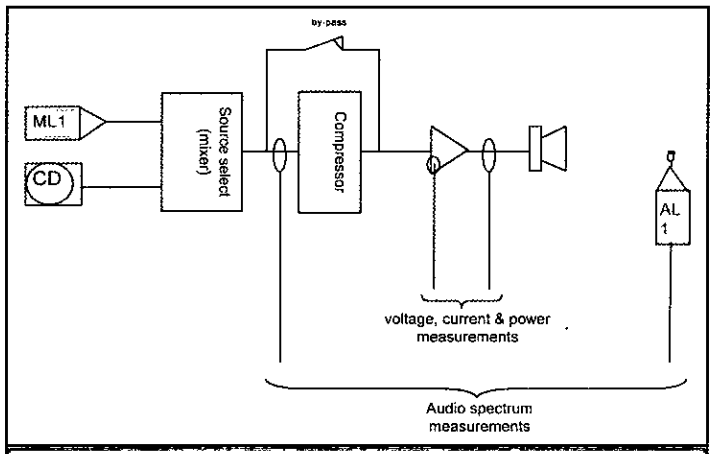

Figure 2

Schematic of test rig for comparison of real-world and steady-state signals

The research is still ongoing and the full results will be published separately at a later date. However it was observed that the speech signal required 18dB more gain in order to send the amplifier into clipping than pink noise did.

The energy of speech signals

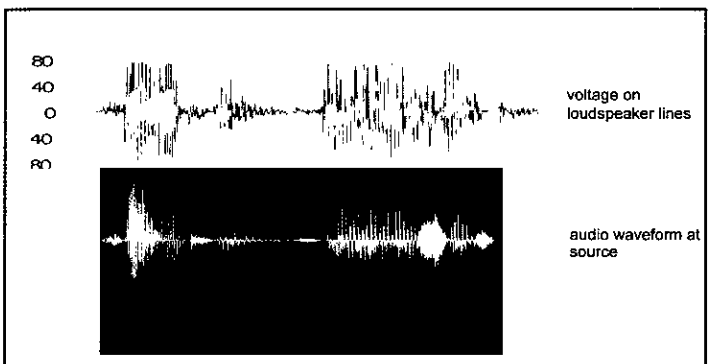

Figure 3

Reproduction of a typical speech signal

Figure 3 shows amplitude over time, which is analogous to energy over time. It can be seen that there is only a percentage of the energy that a steady-state signal would have. The question is, what percentage?

Sound intensity v loudness

To say that two sounds have equal intensity is not the same thing as saying that they have equal loudness. A meter can only measure the intensity of sound.

A loudness of 60 phons means 'as loud as a 60dB, 1000Hz tone'. Real-world sounds can be as loud as steady-state sounds even though their energy and intensity may be lower. We may be deluding ourselves by thinking that our meters are telling the truth – getting the message across is not the same as getting the noise across.

The equal loudness contours show that there is a difference in sensitivity at different sound intensities. In fact, the 'A' weighting curve was derived from a simplified version of the 40 phon Fletcher-Munson curve. At 1kHz, 1 phon is defined as being equal to 1dB of sound pressure level above the nominal threshold of hearing, where the sound pressure level is 20μPa. The phon is the unit of loudness and is a psycho-acoustical subjective measurement. Therein lies the rub: the key word is 'subjective', ie not using a meter calibrated by a UKAS certified laboratory, but the judgement of a bunch of real-world people.

When trying to explain why a message can be measured at 102dB and yet the maximum L_{pA} of the system is 96dB using pink noise, maybe the loudness is a more representative measure of performance than the sound intensity, because it is closer to the actual sound energy. In the world of loudness, as a rule of thumb, it takes ten violins to sound twice as loud as one violin.

Sound intensity v amplitude probability

Since the author presented a paper at RS24, some work has been done by a colleague on the statistical probablitity that one type of sound will be greater than another. One of the findings was that the probability densities of a gaussian (pink) noise signal was a bell shaped curve, whereas the speech signal looked like a spiked dome. The speech signal spends lot of time near zero amplitude, and reaches extreme values such as 3 or 4 times the rms value more often than gaussian noise.

The implication of this is that for real-world signals, compared with steady-state signals:

a) there are occassions when real-world signals will need a lot more amplitude capability in the system for transients, whereas

b) most of the time real-world signals will need significantly less amplitude capability.

How does this translate into system design? Well, if one examines the amplifier topology one finds that a Class D has the capability of handling transients and derives that little extra from the smoothing capacitors of its power supply.

The loudspeaker is rated as being capable of a certain sound pressure level based upon a broad spectrum source and a heavy 'average' of applications. In fact, for a signal producing one or two frequencies with transient amplitudes many times the norm, the driver can physically get out to that excursion and back on the odd occasion without damage.

Indeed, recent work has also shown that both subjectively and (to a certain extent) objectively measured intelligibilities are not adversly affected by amplitiude distortion (clipping) constituting quite a high percentage of the acoustic energy.

So all this business about having to design for high levels of unrepresentative broad spectrum signals (noise) and reproducing them with absolute perfection (no clipping) may be somewhat over-cooked.

The case for de-rating

Provided that the loudspeakers and amplifiers are capable of handling transient peaks to a degree, it is reasonable to design for a maximum output level equal to that degree, even though the theoretical system capability is lower.

The actual measurement of system output level under such circumstances would need to be taken using a real-world signal such as a pre-recorded message and measured as an $L_{eq,t}$ using a very short sampling period such as five seconds. This level and its intelligibility should be assessed subjectively at the same time in order to corroborate the measurement.

It would appear that there is a reasoned argument to de-rate the L_{pA} measurements when using shaped noise. There is also an argument for measuring STI using modulated noise, but de-rating the amount of noise contamination.

These arguments lead to considering both amplifier and battery sizing based on real-world signals, ie much smaller. The differences must be justified at the time of design and taken into account at the time of commissioning and included in the documentation. The critical (and

dangerous) factor is that it all depends upon the amplifier and loudspeaker capability to handle transients.

Work is ongoing to try to establish a guide or even a formula whereby systems can be safely de-rated when used for a particular purpose (fixed installations which are not altered) and use particular equipment (transient tolerant amplifiers and loudspeakers).

Conclusion

It is a tempting thought that a system which would normally be designed for 1000W of amplification could actually be powered by 120W, and all with the knock-on savings in secondary power batteries and maybe some loudspeakers. Nevertheless, even if a reduction of 50% in equipment could be achieved, it would represent a significant saving in both financial and environmental terms.

Steve Jones Associates is at Herne Bay, Kent.

Noise monitoring and control at the Oval

Clive Bentley and Gary King. ICC World Twenty20 cricket matches

The authors have recently completed an unusual project to control and monitor noise from the public address system used at the Kennington Oval for the floodlit ICC World Twenty20 cricket matches occurring during June 2009.

For those who have not been following the games, the PA system plays a short burst of lively music to inspire and entertain the crowd ('Another One Bites the Dust', 'Tom Hark' etc) every time a four or a six is scored, or a wicket falls. This adds to the ambience and excitement, according to those who like that sort of thing.

The organisers aim to achieve a level between 80 and 85 dB in the stands ($L_{Aeq,T}$, where T is the duration of the burst of music: generally between 10 and 15 seconds). After detailed consideration of local circumstances informed by the Sharps Redmore Partnership's survey data and discussions between all parties, the London Borough of Lambeth set a target level of 67dB at the nearest noise-sensitive premises (being 15dB above typical evening background noise levels – based on the guidance in the Noise Council's guide for outdoor events).

Whilst being eminently reasonable, this was felt to be a very challenging target since the closest facades are just short of 20 metres from the edge of the stands and there is no screening between loudspeaker locations and many of these flats (which are in a five-storey block).

Sound at previous events had been provided by the Oval's in-house loudspeaker system, which was primarily used for announcements. This is sited around the edge of the stands with loudspeakers pointing inwards, and was felt to be poor at reproducing music on its own. A series of loudspeakers was therefore added around the boundary of pitch facing up and outwards (towards the stands and beyond these on an uninterrupted path to the closest dwellings) to provide the necessary boost of levels.

First tests of the system were carried out in the snow in February, and without modification it was found that to achieve the levels desired within the stands, noise measured at an open window of a fifth-floor flat opposite was 78dB. The in-house loudspeakers were found to be rather omni-directional, with a level difference between front of loudspeaker and rear of only around 3dB. Hence sound spillage from the ground was quite significant to begin with.

After discussions with loudspeaker suppliers, a solution was found (after much tinkering and trialling a number of different set-ups) that involved the use of line array loudspeakers with a highly directional emission pattern. These effectively beamed sound into the stands with very little spill to other areas, as shown in the Figures for the 500Hz and 2kHz octave bands.

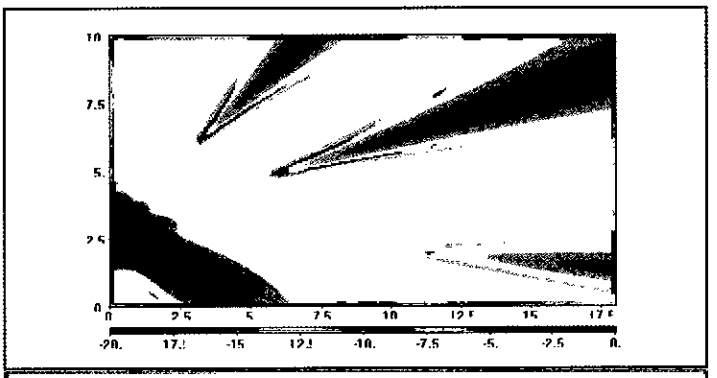

Figure 1

Loudspeaker emission pattern at 500 Hz (supplied by Ateis)

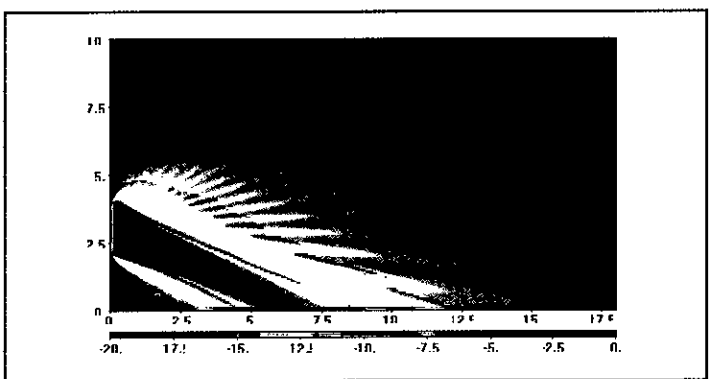

Figure 2

Loudspeaker emission pattern at 2 kHz (supplied by Ateis)

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Noise monitoring and control at the Oval - *continued from page 37*

The drawback of using these loudspeakers was their limited frequency range: they were unable to provide good sound quality at the lower frequencies needed for music, being more usually used for speech. However, it was found that if the sound from the line arrays was supplemented by low frequency sound from the pitch-side loudspeakers (with their output rolled off above 200 Hz) a very good quality sound could be achieved within the stands at the level desired without exceeding the off-site target level.

Figure 1

Setting up in the sun before the first World Cup Twenty20 match

The Oval installed these loudspeakers in place of its original system in the affected area of the ground and the system was trialled at a domestic Twenty20 cup match in May. Monitoring was carried out by Sharps Redmore Partnership during this match and during the first ICC Twenty20 warm up match (on 2 June). This allowed the sound engineers from K2B (who run the sound system) and Ateis (who supplied and set up the line array loudspeakers) to adjust levels to achieve a good balance around the ground, and took into consideration the presence of the crowd. After much fine tuning, the target off-site level was achieved with noise levels within the crowd at the closest stand of 80dB.

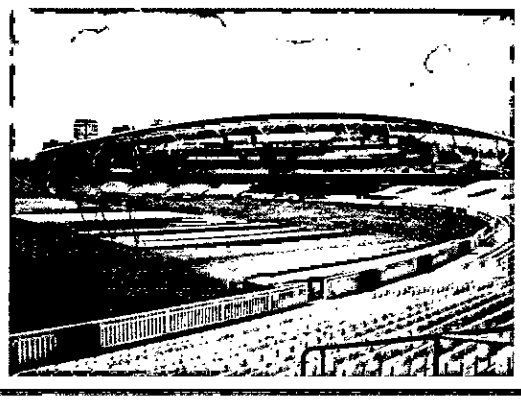


Figure 4

View across the pitch showing the pitch-side loudspeaker system

Levels for future matches will now be monitored by the Oval's own technical manager, Paul Plumridge, who has recently attended the IOA's Certificate of Competence in Environmental Measurement course, and who worked closely with SRP during the first matches.

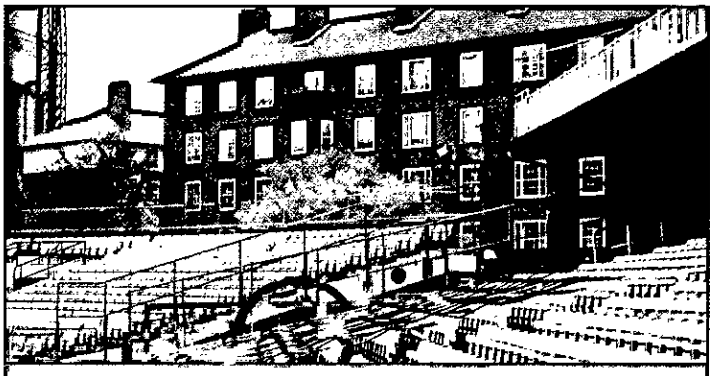


Figure 5

View across the stands showing the location of flats overlooking the ground

The project has been a great success since, despite initial objections and concerns being raised by nearby residents. No complaints have been received about noise from the event. Levels were described by one resident during the monitoring as 'much better than usual'.

Clive Bentley and **Gary King** are with the Sharps Redmore Partnership

Figure 6

View from fifth-floor flat window during testing in February 2009

Figure 7

Twenty20 match under way: a full house

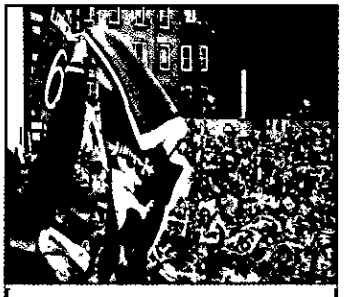


Figure 8

That's a six!

Industry News

Richard Tyler. Company moves premises

AVI CALIBRATION Ltd

AV Calibration Ltd is pleased to announce that a calibration service for Tapping Machines is now offered. Within a short time Reverberation Time Measurement will be added to the range of services. UKAS Accreditation is expected to follow within the next few weeks.

AV Calibration has also moved to bigger and better premises. From 6 July 2009 the company is based at 2 Warren Court, Chicksands, Shefford SG17 5QB. All the existing services for your noise and vibration equipment calibration are still offered, and phone, fax and email addresses remain the same.

For more details on the new or existing services ring Richard Tyler on **01462 638600** or email **lab@avcalib.co.uk**.

AVI Ltd

AVI Ltd is pleased to announce that the company is on the move. From 6 July 2009 it will be at new premises at 2 Warren Court, Chicksands, Shefford SG17 5QB. The company will still be offering bespoke advice, design, and supply of specialist instrumentation fro the measurement of noise and human response to vibration. Phone, fax and email addresses remain the same.

For more details please ring Richard Tyler on **01462 638618**, email **ales@avi.f2s.com**.

Wallsorba

Wycombe Police station interview rooms

Four police interview rooms and two solicitor interview rooms have been built by using Wallsorba acoustic wall panels to reduce the sound levels in rooms at High Wycombe Police Station. These acoustic wall panels were specified by Thames Valley Police for their high acoustic performance. Chris Duerdon, project manager for the rebuild said that the panels were made to the custom sizes which were requested, and were delivered very quickly. They were pre-decorated as they are available in a wide range of colours and all that was required of the contractor was to fix them to the walls using adhesive. He was very pleased with the finished job and would be using the product on future projects. Mark Anthony, the installation contractor, said that the panels were really easy to fit. He had found that they could modify the panels on site, which was a useful 'plus'. He wished all the company's work was as easy as fitting Wallsorba acoustic wall panels.

Recticel

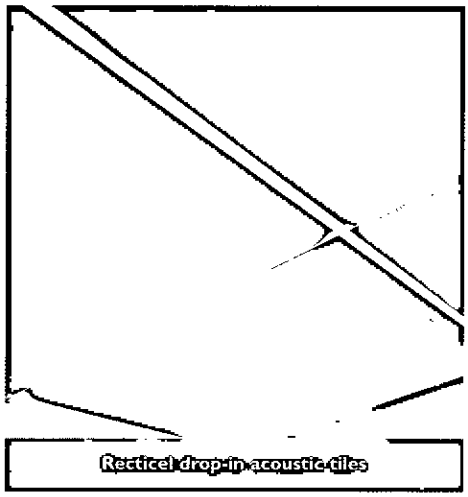
Recticel drop-in acoustic tiles installed at new factory

The new drop-in acoustic tile from the ANS (Anti Noise Systems) division of Recticel is quick and easy to install and is available in a number of RAL colours.

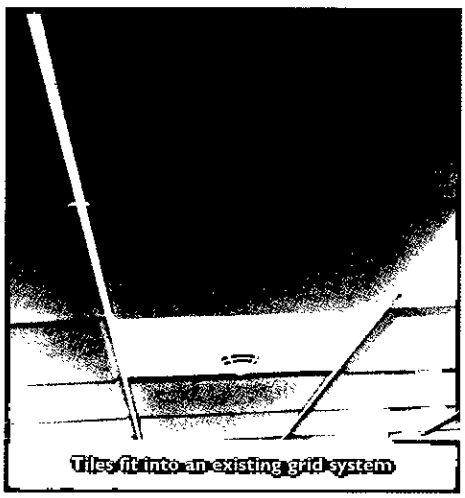
Recticel UK has recently treated the conference room of its new insulation factory using the new tiles painted to their blue corporate colour. The brand new purpose-built manufacturing site at Stoke-on-Trent produces rigid PUR and PIR thermal insulation boards for the construction industry.

Despite being built to the latest standards of construction the conference room was considered too reverberant for the numbers and types of meetings that were being held. The block walls of the offices managed to insulate the room effectively from the factory noise but were too reflective for the desired comfort of the occupants.

The existing suspended ceiling offered minimal sound absorption, being made from a hard finished glass fibre board. This was removed and the new tiles were simply laid into the existing grid. No additional fixings were required as the tiles located precisely.



Recticel drop-in acoustic tiles



Tiles fit into an existing grid system

Calculations showed that introducing a certain number of tiles would achieve the required reduction in reverberation. A mid-frequency reverberation time of approximately 2.2 seconds was reduced to just over one second, providing a more than satisfactory acoustic environment.

The room acoustics are noticeably better, according to Andrew Brown, facilities manager at Recticel Insulation, and it was ideal that the tiles fitted into the corporate colour scheme is ideal.

Recticel drop-in tiles are made from CNC contour cut Class O fire rated melamine foam and can be supplied with a painted surface to suit almost any colour requirement. The company is a manufacturer and supplier of technical foams to a wide range of industries and has established itself as an innovative market leader with a heavy focus on research and development.

It has been a licensee for Basotect® for over twenty years, complementing the existing range of high performing polyurethane foams which cover the acoustic, filtration, automotive and consumer markets.

For more information on this project and on other acoustic products please contact Chas Edgington BSc MIOA, sales manager for composite and acoustical products.

Tel: **01536 402345** fax: **01536 400524**

Web site: **www.recticel.co.uk**

CMS Acoustics and EWA

Realise architectural vision for £45m Merseyside College

CMS Acoustics, the UK's largest provider of acoustic solutions, has designed and manufactured a bespoke SuperPhon suspended absorber system for the new £45m St Helen's College, Merseyside, after EWA Architects conceptualised a 'floating' acoustic panel for reverberation control and BB93 compliance.

Responding to the brief from EWA Architects, CMS Acoustics used its in-house research and development team to design an innovative translucent hanging system that could horizontally suspend a 25mm thick SuperPhon suspended absorber. A number of prototypes were manufactured and tested on site, resulting in the development of a final system that achieved the illusion of floating combined with the required loadbearing and acoustical performance.

Managing the project through to completion, the CMS Acoustics technical team provided free on-site supervision to ensure that the contractors were effectively trained and competent in the approved installation procedure.

Richard Alonso, project architect, EWA Architects, commented that he was extremely impressed with the responsiveness, technical knowledge and manufacturing capabilities of CMS Acoustics. He had presented a challenging design vision that added a special touch to the teaching environment, and they responded with a cost-effective system that looked excellent, and more importantly, delivered on BB93 performance.

The SuperPhon range is designed to absorb high levels of reflected noise within a room to improve the listening environment. Panels are manufactured in standard 25mm and 50mm thicknesses, with bespoke thicknesses also available to order. Depending on panel thickness, the level of coverage and the installation method used, the absorption ranges from class D to class A.

Available in 40 standard colours and as wall mounted and ceiling suspended systems, the range facilitates flexibility in design while delivering cost-effective reverberation control. At St Helen's, a combination of suspended absorbers and wall panels was used throughout the new education development. A total of 320 panels were installed, covered with standard open weave fabric and in a combination of 'Adriatic' and white colour schemes.

A bespoke suspended SuperPhon system was used at St Helens College

The St Helens College scheme involves the construction of a new college and the demolition of existing buildings. The total area to be constructed is over 17,500m2, and the build will provide new facilities including a theatre, art rooms, fitness suites and administration areas.

For more information:

Tel: **01925 577711** fax: **01925 577733**

Email: **enquiries@cmsacoustics.co.uk**

British Tinnitus Association Annual Conference

Leading experts to be brought together

The British Tinnitus Association (BTA), the only charity in the UK solely dedicated to supporting those who experience tinnitus, is set to host its annual conference and AGM at Sheffield Hallam University on Thursday 3 September 2009.

The Conference will include a series of seminars from a number of world-leading experts in the field which will focus both on the latest developments in treatment as well as contemporary theories and research-based knowledge about tinnitus. Delegates will also have the opportunity to participate in a question-and-answer session following each presentation.

Sharon Atkin and Diane Kenyon pictured at the 2008 BTA conference

Expected to attract over a hundred people from across the country including healthcare professionals, ENT specialists, audiologists, members of the BTA and others who either experience tinnitus or have an interest in the condition, the conference has become well-established and follows the great success of last year's event which was attended by a record number of delegates.

Interactive in nature, the conference is highly regarded in the field as a means of ensuring the latest developments in clinical research are shared among both those in the industry and those affected by tinnitus.

The conference programme includes:

- Dr Ewa Raglan of St Georges Hospital, London will be speaking on *'Department of Health initiatives for tinnitus sufferers'*
- Dr Amr El Refaie of University of Bristol will be speaking on *'Contemporary theories of tinnitus generation'*
- Dr Veronica Kennedy of Bolton NHS will be speaking on *'Update of tinnitus treatments'*
- Professor Rene Dauman of University of Bordeaux will be speaking on *'From interview with tinnitus patients to questionnaires'*
- Tim Husband, chief audiologist/hearing therapist of Dewsbury and District Hospital will be speaking on *'Candles, coloured lights and other questionable cures for tinnitus - An evidence based review of alternative treatments'*

The prestigious Marie and Jack Shapiro Prize is also presented annually at the conference in recognition of the published research paper by a UK-based author most likely to result in improved treatment or public awareness of tinnitus.

To secure a place contact Krys Klytta at the BTA office on **0114 250 9933** or email **krys@tinnitus.org.uk**. A conference programme can also be obtained from **www.tinnitus.org.uk**.

For advice, support and information about tinnitus call the BTA free helpline on **0800 018 0527** or visit the British Tinnitus Association online at **www.tinnitus.org.uk**

The British Tinnitus Association (BTA) is an independent charity which supports thousands of tinnitus sufferers and advises medical professionals from across the world. Not an illness or disease, tinnitus is a term that describes the sensation of hearing a noise in the absence of an external sound. The noise can have virtually any quality. Ringing, whistling, and buzzing are common, but more complex sounds may also be reported.

Scottish noise advisory group

Environmental Protection UK

Environmental Protection UK is a national membership-based charity and has been playing a leading role in environmental protection in the UK since 1898. Based in Brighton we have ten regional divisions throughout the UK. The Scottish Division promotes the aims of the UK organisation and provides a forum for members in Scotland to discuss national issues and concerns and ensure that these are taken into account at the UK level.

Our Scottish noise action group (SNAG) aims to promote integrated policies and practices that encourage the effective management of noise in Scotland by providing continuity for the Scottish noise community. One way of doing this is by organising training events: to launch Noise Action Week 2009, SNAG organised a one-day workshop on the topic of noise and nuisance.

Nigel Kerr (Glasgow City Council, SNAG member and organiser of the event) said that dealing with noise complaints was a complex issue requiring a comprehensive knowledge of both acoustics and the law – this was highlighted on the day during some of the lively discussions within the workshop sessions.

Please check our website **http://www.environmentalprotection.org.uk/your-region/scotland/** for further information. Details of SNAG are available from **Iain McLellan**, Policy Officer: **iain.mclellan@environmentalprotection.org.uk**.

Environmental Protection UK – Scottish Division (formerly NSCA Scotland)

c/o Glasgow City Council, Land & Environmental Services

Tel: **0141 287 6530** Fax: **0141 287 6592**

email: **clare.carruthers@environmentalprotection.org.uk**

Registered charity number: 221026

Parliamentary reports

From Hansard

Commons Written Answers

23 March 2009: Highways Agency

Mr Winnick: To ask the Secretary of State for Transport (1) if he will make it his policy to direct the Highways Agency to accept requests from hon Members to accompany them to site meetings in relation to work authorised by the Highways Agency; and if he will make a statement; (2) for what reasons the Highways Agency decided that no member of staff would accompany the hon Member for Walsall North to a site meeting in his constituency on 20 March in relation to work being undertaken under the authorisation of the Highways Agency; (3) what mechanisms are used by the Highways Agency for public consultation on work it plans to undertake which is likely to affect households near the site of such work; (4) if he will make it his policy to direct the Highways Agency to notify each household in an area in which work authorised by the Highways Agency is to be carried out; and if he will make a statement.

Paul Clark [holding answer 20 March 2009]: The Highways Agency already accepts reasonable requests to meet hon Members either on site or separately on any schemes for which it is responsible. Representatives from the Highways Agency accompanied the hon Member for Walsall North to a site meeting on 20 March to discuss the details of the Active Traffic Management scheme currently being undertaken on the M6 in his constituency.

Where appropriate, the Highways Agency consults those likely to be affected by schemes being undertaken, and this was the case with the scheme on the M6. The Highways Agency has followed all environmental assessment and statutory procedures, including issuing public notices. It has listened to concerns raised, and has taken residents' concerns about current noise levels into consideration. An exhibition is planned where further issues can be raised. The scheme design has also been reviewed in the light of comments received.

Schemes carried out by the Highways Agency on or near highway land vary in complexity and scale. For schemes planned outside of the highway boundary, such as bypass work, the Highways Agency makes every effort to contact individual households and businesses likely to be affected.

Work carried out within the highway boundary tends to be of a relatively smaller scale, or is carried out as part of a routine maintenance programme. Although there is no statutory requirement for local residents to be contacted ahead of schemes taking place within the highway boundary, and it would be impractical and costly for the Highway's Agency to undertake to contact individual households for each one of these schemes, the Highways Agency seeks to ensure that public involvement takes place in a proportionate manner.

27 April 2009: Noise - Airports

Sir John Stanley: To ask the Secretary of State for Environment, Food and Rural Affairs when he expects the final guidance to airport operators on preparing noise action plans in accordance with the European environmental noise directive to be published.

Huw Irranca-Davies: [holding answer 23 April 2009]: DEFRA consulted on Guidance for Airport Operators on noise action plans in September 2008. The consultation period finished at the end of November and the responses received were evaluated. After making some amendments the final version of the guidance was published in March and copies have been placed in the Library of the House.

15 May 2009: Road Traffic

Mr Sanders: To ask the Secretary of State for Transport what recent research his Department has commissioned and evaluated on the effects of traffic congestion on the environment.

Paul Clark: The Department for Transport has commissioned research into assessing the cost of transport's impact on the natural landscape. The results of phases 1 and 2 of the study are reported on the Department's website at:

http://www.dft.gov.uk/pgr/economics/rdg/landscape/

In addition the Highways Agency is developing a methodology to account for the changes to the quantity of vehicle emissions that affect air quality that can result from major roads schemes.

Also, the Department is collaborating with DEFRA to manage research that DEFRA has commissioned to investigate the health impacts of environmental noise. Although the remit of the study is not confined to transport, it is recognised that transport is a major source of noise exposure to those who live or work near roads.

Although not recent, from 1998 to 2004 the Department ran a research programme - TRAffic Management and Air Quality research (TRAMAQ) - looking at the impact of traffic management schemes on air quality. Details of this can be found on the Department's website at:

http://www.dft.gov.uk/pgr/roads/network/research/tmairqualityresearch/trafficmanagementandairquali3927

There is also recently commissioned related research that is looking at the impacts, including environmental ones, of smarter choices, cycling initiatives, and sustainable travel measures generally.

10 June 2009: Transport - Coventry

Mr Jim Cunningham: To ask the Minister of State, Department for Transport what recent steps his Department has taken to reduce the effects on the environment in the Coventry area of public, road and air transport.

Mr Khan: The Government announced in December 2008 a series of changes to the Bus Service Operators Grant (BSOG) which is paid to operators of local bus services in England. Changes have been introduced to ensure that the grant is targeted more towards achieving environmental and climate change objectives. The changes encourage operators of local bus services in and around Coventry (and the rest of England) to achieve greater fuel efficiency by paying a higher rate of grant to any operator which achieves fuel efficiency improvements. In addition, an extra payment of 6p per kilometre will now be paid for all operations by low carbon emission buses.

The Local Transport Act 2008 requires local transport authorities, including Coventry, to have regard to Government guidance and policies on the environment when formulating their local transport plans and policies. Under European Union legislation, authorities are also required to undertake and monitor a strategic environmental assessment to ensure

the environmental impacts of any transport-related investment are fully considered. These requirements ensure consideration is given to initiatives to encourage walking, cycling and other forms of sustainable travel.

The Government have recently invested over £80 million in major public transport and road schemes in the West Midlands conurbation, including Coventry, to encourage greater bus travel and tackle the problem of congestion and the effects on the environment. These include the Coventry Primelines Bus Network scheme, upgrading the Urban Traffic Control Centre and the first phase of the Red Routes network.

With regard to air transport, the Department for Transport's responsibilities for noise mitigation measures do not extend to airports in the West Midlands. Noise restrictions at Coventry airport may be imposed voluntarily by the airport operator or by the local planning authority through planning conditions or agreements.

16 June 2009: Heathrow Airport

Justine Greening: To ask the Minister of State, Department for Transport what recent representations he has received from representative business organisations on his decision on the consultation on adding capacity at Heathrow Airport; if he will review that decision for the purposes of taking account of those representations; and if he will make a statement.

Paul Clark: Decisions on adding capacity at Heathrow airport were announced on 15 January following an extensive period of evaluation and widespread public consultation. The business community has generally supported expansion, recognising the economic benefits, although some business interests have since expressed different views. The Government's position remains unchanged.

Justine Greening: To ask the Minister of State, Department for Transport pursuant to the answer of 26 March 2009 on Heathrow airport, what the conclusions of the environmental assessment programme were on the likelihood of meeting the noise and air quality limits if Heathrow was expanded.

Paul Clark: As explained in the answer of 26 March 2009, the conclusions of the environmental assessment programme were as set out in the Adding Capacity at Heathrow Airport consultation document published in November 2007, namely that Heathrow could be expanded within the noise and air quality limits at the indicated levels of traffic.

Lords Written Answers

19 May 2009: Airports: Heathrow

Lord Taylor of Warwick asked Her Majesty's Government what was their latest assessment of whether a third runway at Heathrow will cause a significant increase in pollution.

The Minister of State, Department for Transport (Lord Adonis): The predicted impacts of adding a third runway were set out in the Adding Capacity at Heathrow Airport consultation document and supporting technical reports in November 2007. These show that a three-runway airport in 2020 with around 605,000 annual movements would be no noisier than in 2002, as measured by the size of the area affected by aircraft noise at 57 decibels or above; and concentrations of nitrogen dioxide (the key pollutant of concern) would be lower than they were in 2002.

Motorsport noise

Mike Fillery.

I read with interest the article by Andy Watson in the May/ June 2009 edition of Acoustics Bulletin. It is welcome news that the UK Motor Sport Association (MSAUK) is working on methods to achieve positive control of the environmental impact from motor sport events: however the method, as outlined, has several significant flaws.

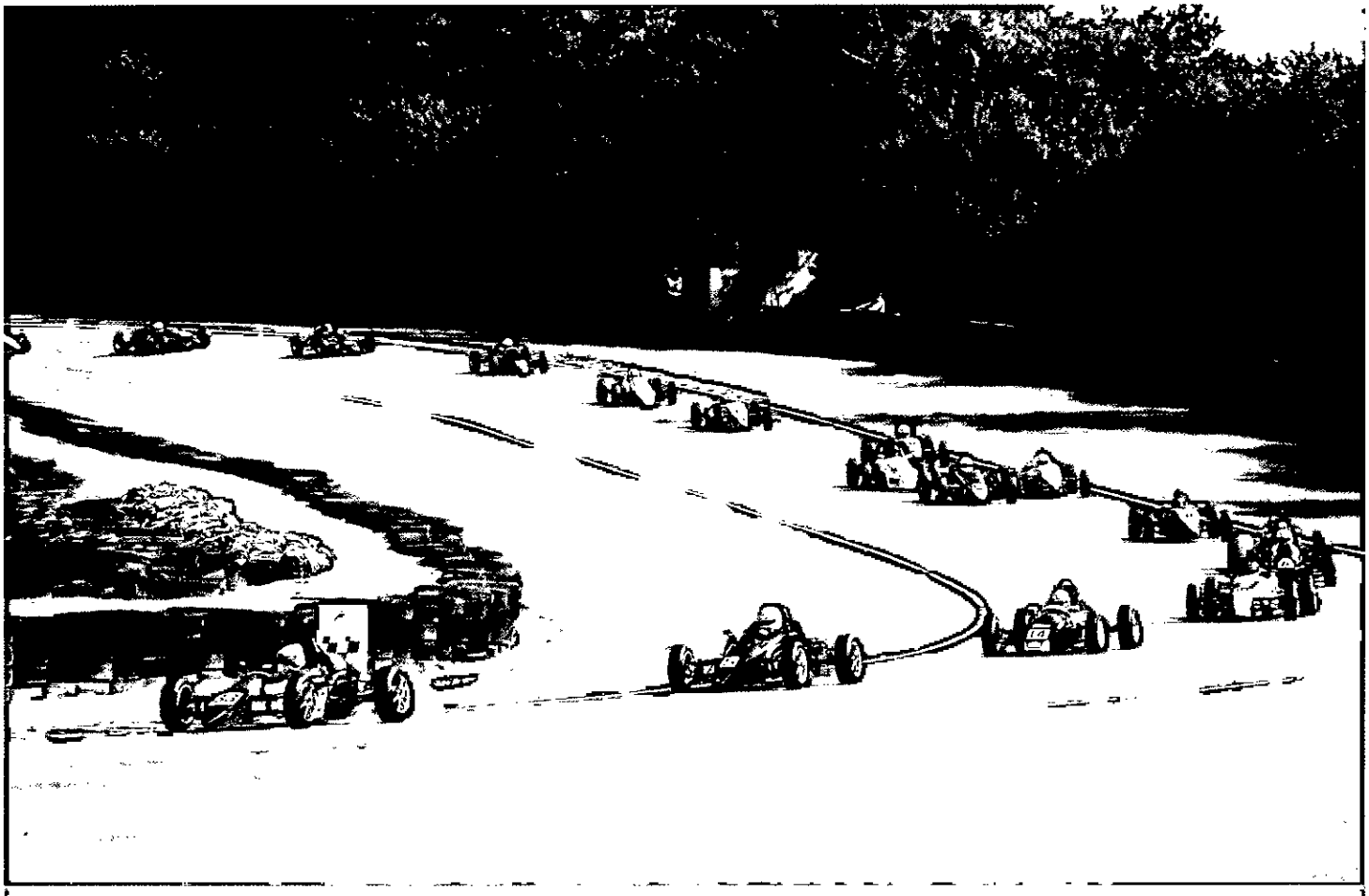
Basing the assessment of the environmental impact on a community level measured as $L_{Aeq,T}$ may be 'normal' for many noise sources but it is questionable that it is the best criterion for motorsport noise. I appreciate the attraction of using $L_{Aeq,T}$: it is readily measured, it is well established, it has authority (being used by WHO, PPG24 etc), but in my experience of dealing with complaints about motor sport noise it does not assess the likely impact of a motor sport event. Motor sport noise stems mainly from highly developed internal combustion engines that give the noise a character easily recognised by a listener. The noise is a series of transitory noise peaks as individual vehicles pass by. These peaks remain audible to all, and especially the vexed complainant, at very low noise levels often well below the prevailing $L_{Aeq,T}$.

For a number of years now the L_{Amax} has been the criterion used to control noise levels on 'Quiet use' days at Donington Park. The L_{Amax} limit for sensitive locations was set at 5dB above the ambient $L_{Aeq,T}$. To this community limit, the transmission loss to trackside was added, to give a trackside drive-by L_{Amax} for an individual vehicle. Continuous monitoring ensures that any transgressors can immediately be removed from the track, thus establishing a direct link between the environmental impact and the individual vehicle. This provides both circuit operator and the community with instant response to over-loud vehicles, unlike the delayed response resulting from a daily $L_{Aeq,T}$ limit. The LAmax may not be the 'best' criterion for motor sport noise but it does offer a practical and pragmatic measure that closely accords with community nuisance. It is also in line with the criterion already used by the MSAUK static noise tests for individual vehicles.

My other main concern is with the proposed method is the retrospective nature of the monitoring. Only after the event is finished is the daily $L_{Aeq,T}$ known. A more positive method would accumulate the noise load throughout the day, but then all activity would have to cease once the set limit was reached. I have personally witnessed a race officer being placed under considerable pressure, and risk to his personal safety, when a group of competitors were found to be over the static noise limit and were told that they could not race that day. How would a race officer deal with the situation when earlier events were noisier than anticipated and so the last couple of races could not run?

Where I am in wholehearted agreement with Andy Watson is the need for circuit and event operators to be more proactive in the control of noise from motor sports. If motor sport is to remain viable in the overcrowded UK then all concerned with the sport must take the issue of noise control seriously and formulate noise management programmes that are robust and forward-looking.

Mike Fillery



Highly developed internal combustion engines give the noise a character easily recognised by the listener

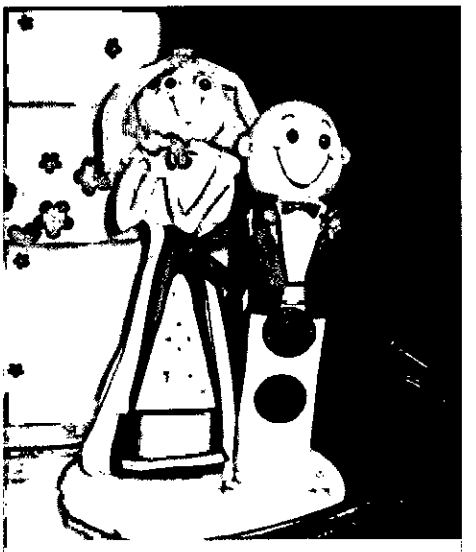
An acoustical wedding

Bridget Shield.

Anne Carey (secretary of the Building Acoustics Group) and Philip Budd were married in April this year. The wedding took place at the Ceilidh Place in Ullapool in the north of Scotland. Anne and Phil met in the acoustics department at Salford University, and both are pursuing careers in acoustics. They are currently living in Glasgow, where Phil works for the audio company Linn, while Anne is with New Acoustics and also completing her PhD at London South Bank University.

The couple tie the knot

There was an acoustical theme to the wedding as can be seen from the photograph of the wedding cake figures: the groom appears to be wearing a loudspeaker in the style of Linn Products' Klimax 350 loudspeaker on his lower half, while the bride's dress bears a strong resemblance to a well known sound level meter. Attractive as this couple were, the other photograph shows that the real couple looked even more glamorous.



Wedding cake figures

We offer Anne and Phil our congratulations and wish the couple many happy years enjoying acoustics together. We also hope that 'Mrs Budd the BAG Lady' will continue to serve the IOA for many years to come.

Stolen equipment

Hazel Wayman.

In what seems, sadly, to be an all-too-frequent occurrence these days, KR Associates (UK) Ltd would like readers to be aware that they have recently been the victim of theft of specialist equipment. A Brüel & Kjær sound level meter, type 2238, serial number 2163431, and a Brüel and Kjær microphone type 4188, serial number 2200771, were stolen at some time towards the end of June 2009. The theft was reported to the police, but obviously if anyone were to come across the items the firm would greatly appreciate being contacted.

Hazel Wayman, KR Associates (UK) Ltd, tel: **023 8055 0455**

Web site: **www.kra.uk.com**

AcSoft at Euronoise 2009

AcSoft announces several new releases at Euronoise 2009

AcSoft will be exhibiting at the forthcoming Euronoise 2009 conference on 26 - 28 October.

Stand 22 will be the focus for the latest revision of NoiseLab from Delta Acoustics, which is an easy-to-use and flexible tool for post-processing signal recordings from sound level meters and other devices.

NoiseLab now combines the analyser and batch processor into a streamlined user interface, making it easy to calibrate and edit files for calculation of all environmental noise parameters. The optional tonal analysis module is the only fully specified analysis package available for ISO1996 tonal calculations, ideal for wind farms or industrial sources, for example.

The package takes any .wav files which have been recorded on sound level meters, such as the Svantek 95x series, and post-processes both in time and frequency.

As well as AcSoft manning their own stand, all their major suppliers will be represented at the exhibition, on their own booths.

Svantek will be announcing the new Svan 979 sound analyser, which features colour OLED display, a first for a sound level meter, with very low power consumption. A successor to the powerful 959, the 979 features many options, including signal recording, real-time 1/n octaves and FFT, and building acoustics, as well as vibration capability.

The new SV200 intelligent environmental microphone will be previewed, which includes an environmental noise analyser built-in to the microphone unit, with connectivity via GPRS or WiFi. This low power device is designed for boundary or array monitoring, and is completely weather protected.

Svantek will also be introducing the SV101 whole body vibration dosimeter, and MIRE microphone for the SV102 noise dosimeter.

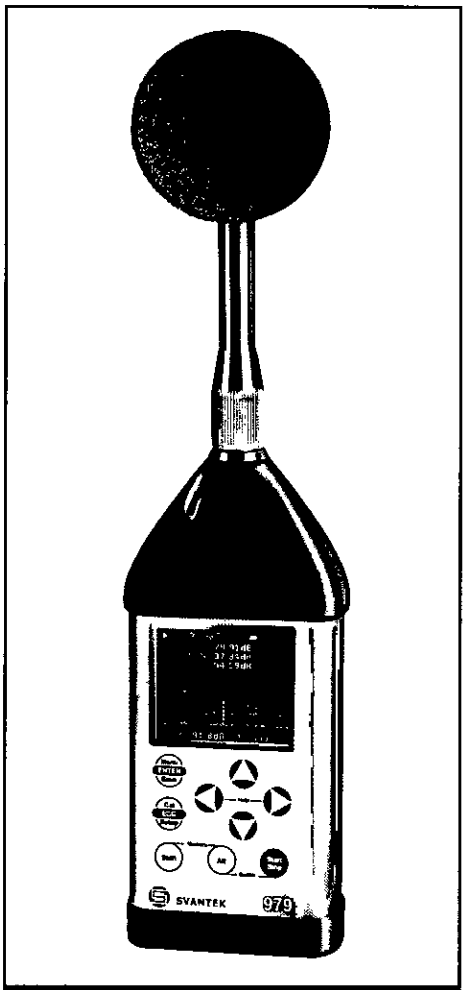
HEAD Acoustics will be showing their new HEAD Visor beam-forming system for real-time acoustic source location, along with version 11 of the advanced ArtemiS analysis software. The new HMS IV digital binaural head will also be on duty.

Sinus will be showing the new Hurricane multichannel front-end, which measures up to 32 channels of sound or vibration in a compact format. The Samurai software handles all the analysis in the same way as for the established SoundBook platform, for both environmental noise and vibration, as well as NVH applications.

Finally, **GFaI** will be showing their compact acoustic camera, with smaller array, and lower cost, and using the latest version 4 revision of the powerful NoiseImage software, for sound source localisation in environmental and industrial applications.

Considering there is a recession on, this lays out a remarkable array of new instrumentation to make life easier for the noise and vibration professional. Technical staff will be on hand to discuss specifications and applications.

For more information, visit **www.acsoft.co.uk**



AcSoft's Svan 979

Huet Euronoise 2009

One of Europe's leading manufacturers of high performance timber acoustic and fire rated doorsets

HUET HIGH PERFORMANCE DOORS

In 65 years, HUET has become one of Europe's leading manufacturers of high performance timber acoustic and fire rated doorsets. Their eight factories and 1100 staff produce over 15000 doors per week.

At an R_w value of 51dB the company offers one of the highest levels of acoustic ratings for timber doorsets available in the market. This represents a performance to suit the demands required in music rooms, recording and TV studios and sport auditoriums. With performance levels from 39dB to 47dB Rw, and their ultra-thin 41mm door leaf, Huet doorsets are ideal for hotels, meeting rooms and interconnecting rooms.

Stability of the door leaf is paramount to maintain acoustic performance. This is achieved by the inclusion of metal sheets and other materials, resulting in a door with less than 1mm of distortion.

For the education sector such as classrooms and music rooms, there is an extensive choice of finishes to choose from including laminates, veneers and a selection of vision panels to suit many applications.

Further information can be obtained from

Tom Moir

Huet High Performance Doors
Barking, Essex

E-mail: **tmoir@huet.fr**

Tel: **+ 44(0) 7977 120 905**

+44(0) 208 214 1218

Fax (UK): **+ 44(0) 208 082 5017**

Web site: **www. huet-doors.co.uk**

New products

Cirrus launches a versatile noise activated warning sign

Cirrus Research plc, the UK company which specialises in the design and development of noise measurement equipment for health and safety applications, has unveiled its new electronic noise activated warning sign – the Sound Sign.

The Sound Sign is a highly visible noise-activated warning sign that has been designed for use in environments where there is a need to warn or indicate when a designated noise level is exceeded. Easy to install and operate, it is controlled by setting a noise trigger level and connecting the 12v power supply to the unit. When noise reaches the set level, the Sound Sign illuminates and the warning information can be clearly seen.

Suitable for the management and control of noise levels in many different applications, the product is perfect for use in industrial workplaces. James Tingay, Group Marketing Manager for Cirrus Research says that in the workplace, noise surveys may indicate that at times, recommended noise levels are exceeded, but that the wearing of constant hearing protection is not required. By using the Sound Sign, employees can be quickly and easily informed when personal protective equipment (PPE) is required and when it can be removed. The sign remains inactive and blank when sound levels are at an acceptable level, removing any confusion that could occur with traditional warning signs.

Apart from health and safety applications, the unit can also be used in offices, libraries, hospitals and schools, with custom versions available with messages designed to inform about designated quiet areas. If there is a need to ensure that the warning can be seen over a large area, up to three remote display units can be quickly and simply connected to the master unit, mirroring the action and information of the controlling Sound Sign. The system can also be easily upgraded with a data logger which can record noise levels over long periods of time, allowing the user to detect patterns of noise.

The Sound Sign was previewed at the recent Safety & Health Expo, where the unique design and simple operation met with widespread approval and interest from many visitors.

Cirrus Research plc has over 30 years' experience of the design and manufacture of noise measurement instruments, and is accredited to ISO9001:2008. During that time, the company has developed a reputation for producing robust, practical equipment which can perform in real situations. All Cirrus equipment is made in the UK and the company is responsible for all after sales service and calibration work. Spare parts and support are therefore always available.

For further details:

Gill Cussons, Cirrus Research plc

Tel: **01723 891655**

Fax: **01723 891742**

Email: **gill.cussons@cirrusresearch.co.uk**

Web site: **www.cirrusresearch.co.uk**

Class 1 portable noise monitoring system

Brüel & Kjær releases a battery- powered, weatherproof Class 1 noise measurement kit

As unattended short-term to medium-term noise monitoring is a common requirement for consultants and local authorities, Brüel & Kjær has launched an 'all-weather case' to protect unmanned equipment.

The new 3535 all-weather case is a compact and lightweight enclosure for the noise monitoring system, which includes a sound level meter and outdoor microphone. As measurement integrity is crucial for noise measurement, uniquely the combination of the 2250 noise analyser and 4952 outdoor microphone is type-approved to provide Class 1 measurements to IEC 61672-1:2002. This ensures that the measurement system complies with the minimum requirements of accuracy for unattended noise measurement, a consideration often overlooked in portable noise monitoring systems.

Two small slim-line lithium ion battery packs provide the power to operate all equipment inside the case. This type of battery has five times more power-to-weight ratio than the equivalent lead-acid batteries traditionally used in similar systems. This provides 12 days of daytime monitoring with a case weighing less than seven kilograms. The batteries can be recharged in the case, 'hot-swapped' in-situ allowing uninterrupted measurements, or the unit can be run off a mains electricity supply.

High speed internet based communication is provided by one of the 3G or GPRS modems supported in the case design, allowing remote data retrieval and monitoring of the real-time noise levels. Events such as noise conditions, low-battery power levels, memory storage status, calibration status and many other user-programmed trigger conditions are instantly emailed or sent by SMS text message to the user's PC or mobile phone.

The 3535 supports the new SDHC high capacity standard for SD memory cards, which allows up to 32GB of data storage on one SD card offering the convenience of long periods between data retrieval tasks, with the flexibility to store long duration, high quality sound recordings to enhance assessment.

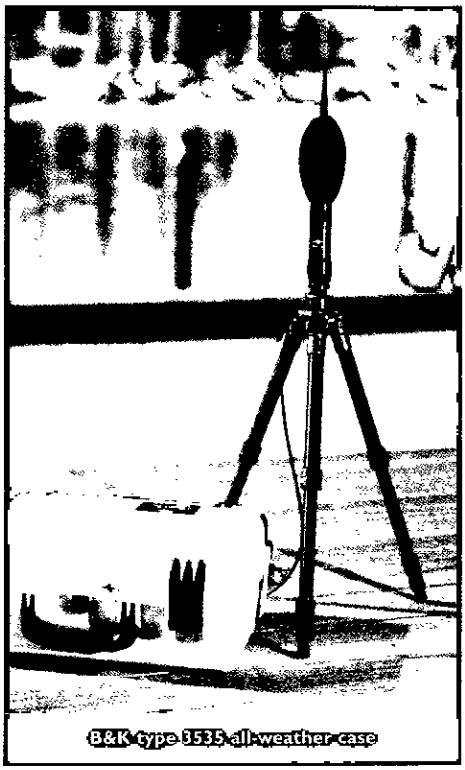
As measurement integrity is very important in any noise monitoring exercise - particularly when the system will be left unattended for many days or even weeks – the patented charge injection calibration allows regular auto-checking of the measurement system to ensure the continued and accurate operation of the unsupervised monitoring system.

Brüel & Kjær's 3535 case is suitable for many different environmental applications including environmental impact assessment and planning, building construction noise assessment, concert and sports venue licensing, assessment of road, railway and aircraft noise, industrial process licensing and noise map validation.

Please note that to help the environment by saving paper usage, Brüel & Kjær is no longer printing copies of its bi-annual magazine. The magazine is now available as a downloaded PDF document for which customers can sign up online. Make sure you continue to receive your copy of Brüel & Kjær's magazine by sending your full name, company name and email address to bkmagazine@bksv.com.

Brüel & Kjær UK Ltd, Stevenage,
tel: **01438 739009**, fax: **01438 739099**

Web site: **www.bksv.co.uk**



B&K type 3535 all-weather case

Sound Reduction Systems

Acoustic insulation for suspended ceilings

Acoustic insulation innovators, Sound Reduction Systems, are proud to announce the launch of their latest SoundBlocker brochure

The new format sees the SoundBlocker system formed into ranges for ease of problem identification and specification, so that there is now a solution to every problem.

Modern offices and classrooms can be very busy, noisy places and as noise levels rise, so can stress levels, whilst productivity and comfort suffer. Introducing the Office and Classroom range of SoundBlocker products to the suspended ceiling will upgrade the acoustic performance of a standard suspended ceiling and significantly improve working and learning conditions.

Most businesses and organisations have areas where higher levels of privacy are required. Whether it is a private office or an interview room in a school or business, ensuring confidentiality and privacy in certain areas is essential. The Private Office range is ideal for giving a suspended ceiling a higher level of acoustic performance.

Buildings such as Government offices, hospitals, banks and police stations all have areas where speech privacy and confidentiality is paramount, such as medical consultancy rooms, police interview rooms and boardrooms. The Confidentiality range offers an extremely high level of acoustic insulation for suspended ceilings installed in these types of environments.

The Entertainment range is for use where extreme breakout of sound through lightweight ceilings will cause serious environmental issues. Applications include nightclubs, cinemas and industrial buildings positioned close to residential properties.

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Committee meetings 2009

DAY	DATE	TIME	MEETING
Thursday	3 September	10.30	Membership
Thursday	10 September	11.00	Medals & Awards
Thursday	10 September	1.30	Executive
Thursday	17 September	11.00	Publications
Thursday	**24 September**	**11.30**	**Council**
Thursday	1 October	10.30	Diploma Tutors and Examiners
Thursday	1 October	1.30	Education
Thursday	8 October	11.00	Research Co-ordination
Thursday	15 October	10.30	Engineering Division
Thursday	5 November	10.30	Membership
Tuesday	10 November	10.30	ASBA Examiners
Tuesday	10 November	1.30	ASBA Committee
Thursday	12 November	10.00	Meetings
Tuesday	17 November	10.30	CMOHAV Examiners
Tuesday	17 November	1.30	CMOHAV Committee
Thursday	19 November	11.00	Executive
Wednesday	25 November	10.30	CCENM Examiners
Wednesday	25 November	1.30	CCENM Committee
Thursday	26 November	11.00	Publications
Thursday	**3 December**	**11.30**	**Council**
Tuesday	8 December	10.30	CCWPNA Examiners
Tuesday	8 December	1.30	CCWPNA Committee

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.

Meetings Programme 2009

26-28 October 2009
EURONOISE 2009 - ACTION ON NOISE IN EUROPE
EICC, Edinburgh

19-20 November 2009
REPRODUCED SOUND 25 - THE AUDIO EXPLOSION
The Thistle Hotel, Brighton

29-30 April 2010
Joint conference IOA with ABAV and supported by EAA
NOISE IN THE BUILT ENVIRONMENT
Ghent University

24-28 July 2011
Joint conference IOA with ICBEN
ICBEN 2011
Imperial College, London

Further details on all conferences are available on the IOA website **www.ioa.org.uk**

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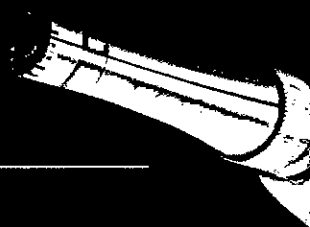

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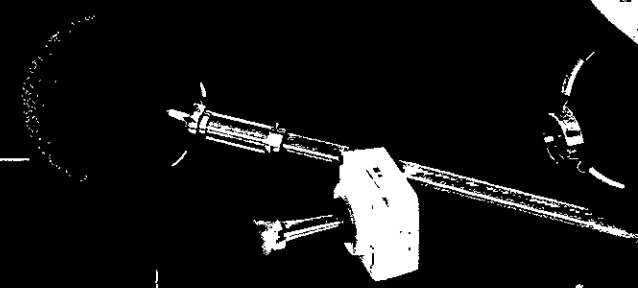

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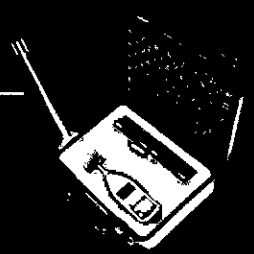

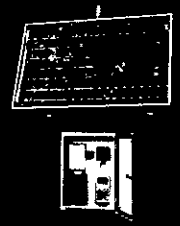

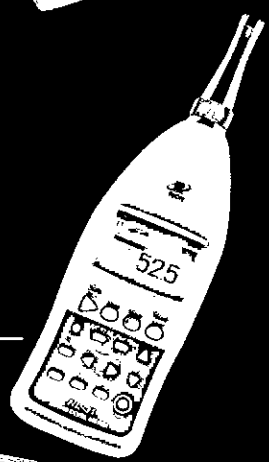

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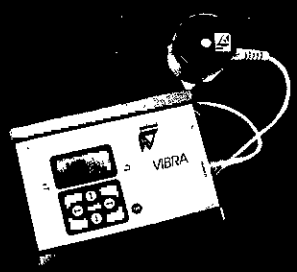

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