Vol 36 No 3 MAY/JUNE 2011

ACOUSTICS BULLETIN

in this issue... Annual Report 2010

plus... Chameleon subwoofers arrays in live sound
Sound insulation through open windows
Noise breakout from a public entertainment venue

Institute of Acoustics

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ACOUSTICS BULLETIN

Vol 36 No 3 MAY/JUNE 2011

Contents

Front cover photograph: Picturesque waterside locations were a common feature of several of the IOA's conferences in 2010, ranging from the navigable rivers of northern Europe (Noise in the Built Environment, Ghent) to the narrow canals of England (Practical Acoustics in an Ever-changing World, Birmingham) and the revitalised Cardiff waterfront (Reproduced Sound 2010). The front cover photograph shows the river Schelde near Het Pand, Ghent University.

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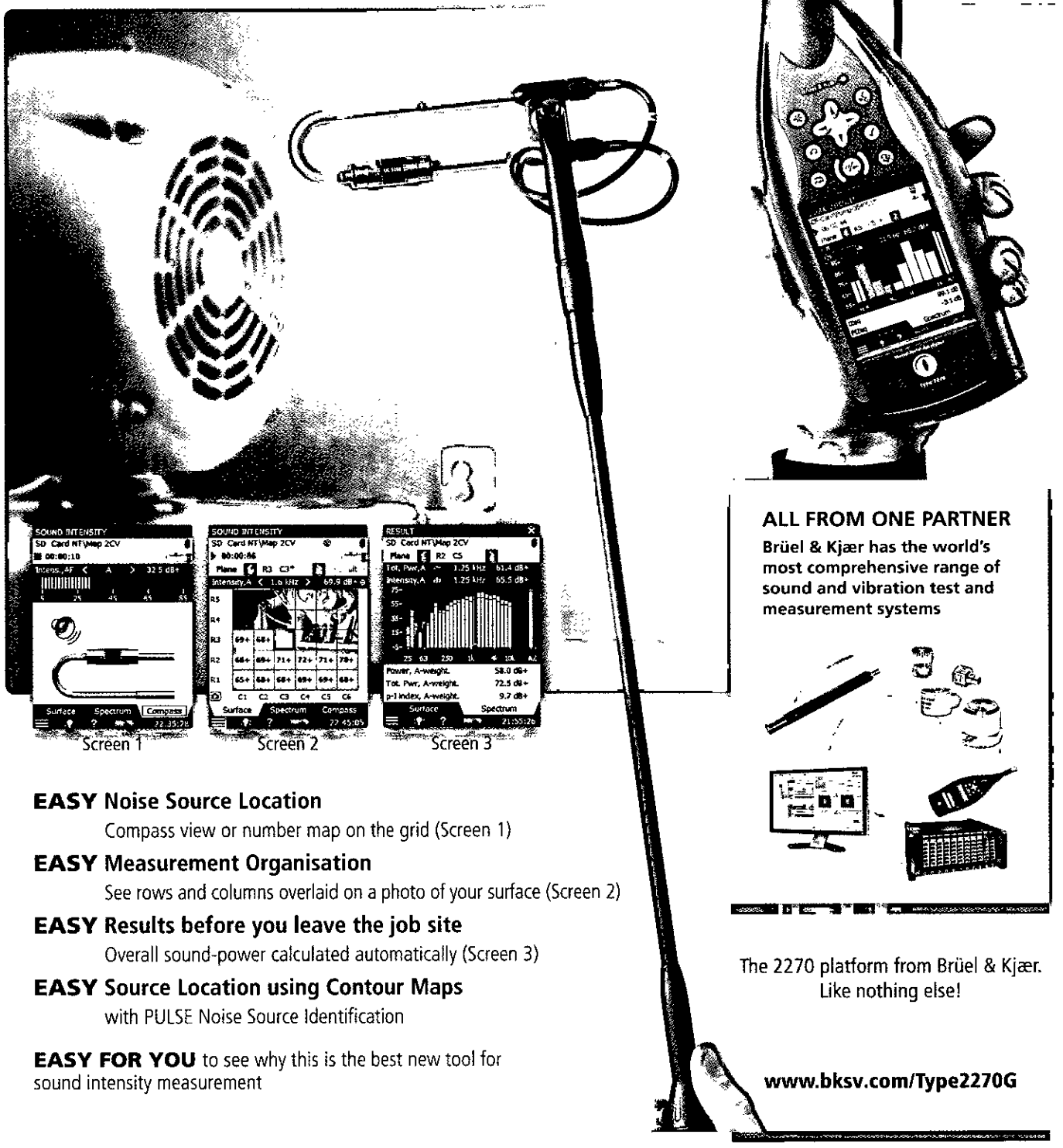

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Dear Members

My local ice cream van plays a jolly rendition of Popeye the Sailor Man. But this soundmark of summer, or more specifically the rules governing the noise levels of ice cream van jingles, is apparently a serious enough problem to warrant a comment from business minister Mark Prisk: 'When the man from Whitehall is telling Mr Whippy how to sing, something has gone wrong'. This is one example of how acoustical rules and regulations are under intense scrutiny by the government. Another example comes from the budget which included an announcement about simplifying planning to boost development, but this might lead to poorer quality developments and a subsequent increase in noise complaints – detailed proposals are still to be published.*

Interestingly, these stories emerged just a few days before the World Health Organisation and the European Commission's joint research centre published a major report on the 'Burden of disease from environmental noise'. Unfortunately for the government, there is no information on the hot topic of ice cream van jingles, but instead there are lots of startlingly large numbers showing the impact of noise.

The report uses disability-adjusted life-years (DALYs) which combine the costs of early deaths together with the loss of healthy years into one measure. Headline figures include: 61,000 years lost owing to ischaemic heart disease; 45,000 years for cognitive impairment of children; 903,000 years for sleep disturbance; 22,000 years for tinnitus; 587,000 years for annoyance across the European continent. In these terms, the burden of noise is somewhere between a fifth and a third of the DALYs lost as a result of air pollution. In general, noise has a minor effect, for instance it is estimated to be responsible for 2.9% of cases of heart disease, but when this is multiplied by the large number of people suffering from heart disease in Europe, large numbers result.

It is hard to know whether to rejoice or weep when presented with these numbers. Rejoice, because the large numbers can be used in arguments with government. Weep, because behind these numbers lie personal stories of noise misery. But before we rejoice too much about the numbers it is worth looking in detail at how the estimates of DALYs were made. Like all good science, the methodology and assumptions are laid out in great detail. This enables me to see that the 45,000 years for cognitive impairment of children uses aircraft noise studies to estimate the effect of noise exposure on cognition, but then appears to use road traffic noise levels to estimate how many children are exposed! This is even though at a given sound level traffic (as the report itself states) noise probably has less effect on children than aircraft.

Reading the report I am left with an impression that a lot more research data are needed to make the estimate of DALYs more robust. Maybe some of that much-needed research will be reported at ICBEN (the International Congress on Noise as a Public Health Problem) in London in July. The conference will be an ideal time to network with experts. Maybe you could step outside onto Exhibition Road, buy a couple of cones from an ice cream van and chat about noise. The vans will be easy to find, following deregulation by the government, as they will be playing Metal Machine Music by Lou Reed or The Struggle Within by Metallica.

Trevor Cox

PRESIDENT

* http://www.bbc.co.uk/news/business-12706616

37th Annual Report

of the Council for the year ended 31 December 2010

The Institute has continued to serve the interests of its members through its established programmes in the areas of education, professional development, meetings and publications, and by providing representation in areas such as the Engineering Council, Standardisation and International affairs.

The Trustees confirm that in the exercise of their powers as charity trustees, they have had due regard to the published guidance from the Charities Commission on the operation of the public benefit requirements and the aims of the charity are carried out for the public benefit.

During the year:

- In December, a Groups and Branches meeting was held in St Albans, the first one since April 2008 and the fifth in the last ten years.
- One new team member joined the staff at Head Office during the year: Charles Ellis joined the team as publicity officer, replacing Debbie White.
- An ambitious programme of well attended conferences and technical meetings was undertaken at international, national and regional level.
- Nine formal applications for Chartered Engineer registration were submitted in 2010 and professional review interviews were held in May and December. Four were 'standard route' candidates, holding accredited degrees, and five were 'non-standard route' candidates. All were successful.
- By September 2010 the 'new' Diploma in Acoustics and Noise Control, now in its second year, recruited 112 new candidates of which 37 chose to study by the distance learning scheme. As a result of grades obtained in 2009/10, the Diploma has been awarded to 83 students.
- Planning has been ongoing throughout 2010 for ICBEN 2011 which will take place between 24 and 28 July 2011 at Imperial College, London. This is the first time in the conference's history that it will be held in the UK.
- The Institute's e-newsletter changed its format and frequency during the year. It is now monthly and consequently more relevant and up to date.
- The Senior Members' group was formed, Ralph Weston being appointed its first chairman.
- The Institute is represented internationally through the following members: Colin English (vice president, EAA), Barry Gibbs (director, IIAV), and Rupert Thornely-Taylor (director, IIAV).
- This year the Institute produced its first ever five-year strategic plan and this was submitted to the Engineering Council.
- The Institute sponsored one of the Noise Abatement Society's John Connell Awards in 2010.

Standing Committees

The operation of the Institute is guided by Council through standing committees concerned with Education, Medals and awards, Meetings, Membership, Publications, and Research co-ordination. There is also a committee of the Engineering division.

Education committee

The Diploma and Certificate courses have continued to recruit and to provide education and training for both members and non-members of the IOA. The education programmes and courses introduce many working in acoustics and associated professions to the Institute and help in the recruitment of new members.

In September 2010 the 'new' Diploma in Acoustics and Noise Control, now in its second year, recruited 112 new candidates of which 37 chose to study by the distance learning scheme. As a result of grades obtained in 2009/10, the Diploma has been awarded to 83 students.

To date the distance learning notes for the new General principles of acoustics (units 1-10) and *Environmental noise: Prediction, measurement and control* modules have been revised, edited and distributed. Revised versions of the Building acoustics notes are being prepared by Mike Fillery and Nick Conlan.

In 2009/10, the Certificate of Competence courses recruited as follows: Management of hand-arm vibration 15 students (12 passes); Environmental noise 142 students (118 passes); and Workplace noise and risk assessment 56 students (50 passes). The Certificate of Proficiency programme in anti-social behaviour (noise), which is run only in Scotland by Bel Education and Strathclyde University, attracted 43 students (40 passes).

There has been a reduction in numbers on courses generally, probably a result of the economic climate. The Diploma may also have been affected this time only by the change in syllabus. The Certificate of Competence course enrolment may be affected by a change of emphasis in health and safety from technical assessment towards generic risk assessment.

The issue of the postgraduate status of the Diploma has continued to be raised. The education committee has identified that the Open University accreditation schemes offer a route that is compatible with the IOA structure.

During the year the committee has accredited a new Diploma centre at Napier University and re-accredited centres at Ulster (Diploma) and Bel Education (ASBA and CCENM).

A proposed Certificate of Competence in Building acoustics measurement is being considered, with a firm expression of interest from Napier University. Following a request from the Electro-acoustics group, we are also considering the provision of short courses in specialist subjects, possibly associated with conferences and meetings.

The committee is seeking to expand the schools activities, to roll out the 'Acoustic Ambassador' scheme to other areas following successful co-operation with Setpoint in Herts, and to develop the sound insulation workshop devised by Richard Collman.

John Walker stood down after three years as chief examiner and six years as deputy chief examiner and we are very grateful for his excellent service in this role. The new chief examiner is Stuart Dyne and Neil Ferguson is the new deputy chief examiner.

During 2010, Clive Bentley resigned from the committee. We were pleased to welcome David Trevor-Jones as a member of the committee, although sad to lose him as chair of the Certificate of Competence in Environmental noise measurement, a position he has occupied since its inception.

The Education committee continues to be indebted to the support of its members, the work of the education manager and for the assistance provided by members of office staff.

Engineering division committee

The committee met three times during the year. One internal audit was carried out, with no non-compliances identified. The number of initial enquiries for registration from Institute members grew to 97 and the increase in numbers of candidates wishing to present themselves for interview continued.

Nine formal applications for Chartered Engineer registration were submitted in 2010 and professional review interviews were held in May and December. Four were 'standard route' candidates, holding accredited degrees, and five were 'non-standard route' candidates with diverse backgrounds. All candidates were successful.

Presentations on Engineering Council registration were given to consultancies and to students at ISVR.

Two new members joined the committee in 2009 and they have completed their training to become interviewers. The chair was also successfully passed from Dr Bernadette McKell to Richard Perkins at the May committee meeting. Bernadette was presented with a Distinguished Service Award in November for her services to the Institute.

With IMechE, the periodic degree-accreditation visit to ISVR took place in March, and a further five-year accreditation was granted for their BEng, MEng and MSc courses.

The Engineering Council granted the Institute a further five-year licence in January 2010, following the visit in November 2009. They commended the work of the committee and the quality of our new registrants and they encouraged us

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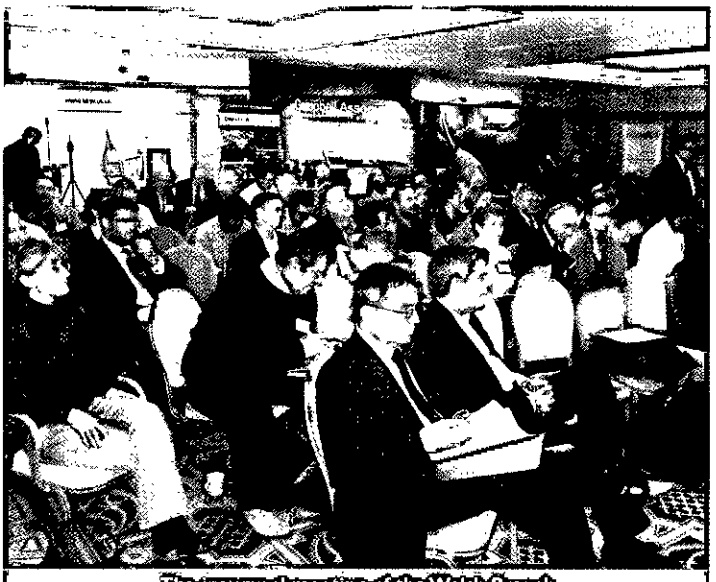
Charles Ellis, the IOA's publicity officer

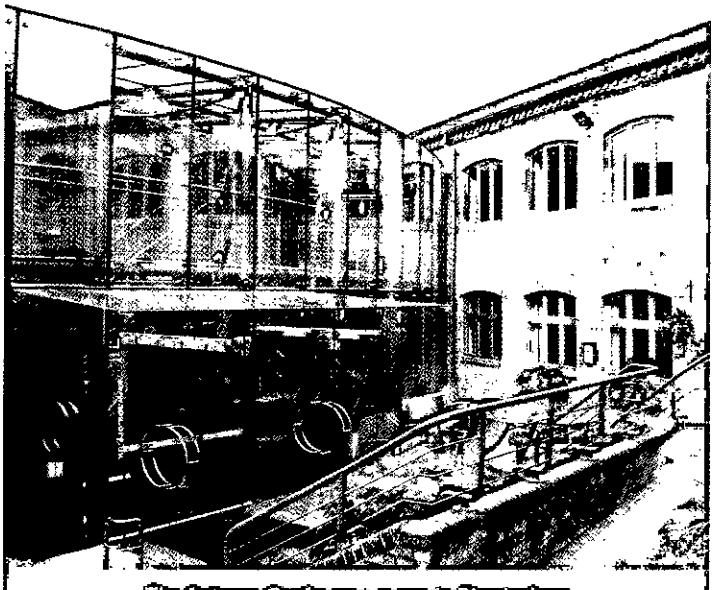


The inaugural meeting of the Welsh Branch was also the latest in the series on wind turbine noise

Andy Watson at the successful Motor Sport Noise meeting, Silverstone

Gwyn Mapp introduces Geoff Levethall at the Cardiff meeting

Trevor Cox took up the reins of the Presidency



The Autumn Conference venue in Birmingham

37th Annual Report of the Council - *continued from page 6*

to increase the numbers of members seeking registration. They recommended that the Institute develops a formal Risk Register, covering its full range of activities as a professional institution, and this work has been undertaken during 2010 under the auspices of Council.

Medals and awards committee

Professor Bob Craik was awarded the 2010 Rayleigh Medal at the Autumn Conference for his outstanding contribution especially in the area of statistical energy analysis. It was a busy conference for awards: the Engineering Medal was awarded to Alan Fry, Bernadette McKell received an Award for Distinguished Services to the Institute, Colin English an Honorary Fellowship and Darren Clucas the ANC prize for the best IOA Diploma project 2010.

The 2010 Tyndall Medal was awarded to Dr Olga Umnova at the Noise in the built environment conference in Ghent for her ground-breaking work modelling absorbers. Dr Mario Zampolli received the 2010 A B Wood Medal.

An Honorary Fellowship was given to Linda Canty and an Award for Distinguished Services to the Institute to Sue Omasta, both in recognition of their excellent work for the Institute over many years. Oliver Hetherington was given an Award for Distinguished Services to the Institute at the annual Gerry McCullagh Memorial Lecture.

The Award for Promoting Acoustics to the Public was given to Mary Stevens from Environmental Protection-UK. The Professor D W Robinson prize was awarded to Nicholas Crowe.

Finally, it was a delight to give Leo Beranek, one of the most famous acousticians in the world, the Peter Barnett Memorial Award at Reproduced Sound 2010.

Meetings committee

The Meetings committee met four times in 2010. The year has seen some change in the active members of the committee, as Hilary Notley returned from maternity leave to resume as secretary and a new recruit was found to fill the 'young member' role. The committee now consists of a chairman, secretary, young member (Chris Turner) and two other members, Ken Dibble and Paul Lepper.

The committee presided over the organisation of eleven meetings covering a wide variety of topics. The number is slightly down on the target owing to one postponement and one cancellation from those planned. Despite this, initial indications are that the financial target of an average surplus of £1000 for each meeting will be met or even slightly exceeded. The feedback from the meetings questionnaires continues to be very favourable. Given the global recession, the financial performance of meetings has been under some scrutiny and we continue to review performances and learn from our experiences so that deficits may be minimised in the future and meetings continue to generate a moderate surplus.

Membership committee

The Membership committee met four times. One new member has joined the committee which now has its full complement.

Of the 310 applications for membership that were considered, 281 were accepted. The majority of these were for new Associate Members and for Associate Members transferring to a Corporate Member grade when they had accumulated sufficient experience.

The committee again considered a number of Code of Conduct cases, with four new cases. This has been an increasing part of the committee's work in recent years. Many of these were resolved informally, but in three cases this year, formal action was taken. The committee regularly has to decide whether a complaint is really about a lack of professional standards (and competency in one case) or whether the complainant has simply not achieved the desired result in an inquiry and feels that the acoustical report is to blame. Over recent years the committee has in the majority of cases found in favour of members over complaints against them.

A regular discussion point during the year has been the role of sponsor members and the conditions attaching to them. This is likely to continue in 2011.

A continuing professional development team was formed to establish a policy and action plan for CPD, a much-discussed committee topic. CPD is now to be a requirement rather than an option for membership applications. We believe that the Institute is moving towards a clearer and more workable CPD scheme.

The committee instigated the formation of a Senior Members' group. This is now in operation and the committee wishes it every success.

2010	FIOA	MIOA	AMIOA	Tech	Affl	Student	Sponsor	Total
Applicants	9	117	120	18	10	32	4	310
Elected	9	99	110	15	14	30	4	281
New members	2	22	99	13	14	30	4	184
Resigned	6	83	77	8	17	16	14	221
Deceased	2	2						4

Publications committee

Throughout 2010 the focus of the committee has continued to be the Institute's web site. Following the launch of the revised web site in 2009 various concerns had been raised, and the opportunity has been taken to ensure that the web site can meet the requirements of the Institute and is able to undergo further development in the future. A sub-committee has been formed to manage this process, initially capturing the detailed requirements of the web site from Head Office, and from groups, branches and committees.

Acoustics Bulletin continues to be produced to a high standard, containing reports of the Institute's meetings and affairs, and a broad selection of technical contributions. The committee is always keen to receive technical contributions of all kinds for inclusion, so why not put 'fingers to keyboard' and report on your latest interesting work?

The e-newsletter has now become a focused monthly production, and is produced by Charles Ellis, the IOA's publicity officer. The IOA groups on the social networking sites Facebook and LinkedIn continue to attract a steady stream of interested people, now with over 700 on LinkedIn.

There have been several changes in committee membership over the year. Thanks go to all members of the committee, who have put in sterling work throughout the year, particularly to the web site sub-committee who have generously made substantial efforts with the web site project. Enthusiastic committee volunteers are always welcome.

Research co-ordination committee

The research coordination committee (RCC) seeks to involve academic members of the Institute in raising the profile of acoustically-related research in the UK and to monitor such research through surveys and formation of a database. During 2010 the RCC has had two meetings. Continuing activities include liaison with EPSRC and with government departments (particularly Defra) sponsoring acoustically-related research.

Dr Louise Tillman has continued as the EPSRC representative on the committee. New RCC members appointed during 2010 were Prof Jian Kang, Sheffield University, and Prof Kirill Horoshenkov, Bradford University.

Liaison with DEFRA continues to be important and, following the retirement of Richard Perkins, Yvette Hood has agreed to be their representative on the committee. DEFRA hosted both of the meetings in 2010.

The RCC was active on behalf of the IOA in nominating members and non-members carrying out acoustically-related research to serve as sub-panel chairmen or members for the Research Excellence Framework, which will be completed in 2014 and replaces the Research Assessment Exercise, the last of which was completed in 2008. One of the IOA nominees, Prof Philip Nelson, Southampton University, has been appointed Chairman of the Mechanical Engineering sub-panel. At the time of compiling this report, the results of nominations for sub-panel members had not been announced.

The chaiman serves as a representative on the publishing sub-committee concerned with the new IOA web site.

RCC continues to monitor and assist with arrangements for the joint IOA/SFA conference to take place in Nantes in April 2012.

Specialist Groups

The Institute reflects the broad spectrum of the science and application of acoustics and several specialist groups exist to foster contacts between members of the various specialisms.

Building Acoustics group

In 2010 The Building Acoustics group (BAG) has continued its mission of:

- delivering high quality educational meetings
- providing thorough and coherent consultations for new documents published in the field of building acoustics
- Promoting the IOA member acoustical consultants to the building industry both in the UK and across the rest of the world.

This has been another busy and successful year for BAG. It started with a collaboration between BAG and the Belgian Acoustics Association (ABAV) organising a highly successful meeting *Noise in the built environment* held in Ghent, Belgium in April 2010.

The main objective for 2010 was to organise the Autumn Conference, which took place in Birmingham. *Practical acoustics in an ever changing world* was a ground-breaking meeting where for the first time we joined forces with the Association of Noise Consultants (ANC) to provide another successful and highly educational two-day event.

To end the year a one-day meeting called *Symposium on school acoustics* gained sponsorship from a manufacturing company which increased the profitability of the meeting and also attracted an audience of which over 50% were architects.

In addition to the meetings several document consultations were carried out including the AIS Office Design Guide, PPS for Planning for a natural and healthy environment, Code of Practice for sustainable homes and the energy efficiency standard for zero carbon homes, and finally Planning for school development. This element of BAG's work is extremely important as it helps improve the quality of published documents.

2011 presents new opportunities with the different groups within the IOA collaborating to organise a meeting in Glasgow later on in the year. We have also been asked to speak at an acoustics conference in Saudi Arabia where we will have the opportunity to demonstrate the depth and excellence of the acoustical expertise within the Institute.

Thanks go to Peter Rogers who has recently stepped down as chairman and committee member of BAG. His leadership, tireless hard work and enthusiasm will be sorely missed.

Electro-acoustics group

During 2010, the Electro-acoustics group committee organised and put on the annual conference Reproduced Sound 2010, the annual two-day conference that has run every year since 1984. This was held at the Wales Millennium Centre in Cardiff and was once again well attended both by regulars and new faces. Feedback in the form of questionnaires was sought from the attendees and these have been scrutinised to inform future events, especially from the new influx of student attendees. It was announced at RS2010 that Reproduced Sound 2011 would be held at the Thistle Hotel in Brighton over 16 and 17 November. Themes will include high performance sound systems for sports and performance venues, audio networking and streaming and the design of venues for sound. The conference will be subtitled *Sound systems: engineering or art?*

At the EAG AGM held at RS2010 the 2011 committee was agreed. Paul Malpas remains as chairman, and Helen Goddard as secretary. Paul Malpas proposed thanks to Ken Dibble, who was standing down after over 25 years service to Reproduced Sound throughout its whole history. This was enthusiastically agreed *nem con.*

Environmental Noise group

The Environmental Noise group held no IOA events in 2010, but had a busy year responding to public consultations arising in part from the change of government and emerging changes in the planning system. The committee held five meetings and responded to seven consultations: DCLG permitted development rights for small scale renewables, DECC energy national policy statements (NPSs), DCMS Licensing Act exemptions, I-INCE guidance on noise assessment, CLG NPS on natural England, Royal Commission topics for future study, and the Defra nature of England White Paper. Members have made representations on various environmental noise policy groups and committees, including those considering wider permitted development rights, and the National Policy Statement for England.

Much of the work of the committee is not well publicised to ENG members, and it is hoped the forthcoming revisions to the IOA web site in 2011 will facilitate a broader exchange of information.

Measurement and Instrumentation group

The group committee organised two one-day meetings during the year at two new venues. *Motor sport noise* was held at the Silverstone racetrack on 18 March and attracted 79 delegates to the eight presentations plus a short tour of the noise monitoring facilities around the track. Proceedings were occasionally interrupted by noise from cars practising on the track, but everyone seemed to take this in their stride and enjoyed the day.

On 14 July we were at the British Museum for a very well-attended meeting on *Construction noise and vibration.* There were 121 delegates, who enjoyed eight presentations, including an extended one from British Museum staff about the difficulties in preserving their artefacts whilst building a new conservation and exhibition centre on the same site, and much interesting information emerged about BS.5228 and many large-scale construction projects.

For 2011 the group will be playing a full role in the Autumn Conference in Glasgow in September, with two sessions devoted to measurement and instrumentation topics.

Thanks go to all members of the committee for the active roles they take in all aspects of the group's activities and to Martin Armstrong for his secretarial skills on behalf of the group.

Musical Acoustics group

The Musical Acoustics group remains effectively dormant. Many of its former activities were duplicated with the establishment of the EPSRC funded UK Musical Acoustics Research Network, coordinated by Murray Campbell at Edinburgh University. An attempt was made to merge the two groups but, to date, this has not resulted in any new group activity. It would appear that either some new blood must be found to volunteer to revitalise the group, or we must accept that there is no longer a role for an IOA Musical Acoustics group.

Noise and Vibration Engineering group

Five main committee meetings were held during the year, generally by teleconferencing but with meeting in St Albans. The main focus of committee meetings was developing plans for events of interest to the NVEG membership.

A workshop on *Sound power measurement: Problems and practice* was held at the Health and Safety Laboratories, Buxton in early June. This was very successful, generating good feedback from delegates and interesting technical results. There are plans to repeat the event in 2011 at either HSL or ISVR.

A meeting on noise, vibration and harshness (NVH) issues in cars and other transport systems was planned for September 2010, but had to be cancelled because of the poor response to the call for papers. However, the committee's interests in NVH have now been strengthened by a new member, Andrew Wolfindale from Jaguar Land Rover, and a session on NVH is planned for the 2011 Autumn Conference.

Other plans for 2011 include the sound power workshop, two sessions at the Autumn Conference, and participation in a joint meeting with BAG on green buildings.

Joint IOA/IOP Physical Acoustics group

The Anglo-French Physical Acoustics Conference (AFPAC) was held in Kendal, in the Lake District, from 17 to 22 January 2010. This was a joint meeting with the France-UK GDR (group de recherche) network on *Ultrasonics for non destructive testing*, and brought together engineers and applied mathematicians from both countries. There were 110 attendees and the conference was widely acclaimed as a great success. The meeting was part-sponsored by the GDR.

A very successful AGM and tutorial day on physical acoustics were held at the Institute of Physics in London on 23 September 2010. Three external speakers presented tutorials accessible to non-specialists in their field. This year's theme was 'Ultrasonic transduction'. The Bob Chivers prize was presented to Dr Zheng Fan, of Imperial College, for his paper on Elastic waves guided by a welded joint in a plate.

The year saw the sad and untimely death of Prof Andrew Temple, chairman of the PAG committee, on 6 February 2010. His last great contribution to the group was to act as the local organiser of the AFPAC meeting in Kendal. Prof Victor Humphrey has taken over the role of chairman.

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Senior Members' group

Ralph Weston is currently acting as chairman.

The Senior Members group (SMG) was formed during 2010. The idea for a SMG began between some older members at the end of 2008 and continued at Euronoise in 2009. An ad-hoc group met in London in April 2010 to form the group and plan a future programme.

A committee was formally set up in November 2010 and an initial meeting planned for January 2011 at London South Bank University.

The initial programme includes gathering archive information about the IOA for a history project led by Geoff Kerry. The Young Members' group had asked the SMG if it could provide members who have experience of public enquiries to help at meetings and workshops on this subject. It is also planned that SMG members help out the IOA in mentoring and surveying CPD of members wishing to become full members of the Institute.

Speech and Hearing group

The Speech and Hearing group's first meeting of 2010 was a talk entitled *Voice analysis and hearing* by Prof Adrian Fourcin, Emeritus Professor of experimental phonetics at UCL and an Honorary Fellow of the Institute of Acoustics. This was held on 28 January 2010 and attended by some 25 people. It was followed by the group's AGM, attended by 22 IOA members.

The group also organised, jointly with the Centre for Human Communication at UCL, a successful one-day tutorial workshop on *Speech recording and analysis*, held in London on 22 April 2010. This was attended by 27 delegates and a report of this very successful day was written up by Ed Weston for Acoustics Bulletin. The group is hoping to repeat the workshop format at other venues in the future.

Further workshops on similar themes are also being planned.

Discussions are underway with the British Society for Audiology to plan and hold a joint workshop on *Good practice in speech audiometry* during 2011. The group is also liaising with the British Library to arrange a visit and talk on the UK speech archive.

There were four full committee meetings in January, July, September and December 2010.

During the course of the year, Peter Attwood and Mark Tatham resigned from the group committee. Rob Conetta and Graham Frost joined as ordinary members, and Phil Harrison (previously a co-opted member) was elected as an ordinary member of the committee.

Underwater Acoustics group

The major decision of 2010 was to accept a request to run the European Conference on Underwater Acoustics in 2012. This biennial event has not been hosted in the UK before, and we are grateful to Chris Capus of Heriot Watt University for taking on the local organisation in Edinburgh for July, a little before the Olympics.

The city of Edinburgh has been well tested by Euronoise and suitable venues are available. At the same time having Philippe Blondel (Bath) on our committee helps as he has past experience with the ECUA committee.

The second SAS conference at Lerici in Italy was organised by Hugh Griffiths and Gary Heald and was another success, with plans now being formulated for another, possibly in 2013.

The workshop in Cambridge was less well attended but we are grateful for the significant effort by Mike Ainslie, and understand that those who made the effort to run the comparative tests found it worthwhile.

So whilst Mike and Philippe have added their expertise we have lost Simon Richards, who has had to leave the underwater acoustics field: we thank him for his efforts.

Young Members' group

The young members' committee meets quarterly. We have a representative on most of the specialist groups and regional branches.

Young Members' representatives assisted with the organisation for the student event at Euronoise and continue to attend branch meetings and generally trying to promote the group.

Unfortunately, the group organised a half-day event at the Wales Millennium Centre that had to be cancelled owing to low registration numbers.

The group had an article in Acoustics Bulletin to introduce the committee members and has had postcards printed for handing out at future events.

Towards the end of the year all young members were asked to complete an on-line questionnaire, the results of which will be analysed to determine exactly what the younger members of the Institute want.

Regional Branches

The regional branches of the Institute exist to further the technical and social activities of the Institute at local level.

Central branch

The Central branch held three evening meetings during 2010 with an average attendance of around 16. The first meeting was *Do you get the shakes?* presented by Martin Armstrong which provided an informative and wide ranging round up of all things vibratory whether hand-arm, building damage or human perception and comfort. Andrew Parkin and Emma Greenland gave a popular talk on *BB93: Past, present and future* comprehensively covering what was in the title and patiently answering numerous questions. In October, Lawrence Grasty and William Egan hosted a visit to Brüel & Kjær's new premises in Royston continuing the vibration theme under the title *Why, shake, rattle and roll?* by talking about vibration testing and giving a tour of the factory in which large (up to 290kN) shakers are manufactured. Thanks are extended to all the speakers and the venues for hosting for the meetings.

Eastern branch

This year the branch had some wonderful presentations on a wide selection of subjects.

It tried to cater for various interests and also spread the meetings around within Suffolk, Essex and Cambridgeshire. An outstanding success was the guided tour of Snape Maltings in May which attracted a fantastic turn out on a glorious afternoon. Many members stayed on to enjoy a meal afterwards as a social event.

The branch broke new ground at its September meeting in which there was no speaker but a debate amongst the audience on the topic of *Noise from motor sports*. Attendees contributed towards the discussions with various levels of knowledge and all will have benefited. It is a format which may be repeated should a suitable subject matter become apparent or be requested in future.

The meetings held in 2010 are listed below.

17 February: *The next step for auditory safety in noise*, Rob Shepheard (Woodbridge, 19 attended)

17 March: *Noise control on large construction sites: Olympic park*, Stuart Monk (Colchester, 26)

29 April: *Noise control at the Oval. How's that?* Clive Bentley (Ipswich, 10)

20 May: Guided tour and presentation, Snape Maltings, Raf Orlowski (Snape, 38)

29 September: *Why is the violin so hard to play?* Prof Jim Woodhouse (Cambridge, 9)

21 October: *Noise from motor sports* debate led by Clive Pink and Colin Batchelor (Bury St Edmunds, 18)

24 November: *Towards silent aircraft*, Ann Dowling (Colchester, 26)

Irish branch

This year has seen two events organised by the Irish branch, as well as responses being made to consultation documents for the Clean Neighbourhoods and Environment Bill, the proposed revisions to the Building Regulations (Northern Ireland) 2011, and the Irish EPA guidance note on noise assessment of wind turbine operations at EPA licensed sites (NG3).

In February we held our AGM at the Ventac Acoustic Laboratory in Blessington, Co Wicklow. The AGM progressed and closed smoothly, with a number of

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committee members standing down and 'fresh blood' being brought on board. Standing down were Oliver Hetherington, Simon Hetherington, Eugene McKeown and Ray Walsh. A special vote of thanks goes to Oliver Hetherington who has been on the committee since the Irish branch was formed in 1998 and was secretary from its inception until 2004. New members of the committee are Sarah Middleton and Diarmuid Keaney.

In October we held the fifth annual Gerry McCullagh Memorial Lecture. An enlightening presentation entitled *The development and application of noise management policies* was given by Stephen Turner, director of acoustics, Bureau Veritas. As in previous years, it was a pleasure that Gerry's mother (Jean) and his widow (Rita) attended the lecture. The Irish branch annually presents a certificate for the best performing IOA Diploma student resident on the island of Ireland. This was not possible at the usual time owing to changes in the posting of results, but this year's certificate goes to Stephen Byrne who gained merits in all modules as well as the laboratories and project. It was also a special occasion as Oliver Hetherington was presented with an Award for Distinguished Service to the Institute of Acoustics for his efforts in the establishment and growth of the Diploma on the island of Ireland, and his involvement with the formation of the Irish branch. Both these were closely tied to his time spent working with Gerry McCullagh, and thus it was entirely fitting that the presentation was made at the annual memorial lecture.

London branch

Attendance at London branch meetings has been sustained compared with last year with a record 73 members reported at one evening meeting and typically over 40 attendees at most other evening meetings. It has been another very busy year which has included ten events including eight evening meetings, a one-day conference and our annual dinner. As usual, the topics for the evening meetings were very varied in nature, covering subjects from instrumentation through statutory nuisance and the topical 2012 Olympics to various sources of noise generated both in and outside the built environment.

The one-day conference was held in May in the prestigious Royal Society building in central London. The conference was on instrumentation and was chaired by Dr Bob Peters. There were presentations from six authors all of whom gave varied overviews as to the uses and new applications of modern-day instrumentation.

The annual dinner was held in November in the Bleeding Heart restaurant, which is renowned for its excellent French cuisine and friendly ambiance. This year's after dinner speaker was none other than former IOA president and pop-science television personality, Peter Wheeler. His talk, cryptically entitled *Taking tea with Wotan - tales of an itinerant acoustician* took us on the unconventional journey through his life as a teenage professional train-driver, scientist, chaperone to politicians and the royals, as well as an acoustician in industry and academia.

Our new home at WSP for London evening meetings has been very well received and has adequately catered for our numbers.

The meetings started with a fascinating presentation by Prof Ann Dowling who has completed research on quiet aircraft. She methodically went through all the noise sources of aircraft and provided engineering solutions to deal with each component. She finally concluded with an AV demonstration of aviation for the future. This was followed in February by Alex Krasnic who gave a light-hearted and informative presentation reviewing the acoustic design for speech privacy between offices in new developments and fit-outs. A double act was featured in March with a presentation by Dr Stephen Dance and Dr Bradford Backus. The speakers complemented each other in both style and delivery and presented their work on monitoring and reducing the noise experienced by classical musicians. The presentation looked at the issue from two aspects, one focusing on acoustics and the other on audiology.

The potential noise from the event of the century was next on the agenda, with Stuart Monk talking about the noise control and strategy concerned with the London 2012 Olympic Games. Stuart who is co-ordinating the local authorities through JLARS described the extensive monitoring and control processes that were being implemented at each stage of this extraordinary project. The next London evening meeting was in June, and was presented by John Pointing dealing with the often controversial topic of noise and statutory nuisance. John is a barrister practising in environmental and regulatory law and gave an excellent presentation reviewing case law and the use of best practical means as a defence. With over 70 members attending this meeting, it was a fitting conclusion before our normal summer break.

Our meetings resumed with a presentation from Nicky Shiers on her research in the acoustic environment in hospital wards. The project focused on general in-patient wards and consisted of a comprehensive series of noise, acoustic and questionnaire surveys. The preliminary results were interesting in that the use of technology, including medical equipment, communication systems and personal entertainment systems accounted for much of the high level noise and resulted in negative responses from staff and patients. Dr Carl Hopkins gave the next presentation in October. Carl's talk was on the spatial sampling of sound pressure in rooms and gave an excellent evaluation of the advantages and disadvantages of the various techniques available for room analysis. The final London evening meeting was in December and was given by Dr Richard Barham from NPL. Richard gave us all food for thought for future instrumentation by presenting his assessment of the latest microphone technology (MEMS) using the systems adopted in 'smart' type mobile phones. With some work on the frequency response, these types of microphones could soon be seen on our next generation sound level meters at replacement costs of tens of pounds rather than hundreds of pounds!

Exciting and interesting talks are already planned for 2011 and the secretary would like to take this opportunity to thank all the members of the London Branch committee and, of course, Kevin and Linda at HQ for all their invaluable support throughout 2010. All London Branch members are also thanked for their continued support at the meetings and, of course, all the speakers who have helped make the London branch such a success.

Midlands branch

2010 has again been a very successful year for the Midlands branch. It held 12 well- attended meetings with a wide and interesting range of subjects. This is the first time that the branch managed to deliver one presentation a month, and it is the intention to continue this for the forthcoming year. CPD certificates are handed out at all meetings and the objective is to provide a range of topics, and use venues across the region, to appeal to as wide as possible a range of the membership.

The meetings held in 2010 are listed below.

26 January: *Helicopter noise*, Paul Freeborn

2 February: *Open plan office acoustics*, Andrew Parkin

23 March: *Valuing noise nuisance*, Prof Abigail Bristow

21 April: *Sound insulation - round-robin testing*, Dr Robin Hall

10 May: *Aspects of occupational noise and vibration*, Paul Brereton, Paul Pitts and Andy Nash

23 June: *Light railway noise and vibration*, Dr Rick Jones

15 July: *The auditory brain*, Prof Dave Moore, Dr Bernhard Seeber and Prof Alan Palmer

25 August: *Wildlife sound recording*, Ray Goodwin

28 September: *Best IOA Diploma projects*, Mark Dring and Richard Twist

20 October: *Man-made noise in the ocean and its effect on marine mammals*, Dr Paul White

10 November: *Implementation of Noise Action Plans in England*, Stephen Turner (including branch AGM)

7 December: *Advanced development of automotive audio systems*, Kelvin Griffiths, Gabriel Ruiz and Adrian Cartlidge

The branch committee would like to thank all the speakers for their technical contributions, and the support from the various sponsoring venues who included Atkins, Birmingham; Arup, Solihull; Health and Safety Laboratories, Buxton; Institute of Hearing Research, Nottingham University; University of Derby; Loughborough University; and URS Scott-Wilson, Nottingham who all provided the vital facilities and refreshments.

Finally a vote of thanks to the stalwart members behind the scenes, including Kevin Howell for his reports in *Acoustics Bulletin*, and Andrew Jellyman for creating the CPD certificates.

The branch committee also held its traditional planning meeting, and an equally full programme of monthly meetings is planned for 2011.

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BAP Band entertains at the 2010 Autumn Conference Dinner

A Symposium on school acoustics ended the Building Acoustics group's year

Trevor Cox presents Leo L Beranek with the Peter Barnett Memorial Award at RS2010

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North-west branch

Yet another year has passed by and the average age of the North-west branch committee gets ever greater: despite attempts at encouraging younger members to be involved with organising the activities of the branch, we have not benefited from more youthful input, although Mike Barrett does his best among the aged. So our report begins with the often heard plea for members to participate in identifying and possibly organising meetings either by joining us at one of our informal committee meetings at Bureau Veritas, Didsbury or by contacting one of the committee members. If you would like to attend a committee meeting please contact Paul Freeborn on 0161 446 4793 to find the location and the date of the next meeting.

Perhaps as a consequence of the ever-increasing average age of the committee, the Senior Members' group started its life for the North-west branch on 30 September with a meeting and tour of the facilities in the acoustics laboratories at the University of Salford, organised by past president Geoff Kerry. It must have been successful, since further meetings have been planned for the older members, if they can remember!

The meetings during the year started in February at Arup where Richard Barham from National Physical Laboratory addressed one of the criticisms from the first round of noise mapping exercises required by the European Noise Directive, which related to the absence of any measurements in the computer modelling process. Richard in a valuable insight described the MEMS (Micro-Electro-Mechanical Systems), a measurement system that has been developed and tested to provide *Low-cost environmental noise measuring*. The early results of the trial to show the added value of including measurements in the mapping process and the potential for MEMS microphones in measurement applications were discussed.

In March at BDP Professor David Oldham of the University of Liverpool discussed difficulties encountered by many acoustical engineers in determining the requirements for the external envelope of buildings in noisy environments to achieve both reasonable sound insulation and also ventilation. The apparent incompatibility of acoustical insulation and natural ventilation, an area of interest and concern not only to acoustical engineers, was presented, with various useful approaches to the inherent conflict of these opposing requirements provided. The theoretical aspects of ventilation requirements appeared to leave many of the audience at BDP with blank faces but the issue was suitably aired.

Claire Shepherd of Bureau Veritas gave an illuminating presentation at Arup in May on the concept and importance of 'Quiet areas', their context in the European Noise Directive, and practical examples of her work with local authorities.

At BDP in October Dr Graham Day of the University Hospital of South Manchester NHS Foundation Trust gave a fascinating talk on effective hearing aids in *An approach to audiology*, and the strides forward made using modern technology.

The best attended meeting of the year was a workshop in November on *Use or abuse of BS.4142* which was chaired by Geoff Kerry following provocation by Paul Michel who had concerns regarding the use of this standard in some situations. The meeting room at Arup was crowded as the audience, who had obviously arrived for the AGM, were keen to understand the background to the workings of BS.4142 and how it should be used. Concerns were aired including:

- the use of BS.4142 for noise from delivery activities, night clubs, barking dogs etc;
- the location of measurements, and whether these should be at a façade or free-field;
- the range in assessing the rating levels, *ie* from -10dB to +5dB;
- the effect on general planning issues.

It was generally agreed to be a useful meeting; and a precursor to other types of meeting.

Scottish branch

The Scottish branch started the year with a meeting on 22 January 2010 in Kelvinside Hillhead Parish Church, Glasgow to discuss the ongoing revision of PAN - 56 Planning and noise. Scottish branch members exchanged views on what requires revising, adding, removing or leaving alone. This was followed by the Scottish branch Annual General Meeting which was well attended.

2010 has been a year of significant change in building acoustics, with changes to Section 5 of the Building Standards (Scotland) Regulations being implemented in October and with compulsory testing being phased in during 2011. The implementation of the new standards and testing regime has involved Scottish branch in meetings with the Scottish Government, consultants, universities and local authorities.

The Scottish branch responded to two important Scottish Government consultation documents during 2010 on *Permitted development rights for domestic micro-wind turbines'* and *Air source heat pumps and microgeneration equipment on non-domestic properties*. Thanks go to Alistair Somerville for coordinating the Scottish branch response to both consultations.

2010 has also been a sad year for branch members who tragically lost a friend, work colleague and enthusiastic member of the Scottish branch committee. John Nicol, who died on 28 June, will also be remembered for his flute renditions in Kelvinside Hillhead Parish Church preceding our 2006 AGM, and for his guitar jam-sessions following many Scottish events.

The chairman, secretary, treasurer and young members' representative of the Scottish branch remain unchanged. Many thanks to Andy Watson for continuing to look after financial matters, to Nicola Robertson for her continued commitment as young members' representative and to committee members for their support during 2010.

Southern branch

Activity was light in the year, though we are hoping to reinvigorate for the coming year.

The Southern branch enjoyed a presentation from John Shelton of AcSoft on the possible applications of a multi-channel microphone system which together with an embedded webcam functions as an acoustical camera. The discussion included practical demonstrations of how the beam-forming device operates and how it can be used quickly and easily to locate noise sources.

A series of evening meetings is being planned for 2011. Members willing to discuss a relevant topic are asked to contact either Steve Gosling or Nigel Cogger in the first instance.

South-west branch

The SW Branch met five times during 2010. Changes to the committee were made, it now being chaired by Hannah Kent of Parsons Brinckerhoff with Daniel Pope of WSP acting as secretary. Mike McLoughlin of Atkins takes on the role of young members' representative.

During the year the branch organised talks on *Attenuation solutions for natural ventilation*, presented by Ze Nunes of Mach Acoustics at the University of the West of England in Bristol; on *Causes of non-compliance with BB93*, presented by Andrew Mitchell of University of Exeter; and on *Auralisation as an assessment tool in schools* presented by Konca Saher of Atkins, at Atkins' offices in Exeter.

A social event in July also acted as a double meeting with the inaugural meeting of the senior members' group for the South-west, with eight branch members expressing interest in joining this new group. The committee met again in November to plan presentations and events for 2011.

Welsh branch

The Welsh branch has had an eventful first year. January saw the branch hosting *Wind turbine 6*, the latest in the series of IOA events examining the issues surrounding wind turbine noise. The conference was well attended, with over 110 delegates who were treated to presentations of a very high calibre, including a keynote speech from Welsh Assembly Minister Jane Davidson AM. In addition, the conference generated positive publicity for the IOA and interest in the topic of wind farm noise, with Professor Leventhall being interviewed by several national newspapers and Gwyn Mapp appearing on the S4C evening news.

June saw a second meeting of the branch, a networking event that involved a tour of the Millennium Stadium as the venue prepared for an international rugby match between Wales and South Africa.

It was a positive year, with more to come, we hope, in 2011.

Yorkshire and North-east branch

The Yorkshire and North-east branch had its first meeting on Tyneside for many years, at Armstrong World Industries in Gateshead, for a plant tour and a lecture on *The art of manufacturing acoustic ceiling tiles*.

TABLE 1: MEMBERSHIP

Grade	2009	2010
Hon Fellow	32	33
Fellow	185	186
Member	1637	1655
Associate Member	844	811
Affiliate	96	82
Technician Member	72	77
Student	70	74
Totals	**2936**	**2977**
Key Sponsor	3	3
Sponsor	49	56

TABLE 2: GROUP MEMBERSHIP

Group	2009	2010
Building Acoustics	1120	1171
Electro Acoustics	278	296
Environmental Noise	1426	1474
Measurement & Instrumentation	402	427
Musical Acoustics	227	259
Noise & Vibration Engineering	940	940
Physical Acoustics	155	164
Speech & Hearing	170	190
Underwater Acoustics	138	137

Rob Gardiner of Armstrong gave a presentation which covered a wide range of themes related to suspended ceilings and acoustics. He expanded on the topics of test methods, quality control and sustainability, and endeavoured to answer questions such as:

- What affects the performance of a ceiling tile?
- How can you test suspended ceilings... Δ_w, D_{nfw}, R_w, rain noise?
- How do you test floating canopy ceilings ... discrete absorbers or planar absorbers?
- Are ceiling tiles porous or panel absorbers?
- School acoustics: BB93, solutions for exposed (thermal mass) concrete soffits
- Healthcare acoustics: HTM0801 – acoustics versus infection control
- How sustainable are ceiling tiles?
- What quality controls are in place to ensure that products meet their stated performance?

The tour of the mineral fibre ceiling tile plant took us through the process from the raw materials to the finished product coming off the manufacturing line.

The committee is currently looking at meetings in 2011 to encompass airports, utilities and education.

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TABLE 3: BRANCH MEMBERSHIP

Branch	2009	2010
Central	123	135
Eastern	259	259
Irish	139	142
London	730	728
Midlands	423	402
North-west	409	392
Overseas	326	321
Scottish	180	169
South-west	298	291
Southern	484	485
Welsh		45
Yorkshire & North-east	223	215

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TABLE 4: DETAILS OF EMPLOYMENT

Employment Category	2009	2010
Architectural Practice	31	31
Consultancy	1347	1388
Education	216	209
Industry & Commerce	353	345
Public Authority	468	433
Research & Development	180	185
Retired	120	134
Other	84	86

TABLE 5: MEETINGS ATTENDANCE IN 2010

Topic	Date	Venue	Attendance
Wind turbine noise	27 Jan	Cardiff	101
Motor sport noise	18 Mar	Silverstone	79
Sonar performance tools	7-9 Apr	Cambridge	30
Speech recording and analysis	22 Apr	London	29
Noise in the built environment	29-30 Apr	Ghent, Belgium	125
Aspects of noise and vibration	26 May	London	41
Sound power measurements	03 Jun	Buxton	30
Construction noise and vibration	14 Jul	London	121
Synthetic aperture sonar and radar	13-14 Sep	Lerici, Italy	55
Autumn Conference	2-3 Nov	Birmingham	133
RS2010	18-19 Nov	Cardiff	105
School acoustics	07 Dec	London	46

TABLE 6: INSTITUTE PERSONNEL AT 31 DECEMBER 2010

COUNCIL

	Officers	Ordinary Members
President	Prof T J Cox MIOA	Ms L D Beamish MIOA
President Elect	Prof B M Shield HonFIOA	Mr K Dibble FIOA
Immediate Past President	Mr J F Hinton OBE FIOA	Dr E E Greenland MIOA
Honorary Secretary	Dr N D Cogger FIOA	Prof J Kang FIOA
Honorary Treasurer	Dr M R Lester FIOA	Mr P R Malpas MIOA
Vice President: Engineering	Mr R A Perkins MIOA	Mr P J Rogers MIOA
Vice President: Groups & Branches	Mr S W Turner FIOA	Mr A W M Somerville MIOA
Vice President: International	Dr W J Davies MIOA	Prof P D Thorne FIOA
		Ms L J Webb FIOA

COMMITTEES AND SUB-COMMITTEES

	Chairman
Education	Mr S W Kahn MIOA
- *Diploma in Acoustics and Noise Control, Board of Examiners*	Mr S J C Dyne FIOA
- *Certificate of Competence in Environmental Noise Measurement*	Dr M E Fillery FIOA
- *Certificate of Competence in Workplace Noise Assessment*	Mr G Brown MIOA
- *Certificate of Proficiency in Anti-Social Behaviour (Scotland) Act 2004 (IOA/REHIS)*	Mr J Stirling
- *Certificate in the Management of Occupational Exposure to Hand Arm Vibration*	Mr T M South MIOA
Engineering Division	Mr R A Perkins MIOA
Medals & Awards	Prof T J Cox MIOA
Meetings	Mr J P Newton MIOA
Membership	Dr B J Tunbridge MIOA
Publications	Mr A Lawrence MIOA
Research Co-ordination	Prof K Attenborough FIOA

SPECIALIST GROUPS

	Chairman	Secretary
Building Acoustics	Mr R O Kelly MIOA	Mrs A L Budd MIOA
Electroacoustics	Mr P R Malpas MIOA	Ms H M Goddard FIOA
Environmental Noise	Mr S C Mitchell MIOA	Ms N D Porter MIOA
Measurement & Instrumentation	Mr R G Tyler FIOA	Mr M J Armstrong MIOA
Musical Acoustics	Dr P F Dobbins FIOA	vacant
Noise and Vibration Engineering	Dr M G Smith MIOA	Mr M D Hewett MIOA
Physical Acoustics *(Joint with the Institute of Physics)*	Prof V F Humphrey FIOA	Dr M Lowe
Senior Members' Group	Mr R J Weston MIOA	Mr M R Forrest MIOA
Speech & Hearing	Dr E E Greenland MIOA	Dr G J Hunter MIOA
Underwater Acoustics	Dr P F Dobbins FIOA	Dr R A Hazelwood MIOA
Young Members' Representatives	Ms L D Beamish MIOA	Ms E Keon MIOA

REGIONAL BRANCHES

	Chairman	Secretary
Central	Mr D L Watts FIOA	Ms R H Canham MIOA
Eastern	Mr C L Batchelor MIOA	Mr C M Pink AMIOA
Irish	Dr M R Lester FIOA	Mr S Bell MIOA
London	Mr J E T Griffiths FIOA	Mrs N Stedman-Jones MIOA
Midlands	Mr P J Shields MIOA	Mr M Swanwick FIOA
North-west	Mr P E Sacre MIOA	Mr P J Michel MIOA
Scottish	Mr A W M Somerville MIOA	Ms L Lauder MIOA
Southern	Dr N D Cogger FIOA	Mr S J Gosling MIOA
South-west	Ms H G Kent MIOA	Mr D C Pope MIOA
Welsh	Mr G O Mapp MIOA	Mr J M Keen AMIOA
Yorkshire & North-east	Mr D Daniels	Prof K V Horoshenkov FIOA

CHIEF EXECUTIVE: Mr K M Macan-Lind

Meeting Report

Mike Breslin. Central branch

A current review of acoustic design for speech privacy between offices in new developments and fit-outs was the title of a presentation by Alex Krasnic on 1 February 2011.

Alex delivered a highly-informed and practical review of current standards and practices for the acoustic design of offices with poise, wit and humour. The central theme was achieving the balance between the potentially conflicting requirements for comfort and privacy and the knock-on effects upon productivity. To illustrate this Alex quoted from the 2006 British Council of Offices (BCO) guidance *The impact of office design on business performance*

'Acoustic conditions suited to work are ... the subject of a balance between adequate quiet (to avoid discomfort and disturbance...) and adequate masking sound (to protect confidentiality and create a buzz)'.

Alex went on to discuss five further documents in some detail: BS.8233:1999, BCO Guide to Specification 2009, the BREEAM Offices 2008 Assessor Manual, CIBSE Guide A 2006, and BS.9241-6:2000 *Ergonomic requirements for office work with visual display terminals - Part 6: Guidance on the work environment).*

He discussed the similarities and differences in the approaches advocated by these documents and quoted from BCO 2009:

'Unfortunately, the BREEAM requirement for single occupancy offices is inconsistent with BCO, CIBSE and other industry standards. Adherence to the latest BREEAM proposals would result in reduced privacy between offices, or a need to uprate partitioning, owing to the lack of masking noise from building services which BREEAM would limit to somewhere in the range of NR25 to NR34 (depending on the contribution from traffic noise).'

Alex explained how privacy factor (PF), the sum of sound insulation (expressed as Dw) and ambient noise level (expressed as L_{Aeq}) can be used to achieve the balance between background sound level and sound reduction necessary for privacy and comfort. BS.8233 refers to a minimum PF of 75dB (subjectively 'slightly intelligible') and Alex described a PF of 80dB as potentially being the 'magic number' indicating the cusp of intelligibility.

Some practical examples of calculations were presented, including building services noise transmitted via core risers and supply duct branches, the use of cavity barriers, and sound insulation performance of partitions (direct and flanking).

A number of products, particularly glazed internal panels, were discussed specifically and it was the rather optimistic-looking manufacturers' performance claims for some of these that initiated the discussion at the end of the presentation. The meeting wholeheartedly supported David Watts' observation that the quality of the test data was of fundamental importance to the acoustician when specifying or evaluating a product. Tony Woolf (Woolf Acoustics) then moved the discussion on to projects where an even greater degree of privacy was required than that implied by PF(80)dB, owing to requirements of commercial or personal confidentiality. The practical difficulties of achieving a very high degree of privacy between real rooms with doors were discussed, as was the question of whether D_w is a sufficient basis for specifying partitions for projects when privacy is the overriding concern.

The Central branch is grateful to Alex for an excellent presentation and to Casella CEL for providing the venue for the meeting. Post-meeting discussions of a more-or-less technical nature continued at the King William IV in Kempston, and were facilitated by traditional hearty food (the steak and Stilton puddings being particularly popular) and beer from the local Charles Wells brewery.

Institute of Acoustics

AGM

The Annual General Meeting of the Institute will be on Monday 25 July. It will take place during the ICBEN conference at South Kensington Campus, Imperial College London, Exhibition Road, London SW7 2AZ. All members are invited to attend, but only corporate grade members (MIOA and FIOA) are entitled to vote.

Erratum

The March/April 2011 issue of Acoustics Bulletin carried an article 'Recent developments concerning aircraft noise annoyance'. Unfortunately, the version published was not the final one, but a late draft. We apologise for any misunderstanding this may have caused. The correct and up-to-date version can be obtained on request from **mrickaby@hillingdon.gov.uk**

Plans for new IOA Certificate Course in Building Acoustics Measurements

The IOA has issued a call to existing certificate and diploma centres for expressions of interest in offering a new Certificate Course in Building Acoustics Measurements (CCBAM). This week-long course will be open to all and successful completion will meet the specialist educational requirements for Technician grade membership of the Institute (TechIOA). Those aspiring specifically to carry out Building Regulations ADE PC Testing will continue to be advised to investigate the ANC or UKAS schemes. The new CCBAM is not intended to compete with or replace these schemes but to meet the specialist educational background to support these schemes and to meet the demand from people, such as building control officers and commissioning engineers, who may want to understand the process but not register through ANC or UKAS. Although the course is to be centred around measurements according to the requirements of ISO 140 parts 4 and 7, it is intended to be relevant to other situations requiring competence in sound insulation testing including Building Regulation requirements (Annex B of Approved Document E in England, Booklet G in Northern Ireland, Building Bulletin B93), hospitals (Health Technical Memorandum 08-01) and offices. The assessment will be similar to that for the other IOA certificates: it will involve a practical test and an exam. The call and draft syllabus can be obtained from **education@ioa.org.uk** and expressions of interest should be received before 18 June.

Instrumentation Corner

Richard Tyler. Uncertainty of vibration measurements

Uncertainty arises from all measured sources. An absolute unit of acceleration that can be checked for perfection does not exist. The measurements that define any quantity have a small degree of possible error that can usually be expressed in terms of a small fraction of the unit under consideration. For most of the parameters associated with vibration measuring instrumentation, the errors are finite and the estimate of their magnitude can be made under fairly closely controlled conditions.

Note that when assessing measurements against the values in the Physical Agents (Vibration) Directive (PA(V)D), the actual measured levels ***plus*** their associated uncertainty of measurement must be less than the exposure limit values (ELV)

The list below shows typical values for some of the more common uncertainty terms that affect vibration measuring instruments.

- Reference accelerometers: typically 0.7%, and 2% at higher frequencies
- Accelerometers in daily use: 3% to 5%
- Voltmeter: 0.25% for AC volts
- Frequency counter: negligible

The number which is impossible to quote reliably in the above list is that associated with the mounting of the transducer. An allowance of 10% to cover the location and fit is probably a reasonable starting point.

Any uncertainty calculation must consider the following elements.

- Mounting of the transducers
- Location and orientation of the transducers
- Changes from the normal operation caused by the introduction of the transducers
- Changes in the machine condition during measurement
- Changes in the operator's working conditions during measurement, eg a vehicle on rough or smooth ground
- Errors in the duration of work cycles
- Errors in the number of work cycles per day
- Variability in the work patterns over different days
- Errors in the measuring instrumentation.

As nobody usually knows the limit of uncertainty, it is usually calculated from formulae which define uncertainty with respect to a degree of confidence. The most common value used is 95%, and as an approximate rule, the uncertainty calculation is multiplied by 2 to give 'the expanded uncertainty with a confidence level of 95%'.

The uncertainties associated with the accuracy of the measuring equipment are usually dwarfed by those associated with trying to measure the vibration source. The effects of people on the vibration source can cause very large variations in the vibration transmitted to the person.

The positioning of transducers can cause significant differences between the measured level and the actual levels received by the person, and the quality of transducer attachment can impact on the measured values. Attempting to put figures to the uncertainty of these items is fraught with difficulty. A suggested range of values is given in Table 1.

Examples of instrument accuracy

The National Measurement System of the DTI (as it was then) funded experimental work to investigate uncertainty of measurement in the instrumentation of human exposure to vibration. This work used a range of commercial instrumentation systems to measure hand-arm and whole body exposure in controlled yet realistic environments.

Individual measuring systems returned consistent and repeatable measures of vibration amplitude, well within the uncertainties suggested in the table. Weighted acceleration results were distributed with a worst-case ratio of standard deviation to mean of 6.6%. This distribution was caused by the consequences of removing and replacing the accelerometer, rather than the intrinsic accuracy of the instrumentation system itself. In repeat measurements involving no such repositioning of the transducer, the repeatability was <1.5%.

Further information

Tyler, Richard: *Good Practice Guide on the use of instrumentation to measure vibration affecting people*. Published by the Institute of Acoustics, St Albans 2004

Bell, Stephanie *A beginner's guide to uncertainty of measurement.* Measurement good practice guide no.11. National Physical Laboratory, London 1999

Richard Tyler FIOA is with AVI Ltd, Northill, Biggleswade SG18 9AD

Parameter	Uncertainty	Estimate of typical uncertainty, % best practice
Instrumentation		
Accelerometer calibration (at reference)	±3%	±3%
Accelerometer frequency response	±2.5%	+2.5, -0
Instrumentation	±4%	±4%
Measurement process		
Measurement duration	+10/ -0%	+10, -0
Triboelectric effect	negligible	±2%
Electrical pickup	negligible	±2
Mounting: rigid	negligible	±2
Mounting: hand-held	+100/ -50%	-
Mass of transducer(s)	negligible	±2%
Transverse response (with or without mechanical filters)	+4/ -0%	+4, -0
Location of transducer	+100/ -50%	±15
Exposure time measurement		
Video monitoring	negligible	±2
Number of components from production records	~±10%	±10
Number of components by video	~±2%	±4
Active sampling	variable	±10

Table 1

Indicative uncertainty values

Meeting notice

International Institute of Noise Control Engineers

'Buy-Quiet' is a Paris symposium which offers a new challenge for noise control engineers. Inducing a 'Buy-Quiet' attitude among product purchasers is a new challenge to noise control engineers for quietening the world.

Join this pioneering initiative by participating in the Paris I-INCE Symposium this July. Our world has become more and more noisy in recent decades and noise control engineers have not succeeded in reversing this rising trend. Among the many reasons and despite the technical progress that has been made, there is an ever-wider dissemination of sources of noise (vehicles, machinery and tools, household appliances, industrial equipment, entertainment devices and other products) in our daily life, in transport, at home, in offices and workshops, around buildings and in recreational areas.

Noise in the environment and at home is also adversely affected by:

- Increased automation of work and more powerful equipment
- Ineffective policies encouraging product noise reduction, relatively limited development by manufacturers, and lack of availability of low-noise machines and other products on the market
- Complexity or lack of information on product noise given to the different types of purchasers, and
- Limited information on the availability of quieter products of all kinds and thus an absence of market competition for low-noise products ...
- ... and a consequent lack of broad market penetration.

A drastic change of attitude is needed to inform and convince the worldwide population of purchasers of all types (individuals, purchasing agents and professional buyers) that they can buy quieter products. The primary responsibility for this change is with the noise control community.

In coming years 'Buy-Quiet' should become a new slogan carried by the wave of 'green' marketing that should bring a new impetus to noise control engineering activities (research and development, consulting engineering, *etc*) and pave the road to a quieter world.

Last summer the Board of International-INCE, in launching a new initiative, chose 'Buy-Quiet' as the theme of its first symposium. It will take place in Paris on Tuesday 5 and Wednesday 6 July 2011.

The Symposium is being organised by INCE/Europe in cooperation with the Federal Institute for Occupational Safety and Health (BAuA) in Germany, the Centre d'Information et de Documentation sur le Bruit (CIDB) and the Institut National de la Recherche et Sécurité (INRS) in France, and in partnership with the International Council of Academies of Engineering and Technological Sciences (CAETS).

The background and preliminary programme of the symposium as well as information on the venue and how to register can be found on the web site **http://www.bruit.fr/buyquiet/**

Readers of *Acoustics Bulletin* are warmly invited to attend this pioneering event and bring your experience to the discussion periods.

Jean Tourret, chairman, on behalf of the organising committee

AGM report

Robert Conetta. Speech and Hearing Group

The Speech Hearing Group's AGM was held at WSP House on Wednesday 16 February 2011.

Before the meeting Prof David McAlpine presented a lecture detailing his current work with the Ear Institute, University College London (UCL). David is director of the Ear Institute. His current research interests lie in the study of hearing and deafness - particularly how the central auditory system is able to cope with noisy environments and into brain mechanisms for spatial hearing.

The Ear Institute specialises in the study and research of the human auditory system. It has 24 researchers specialising in diverse areas of human hearing such as the study of oto-acoustic emissions, hair cell regeneration, hearing loss, spatial hearing, auditory cortex and neural activity and computer modelling of the auditory system. The institute also has expertise in ENT, rhinology and skull base surgery (**http://www.ucl.ac.uk/ear/research**).

Research at the Ear Institute aims to be interdisciplinary; with laboratories sharing resources, facilities, personnel and expertise. The institute also collaborates with partners in other departments within UCL and international research institutions.

David's seminar was well attended with some 44 delegates present. The topic of his talk was *Tinnitus and hidden hearing loss - pain, gain and the brain*, and discussed and described recent findings on the physiology of the human auditory system in relation to the manifestation of tinnitus.

Tinnitus and its effects on sufferers is currently not taken as seriously as it should be. However with the large number of personal audio system users and club goers it might soon become a mainstream concern for many young people.

David described how tinnitus has less to do with the acoustics of the auditory system and more to do with its neural activity. He made the analogy of tinnitus as a gain control gone wrong. In auditory threshold tests, sufferers of tinnitus were shown to have a 'ski-slope' roll-off in terms of their sensitivity to high frequencies. Although these high frequency sounds are not perceived, the brain still looks for information in this range. When it does not receive any neural signals from the dead nerve fibres in the damaged area of the basilar membrane, the auditory cortex is activated. This effectively turns up the gain in the auditory system causing more spontaneous firing of neural fibres, resulting in the 'ringing' sound we know as tinnitus.

David revealed that this gain control is actually a normal function of the auditory system and can occur even when the system is undamaged. For example a temporary turning up of the gain control can also result after prolonged exposure to a high level of noise, an effect many people experience after attending a gig or club-night. David also described a scenario where the gain control can be activated in low-level noise environments. This was tested with an experiment where subjects were asked to wear an ear plug in one ear for a week. At the end of this week the auditory system had adjusted itself and a temporary shift in the sensitivity had occurred resulting in tinnitus (temporarily) in the occluded ear.

The Speech and Hearing committee would like to thank David for his very interesting and insightful seminar.

The AGM was attended by 18 members of the group. Chairman Dr Emma Greenland provided an overview of the group's activities during 2010, which included a successful one day workshop in conjunction with UCL entitled *Speech recording and analysis*.

In other news there have been two changes to the committee board. Firstly the committee would like to welcome Roz Cummins. Roz is co-founder of the Voice Care Network (**www.voicecare.org.uk**). VCN is a registered charity which brings together expertise from the two disciplines of speech and language therapy and voice coaching with the aim of providing expertise in vocal health. They provide workshops and work within the education, call centre, healthcare and media professions.

Dr Gordon Hunter has stepped down from his role as group secretary, but will still remain on the committee. The committee would like to take this opportunity to sincerely thank Gordon for all his hard work since 2008 when the group was re-formed. Committee member Graham Nash has agreed to replace him.

The Speech and Hearing committee regularly organises seminars throughout the year. Although speakers are generally chosen by the committee members, any suggestions for future meetings from group members are welcomed. Please contact Emma Greenland
Email: **Emma.Greenland@WSPGroup.com**
Tel: **+44 (0) 20 7314 4639**).

Membership

The following were accepted by Council for membership of the Institute of Acoustics in the grades mentioned following the recommendations of the Membership Committee on 10 March 2011.

Member

Arthurs, I J
Babington, X
Battaner-Moro, J P
Burgess, B
D'Avillez, J V A
Dellatorre, L
Dufaud, J
Elias, A I
Emery, A J
Evans, L D
Ferreira, T M D
Fithyan, J
French, T A
Gillibrand, A
Hannan, S
Hardy, S C L
Harper, A M
Heaton, R T
Hooper, C
Knott, S D
Lewis Nunes, A
Linnett, R H
Marriner, R E
Mellor, S B
Morgan, A W
O'Connor, C
Robinson, B J
Rossiter, P R
Sharps, I
Smethurst, J J
Tomes, MS
Townsend, M D
Villa, S
Whyman, G D
Wong, KSB
Young, G J

Associate

Addy, D J
Birchby, A J
Cheong, M A
Cloy, C W
Curtis, D
Dring, M R
Emery, D
Fenton, R
Ferreira, N
Goodwin, K D
Goose, T D
Haines, A
Hayward, J
Hulse, V
King, L
Klabou, P
Leach, T
Lees, M R
Longman, L R
Lowe, K T E
Makewell, H K
McDonald, P A
Milton, A
Moore, A
Oxborough, E
Pates, N A
Pickford, A R
Poxon, J D
Poxon, F D
Ricketts, D J
Scott, S J
Sharples, J
Shiers, N J
Tournier, G A J
Wong, W Y A

Student

Birchall, T
Clayton, A D
Feodorova, A
Layfield, G M
Westwood, R F

Technician

Clayton, J
Costello, K
Hancock, A R
MacIsaac, B J
Reeve, G J
Smyth, K L

Acoustician admits to fraud

Sound insulation testing was not accredited as claimed

A qualified acoustician has admitted issuing false accreditation certificates. Mr Mike Legon had been contracted to carry out sound insulation tests on various properties in Haringey and Lewisham. As part of signing-off procedures by Lewisham Council's Building Control team, surveyors checked Mr Legon's documentation. Third-party accreditation is not a legal requirement, but the government advises that anyone carrying out building work should arrange for sound insulation testing to be carried out, preferably by a body with appropriate third-party accreditation.

His company, Sound Solution Ltd (ASSL) had submitted an Accreditation Certificate issued by the Association of Accredited Companies (AAC) of 1 Victoria Square, Birmingham B1 1BD as proof that ASSL had been assessed against a recognised quality standard and had been awarded a third party accreditation. This accreditation was then presented as proof that ASSL could carry out pre-completion sound insulation tests in accordance with the requirements of the Building Regulations Approved Document E.

The surveyors had not heard of the Association of Accredited Companies, the organisation that had issued the accreditation certificate for ASSL. No record was found of the Association of Accredited Companies on the Companies House web site and it was not known to be a third party scheme recognised within England and Wales, or the EU, and no other acoustics testing body or other company was known to be accredited by the AAC. No contact telephone number was listed on the AAC's web site and the only method of communication with the organisation was via their web e-mail form. Three requests via this form were submitted to the AAC in the course of the investigation, but no responses were received.

Investigations by Trading Standards colleagues revealed that Mr Legon had created the Association of Accredited Companies himself. He had also set up a bogus web site and asked surveyors doing company checks to refer to it.

The AAC web site provided a facility whereby accredited organisations could be searched for. Entering various keywords and phrases (noise, sound, air, leakage, air leakage, PCT, on-site testing etc) which might be expected to identify organisations accredited by the AAC and carrying out testing - whether that be sound, air or any other form of testing - resulted in details for only one organisation: A Sound Solution Ltd, of Unit 23b Denman Road, London SE15 5NS. A hyperlink to their web site was also provided. By July 2009 the web site was no longer active, which would not be the case if the AAC had been an organisation with numerous accredited members.

Birmingham Trading Standards were contacted and their Commercial Investigation Unit could find no record of the AAC. They could, however, state that they recognised the address, which was identical with one belonging to Birmingham City Council: Council House, 1 Victoria Square, Birmingham B1 1BD.

Haringey Building Control officers first questioned the company's third party accreditation in 2008 and refused to accept their reports and certificates. After investigations, officers found that Lewisham Council Trading Standards was already looking into the company and agreed to act as witnesses in Lewisham's case.

The testing involved would have confirmed, for example, that flats had sufficient insulation to prevent noise carrying from one home to another. An inaccurate claim could lead to legal challenges and much dissatisfaction among residents and homebuyers. Haringey's Cabinet Member for Neighbourhoods, Cllr Nilgun Canver, said that it was a serious matter to buy a flat or a home and find that the walls were paper-thin and the floors not at all soundproofed. Accreditation to professional bodies is what gives a buyer peace of mind when employing an expert. He was grateful to all the officers concerned, whose vigilance may well have saved households and housebuilders from getting a very raw deal.

Mr Legon, director of A Sound Solution Ltd, was prosecuted by Lewisham Council. He pleaded guilty in Woolwich Magistrates' Court to one charge under the Fraud Act 2006 for creating a fictitious organisation, the Association of Accredited Companies, and using it to make it appear that his company was accredited by an independent third party. His company, A Sound Solution Ltd, admitted four charges under the Fraud Act: one charge of dishonestly making a false statement in an accreditation certificate that it was accredited by an independent third party to carry out sound insulation testing; two charges of dishonestly making the same false statement on two testing certificates submitted to Lewisham Council Building Control; and one charge of having in its possession an article, in this case the Association of Accredited Companies' web site, for use in connection with a fraud. The company and Mr Legon were each fined £1,000. Mr Legon also agreed to pay £7,000 towards the council's costs.

Details of Mr Legon's current company, Site Sound Ltd of London SE3, appeared in the 2010 Institute of Acoustics Members' Register. M R Legon has been expelled from IOA membership and his details do not appear in the 2011 Register.

Please note that there is no connection with the company The Sound Solution Ltd of Nun Monkton, York, whose web site is at **www.noisestopsystems.co.uk**

The World's Biggest Noise Map.

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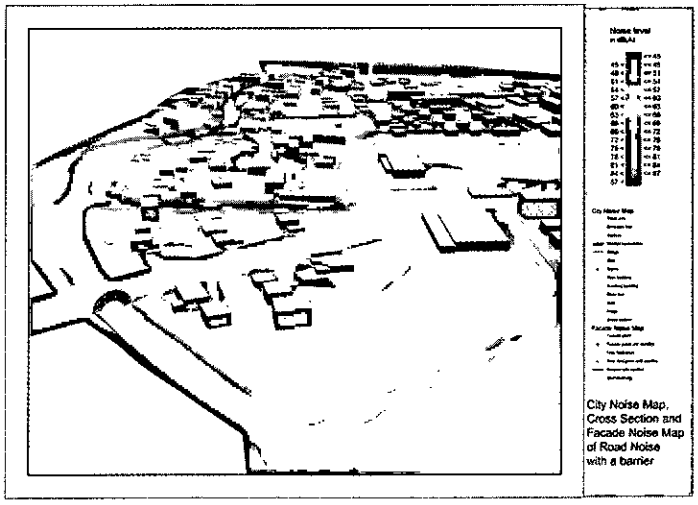
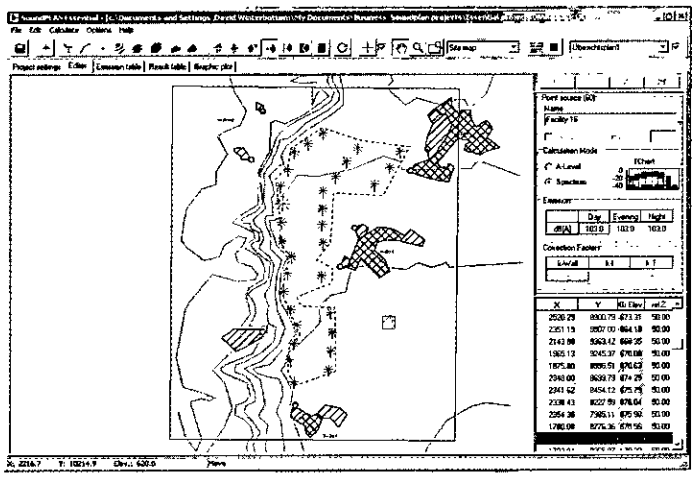


City Noise Map, Cross Section and Facade Noise Map of Road Noise with a barrier



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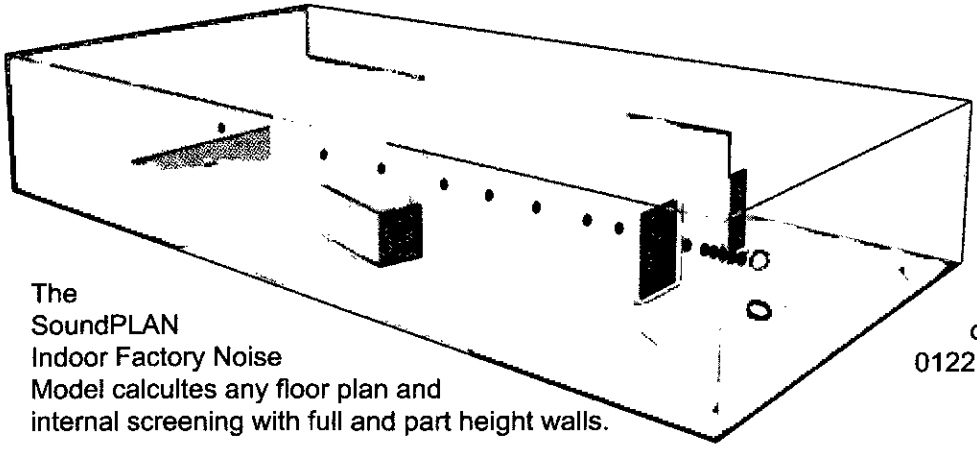

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SoundPLAN

Meeting report

ISCEx2011

The Institute of Acoustics was represented at the annual exhibition and seminars run by ISCE, the Institute of Sound and Communications Engineers, in Watford. Kevin Macan-Lind and staff from St Albans fielded visitors' queries on the IAO stand, and reported a good level of interest.

Kraken Acoustics used the ISCEx2011 exhibition to launch its new carbon fibre BB80 micro-bass loudspeaker together with the unique BB80 X3 active crossover amplifier. The company was very impressed with the excellent turnout. All exhibition spaces were taken and the wide variety of exhibitors and seminars attracted a larger than ever number of bookings at an event that goes from strength to strength each year. Andy Tinsey, of Kraken Acoustics, thanked ISCE for the organisation of a great exhibition. He had been extremely pleased with the response to the product launch which has generated enquiries worldwide, and was happy to have chosen ISCEx2011 to do it.

Tony Torlini of Fuzion plc was also happy. As an exhibitor, he found ISCEx2011 a great success, with a good solid flow of industry professionals generating a good number of leads, especially considering that it was a one-day show. He thought the seminars scheduled throughout the day were particularly relevant and interesting.

These popular seminars, which ran alongside the exhibition, covered a variety of topics. Tony Payn of Vimpex Ltd talked about voice sounders for evacuation and how they meet the requirements of alarm systems. This was followed by a seminar by David Tyas of Ikon AVS, who gave an interesting presentation about video for audio engineers and how incorporating video into a system could be a good additional source of revenue for audio professionals.

In the afternoon, Gordon Morris of Gordon Morris Ltd, with his first-hand experience as a user of hearing aids for more than 50 years, told a fascinated audience about why loop systems are failing, covering both the technical and human complexity involved. The day concluded with a presentation from Peter Alberry-King of Penton UK who covered the very topical subject of loudspeakers in relation to EN.54 part 24. He explained what the certification was, the reasons for its introduction, and explored the implications of EN.54 for both manufacturers and installers.

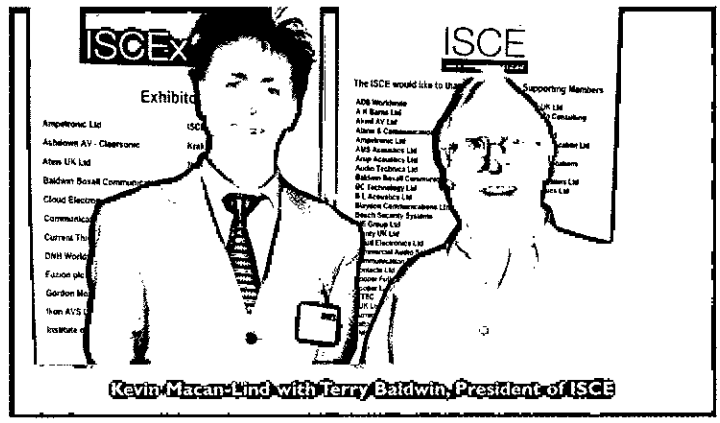
Roland Hemming of RH Consulting, said that he and his colleagues, as first-time visitors to the show, thought that despite its small size there were a good number of useful people to speak to.

ISCE contact: Ros Wigmore, tel. **0118 9542175**

Kraken Acoustics show their new products at the exhibition

David Tyas presenting his seminar

Gordon Morris presenting his seminar



Kevin Macan-Lind with Terry Baldwin, President of ISCE

IOA staff promoting the Institute to attendees at the recent ISCEx in Watford

An assessment of the acoustical performance of open windows

Ze Nunes, Ben Wilson, Michael Rickard. and the requirements for natural ventilation

Introduction

As we all move towards a more sustainable future, the use of natural ventilation becomes increasingly important. In addition, our expectations and demands from buildings are increasing. Naturally ventilated buildings are therefore becoming more frequently used within inner city locations and on other noisy sites, although our expectations of these buildings remain unmodified, meaning that low internal background noise levels are still required. As a result, a better understanding of key factors affecting the acoustical performance of vented facades is required.

The acoustical performance of a partially open or minimally open window to a bedroom is often stated to be between 10 and 15 dB. The figure appears in several published documents, and the guidance is often used to assess the acoustical performance of vented facades to classrooms, healthcare buildings and offices. This assumed attenuation through a partially open window is a very vague basis for a design, and questions often arise as to whether the guidance can be used for natural ventilation, in view of its large free area requirements.

This article looks at current literature on the subject of open windows. As well as publishing the results of on-site testing for a 'Velfac' window, results are published for different window open areas and different opening combinations. The article concludes with a comparison between free-field measurements and laboratory diffuse-field measurements for similar window types. Along with a comparison between laboratory and field measurements, sound insulation levels are presented for a range of vertical and horizontal angles. It is hoped that this will provide some insight into the acoustical performance of openable windows used in combination with natural ventilation.

Literature review

Current literature which discusses sound attenuation values for open window noise insulation generally comes in the form of guidance documents and experimental research papers.

Guidance documents

Guidance documents, standards and regulations tend to give broad range of values for the sound insulation performance of an open window but typically give no attribution as to the source of the data. Nevertheless there is a clear agreement between all of them, from which a shared heritage can be inferred. It is very difficult to determine whether the source was in fact common, and if it was, whether the original data source was experiment or theoretical, so this article does not enquire in that direction.

Table 1 presents a summary of the guidance documents and the corresponding values quoted in them.

A more detailed list of the guidance documents is shown in the adjacent panel.

Experimental research

While there is generally no confusion as to the source of the data in experimental research papers, the results obtained by them are situation-specific and hard to apply in the same broad sense as the values in guidance documents.

Two of the more recent experimental research papers have been selected for comparison with the results presented in this article, one based on laboratory test results and the other based on field tests. A summary of the papers appears below. A number of other experimental studies were also identified and have are included in list appended.

Document	Quoted value for open window sound insulation performance
BB93	10 - 15 dB R_w
BS.8233:1999	10dB or 15dB
EN 12354-3:1999	R_w of 10 – 15 dB
WHO (1999)	10 dB - 15dB (A-weighted)
PPG 24 (1994)	10 dB - 15dB (A-weighted)
BRE Digest 338 (1988)	10 – 15 dB
Nelson – Transportation Noise (1987)	5 – 15 dB
DoE Design Bulletin 2	10 dB - 15dB (A-weighted)

Table 1

Summary of values quoted in guidance documents

NANR116 (2007)

Napier University School of the Built Environment's NANR116 paper 'Open/closed window research: sound insulation through vented domestic windows' (2007) provides the results of a range of tests undertaken on open windows. Although testing was carried out in a laboratory, the source room was anechoic; therefore the investigation followed, as closely as it could, the methodology provided in BS ISO EN 140 Part 5 'Field measurements of airborne sound insulation of façade elements and facades'.

The investigation included seven popular domestic window models, and tested for the effects of amount of opening and noise source angle of incidence. The range of measured insulation ratings D_w for windows with a free open area of 0.05m² was found to be between 14 and 20 dB. A single figure weighted rating D_{new} for a 0.05m² opening was given as 19dB. Increasing open areas were found, unsurprisingly, to offer a consistent reduction in the amount of acoustical insulation. The weighted sound insulation based on measurements was found to decrease by 1dB moving from an open area of 0.05m² to 0.1m², and by 2dB from with an increase from 0.1m² to 0.2m². This suggests that there may be a simple relationship between the open area of a window and the level of insulation. The glazing specification and frame material of a window was found not to affect greatly the level of sound insulation when the window was open.

It was also found that the acoustical resistance offered by an open window was dependent on the angle of the incident noise.

Sound measurement and natural ventilation in schools

Anderson and Hopkins' paper *Sound measurement and natural ventilation in schools* examined the potential benefits of using small window openings so that that adequate air ventilation could occur while maintaining good levels of sound insulation. As part of the

continued on page 24

An assessment of the acoustical performance... - *continued from page 23*

investigation, laboratory airborne sound insulation tests were conducted on a top-hung Velfac 200 window at a range of different opening distances between 1cm and 22cm. Measurements were made in accordance with BS EN ISO 20140 10:1992.

The results presented in the Hopkins paper are in the form of octave band element-normalised level differences, and were used for comparison with the data measured in the field tests outlined in the present article. The insulation values, given in terms of D_{ne}, were obtained in a diffuse noise field under laboratory conditions. Some of the results presented in the Hopkins paper are shown in Figure 1.

Having reviewed the available literature on the topic of open window sound insulation, it is clear that there are many issues associated with using the data contained in them. The data presented in Table 1 shows variations in the recommended values of up to 10dB. In some case the sound reduction index is provided, in others a value in dB(A) is quoted, and in some cases a simple level in dB is given. Furthermore, the figures quoted are sometimes dependent on the extent to which the window is open, and sometimes not.

Typically the data apply to a partially open window, but the degree of openness is difficult to quantify. The attenuation through a partially open bedroom window has little correlation with that of an open vent to a naturally ventilated office, educational building or hospital.

The testing that has been conducted for this article aims to extend the available information on this subject and to provide further evidence that the conventional broad-brush approach of '10 to 15 dB reduction in the A-weighted level' is not sufficient for accurate acoustical design.

Field testing

Test environment

Three room facades were involved in the testing, all of identical dimensions and construction. They included areas of brickwork as well as two large glazed areas, each containing nine Velfac 200 top-hung windows arranged in a three by three pattern. The area surrounding the façade was open, with no nearby buildings or reflective walls. Background noise levels were generally constant throughout the testing.

The three test rooms were large classrooms all of identical dimensions. All surfaces were acoustically 'hard', including the floors, and none of the rooms contained any soft furnishings. Each of the rooms contained a number of tables and chairs.

Window specification

Velfac 200 top-hung 1.06m by 1.14m double-glazed windows were used for all tests. The test windows were physically restricted to maximum opening distances of 12cm. The window model was the same as used by Hopkins for his research paper as discussed above, but the frame dimensions were different: no site containing Velfac 200 windows of identical dimensions could be located in the time available.

Measurement procedure

The methodology for all testing was generally in accordance with the element loudspeaker method defined in BS EN ISO 140-5. In

continued on page 26

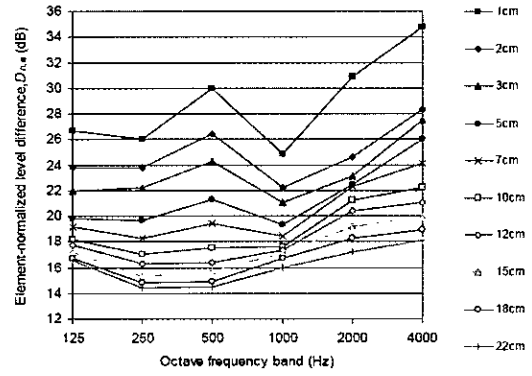


Figure 1

Laboratory airborne sound insulation data for a Velfac 200 window at a range of window opening distances (Anderson and Hopkins 2005)

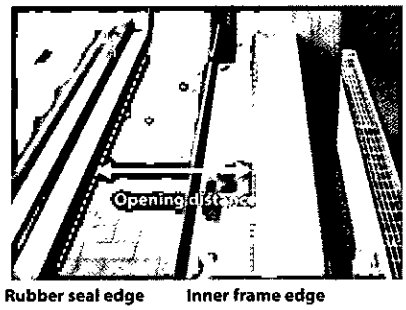


Figure 2

Window opening measurements: detail

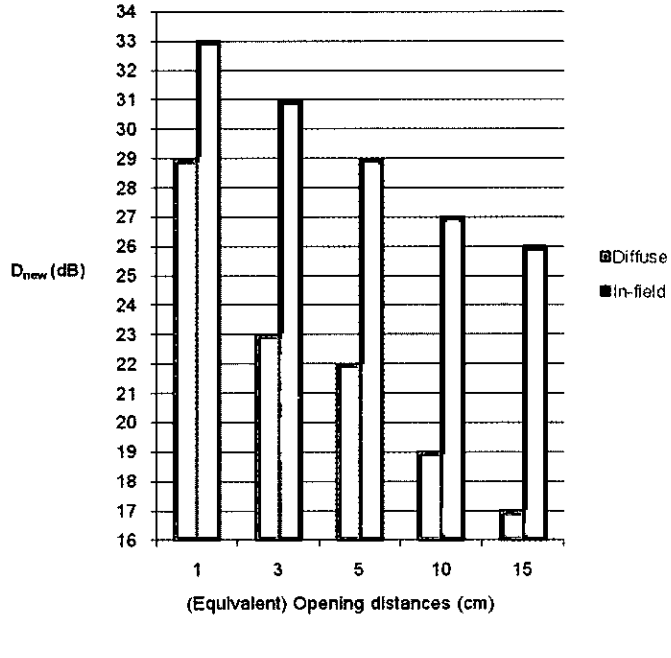


Figure 3

Field and laboratory D_{new} results

An assessment of the acoustical performance... - *continued from page 24*

some cases, the method deviated slightly from this guidance: when altering the angle of incident noise from the loudspeaker to the test window, the distance between the loudspeaker and the window had to be increased beyond the 5m maximum in the guidance.

For the purpose of these tests, the opening area of a window was considered to be the area created between the leading contact points of the window and the façade mounted frame. This is explained in Figure 2.

Three measurements were taken with the microphone of the sound level meter positioned immediately next to the lower edge of the window under test, in the closed position. The microphone was placed successively at the bottom of both vertical edges, and in the middle of the lower edge. If we take the open area of the window to be the 'element' under test, this method can be regarded as a fair interpretation of the guidance given in ISO 140-5.

Sound tests of the airborne sound insulation of open windows - field and laboratory results

In-field sound insulation for an open Velfac 200 window was tested according to BS ISO EN 140 Part 5, except where any part of the method was incompatible with the requirements of the test. The objective was to measure the attenuation through an open window with incremental open areas for comparison with the laboratory results outlined in the Hopkins paper.

Interpretation of the guidance provided in BS EN ISO 140-5 suggests that where there is a difference of at least 6dB of insulation between the case where the test window is closed, and any case where it is partly open, meaningful comparisons can be made with laboratory measurements.

While the windows used in the testing were not of the same dimensions as those used in the Hopkins study, the NANR116 report does state that no discernible difference in sound insulation was measured between windows of different surface area whilst in an open position. It is therefore deduced that a fair comparison can be made with the Hopkins study by matching the overall open-window areas.

The field measured D_{new} ratings were consistently higher than the equivalent laboratory values for the test window across all octave bands as shown in Figure 3. This may indicate that the insulation performance of open windows in the field is characteristically better than the equivalent performance measured in diffuse laboratory conditions.

The D_{new} for the laboratory tests on a window seems to improve logarithmically as the window opening distance decreases, although the insulation performance at 3cm opening is then a little poorer than would be expected.

Similarly, for the field tested window, as the opening distance is decreased, the insulation improves in a manner that may be described as broadly logarithmic.

The graphs in Figures 4 to 7 show the differences in the D_{ne} performance for incremental increases in the window open area, compared with a base case. The base case is defined as the smallest window open area tested. Both the field and laboratory performance results are shown on the graphs. In addition, the theoretical difference based solely on the increase in the window open area is included on the graphs.

The results indicate that there are significant differences in the insulating performance at each octave band in comparison with the theoretical performance. The theoretical performance reflects the broad approach adopted in much of the guidance documentation, however on inspection of the octave band results, it is clear that the approach may not be appropriate for accurate predictions.

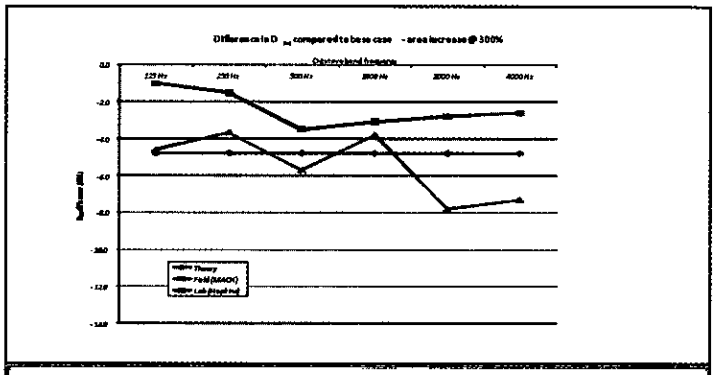


Figure 4

Difference in D_{ne} compared with base case – increase 300%

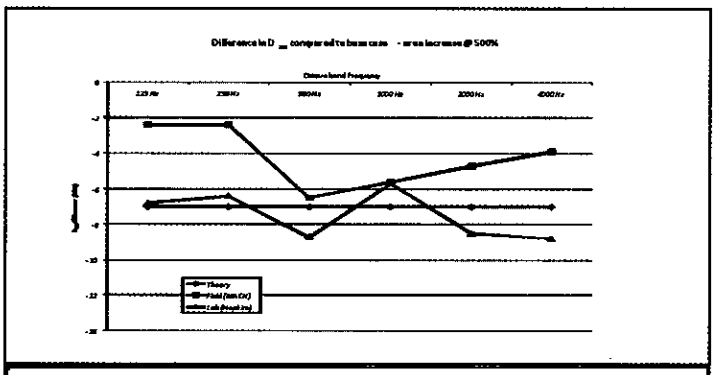


Figure 5

Difference in D_{ne} compared with base case – increase 500%

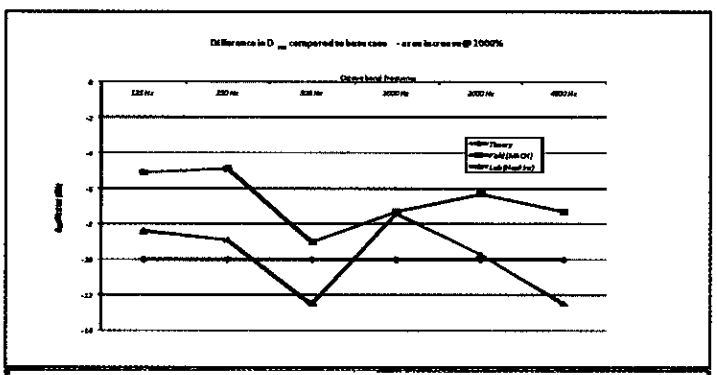


Figure 6

Difference in D_{ne} compared with base case – increase 1000%

Variation in D_{new} for doubling of open area

As a general rule, it is accepted that the sound reduction of a window decreases to 10 log n or 10 log (s_1/s_2) where n is the number of open windows or vents and s_1/s_2 is the ratio of the two different open areas in question.

To understand the results of the field testing more fully, the derived D_{new} values were used to predict internal noise levels in a nominal room of size 4m by 5m with a façade exposed to road traffic noise. The graphs in Figure 8 show the resulting difference in room internal noise level as the window open area increases.

The graphs further suggest that the 10 to 15 dB of attenuation typically quoted in documentation may not be appropriate for use in all circumstances.

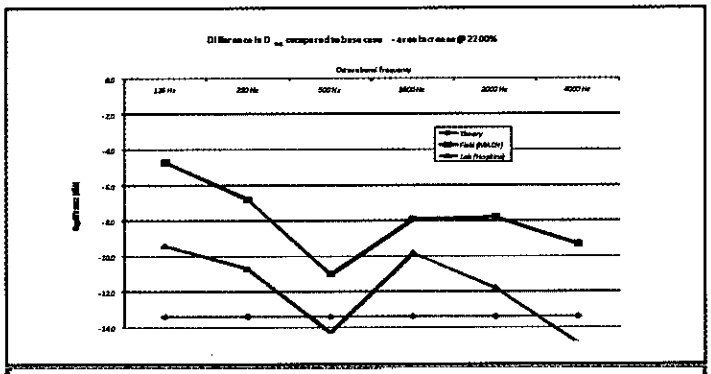


Figure 7

Difference in D_{ne} compared with base case – increase 2200%

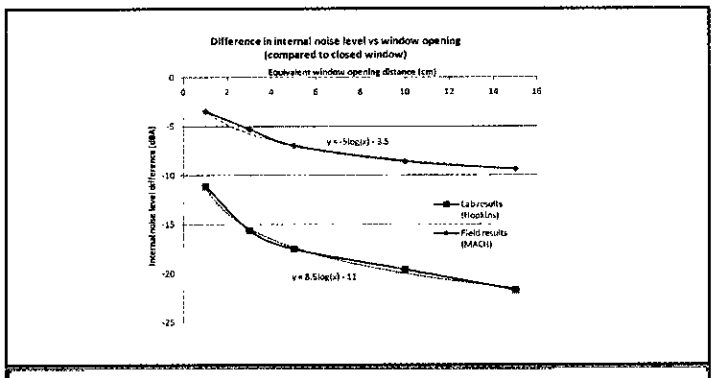


Figure 8

Changes in noise level with open area

Figure 7 suggests that 10 log *n* or similar relationships may tend to overpredict significantly the sound reduction as the open area increases. A more accurate representation of the change on site may be given by:

Free field conditions	5 log *n*	eq [1]
Diffuse field conditions	8.5 log *n*	eq [2]

Sound tests of the airborne sound insulation of open windows: incidence angle and multiple windows

In addition to the test described above, a number of variations were investigated. The objectives were:

- To compare the attenuation of a single open window and a pair of open windows in a façade, with increasing open areas;
- To measure the attenuation of an open window for different angles of noise incidence on the vertical and horizontal plane, with increasing open areas;
- To measure the attenuation of an open window at various openings, with the noise source at normal, 45° and 90° incidence on a horizontal plane.

A single figure D_{new} value for each window test was calculated using the method described in BS EN ISO 717-1:1996. The results were normalised to a receiving room reverberation time of 0.5 seconds.

continued on page 28

An assessment of the acoustical performance... - *continued from page 27*

Effect of multiple windows

The graph in Figure 9 presents the results of the multiple window tests. The figure shows a strong correlation in insulation performance between the one- and two-window systems, provided that they provide the same total window opening area (for the façade). Insulation performance for both systems improves logarithmically as the total open area of the window(s) is decreased.

Effect of change in horizontal incidence angle

Figure 10 shows that when the noise source is rotated away from the normal on a horizontal plane (ie about a vertical axis) the result is a fairly consistent improvement in sound insulation. For each successive 45° rotation away from normal incidence, the D_{new} increases by 2dB: there is thus a difference of 4dB between normal and 90° incidence. This trend was consistent for all window opening areas, except the smallest. This result is consistent with the general results presented in the NARN116 report.

Effect of change in vertical incidence angle

When the noise source is rotated in a vertical sense (*ie* about a horizontal axis) the insulation rating of the open window again improves as the loudspeaker moves away from normal incidence. However the effect is variable depending on the size of the open area of the window. The effect is more pronounced for small window opening areas, with a range of 5dB for a 0.5cm opening decreasing steadily to a difference of 1dB at an 8cm opening. It may be hypothesised from the results of the horizontal incidence test that a vertical noise incidence angle of 90° would provide a still larger range of measured Dnew ratings.

Conclusion

A review of literature found a wide range of values and measures to determine the sound insulation performance of an open window.

Existing experimental results show the open area and incidence angle can significantly affect the sound insulation performance of a window.

A comparison of the results of the present study with previously published laboratory results revealed that the values for open window attenuation appear to improve when they are measured in free-field conditions as opposed to a diffuse field in the laboratory. The apparent improvement in D_{new} may be in the region of 8dB.

The measured D_{new} of an open window in a façade will decrease according to a broadly logarithmical relationship as the window opening is increased. If a second window is opened, then the combined insulation will drop, though by how much remains uncertain. Nevertheless, it is the total open window area that determines the sound insulation of a system rather than the number of open windows in that system.

The apparent sound insulation through an open window consistently improves as the incident noise source is rotated away from the normal. The effect may be consistent across a range of opening distances for horizontal noise sources, but the effect is observed to lessen across vertical noise incidence angles as the window opening distance is increased.

It was also found that the acoustical attenuation as a result of an increased open area does not change by ten times the logarithm of the number of openings, or ten times the logarithm of the area ratio: a multiplier of five is more appropriate. A relationship wherein the change is proportional to 5 log *n* or 5 log (s_1/s_2) is therefore proposed.

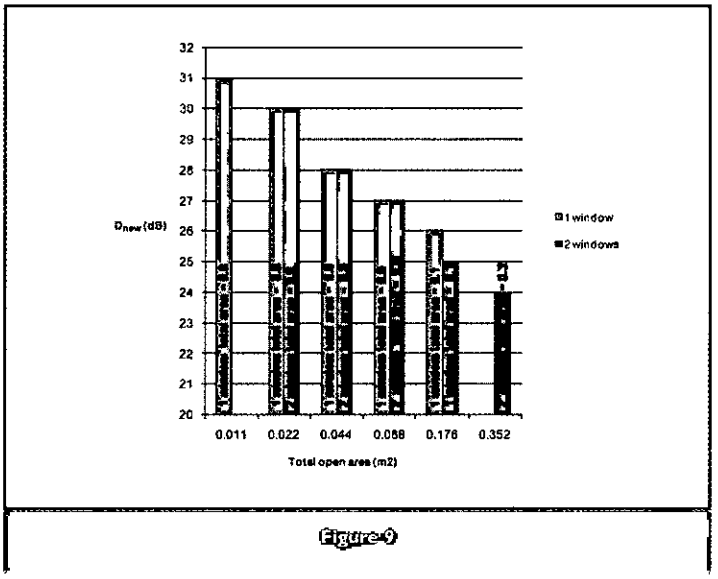


Figure 9

Comparison of D_{new} results for one or two open windows, per doubling of total open area

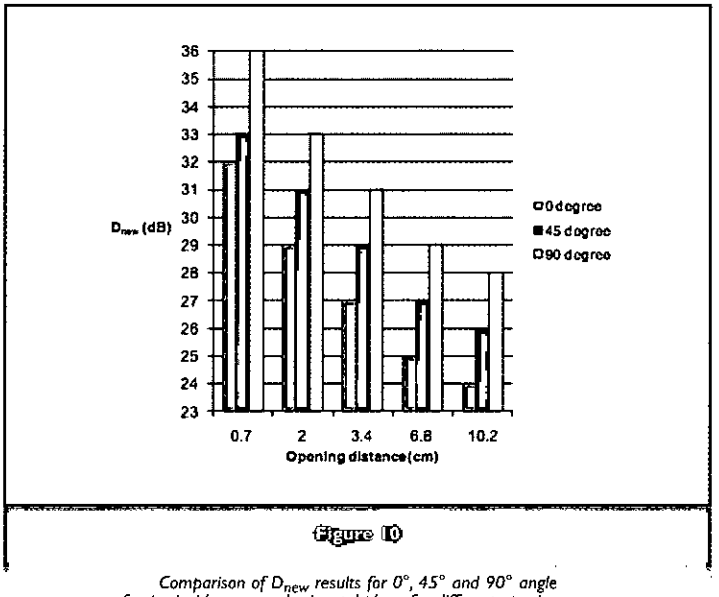


Figure 10

Comparison of D_{new} results for 0°, 45° and 90° angle of noise incidence on a horizontal plane for different opening areas

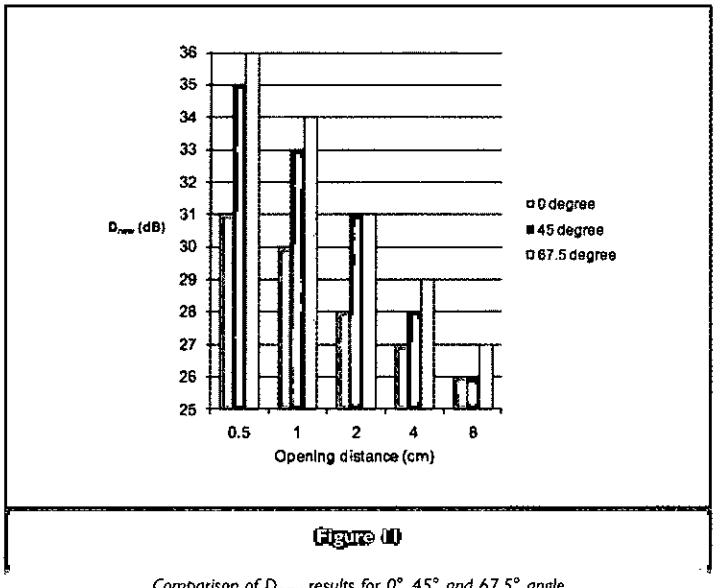


Figure 11

Comparison of D_{new} results for 0°, 45° and 67.5° angle of noise incidence on a vertical plane per doubling of opening distance

The results from this study suggest that using general guidelines for the performance of an open window is not sufficiently accurate to predict the internal noise levels. Conducting on-site field testing would seem to be the most reliable way of assessing the acoustical insulation performance of an open window or windows.

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Summary of guidance documents

BB93: 2003 'Acoustic Design for Schools'

BB93 states: *For partially open single-glazed windows or double-glazed windows with opposite opening panes, the laboratory measured airborne sound insulation is approximately 10-15 dB R_w. This increases to 20-25 dB R_w in the open position for a secondary glazing system with partially open ventilation openings, with the openings staggered on plan or elevation, and with absorbent lining of the window reveals.*

BS 8233: 1999

According to BS 8233, if windows are opened with the intention of providing rapid ventilation and summer cooling, then *the insulation will reduce to about 10 dB or 15 dB.* As part of a more rigorous calculation, reference is made to EN 12354-3:19994.

EN 12354-3:1999 [1]

In section 8.4.7 a value of R_w of 10 - 15 dB is given for *any type of window in a façade when partially open.*

WHO (1999) [2]:

Chapter 2 of WHO's Guidelines for Community Noise states that *completely open windows ... would have a sound reduction index of 0dB. If window openings make up 10% of the area of a wall, the sound reduction index of the combined wall and open window could not exceed 10dB.* Chapter 4 assumes that the noise reduction from outside to inside with the window partly open is 15dB.

PPG 24 (1994) [3]

According to Annex 2 of PPG 24 the sound insulation qualities of a partially open window are usually taken to be 10 – 15 dB(A). The source of this guidance is given as Nelson[5], however originally it appears to come from Design Bulletin 269. For the purposes of Noise Exposure Categories (NECs), a 13dB level reduction through a façade via an open window is assumed for the night-time limits.

BRE Digest 338 (1988) [4]:

Field measurements were taken of average sound level differences (100 – 3150 Hz) through different types of window in a masonry façade. The average sound level difference for a small window is 15 dB. It is also stated that *when windows are open, only the area of opening is significant; if this is 10% of the total area, the basic noise reduction will be about 10dB whatever type of window or wall construction occupies the remaining 90%.*

Nelson – Transportation Noise (1987) [5]:

The sound insulation of a single open window is given as 5 – 15 dB.

DoE Design Bulletin 26 (1972) [6]:

Open doors and windows are comparable in their resistance to sound, both offering *about 5dB(A) when wide open, 10 - 15 dB(A) when partly open.*

Summary of experimental research

These last three research papers listed are identified in **NANR116** **[7]**, where a detailed summary of them can be found. NANR116 is the most recent paper on the subject of open window sound insulation.

Lawrence and Burgess (1982-83) [8], [9]

A vertical sliding sash open 9% of the total façade provided a sound reduction index R_w of 10dB (field study).

Kerry and Ford (1973-74) [10], [11]

A horizontal sliding sash window open 25mm and 200mm provided average sound reduction indices R_w of 14dB and 9dB respectively (field study).

Mackenzie and Williamson DoE Report (1972-73) [12], [13]

A vertical sliding sash window open 0.027m² (summer night-time ventilation) and 0.36m² (summer daytime ventilation) provided sound level reductions of 16dB and 11dB respectively (laboratory study).

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2. *Guidelines for community noise* (WHO 99), World Health Organisation (1999)
3. *Planning and noise* Planning Policy Guidance 24 (PPG24) ODPM (1994)
4. *Insulation against external noise* BRE Digest 338, Building Research Establishment (1988)
5. Nelson, P M – Transportation Noise Reference Book, Butterworth, Section 11.2 (1987)
6. *New housing and road traffic noise - A design guide for architects* Design Bulletin 26, Department of the Environment (1972)
7. Napier University, School of the Built Environment – NANR116: *'Open/closed window research' Sound insulation through vented domestic windows* (2007)
8. Lawrence, A and Burgess M – *Traffic noise and the open window* Acoustical Society of America, Meeting 104, Paper XX2 (1982)
9. Lawrence, A and Burgess M – *Reduction of traffic noise by facades containing windows* Economics of Noise Control, Proceedings of the 1983 Annual Conference of the Australian Acoustical Society, Sydney, Australia (1983)
10. Ford, R D and Kerry G – *The sound insulation of partially open double glazing* Applied Acoustics 6: pp57-72 (1973)
11. Kerry, G and Ford R D – *The field performance of partially open double glazing* Applied Acoustics 7: pp213-227 (1974)
12. Mackenzie, R K and Williamson J J – *The cost effectiveness of double glazing against traffic noise* Department of the Environment (1972)
13. Mackenzie, R K and Williamson J J – *The cost effectiveness of double glazing against traffic noise with particular reference to schools, hospitals and offices* Department of the Environment (1972)

Technical note

John Campbell, Richard Divey and Lesley Oldfield.

Case study: Noise breakout from a public entertainment venue

Using an acoustic camera to identify sound leakage

Background

St Andrews Hall is a 14th century building in central Norwich and is owned by Norwich City Council. The hall is a popular venue for concerts and other licensed events but in recent years has had problems with noise from events. Residential flats approximately 35 metres from the hall have experienced unacceptable sound levels, which limited the uses of the hall, especially for amplified music. A sound limiter is installed to cut off power to the stage and public address (PA) system when internal noise levels reach prescribed limits. The limits are low, and this makes the venue unpopular with many artists.

This has led to a significant loss of income for the council, which is necessary for the upkeep of an important building for the city.

In order to reduce breakout noise, secondary glazing has been installed to the first and second floor windows of the hall opposite the flats. These windows can be seen in Figure 1. In addition, the main entrance to the main hall was given an acoustic seal and an internal acoustic door has been installed.

The result of the acoustic treatment was an approximate 1dB improvement at the nearest noise-sensitive property.

Acoustic camera measurements

In order to identify acoustical leaks on the main façade shown in Figure 1, additional loudspeakers were placed in the hall, playing pink noise so as to give an internal reverberant sound pressure level of 105dB(A). The Norsonics 848 acoustic camera was then pointed towards the façade to see if leaks could be detected outside.

Results

Measurements from distance

Two main areas could be seen where sound was leaking from the hall. The first was a side window closest to the camera in Figure 2. The second was from the top of the windows in the main façade. In order to identify these more readily, the acoustic camera was moved closer to the hall.

Measurements for side window

The camera was placed approximately 5m from the side window. This window shows an obvious acoustic leak, as can be seen in Figure 3. The window had not received secondary glazing and from the acoustic camera it could be seen that it made a significant contribution to the sound level at the nearest residential receptors. An improvement would be seen if this window was provided with secondary glazing.

Measurements for door to main hall

The inner acoustic door and the external door were both closed fully. From 1kHz upwards a leak was detected (see Figure 4) where the seal was missing on the external door (Figure 5). On the internal acoustic door it was discovered that there was also a seal missing, as can be seen in Figure 6.

Replacing these seals would improve the sound insulation at minimal cost.

Measurements for windows on main façade

Placing the acoustic camera close to the main façade it could be seen that the sound was leaking from the far end of the building, as illustrated in Figure 7.

By using the virtual microphone with the camera (the blue circle seen on the screen) it is possible to focus on any part of the screen to hear that area in isolation. A significant leak was detected and seen at the far end of the building. A bird singing can be detected on the video file for this measurement.

The acoustic camera was placed close to the façade at the far end of the building, and a significant acoustic leak was identified above the window.

The construction of the building is masonry with large wooden beams laid across the top of the walls to support the roof. The leak could be pinpointed to a major beam located above the window as shown in Figure 8. Of the leaks detected, this was the most significant acoustical transmission path from the hall, and the main contributor to the higher than expected noise levels measured at receiver locations. To a lesser extent, a leak detected on the second window from the left in Figure 8 was also contributing.

Conclusions

The main leak shown in Figure 8 needs further investigation. A 'cherrypicker' or hydraulic working platform is required to access the pinpointed areas, but it is likely that repairing the masonry will improve the sound insulation significantly.

The acoustic camera was able to identify significant acoustic leaks which were not apparent by subjective assessment alone. The setup is shown in Figure 9.

Videos of the measurements can be found at www.youtube.com by entering 'CAssoc1' in the search box.

John Campbell is with Campbell Associates Ltd

Richard Divey and **Lesley Oldfield** are with Norwich City Council

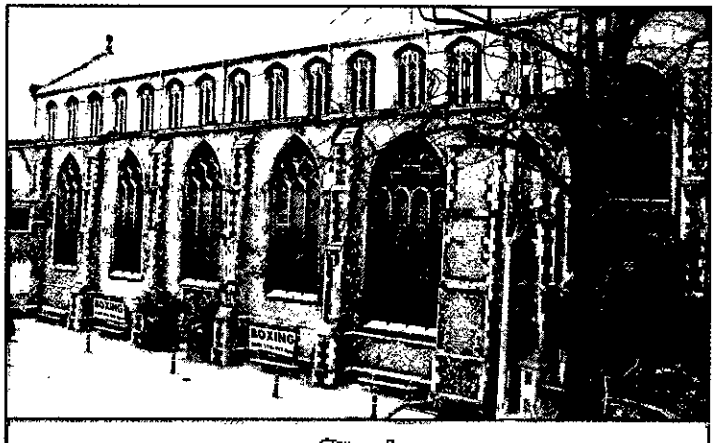

Figure 1

St Andrews Hall, Norwich

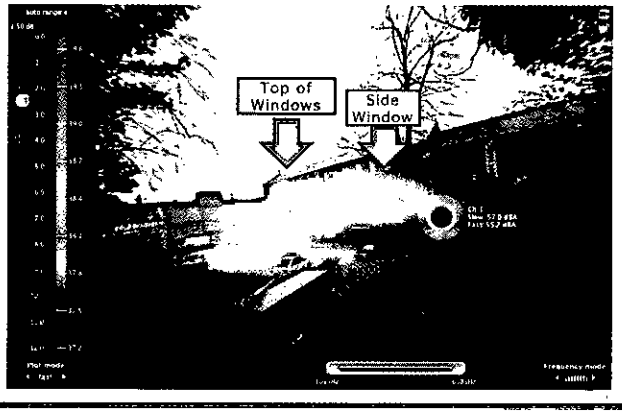

Figure 2

Acoustic camera image from distance

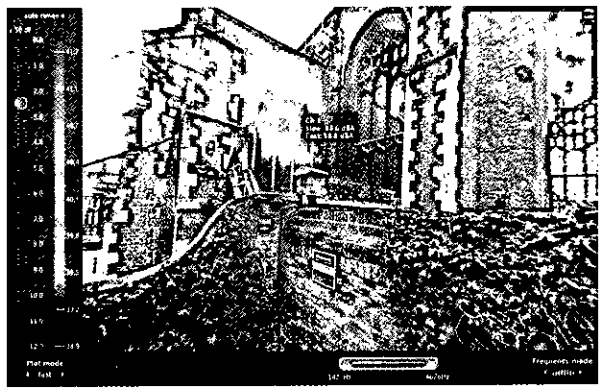

Figure 3

Acoustic camera image of side window

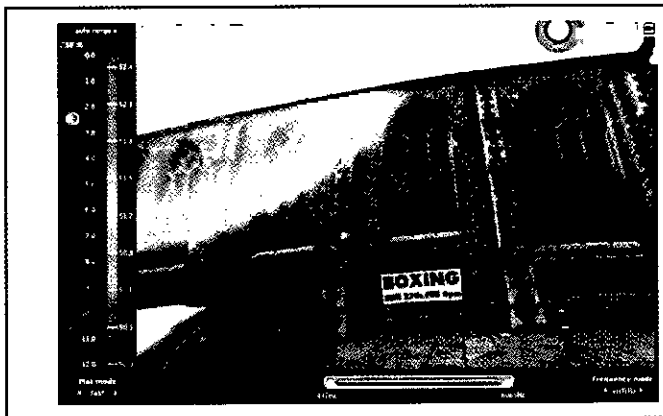

Figure 7

Measurement at main façade

Figure 4

Seal missing on external door

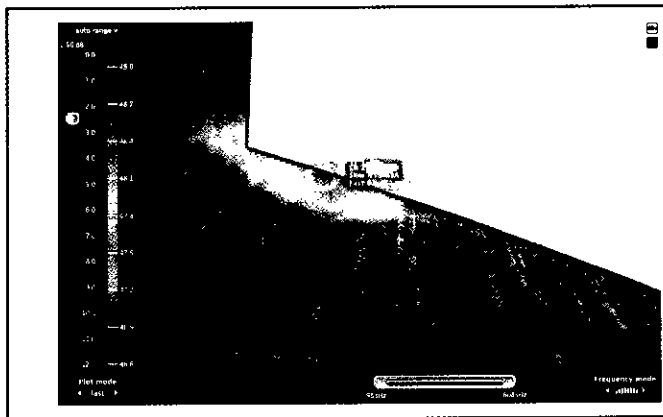

Figure 8

An acoustic leak pinpointed

Figure 5

Seal missing on external door

Figure 6

Internal acoustic door also not sealed

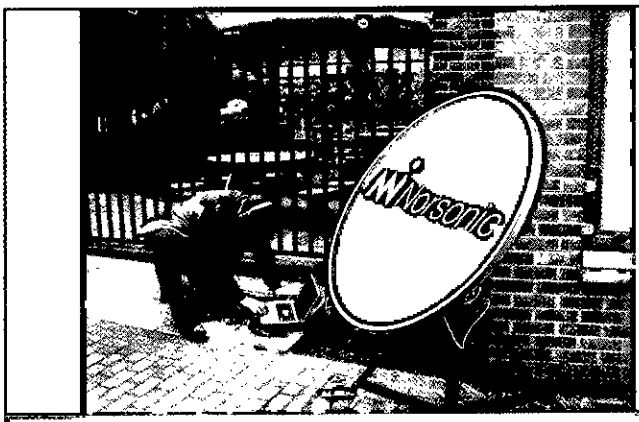

Figure 9

Setting up the acoustic camera

Chameleon subwoofer arrays in live sound

Adam Hill and Malcolm Hawkesford.

Introduction

A high quality sound system should provide consistent coverage over the entire audience area while at the same time keeping the sound pressure level on stage to a minimum in order to provide musicians, technicians and production staff with a reasonable working environment. These requirements have predominantly been met with recent advancements in line array technology, where horizontal coverage patterns of 90° or 120° are easily achievable, minimising sound wraparound to the stage. Coverage patterns in the subwoofer operating range (generally below 100Hz), however, are more difficult to control using simple 'one size fits all' system configurations.

Historically, industry-standard subwoofers have operated as roughly omnidirectional sources, radiating energy equally in all directions. In recent years, a handful of companies have introduced cardioid or supercardioid pattern subwoofers which can help to limit low frequency energy on stage, depending on the system configuration. In addition to this, system technicians have long used the technique of rotating every other or every third subwoofer in vertical stacks 180° to achieve an approximate cardioid radiation pattern.

Conventional subwoofer systems suffer from a number of constraints which can differ from venue to venue, including placement issues, rigging capabilities, sightlines, truck space and, of course, budget. These drawbacks, which will be discussed in the following section, can severely diminish a system's capability to meet the low-frequency coverage and rejection criteria[1]. With this in mind, it is proposed that an adaptation of an emerging technology for small-room low-frequency control, termed a chameleon subwoofer array[2] (CSA), can circumvent these practical issues and easily achieve venue-specific coverage patterns that should benefit both the audience and stage areas.

Conventional subwoofer system issues are explored in this article, with relevant simulation results emphasising key points, followed by a discussion of common techniques for low-frequency coverage pattern control. Next, chameleon subwoofer array correction theory is presented in the context of small room applications and then the live sound adaptation is explained with emphasis on incorporating the system into existing industry-standard hardware. Simulations of large-scale concert venues utilising this low-frequency control approach are presented, highlighting the potential advantages of CSA technology in live sound.

Conventional subwoofer system issues

Units within a live sound subwoofer system can theoretically be placed and configured to achieve the desired coverage pattern. Unfortunately, there is a long list of constraints that usually prevent this, primarily stemming from production, venue and time restrictions, all of which will be discussed in the following.

Subwoofer placement

Disregarding production or venue constraints, simple subwoofer placement can be critical to define the overall coverage pattern.

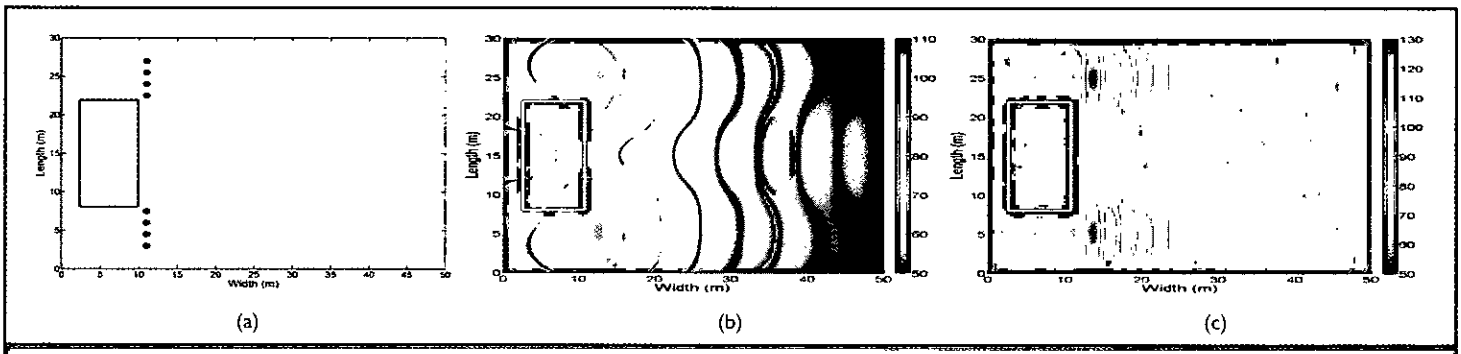

Figure 1

16-unit cardioid left/right subwoofer system with system layout (a) and simulated coverage patterns at (b) 40Hz and (c) 90Hz

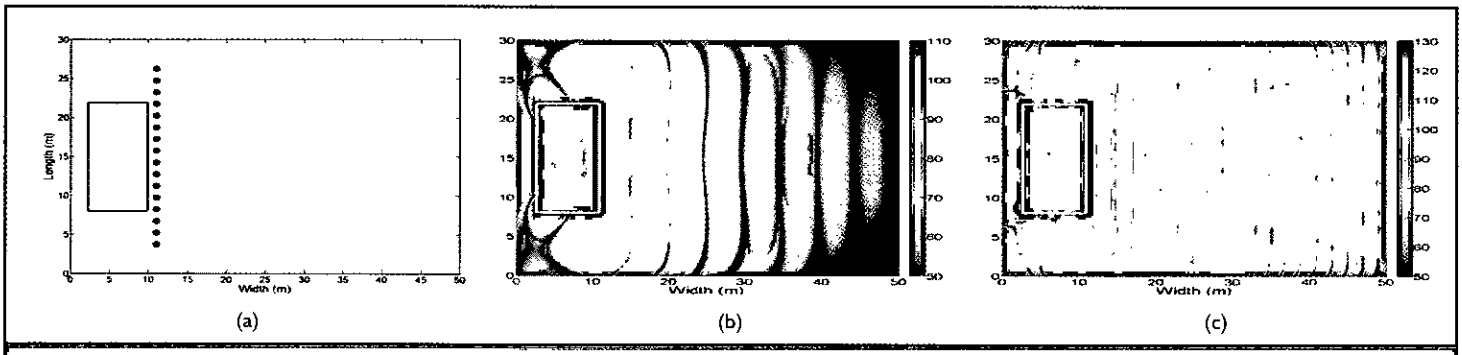

Figure 2

16-unit cardioid central subwoofer system with system layout (a) and simulated coverage patterns at (b) 40Hz and (c) 90Hz

Depending on the spacing between each unit within the system a 'power alley' (overly strong low-frequency energy down the centre of the audience area) can emerge along with any combination of pressure nulls which travel outward from the stage. The individual unit spacing can also affect the sound pressure level on the stage. This is due to the constructive/destructive interference between the sound waves emitted from each source where location of any peaks/nulls depends of the intersection points of the individual sound waves.

To highlight this issue, a virtual outdoor venue was created with dimensions 50 by 30 by 10 metres, where all surfaces except the ground plane and the stage were set as anechoic. Simulation of the stage has been shown to be critical for accurate results owing to interfering reflections off the stage, corrupting the individual subwoofer directionality[1].

Sixteen cardioid subwoofers (with the cardioid pattern achieved following Olson's work on gradient loudspeakers[3]) were initially placed in stacks of two in left/right clusters to simulate placement outside the stage corners, in line with the main PA. Sinusoidal test signals at 40 and 90 Hz were used to analyse the pressure distribution of the system (Figure 1).

The left/right clusters give clear nulls within the central audience area as a result of destructive interference between the clusters. Also, stage rejection appears to suffer from the wide spacing causing a high stage sound pressure level. Repositioning the units with equal spacing across the stage front can result in a significant reduction of the pressure nulls within the audience and also improve stage rejection (Figure 2).

The equal spacing configuration evokes higher sound levels within the front rows of the audience (which can be a safety issue), while the left/right system does not produce this effect for the audience centre. Also, the equally spaced system causes a power alley to arise due to the constructive interference from all units coinciding at the centre axis of the system. Often, this power alley issue is ignored since the front-of-house (FOH) engineer is located at the venue centre, which coincides with the optimal location for the best stereo effect from the main PA. Moving off centre will gradually result in a diminished stereo effect and a reduction in low-frequency sound level. This is undesirable since the goal is to deliver equal low-frequency energy to a large audience area. It is also important that subwoofers are not positioned directly below the stage. This sort of placement has been demonstrated to diminish subwoofer directionality[1] and is apparent in Figure 2 with the higher sound pressure level on the stage due to reflections off the stage decking.

Practical issues

Subwoofer spacing and stage proximity often become moot points because of practical constraints. To begin with, the system must be

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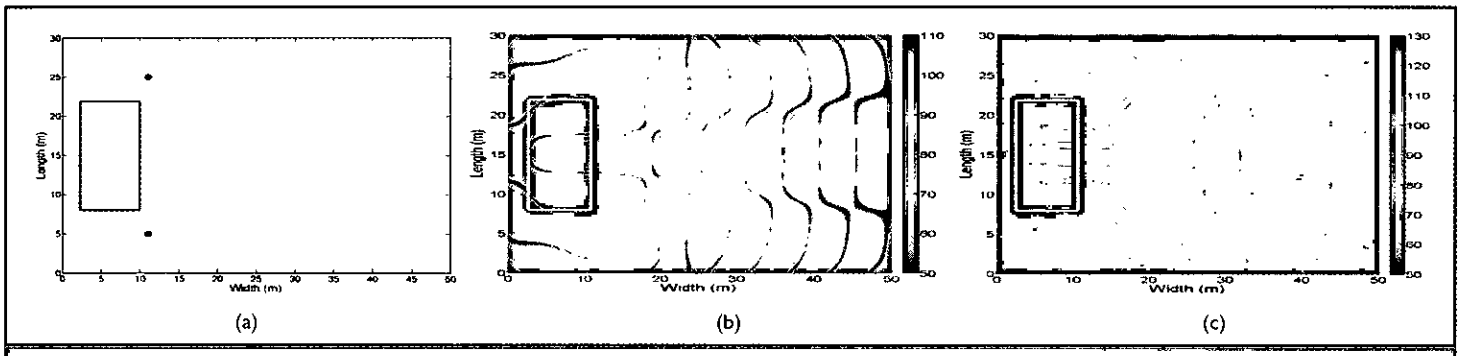

Figure 3

Eight-unit left/right flown subwoofer arrays with system layout (a) and simulated coverage patterns at (b) 40Hz and (c) 90Hz

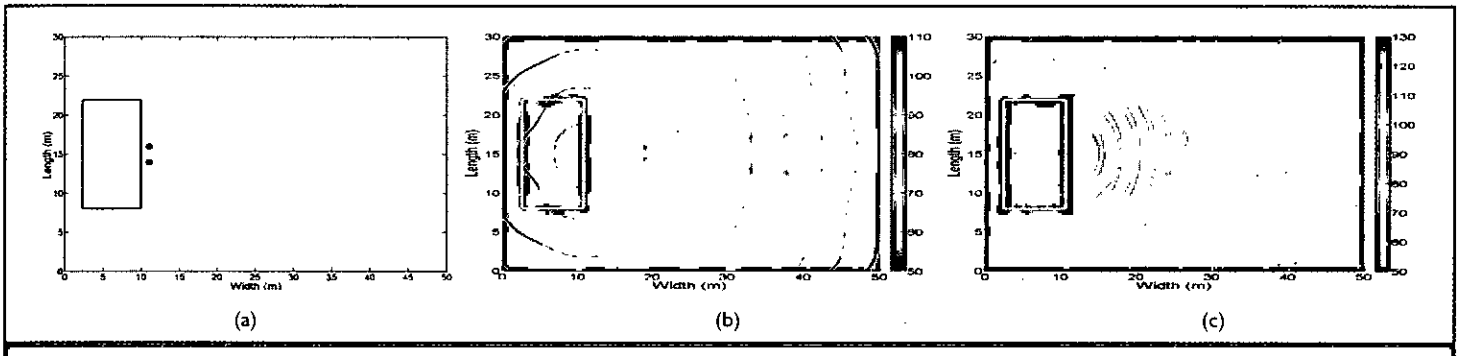

Figure 4

Eight-unit centrally flown subwoofer arrays with system layout in (a) and simulated coverage patterns at (b) 40Hz and (c) 90Hz

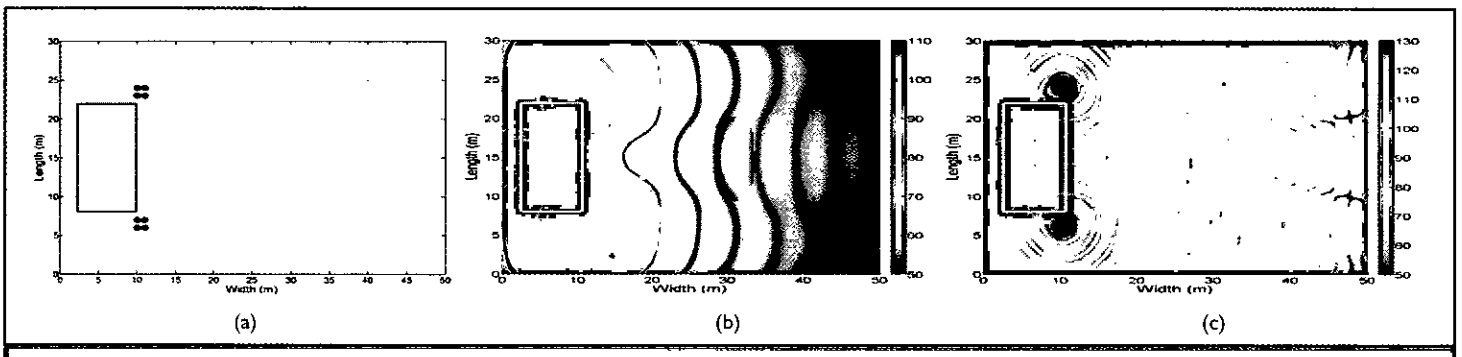

Figure 5

Left/right steerable clusters for 270° audience coverage with system layout (a) and simulated coverage patterns at (b) 40Hz and (c) 90Hz

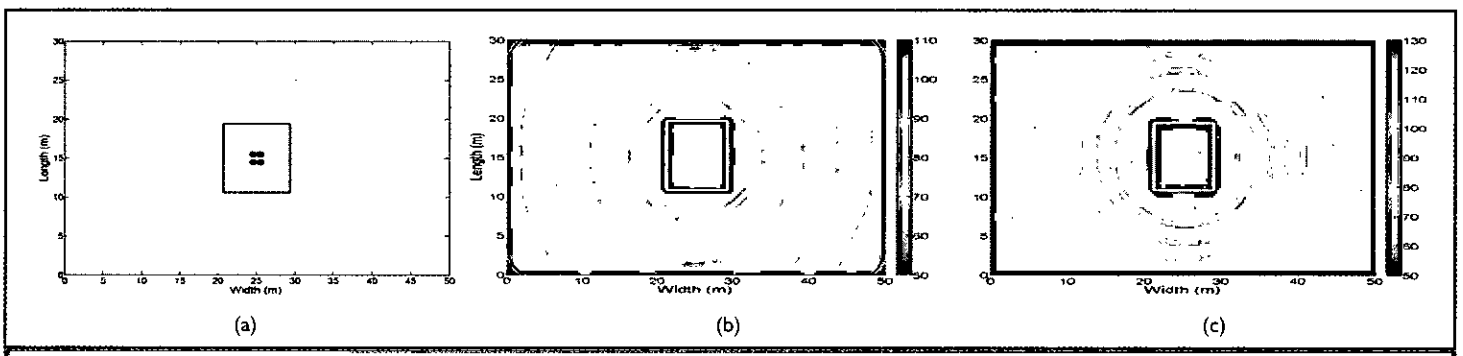

Figure 6

Central flown steerable cluster for 360° audience coverage with system layout (a) and simulated coverage patterns at (b) 40Hz and (c) 90Hz

Chameleon subwoofer arrays in live sound - *continued from page 33*

transported to the venue. This requires a significant amount of truck space leading to greater fuel, driver and transportation permit costs. Owing to a restricted production budget, the sound system is often reduced in size to fit the allocated truck space, resulting in a less than desirable system before it even reaches the venue.

Once at the venue, subwoofer placement usually is compromised to meet the sightline, set piece, lighting, video and venue requirements. These factors will cause the system configuration to be altered from venue to venue, requiring manual system tuning which there is not always an abundance of time to carry out. Larger venues can often provide the necessary roof support for flown subwoofer arrays which can help avoid many of the above mentioned issues with the cost of additional time to rig the system. An additional factor largely overlooked pertaining to ground stacked systems is the low-frequency absorptive properties of a large audience, which can potentially cause conflict between theoretical predictions and practical measurements in terms of front to back audience coverage[4].

Common control techniques

The practical issues that impact the design of a subwoofer system have led to the development of a number of alternatives to the standard ground-based in-line subwoofer systems. The majority of these solutions involve spatially-compact configurations, clear of sightlines. These systems benefit from using fewer well-configured subwoofers as opposed to many arbitrarily placed units, saving truck space, fuel and money.

Flown subwoofer arrays

Many larger venues are capable of supporting flown arrays, both for the main PA and subwoofer system. These systems benefit from being out of the way of audience sightlines as well as sufficiently far from the staging to avoid unwanted resonances. In addition to this, flown subwoofer arrays (and the main PA) benefit from less difference in propagation length between the closest and farthest listener. For ground-based systems the closest listeners are within a few metres of at least one of the system units while flown arrays are generally suspended many metres above the stage resulting in a more uniform front-to-back sound field where the audience in the first few rows receives approximately equal sound energy as those in the back rows. One disadvantage of flown subwoofer arrays is the loss of the Waterhouse effect[5], which gives ground-based systems 6dB of added sound pressure output owing to the close proximity to the ground plane.

Most common configurations of flown arrays use left/right subwoofer vertical arrays flown directly beside the main PA hangs. These configurations suffer from pressure nulls similar to ground-based clusters due to the spacing of the arrays. This problem is demonstrated in Figure 3 where eight-box left/right vertical flown arrays were simulated using the previously-used virtual venue with the lowest box in the array at a height of 6m.

The flown left/right arrays do not provide adequate stage rejection owing to their height above the stage. Following a similar line of reasoning to that used for ground-based systems, a central flown subwoofer cluster can be simulated to demonstrate more even left-to-right coverage owing to the decreased horizontal spacing of the units (Figure 4).

While this central cluster technique can provide more uniform low-frequency coverage it also restricts the placement of video screens,

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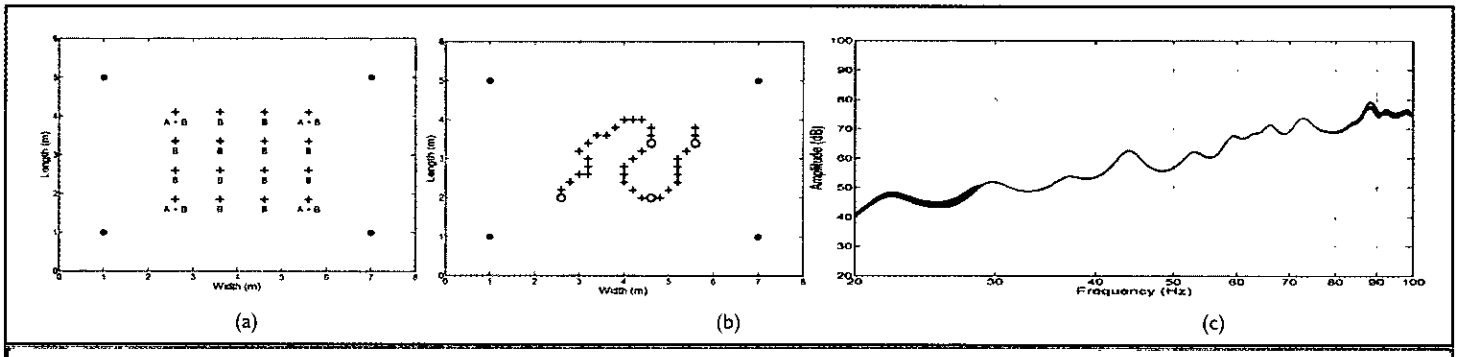

Figure 7

Small-room CSA implementation with (a) correction setup, (b) 36-point virtual walking test layout and (c) corrected frequency responses over the walking path

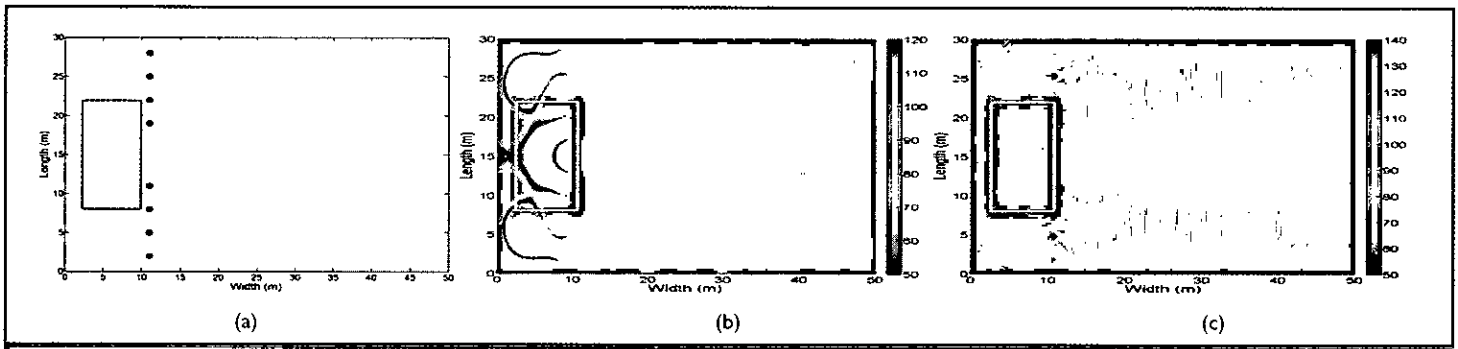

Figure 8

Unprocessed left/right eight-unit cardioid subwoofer system with system layout (a) and simulated coverage patterns at (b) 40Hz and (c) 90Hz

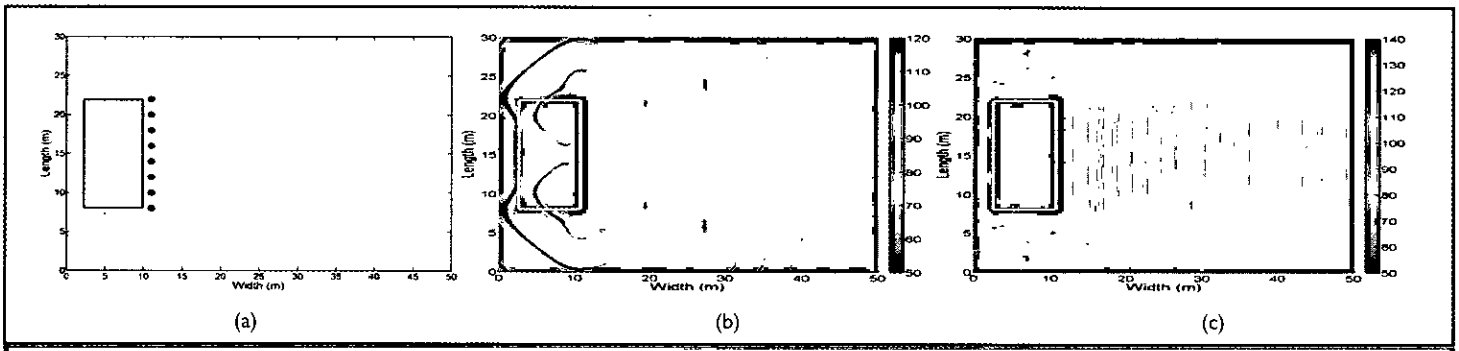

Figure 9

Unprocessed central eight-unit cardioid subwoofer system with system layout (a) and simulated coverage patterns at (b) 40Hz and (c) 90Hz

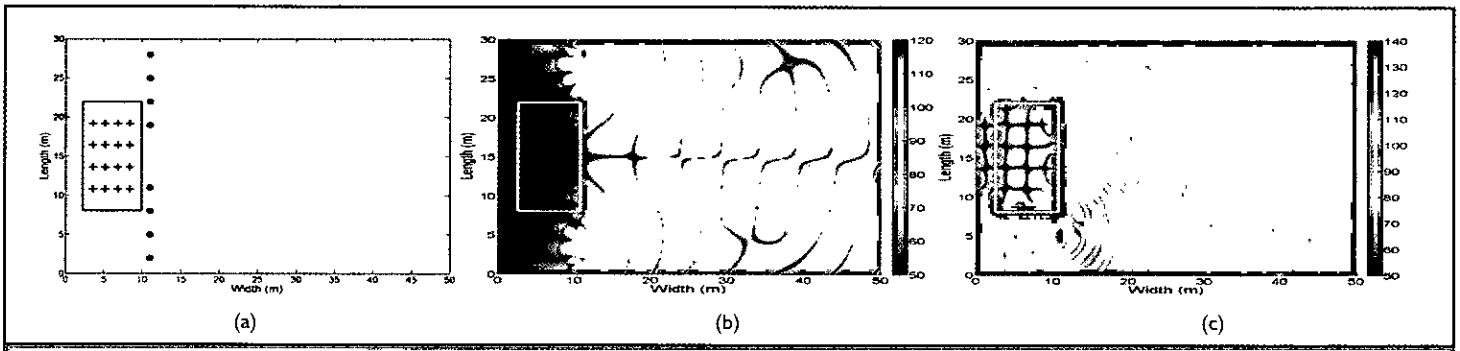

Figure 10

CSA stage-controlled left/right eight-unit cardioid subwoofer system. System layout shown in (a) (target points are shown as +), and simulated coverage patterns at (b) 40Hz and (c) 90Hz

Chameleon subwoofer arrays in live sound - *continued from page 35*

limits any low-frequency stereo effects and often requires large trim heights to be sufficiently clear of the performance area. Stage rejection is superior to the left/right system and the spatial nulls have largely disappeared, giving relatively even left-to-right and front-to-back coverage at both 40 and 90 Hz.

Steerable clusters

A technique gaining popularity involves compact clusters of omnidirectional or cardioid subwoofers capable of applying individual electronic delay to create the desired cluster directivity. This technique has largely been developed and explored by Rat Sound[6] and Meyer Sound[7].

The most common occurrence of this technology is with ground-based left/right clusters. These clusters can achieve acceptable stage rejection while also covering over 270° of audience area, a common requirement for events in large sports arenas (Figure 5).

The disadvantage to the left/right cluster configuration is that the two clusters still operate independently of one another and result in the familiar pressure nulls. While spatial limitations prevent these clusters being placed in front of the stage, some touring systems have employed a central flown cluster for applications with the audience in the round (360°). This sort of configuration benefits from the close spacing of all subwoofers, giving a very even coverage pattern over the audience area (Figure 6).

Subwoofer clusters, both ground-based and flown, offer system engineers many more degrees of freedom towards directivity control. This added control, though, requires pre-planning and also fine-tuning from venue to venue; time that is either not always available or often allocated to other tasks. Also, as seen in Figures 5 and 6, clusters can provide the desired audience coverage but are not guaranteed to result in adequate stage rejection. Steerable clusters are an interesting technique for low-frequency control, but do not provide a robust solution for coverage control.

Chameleon subwoofer arrays

An emerging technique aimed at small-room wide-area low-frequency correction uses chameleon subwoofer arrays[2] (CSA). The chameleon descriptor is used because the system uses individual subwoofer units with multiple degrees of freedom which can blend into an acoustical environment by matching the natural room response over a listening area.

The foundation of CSA technology departs from conventional single drive unit, single degree of freedom omnidirectional subwoofers by incorporating four source components within each unit: one omnidirectional and three dipolar (one in each primary rectangular dimension). While a conventional small-room subwoofer system of four units gives only four degrees of freedom, a similar system employing a CSA gives sixteen degrees of freedom, allowing for detailed correction procedures.

A CSA requires calibration measurements to generate the correction filters for each source component within the system. This setup operates using a single source component at a time while measuring the resulting impulse response at multiple target points within a listening area. The number of target points is governed by the system degrees of freedom. With the measurements complete, a user defines the target response at each measurement location, which can be the same or different for all points. The data is fed through a matrix

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Chameleon subwoofer arrays in live sound - *continued from page 37*

equation to calculate the required filter coefficients to achieve the desired responses at each target point using the equation

$$H = X^{-1}Y$$

where H is an n by l matrix of the complex correction coefficients, X is an m by n matrix of the measured frequency responses and Y is an m by n matrix with the desired frequency response for each target point. The system contains m target points and n source components. If m does not equal n, the larger of the two will be reduced to match the other, discarding the extraneous data. This calculation is performed over all frequency bins in the specified correction range.

To ensure system stability, a number of checks have been built into the CSA system. Filter ringing is avoided by avoiding correction above the Schroeder frequency[8] (in the diffuse sound field range) by imposing an upper correction limit regulated by the room's volume and absorptive properties. Below the lowest room mode the system is only pressurising the room, with little spatial variance across the area, so a lower correction limit is set just out of range of the lowest room mode. Lastly, dipolar sources are inefficient at very low frequencies[9] therefore the CSA is limited to omnidirectional operation for the lower correction range, as defined by the target point spacing[10]. Above this range all system source components will be active in the correction procedure.

To illustrate the potential room correction benefits with a CSA, a virtual room of dimensions 8 by 6 by 2.6 metres was created with a four-unit CSA at room corner locations. A large listening area covers the central area of the space at a height of 1.6m. Correction calibration was performed using the layout in Figure 7(a), where points marked A represent target points in the omnidirectional-only band

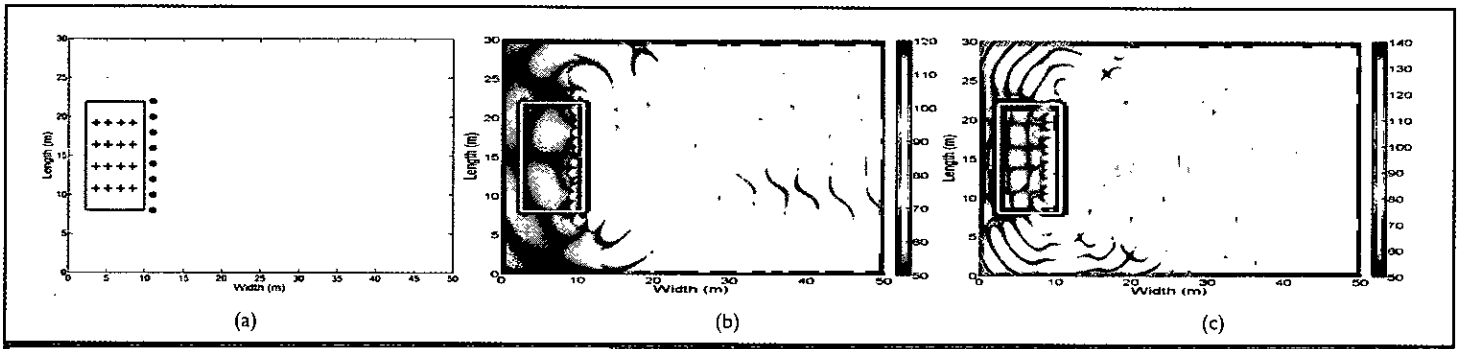

Figure 11

CSA stage-controlled central eight-unit cardioid subwoofer system with system layout shown in (a) (target points are shown as +), and simulated coverage patterns at (b) 40Hz and (c) 90Hz

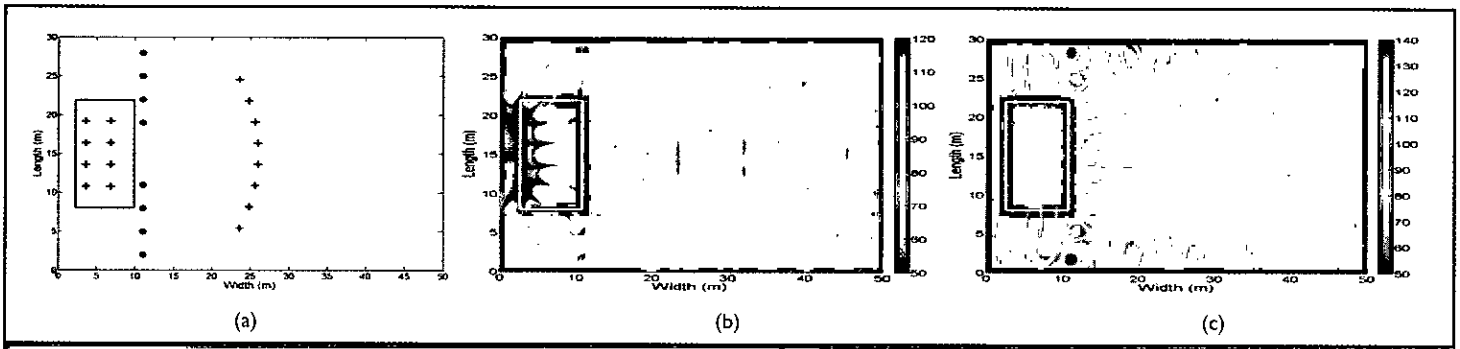

Figure 12

CSA stage and audience controlled left/right eight-unit cardioid subwoofer system with system layout shown in (a) (target points are shown as +), and simulated coverage patterns at (b) 40Hz and (c) 90Hz

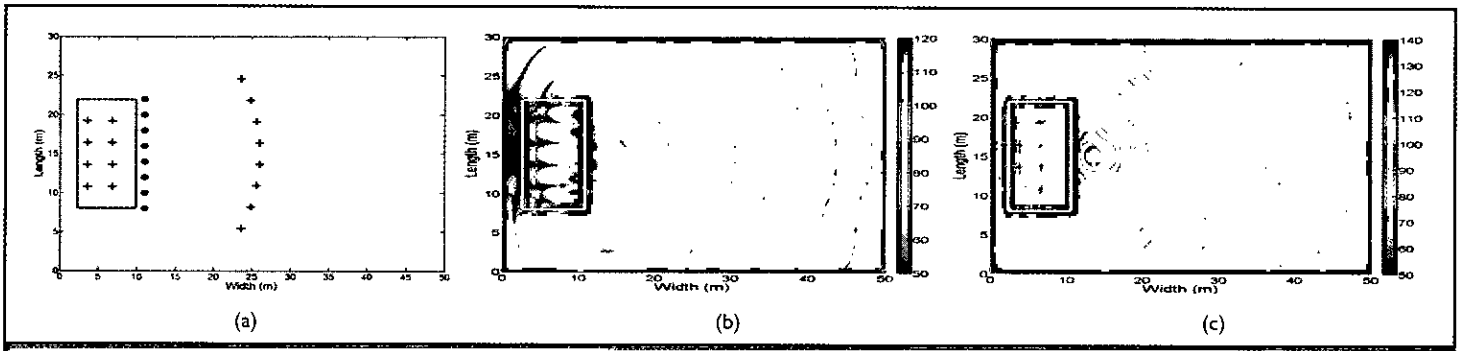

Figure 13

CSA stage and audience controlled central eight-unit cardioid subwoofer system with system layout shown in (a) (target points are shown as +), and simulated coverage patterns at (b) 40Hz and (c) 90Hz

while points marked *B* are the target points for the remaining correction range. A virtual walking path was designed, shown in Figure 7(b) and tested with an MLS signal to determine the frequency responses at both target and non-target points within the path, as shown in Figure 7(c).

The uncorrected system results in 3.92dB spatial variance across the walking path while the CSA-corrected system only exhibits 0.25dB spatial variance, a reduction of 93.8%. This highlights the power of a CSA for small room correction in terms of spatial variance reduction and/or real-time adjustment of specific target point frequency responses, owing to the direct calculation approach.

Live sound applications

As alluded to in the section above, a system that intelligently uses all subwoofers to create an overall coverage pattern would provide a much more robust solution to the low-frequency coverage problems faced in live sound. A CSA can easily be adapted to serve this purpose while fitting within current industry-standard hardware.

The CSA correction procedure is ideally suited for use with multi-component subwoofers, as described in the previous section: however, CSA correction can also operate on any subwoofer system given that each degree of freedom can be independently controlled. Cardioid subwoofers are becoming increasingly common in the industry, usually containing two independently controlled 18-inch drive units. The two distinct drive signals are principally generated within the system's control unit(s) which take the full-range input from the mixing desk and split the signal into relevant operating bands for each system component. CSA control can be applied by inserting an extra DSP unit in between the system processor and the power amplifiers. This supplementary unit will apply the control filters to the drive signals to create the target coverage pattern. Since the setup measurements are taken in line with the system processing, this procedure will not be adversely affected by any processing unit manipulations between the two unit drivers.

As with small-room CSA applications, the live sound CSA control procedure is limited by the number of degrees of freedom within the system and also the spacing of the target points. A subwoofer system driven by a four-mix amplifier rack on both the left and right sides of the stage will give a total of sixteen available degrees of freedom owing to independent processing/amplification for front and rear drive signals (two degrees of freedom per subwoofer). Frequencies with half-wavelengths shorter than the mean spacing between target points will not result in a uniform coverage pattern across the audience/stage area: rather, pockets of control will exist caused by the wide spacing of target points. Small room CSA correction procedures generally recommend a more conservative quarter-wavelength maximum spacing, but half-wavelength spacing is sufficient for the less detailed live sound CSA control procedure.

Unprocessed system results

A 50 by 30 metre outdoor virtual venue was set up containing an eight-unit cardioid subwoofer system with left/right placement. Simulations were conducted in two dimensions to provide simulation time efficiency. As with previous test, the system coverage pattern was simulated at 40 and 90 Hz for the unprocessed system (Figure 8). Following the convention of passive unit placement, an equally-spaced unprocessed central system was also simulated (Figure 9).

The unprocessed systems give reasonable audience coverage patterns, although the left/right configuration does result in the expected spatial nulls at certain points within the audience. Both systems deliver approximately 10 to 15 dB stage rejection compared with the sound

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pressure level in the audience. At loud rock concerts this could amount to over 110dB in some areas of the stage, which can be an unsafe daily working environment for musicians and other production staff.

Chameleon subwoofer array results: stage control

A CSA can be utilised in an attempt to minimise the sound level on stage to ensure a safe working environment. Identical systems as in Figures 8 and 9 were used for the CSA methodologies with target points arranged in a grid pattern on the stage. All target responses were set to the measured average response, but with approximately 40dB attenuation. In addition, individual propagation delay was factored into each target response, based on measured delay time to each target point. Audience coverage is not considered in this approach, although overall system output is set to match the uncorrected system, so similar audience coverage patterns should endure. The eight-cardioid unit systems allow for sixteen degrees for freedom. As before, both configurations were tested at 40 and 90 Hz (Figures 10 and 11).

The stage-only CSA control results in significantly greater stage rejection (up to 50dB in some cases) but also highlights certain problems. Firstly, since the audience area is not considered in the control procedure, there are clear deviations from the unprocessed coverage patterns, most noticeably with large central nulls for the 40Hz trials. Secondly, the 90Hz trials show less stage rejection than at 40Hz. This is due to the target point spacing issue. The mean spacing is 3m which dictates that accurate, uniform control over the entire target area will only exist below approximately 60Hz. At 90Hz, therefore, there are pockets of control with the outlying areas not receiving clear benefit from the CSA procedure.

Chameleon subwoofer array results: stage and audience control

To evade the problems present with stage-only CSA control, the sixteen target points can be divided between the stage and audience area. The stage target responses will remain unchanged from the previous examples, while the audience points will target the measured average response across all points. This technique should provide more even audience coverage while maintaining the stage rejection (although to a lesser extent, because there are fewer stage target points). Again, control is limited to the target spacing, both in the audience and on stage, to around 60Hz. Identical system configurations to those in the previous examples were tested at 40Hz and 90Hz (Figures 12 and 13).

The stage + audience controlled CSA results show notable improvement over the stage-only control. The audience target points ensure that the coverage pattern is evenly distributed throughout the audience area while still minimising pressure on stage. The downstage edge of the stage experiences relatively high sound pressure level due to the target points' upstage placement. Again, the 90Hz results show pockets of control as opposed to uniform control which is due to the wide target spacing, limiting uniform control to below 60Hz. The central configuration, however, does result in even wide-audience coverage at 90Hz, largely because of the naturally even coverage of the configuration.

Conclusions and future work

A live sound application of chameleon subwoofer array (CSA) low-frequency control is presented as a new technique to limit the amount of low-frequency energy on stage while creating a uniform pressure distribution over a large audience area. While conventional control systems can provide up to around 20dB attenuation on stage, largely as a result of the cardioid radiation pattern of the subwoofer units, CSA-controlled subwoofer systems have been shown in simulations to be capable of up to 50dB of rejection while maintaining uniform audience coverage.

The live sound CSA control technique operates within the existing framework of industry-standard systems, using the independent front-and-rear drive-unit processing/amplification capabilities to allow for two degrees of freedom for each cardioid subwoofer. This method can be inserted into a conventional system in between the system processor and the power amplifiers, minimising the need for expensive new hardware.

A drawback with the CSA system is the target point spacing restrictions. Wider spacing corresponds to a lower control frequency limit. Above this limit control will exist in pockets, but will not be uniform. Tighter target point spacing can raise the frequency limit, but will result in a narrower control area unless additional target points are added, which would require additional degrees of freedom within the subwoofer system.

Future work required in this area includes running simulations in closed environments to judge the effectiveness in smaller concert halls and other venues. As the system can easily fit into existing sound systems, real-world testing can theoretically be performed to confirm the effectiveness of the CSA live sound control procedure.

Overall, CSA control can potentially bestow a robust solution to the difficult problem of providing equal low-frequency audience coverage while keeping the sound pressure levels on stage to a minimum. It differs from existing methodologies in the fact that all units within the CSA operate synchronously to give the desired coverage pattern, while other systems use independently operating subwoofers which require time-consuming manual fine tuning from venue to venue.

A J Hill and **M O J Hawksford** are with the Audio Research Laboratory, University of Essex, Colchester. This article is closely based on their presentation at Reproduced Sound 2010, Brighton

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European news

Road traffic noise a 'critical' public health problem

Traffic noise is the second biggest environmental problem affecting our health in Europe, after air pollution, according to a report published today by the World Health Organisation (WHO). Environmental Protection UK (EPUK) hopes the report will ensure policy makers take traffic noise seriously and act now to reduce it.

According to the WHO study [1], 1.8% of heart attacks in high income European countries are attributed to a traffic noise level higher than 60dB. Cardiovascular disease is the largest cause of death in the EU and accounts for approximately 40% of healthcare budgets [2]. A 2008 report by consultants CE for Transport and Environment [3] found that noise from rail and road transport is linked to 50,000 fatal heart attacks every year in Europe and 200,000 cases of cardio-vascular disease.

In the UK, the recent local transport White Paper suggested that the annual cost of transport noise is £3 to £5 billion, and recent research has estimated that up to 108 heart attack deaths in London can be attributed to traffic noise [4].

This new health evidence highlights the urgent need to reduce transport noise according to James Grugeon, chief executive of Environmental Protection UK. EPUK is working to reduce noise from road traffic: the Campaign for Better Tyres, launched on 28 March 2011, encourages transport operators and drivers to choose tyres that are quieter.

The European Commission is expected to release a proposal in June for more stringent vehicle noise standards, and from November 2012 new regulations for stricter tyre noise levels and tyre labelling for noise come into force. EPUK are working with European partners to reduce unhealthy noise from road traffic.

The new figures may be worrying, but the true impact of noise pollution on health is considered by Anne Stauffer, deputy director at Health and Environment Alliance (HEAL), to be much higher. According to the alliance, noise pollution is a 'critical' public health problem. And they hoped that now the EU had the evidence, policy makers would make changes in transport and other legislation that will better protect citizens' health.

The European Environmental Bureau hopes the WHO study will also help strengthen the existing EU Directive on environmental noise, which includes noise mapping. This legislation is currently under review by the European Commission, and is long overdue, according to Louise Duprez, policy officer at EEB. The report reinforced already-known health implications of noise so there was no excuse not to come up with a more ambitious Environmental Noise Directive[5].

European citizens are well aware of the health impacts of traffic noise. According to a recent Eurobarometer[6], almost half of all Europeans believe that noise affects their health 'to a large extent' and another third said that it affected their health 'to some extent'.

For more information, see:
www.environmental-protection.org.uk
www.transportenvironment.org
www.env-health.org
www.eeb.org

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Birthday celebrations for Cirrus Research

at this year's Safety & Health Expo

Specialist noise measurement equipment manufacturer, Cirrus Research, is inviting visitors at this year's Safety & Health Expo at Birmingham NEC on 17 to 19 May 2011 to help celebrate its 40th year in business.

To commemorate its birthday Cirrus Research is offering visitors to its stand (Hall 2, T40) the chance to enter a free prize draw to win an Optimus Red. This sound level meter is ideal for measuring occupational noise and ensuring that industrial hygiene and occupational noise regulations are met. Cirrus will also be holding a Birthday Tea complete with cup-cakes on Wednesday 18 May at 14:30h. This will provide visitors to its stand the chance to learn more about Cirrus' complete offering in a relaxed and informal setting.

The team from Cirrus Research will also be on hand to demonstrate the latest products from its range including the new Optimus Green sound level meter and noise nuisance recorder. The instrument is suitable for both health and safety and environmental measurements. It has been created to combine the existing features from the Optimus range with the latest technological innovation and added functionality that is necessary for environmental noise to be accurately measured.

Additionally, James Tingay, group marketing manager at Cirrus Research, will be participating in a speaker session at the Product and Innovation Hub Seminar Theatre on Tuesday 17 May. He will be discussing monitoring and measurement equipment as part of a session dedicated to environmental compliance and control.

Finally, the company will be unveiling its new informative training course that is designed to give individuals a breadth of information on noise measurement and its importance in the business environment.

Formed in 1970, Cirrus Research plc is a leading expert in the creation and production of noise measurement instruments. Specialising in the design and production of noise measurement equipment, the latest scientific and technological developments are used to produce noise measurement instrumentation to measure noise accurately. Manufactured in the UK, Cirrus instruments are used in a wide range of different applications and across many different industries. Cirrus is part of the British Safety Industry Federation's registered safety supplier scheme, identifying its organisation and products as 'genuine and safe', assuring customers that the products supplied are genuine and properly tested and certificated.

To find out more about the Cirrus Research meet them at the Safety & Health Expo (Hall 2) or visit **www.cirrusresearch.co.uk**

National Science & Engineering Week 2011

BBC Research and Development launches 'Musical Moods' sound experiment

As part of National Science and Engineering Week and BBC Research and Development's Multimedia Classification project, BBC R&D, the British Science Association and the University of Salford are launching the 'Musical Moods' research project.

To help produce a new way of classifying decades of programmes within the BBC digital archive, a pioneering online experiment is being conducted to ask the general public about the moods they associate with a range of past and present television theme tunes.

In the experiment members of the public are asked to rate the moods of TV theme tunes from the BBC archive. Through these ratings, it is hoped that the particular moods portrayed by the theme tunes can be identified. Once these data have been collected, computers can be 'trained' to analyse different TV theme tunes throughout the archive and automatically determine what emotions and moods they convey.

It is hoped that the results from this online experiment will assist in the creation of an entirely novel method of classifying online content. This would allow users to browse and search the archives based on what is happening in the programme, rather than by using any factual descriptions added manually.

An experiment to collect this type of data has never been conducted on this scale before, and it is expected that the results will be of considerable interest to many parties, so they will be published in the public domain.

By listening to five randomly selected clips of TV theme tunes, listeners will be asked three simple questions:

What is the mood of the theme tune?

What genre of TV programme is the theme tune from?

Are you familiar with the tune? or Do you like the theme tune?

Prof Trevor Cox from the University of Salford says that as the public enjoyed themselves on the web site, they would be helping to answer some really interesting research questions such as how well theme tunes portray the mood of a TV or radio programme. There has been surprisingly little research into this. As well as helping the researchers to understand theme music better, the public will provide data which will allow computer programs to identify the mood of theme music automatically.

Sam Davies Research Engineer from BBC R&D added that the BBC Archive recorded the BBC's output over the past 80 years, in the form of TV and radio programmes, news reports, written documentation, sound effects, images, and programme listings. It was a rich record of recent British history, society, and the relationship between the corporation and the public that pay for it. However, making the rich content available and accessible on-line was a difficult challenge. The Musical Moods experiment broke new ground by examining how theme music might be used to make it easier to find material in the archive.

Roland Jackson, Chief Executive of the British Science Association, said that the National Science and Engineering Week was all about engaging as many people as possible with the sciences and engineering. Projects like Musical Moods offered an accessible way for the public to become part of the science that made the UK a world leader in the field.

Music has long been used within television and film to heighten and develop the mood of the content, or to help set the intended programme's tone. Research suggests there are between eight and ten different types of mood that music can portray and the music before a film or TV programme can change the viewers' perceived mood of that film.

As little research has been conducted in theme tunes, a variety of theme tunes have been selected from across the breadth of the BBC Archive for this experiment. Listeners will hear a range of tunes from across the BBC Archive and might find themselves taking a trip down 'Memory Lane'.

The role of BBC R&D is to provide world-class leading edge technical research and innovation expertise to the BBC, to enable the Corporation to create and deliver innovative high quality content and services as cost effectively as possible to the licence fee-paying public. The world class engineers in R&D also advise the BBC on what is coming in the future, what the Corporation needs to be involved in and influencing, what the likely winning and losing technologies may be, and what the BBC needs to lead, follow or ignore. The department has always followed a philosophy of collaboration and openness; it works regularly with other broadcasters, standards bodies and technology partners.

National Science and Engineering Week (NSEW) is a ten-day programme of science, engineering and technology events and activities across the UK aimed at people of all ages. In 2011 it will ran from 11 to 20 March with the theme of 'Communication'. National Science and Engineering Week is funded by the Department for Business, Innovation and Skills and led by the British Science Association. The programme also works in partnership with Engineering UK: see **www.nsew.org.uk**

The British Science Association is the UK's nationwide, open membership organisation that exists to advance the public understanding, accessibility and accountability of the sciences and engineering. Established in 1831, the British Science Association organises major initiatives across the UK, including National Science and Engineering Week, the annual British Science Festival, programmes of regional and local events, and an extensive programme for young people in schools and colleges. The Association also organises specific activities for the science communication community in the UK through its Science in Society programme.

For more information visit
www.britishscienceassociation.org

Armstrong Ceilings

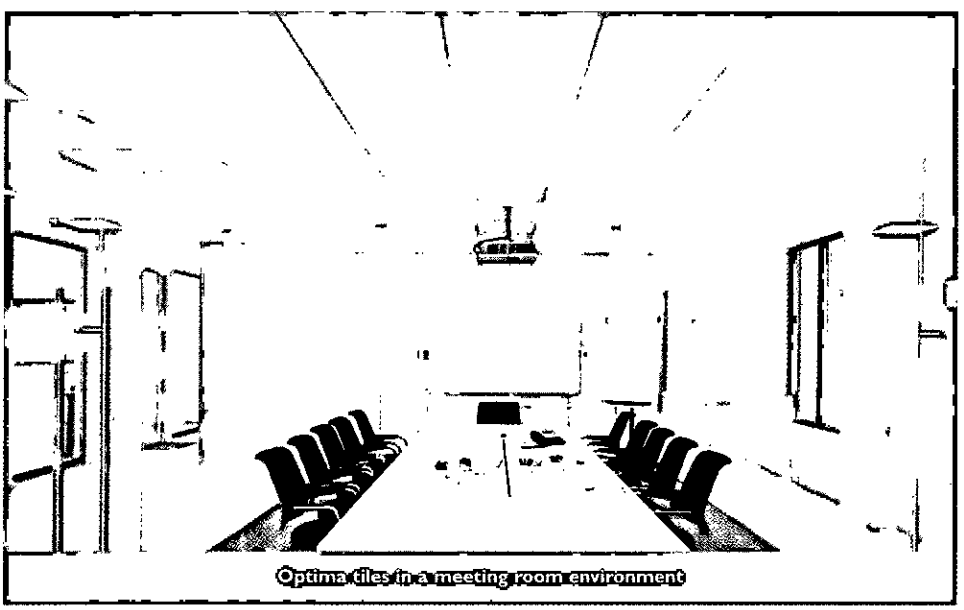
Range is 'pitched perfectly'

Leading manufacturer Armstrong Ceilings has developed three densities of ceiling tiles to meet the specific acoustical requirements of every kind of building space. The high density or 'dB' range of ceilings is designed to aid confidentiality in private rooms or offices, offering excellent sound attenuation and good sound absorption to ensure speech privacy between adjacent spaces. Products in Armstrong's dB range include Ultima, Perla and Dune tiles which provide sound attenuation up to 41dB and a sound absorption α_ω up to 0.65.

The medium density or 'standard' range is designed to aid intelligibility in collective and meeting rooms, providing an optimum combination of good sound absorption and good sound attenuation for workplace effectiveness. Intelligibility can be expressed as the difference in decibels between the level of speech and the background noise (signal-to-noise ratio) as heard at the listener's position. To ensure excellent intelligibility, this difference is recommended to be 10 to 15 dB for people with good hearing and 20 to 30 dB for hearing-impaired people or headset users. Products in Armstrong's standard range include Ultima, Perla or Dune mineral tiles which offer sound absorption levels of up to $0.70\alpha_\omega$ and attenuations up to 36dB.

The lower density or 'OP' range is designed to provide excellent levels of sound absorption to aid improved concentration in rooms such as meeting or class rooms or libraries and call centres where noises such as other people's voices, ringing phones, ventilation systems, office equipment and road noise can distract users. Products in Armstrong's OP range provide the highest level (Class A) of sound absorption (α_ω = 1) and include Ultima, Perla and Sierra OP tile finishes and a range of edge details. The Ultima and Perla ranges are also particularly helpful with aiding visual comfort and when combined with indirect lighting to optimise their high light reflectance of 90% they are capable of helping to produce energy savings where artificial lighting is required.

Splash, Stockton showing the Infusions canopies



Optima tiles in a meeting room environment

Ceilings make a splash in Stockton

Three types of building interiors from Armstrong Ceilings are bringing a splash of colour, style and practicality to a refurbished sport and leisure facility in Stockton on Tees.

Armstrong's 'Infusions' canopies, which were developed to give architects and interior designers high-design capabilities, and were specified by Stockton Borough Council, are suspended like saffron-coloured flower petals in three concave groups of six over the new café and 'chill-out' area.

These are complemented by five Infusions canopies in midnight dream blue which are suspended from the ceiling but also attached to the wall in the reception area to Splash – the town's large wet-and-dry facility, which is based around a 25-metre pool with wave machine and flumes, learner pool and spa pool.

Scott Roberts, an architect in the council's technical services department, said that the Armstrong canopies were specified to provide aesthetic quality to the large double-height space of the café area, while the mineral and metal tiles helped to control ambient sound in administrative areas where particular concentration was required.

As well as the refurbished café and extended foyer and reception, the local authority centre has an extended two-storey Activ8 fitness facility, brand-new dry multi-activity spaces, extra changing facilities, and new Sportwall and Dance Mat technology.

In addition to the polycarbonate Infusions canopies in the reception and café areas, Splash also features Armstrong's Ultima white mineral tiles with Tegular edge detailing in the kitchen, storage and office areas. These tiles combine excellent acoustical qualities with high light reflectance and good humidity resistance.

Armstrong's presence at Splash is completed with Orcal microperforated acoustic metal tiles with fleece. All three types of ceiling solutions were installed over areas ranging from 100m² to 2,000m² and in just over a month by specialist sub-contractor B J Murphy for main contractor F Parkinson.

Contact Armstrong World Industries Ltd on **01895 251122**
web site **www.armstrong-ceilings.co.uk**

Fan 2012

International Conference on Fan Noise, Technology and Numerical Methods

After the success of the previous editions of the International Symposium on Fan Noise organised by CETIAT and CETIM, a new edition is planned for 18 to 20 April 2012 at CETIM, Senlis, this time with an expanded scope. The conference is co-organised by IMechE (Institution of Mechanical Engineers, UK), CETIAT (Centre Technique des Industries Aérauliques et Thermiques) and CETIM (Centre Technique des Industries Mécaniques).

The design of fans has evolved to meet the ever-increasing demands for higher-efficiency machines, combined with the requirements for lower noise and high availability. In addition, many fans are now being used in safety-related applications, such as smoke control in buildings and underground spaces in the event of a fire. Variable speed units are now more common, and this leads to additional design problems. Many existing users are revisiting their plant to find ways of upgrading fans. The use of numerical simulation techniques is also becoming an established part of aerodynamic design processes. Theoretical methods and computational fluid dynamics (CFD) in non-aerospace applications are becoming increasingly important.

The event will be a forum for fan and system designers, manufacturers and operators, with the aim of improving the understanding of fans and their system interaction. The conference combines the next in the series of IMechE international conferences on Fan Technology and the CETIAT/CETIM International Symposium on Fan Noise.

The Fan 2012 International Conference will have three separate, but complementary, parallel sessions focusing on industrial fan technology, fan noise, and theoretical and numerical methods.

Track One: Industrial fan technology

- Fan design for improved efficiency
- Impact of technology on fan design
- Compliance with legislation and regulations
- Operation and maintenance aspects
- Motors and drives
- Critical fans for cooling applications
- Plant enhancement and upgrading
- Fans and system effect

Track Two: Fan noise

- Fan noise generation mechanisms
- Experimental methods for noise source location
- Noise prediction and analysis
- Design of low-noise fans
- Fan noise control by passive and active methods
- Optimisation of fan installation to reduce noise
- Sound quality applied to fans

Track Three: Theoretical and numerical methods

- Influence of CFD on impeller aerodynamics
- Validation of CFD and CAA computer codes
- Three-dimensional CFD methods
- Unsteady flows and LES
- Optimisation of methods and design
- Inverse design

The conference should interest not only fan manufacturers and designers but also fan users in various domains: industrial processes, HVAC, automotive and rail applications, electronics, household appliances, etc. If you work in this field, you are encouraged to present a paper at FAN 2012. The first step is to submit an abstract of between 300 and 400 words, in English, via the conference web site before 1 September 2011.

More information on this event and on how to submit an abstract can be found in the Call for Papers and on the web site **www.fan2012conference.org** which will be periodically updated.

We look forward to seeing you in Senlis next year.

Alain Guedel, *Fan noise track chairman* CETIAT

François Bessac, *Organising committee* CETIAT

Xavier Carniel, *Organising committee* CETIM

Can Hovis rise to Corrie's acoustical challenge?

Potential bakery noise problem on soap set

Dear Sir

According to some recent news reports, Hovis has raised objections to the proposed move of *Coronation Street* to MediaCityUK, Salford. While I acknowledge the bakers' concerns that noise from its adjacent headquarters could potentially be detrimental to filming and cause future noise complaints, it is paramount to the smooth operation of any business on a mixed-use site that nuisance noise is kept to a minimum.

ITV's assurances that it will effectively soundproof the set so that the activities of surrounding sites do not impinge upon production should go some way to allaying Hovis' concerns. However, Hovis themselves would be advised to reduce the impact of noise from their operations on surrounding businesses and residents to foster good neighbour relations.

There are various high performing yet cost effective acoustical solutions available that are suitable for industrial sites which effectively tackle nuisance noise transmissions. Best practice would be to select an acoustical treatment that can be installed quickly and easily retrospectively to ensure minimal interference to productivity.

While its bread may be 'as good today as it's ever been', when it comes to noise control Hovis should strive for improvement to minimise disruptions and ensure they keep raking in the dough.

Yours faithfully

Paul Absolon
TECHNICAL DIRECTOR
CMS Acoustic Solutions

Product News: A mine of (noise) information

Brüel & Kjær noise management system for mine operators

Managing environmental impact whilst expanding operations and keeping down costs is one of the mining industry's key concerns. As public perception of excessive noise levels can lead to complaints, Bruel & Kjaer has created its Noise Sentinel mining system, which enables mine operators to meet the challenge of expanding their projects, but keep within acceptable noise limits, often defined as only 5dB above background levels.

Noise Sentinel gathers reliable and detailed data, which can be shared with communities, allowing stakeholder concerns to be addressed and pre-empting any noise-related issues for the mining companies. The system is supplied on a subscription basis, which involves Brüel & Kjær providing and running the noise monitoring equipment on their customers' behalf. This reduces user costs as there is no need for staff training or operation.

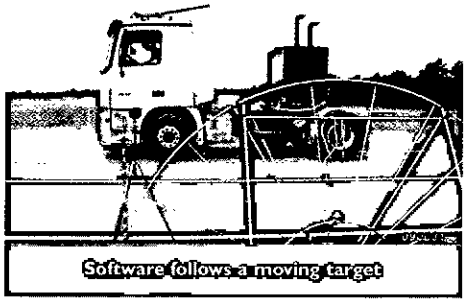
Noise Sentinel monitors noise levels continuously 24 hours a day. Users receive alerts, via email or SMS, when noise limits are exceeded, so that they can take immediate action to reduce impact on local communities. They can also remotely monitor real-time noise levels, via the internet, to see exactly what is going on without visiting the site.

Measurements on the move

'Moving source' software option added to data analyser system

Performing noise source identification on moving vehicles is now an easier process with Brüel & Kjær's Moving Source option. Unlike traditional beamforming kits, the moving source software follows a mobile target, instead of focusing on a single point. It tracks

Mine noise limits can be only 5dB above background



Software follows a moving target

linear movement parallel to a planar microphone array and enables speed-position calculation from a radar signal, GPS or photocells.

Beamforming is a method of mapping noise sources using an acoustical array. It discerns the direction from which a sound originates, by means of the time delays that occur as the sound passes over an array of microphones. This method is very quick, allowing a full map to be calculated from a single-shot measurement, making it ideal for noise source location of sound radiated from moving vehicles such as cars, lorries and trains. Moving source beamforming can also be used as a troubleshooting contribution during pass-by measurements and mapping planes from the side of a vehicle. Brüel & Kjær's PULSE hardware provides a stable and continually evolving data analysis system, which allows users to add upgrades rather than switching to an entirely new system, as software is developed.

On a global scale there are currently more than 9,500 PULSE systems being used within automotive, aerospace, education and telecommunications industries, for research, development and production test purposes. An overview of the complete range of measurement solutions encompassed by the PULSE system platform is given in the latest PULSE Analyser & Solutions catalogue.

Brüel & Kjær is a world-leading manufacturer and supplier of sound and vibration measurement systems with a large portfolio of sound and vibration equipment. The company is a renowned deliverer of innovative instrumentation, including sound level meters, microphones, accelerometers, conditioning amplifiers, calibrators, noise and vibration analysers and software. A variety of training courses, from basic introductions to noise and its effects to more specialised classes teaching customers how to get the most out of their equipment, is also run periodically. Free, online training courses conducted by experts run throughout the year too. For all course registration details visit **http://www.bksv.com/courses**

Brüel & Kjær is a subsidiary of UK-based Spectris plc (www.spectris.com). For further information visit **www.bksv.com** or email **ukinfo@bksv.com**

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with Temple Group

Technical Director (Head of Acoustics): £65,000 - £100,000 + bonus

Temple Group was established in 1997 and is an independent multi-disciplinary consultancy providing environmental, planning and management services. We have an enviable reputation as an industry leader and innovator and a prestigious client list including Defra, FTSE 100 companies (various), Network Rail, TfL, BAA and HS2 Ltd.

In response to significant growth in the business, we are continuing to develop and strengthen our multi-disciplinary, technical and management capability and there are now outstanding opportunities to join us at a key stage of our development based at our office in Shad Thames, Central London. One of our current vacancies is for a Technical Director to lead our acoustics team of 9 staff.

This exciting role would ideally suit a candidate with significant consultancy sector experience, who has successfully managed teams previously, as well as having strong business development acumen. The successful candidate will support and drive Temple's ambitious growth programme to ensure the company's vision and objectives are achieved. You will be a professional member of the Institute of Acoustics and be committed to developing Temple's service offerings to a range of clients in key sectors.

Our acoustic service is varied including: environmental noise and vibration; statutory nuisance; construction; transportation; manufacturing; retail; waste disposal and recycling; gas/energy; architectural and sound insulation testing and expert advice in inquiries and planning appeals.

We maintain an extensive range of noise and vibration instrumentation embracing state-of-the-art technology. Our work is supported by a comprehensive noise mapping and prediction capability. Many specialist bespoke programs have been developed in-house and we utilise Cadna-A and other proprietary software to model noise sources from a variety of sources including roads, railways, construction sites and industry. We are also able to map airport noise using the Integrated Noise Model.

Closing date for applications: Friday, 27 May 2011. Early applications welcome - please note that interviews will be programmed before the closing date in response to early applications. For further information, job specification or application with covering letter and CV please email **recruitment@templegroup.co.uk** or contact **Evy Skinner** on **01825 790964**. To find out more about Temple and the work we do, visit our website at **www.templegroup.co.uk**

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Noise measurement uncovered

The eight-point guide to choosing the right noise measuring equipment

According to HSE statistics about 1.7 million workers are thought to be exposed to noise above levels considered safe[1] and it is estimated that around 21,000 individuals who worked in 2009/2010 suffered hearing problems as a result of their occupation[2].

In an attempt to reduce this level of hearing damage, noise legislation designed to protect hearing and prevent noise nuisance is becoming tougher and more widespread. As a result of this the importance of noise control in the working environment is becoming an increasingly recognised and widely discussed issue, and employers are expected to measure the level of noise in the workplace so that appropriate preventative action or protective equipment can be introduced.

Of course, noise measurement equipment is needed to carry out this activity, and with so many choices of equipment available and with prices ranging from twenty to five thousand pounds, deciding which one to buy can be very confusing and expensive if the wrong choice is made. To simplify this process Cirrus Research has produced an eight-point guide with advice on how to ensure that the best noise measurement tools are chosen for a particular application, and also outlining some of the issues that need to be considered even after the equipment has been purchased.

Step 1: Do the measurement functions comply with Standards, Regulations or Guidelines?

The Control of Noise at Work Regulations 2005 require the following measurements for compliance:

- The equivalent continuous A-weighted sound pressure level L_{Aeq}
- The maximum C-weighted peak sound pressure level L_{CPeak}

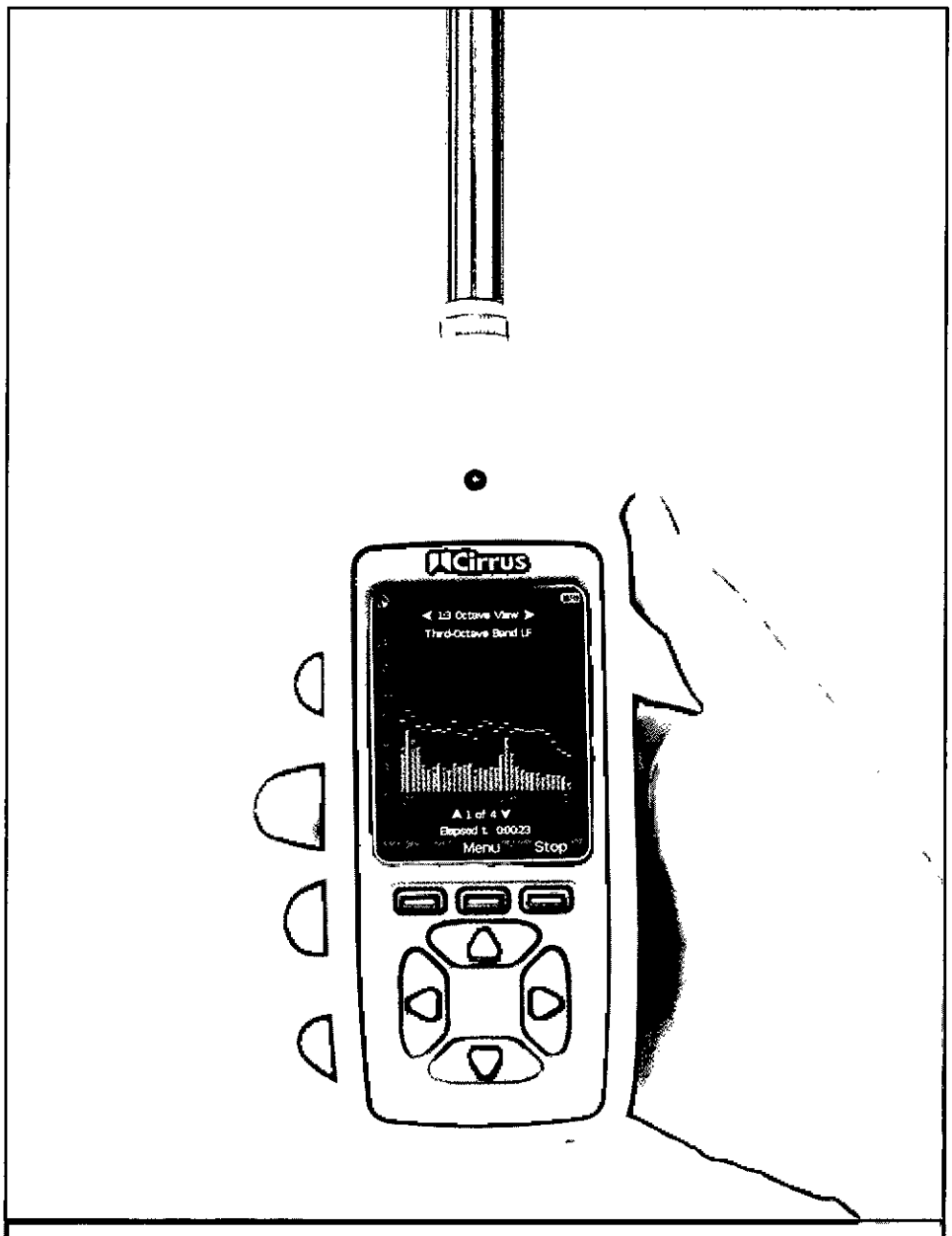
It is important that the right sound measurement equipment is applied in the right situation. There are many situations where using a hand-held sound level meter is not possible for practical or safety reasons, such as employees with complex working patterns. This is where a noise dosemeter is the ideal measurement tool because it can be worn for the whole working shift continually measuring the noise levels, and no further calculations will be required.

Step 2: Does the equipment come with all of the accessories required?

It is always advisable to purchase a sound level meter or noise dosemeter as a complete kit and avoid combining units from different manufacturers. In general the kit will contain the instrument, a suitable acoustic calibrator, a windshield and a protective carrying case. One of the most important accessories is, of course, a calibrator. All noise measurement standards state that an instrument must be calibrated before and after each use, and without a calibrator this cannot be done, and any measurements made could be inaccurate. The windshield will help protect the microphone from damage, even indoors.

Step 3: The importance of recalibration and servicing

Noise measurement instruments are precision tools, and the level of accuracy required from them is very high. Reputable manufacturers spend considerable time and effort to ensure their instruments meet these standards, therefore it is important to keep the equipment at the level of accuracy as when it was purchased. An instrument from a trusted manufacturer and meeting the latest standards should come with a calibration certificate and when recalibrated its performance should be checked against the original specifications and standards. To do this, an acoustic calibrator alone cannot provide enough information about the instrument's performance: to do so requires the microphone capsule to be removed. With many low-cost instruments the microphone



Optimus Green sound level meter

cannot be removed, therefore the recalibration should be carried out by the original manufacturer or by a qualified calibration laboratory.

Step 4: Does the equipment meet the specifications required?

The performances of sound level meters, noise dosemeters and acoustic calibrators are set out in national, European and International standards. The latest sound level meter standard gives two levels of accuracy, Class1 and Class2. The Control of Noise at Work Regulations 2005, which are in force in the UK, state with regard to sound level meters that it 'should meet at least Class 2 of BS EN 61672 – 1:2003'. Personal noise dosemeters have their own standard with which they must comply, which is BS EN 61252:1997.

Step 5: Make sure the equipment comes with clear instructions

The level of training and experience required to operate complex sound level meters can often get in the way of making good quality noise measurements. However, a simple instrument that may require less training to operate might not give accurate enough measurements. An expensive instrument may provide the data required, however the level of training needed could be expensive too. It is advisable to choose an instrument that meets the practical requirements whilst remaining as simple as possible at a realistic cost.

Step 6: Make sure the equipment is simple to use, straight out of the box

Ensure the product bought is user-friendly. Ideally, a product should enable the user to see all the relevant, important information in one place quickly, making it easier to report on the measurements. At the very least, the 'on' and 'off' buttons should be obvious - it is disconcerting to note that on some equipment, even these fundamentals are unclear.

Step 7: Make sure the equipment is 'future-proof'

When looking at different manufacturers, ask some questions and find out about how the investment will be supported. A reputable manufacturer should:

1. Regularly conduct research into noise measurement regulations and requirements to ensure they are kept constantly up-to-date with changing needs;
2. Have an established Research and Development team that ensures the equipment contains the latest functionality to meet all requirements;
3. Offer free software updates so that the purchaser can continue to reap the benefits of the equipment investment for years to come;
4. Provide equipment upgrades so that the use of the equipment can easily be changed without having to reinvest in brand new hardware.

Step 8: Does the equipment come with all the software needed to get the best out of it?

Most noise measurement equipment does not come with reporting software as standard. Only the most basic downloading software may be supplied with the instrument so check what is included. Putting together a report using the measurement findings can be time-consuming, so it is advisable to ensure that the equipment is supplied with full reporting software free: some providers charge a licence fee and this can prove expensive to keep up to date.

For more information or to acquire the full eight-point guide please contact Cirrus Research on **0845 230 2434** or visit **www.cirrusresearch.co.uk**

References

1. http://www.hse.gov.uk/pubns/eis26.pdf
2. http://www.hse.gov.uk/statistics/causdis/deafness/index.htm

Norsonics Nor848

Acoustic camera to visualise sound

Campbell Associates is pleased to announce the release of the new Norsonic 848 Acoustic Camera for the easy visualisation of sound. The system uses an array of 225 microphones to provide incredible resolution of the noise climate under analysis.

Images can be listened to in isolation using the virtual microphone supplied.

Key features include

- Quick and easy to set up and use without training or experience;
- 225 microphones and a wide angle, high-performance video camera;
- Overall, octave, third-octave and FFT for detailed analysis: selectable upper and lower frequency limits;
- Colour intensity plots based on level or frequency;
- Virtual microphone to listen to any part of the image in isolation;
- Analogue-to-digital conversion electronics hidden in the microphone antenna, instead of in a signal analysis interface box;
- LAN cable connection between the microphone array and a MacBook Pro computer (supplied);
- Mains or 12v DC input;
- User-friendly software with all the required functions for overall and detailed analysis of complex noise situations.

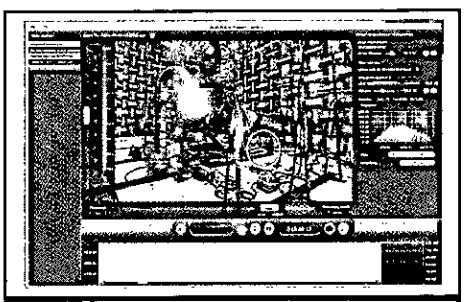
Possible applications include

- Sound source identification: search by frequency to find the sounds of interest quickly;
- Acoustic leaks: identify and display acoustic leaks, and listen to them using the virtual microphone;
- Product design: make products sound better!

Norsonic is a leading developer and manufacturer of noise and vibration instrumentation. Visit www.norsonic.com for more background information. Campbell Associates is the exclusive sales resource for Norsonic products in the UK and Eire. Campbell Associates also has a hire and UKAS calibration operation: see **www.acoustic-hire.com** and **www.campbell-associates.co.uk** for details.

For more information please phone **01371 871030** or email **hotline@campbell-associates.co.uk**

Nor848 Acoustic Camera



Typical laptop screenshot

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Committee meetings 2011

DAY	DATE	TIME	MEETING
Thursday	5 May	10.30	Membership
Thursday	19 May	11.00	Publications
Tuesday	24 May	10.30	CMOHAV Examiners
Tuesday	24 May	1.30	CMOHAV Committee
Thursday	2 June	10.30	Engineering Division
Thursday	16 June	11.00	Executive
Wednesday	22 June	10.30	CCENM Examiners
Wednesday	22 June	1.30	CCENM Committee
Thursday	23 June	10.30	Distance Learning Tutors WG
Thursday	23 June	1.30	Education
Thursday	**30 June**	**11.00**	**Council**
Tuesday	5 July	10.30	ASBA Examiners
Tuesday	5 July	1.30	ASBA Committee
Thursday	7 July	10.00	Meetings
Tuesday	2 August	10.30	Diploma Moderators Meeting
Thursday	8 September	11.00	Executive
Wednesday	14 September	10.30	Membership
Thursday	15 September	11.00	Publications
Thursday	**22 September**	**11.00**	**Council**
Thursday	29 September	10.30	Diploma Tutors and Examiners
Thursday	29 September	1.30	Education
Thursday	6 October	11.00	Research Co-ordination
Thursday	13 October	10.30	Engineering Division
Thursday	3 November	10.30	Membership
Tuesday	8 November	10.30	ASBA Examiners
Tuesday	8 November	1.30	ASBA Committee
Thursday	10 November	10.00	Meetings
Thursday	17 November	11.00	Executive
Wednesday	23 November	10.30	CCENM Examiners
Wednesday	23 November	1.30	CCENM Committee
Thursday	24 November	11.00	Publications
Thursday	**1 December**	**11.00**	**Council**
Tuesday	6 December	10.30	CCWPNA Examiners
Tuesday	6 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 2011

20-22 May 2011
8th International Conference on Auditorium Acoustics
Convention Centre, Dublin

24 May 2011
Environmental Noise Group Workshop
Emerging Government Planning Policy: What does it mean for practising acousticians?
University of Salford

21-22 July 2011
The 5th International Symposium on Temporal Design
Joint event with University of Sheffield

24-28 July 2011
ICBEN 2011
Imperial College, London

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

14-15 September 2011
Organised by Building Acoustics Group, Environmental Noise Group, Measurement & Instrumentation and Noise and Vibration Engineering Group
ACOUSTICS 2011
A new decade - A new reality
Rethinking acoustic practices for the austerity decade
Crowne Plaza Glasgow

3-5 October 2011
Underwater Acoustics Group and the Underwater Sound Forum of the Marine Science Co-ordination Committee
Ambient noise in Noise-European seas: monitoring, impact and management
National Oceanography Centre, Southampton

17-18 November 2011
Organised by the Electroacoustic Group
REPRODUCED SOUND 2011 - Sound Systems: Engineering or Art
Thistle Hotel, Brighton

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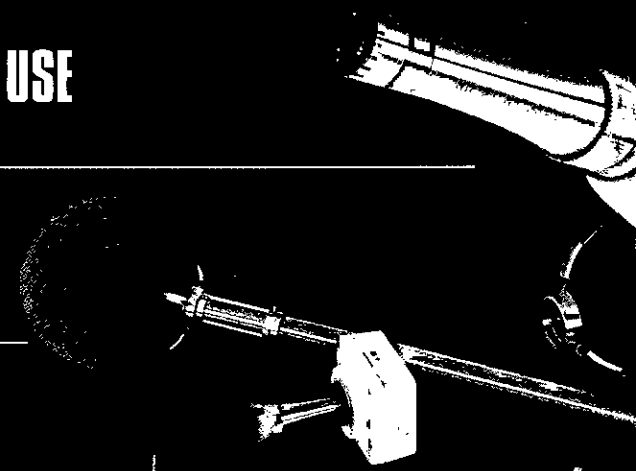

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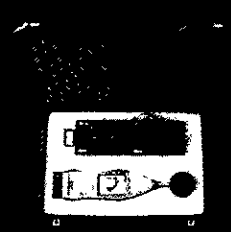

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