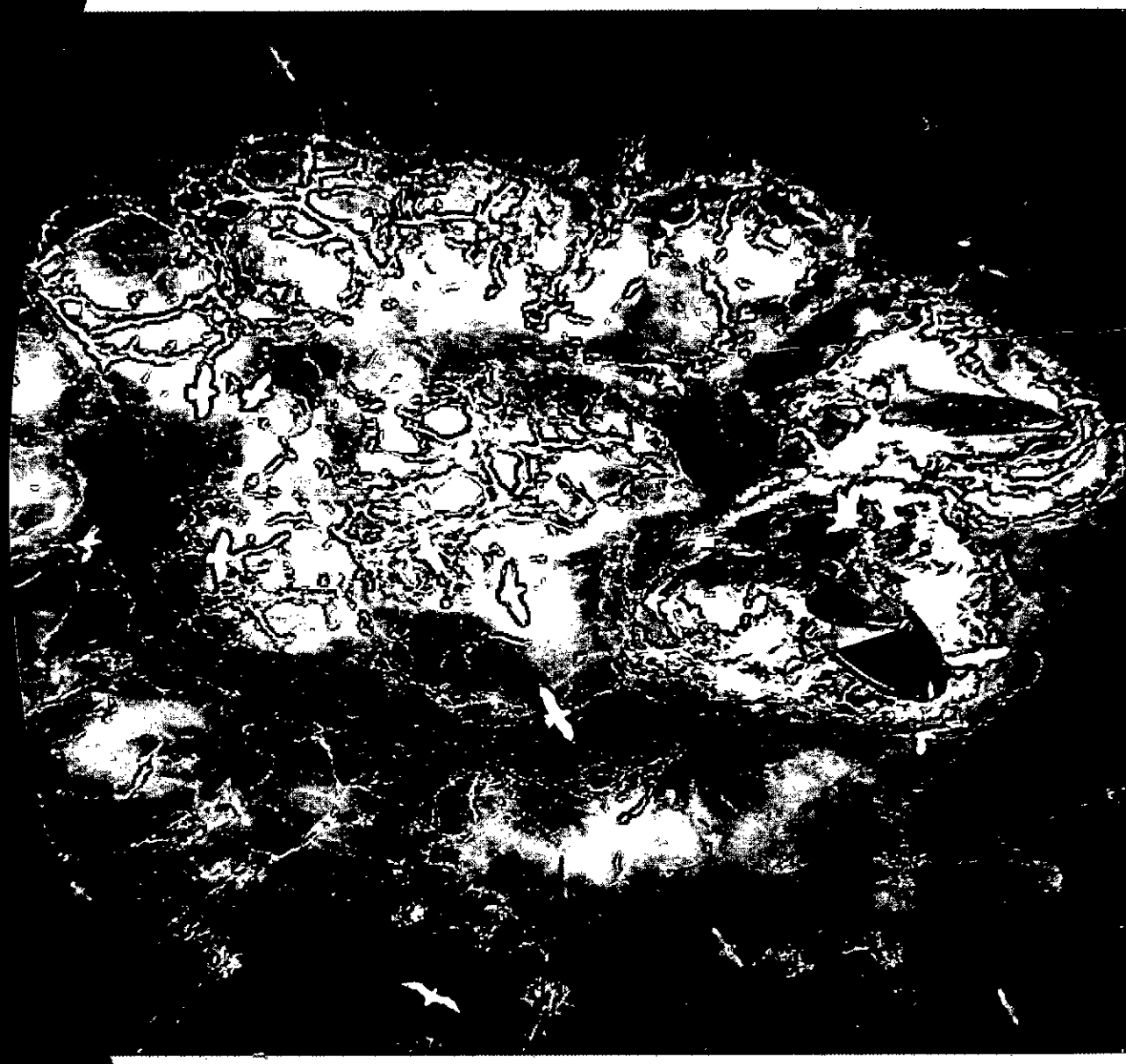
Vol 32 No 1 JANUARY/FEBRUARY 2007

ACOUSTICS BULLETIN



in this issue...

Spiral bubble nets of humpback whales

plus... **RS22 Conference report**

The technological, social and economic importance of acoustics

Ignorability and tonal content in aircraft sound

Institute of Acoustics

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ACOUSTICS BULLETIN

Vol 32 No 1 January/February 2007

Contents

MATRON³

Evolution

MATRON³ (Manually Activated Timed Recording of Noise) represents the future in noise recording systems. At its heart is Brüel & Kjær's innovative Type 2250 hand-held sound analyzer.

Innovation

In response to user feedback, MATRON³ has a case-within-a-case design. The outer briefcase – purely for transportation – can be carried in and out of the complainant's property without awakening the suspicions of noisy neighbours. The lockable inner case, containing the noise monitoring system, is left with the complainant.

Revolution

MATRON³ uses the latest digital audio recording techniques. Sound is recorded to an industry standard Secure Digital (SD) memory card that offers a combination of high storage capacity, fast data transfer, great flexibility and excellent security.

Operation

MATRON³ is easy to use. Once set up, Type 2250 is locked in the prewired inner case. On delivery, the microphone and remote control are connected to the inner case. The complainant simply presses the remote-control switch to start and stop recording. The remote indicates when recording is in progress.

Satisfaction

A high-quality, synchronised audio recording in one simple operationand that, once recorded, cannot be accidentally overwritten or tampered with.

United Kingdom: Bruel & Kjaer UK Ltd. · Bedford House · Rutherford Close
Stevenage · Hertfordshire · SG1 2ND · Telephone: (01438) 739000
Fax: (01438) 739099 · ukinfo@bksv.com · www.bksv.co.uk

DAT-less *Neighbour Noise Monitoring*

Brüel & Kjær

Dear Members

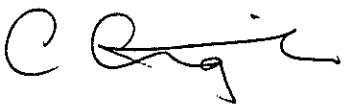
With the Christmas festivities now a distant memory, it is time to look forward to the new year. The continued success of our institute has allowed us to enhance the services to members and we start the year in a stronger position that we have ever enjoyed. We have a full meetings programme planned, with major conferences in Cambridge, Loughborough and Oxford.

Last month we were able to introduce our new e-newsletter and I hope that you found the first issue useful. It is essential that we keep up to date in our work and this innovation is designed to plug the information gap between issues of the Bulletin. For the e-newsletter to be successful it is essential that members with news of meetings, conferences, consultation documents, new standards, and just about anything of topical acoustical interest, let Judy have the information as soon as possible. The e-newsletter's success is also dependant on us having an up-to-date e-mail address. Members changing their e-mail addresses should advise the office so that we can keep in touch.

In the last issue of the Bulletin, our editor announced that this year's issues would all be themed. This will allow us to look in more depth at both the mainstream areas of work and also some of the more obscure, but important areas too. I would urge you not to simply pass over the articles if they are not dealing with your own area of work. Often seeing how acoustical principles are applied in related disciplines can give a new insight into our own work.

There has been much discussion over the last couple of years about the need for accreditation for firms carrying out the pre-completion testing that is required under the Building Regulations Part E. A note in the last Bulletin sought to clarify what is required, but I still hear reports that members are carrying out tests when not accredited. Membership of either of the two accreditation/registration schemes gives your clients and their customers the assurance that they deserve that the tests are conducted in an appropriate manner. It is clear that there is a presumption on the part of government that testers should be accredited and I would encourage any members undertaking this work who are not thus accredited to make a new year's resolution to join one of the schemes.

Finally, the time is rapidly approaching when the Medals and Awards committee will meet to decide on some of our major medals. I look forward to receiving your nominations early in the year.



Colin English

PRESIDENT

Conference report

International Conference on Synthetic Aperture Sonar and Synthetic Aperture Radar (SASSAR)

It is unusual (though not unprecedented) for the Institute to hold events outside of the UK. This particular event, held on 11 and 12 September 2006, was also unusual in its theme, offering an opportunity for the cross-fertilisation of ideas between a somewhat specialised aspect of underwater acoustics and its counterpart in radar.

To expand and explain, Synthetic Aperture Sonar (SAS) is a set of techniques to obtain high-resolution sonar images of target scenes, synthesising a long aperture (and hence high angular resolution) from a sonar moving along a (usually) linear path. It has applications in mine hunting, as well as in the surveying of wrecks, pipelines and other underwater features. Its counterpart in the radar domain – Synthetic Aperture Radar (SAR) – is now routinely used from satellites and aircraft for environmental monitoring and high-resolution surveillance. Despite this apparent synergy, there has been only a limited crossover of ideas between the radar and sonar communities. That provided the motivation for this conference: to provide a forum to compare work on systems, processing techniques and examples of results, with the intention of stimulating new ideas in both domains. Particular themes included synthetic aperture from autonomous vehicles (AUVs and UAVs), non-cooperative target recognition, computer-aided detection/computer-aided classification (CAD/CAC), interferometry and differential interferometry, bistatic and multistatic operation.

The venue for the conference was the Villa Marigola in Lerici, close to the NATO Undersea Research Centre in La Spezia in north-west Italy. This utterly delightful location, plus a packed programme of presentations, attracted 75 attendees from 11 countries as far afield as New Zealand and the USA. The event benefited from the generous support of the US Office of Naval Research and the Acoustical Society of Italy, as well as technical co-sponsorship by the IEEE AES Society. The opening session was attended by the President of the Associazione Italiana di Acustica, Giovanni Brambilla, who gave a short welcoming address.

The programme consisted of 37 oral presentations, plus four invited keynote presentations: 'Issues in radar and sonar signal processing' by Dr Richard Klemm of FGAN, Germany; 'Advances in radar detection of moving targets from air/space-borne platforms' by Professor Pierfrancesco Lombardo of the University of Rome 'La Sapienza'; 'Comparative review of high resolution SAR and SAS research' by Dr Marc Pinto of the NATO Undersea Research Centre, La Spezia, and 'Model-based classification - a possible approach for target classification in SAS and SAR?' by Dr Judy Bell of Heriot-Watt University. These helped highlight some of the current issues, as well as providing an introduction to those unfamiliar with the state of the art in each domain.

Delegates also enjoyed the conference dinner, which was *alfresco*, and was attended by the President of the Institute, Colin English. The dinner was preceded by poster displays of all of the presented papers, giving an opportunity for informal discussion.

It can be concluded that this experiment of holding an event outside of the UK was a great success, and there is evidently a strong desire to repeat the conference at an appropriate interval. The conference Proceedings are published on CD: Vol.28, Pt.5, ISBN 1 901656 79 9.

Professor Hugh Griffiths FREng FIOA
DCMT Shrivenham, Cranfield University

The conference venue Villa Marigola, Lerici.

Synthetic Aperture Sonar (SAS) image of the wreck of U-boat U735 in a Norwegian fjord, from the SAS carried by the HUGIN AUV, and presented by Dr Roy Edgar Hansen of the Norwegian Defence Research Establishment.

Dr Sam Dugelay, presenting her paper 'Parametric synthetic aperture sonar for the detection of buried mines – a feasibility study'.

Meeting report

Paul Michel IOA. North West Branch

With a loudspeaker at each corner and one at the front for good measure the North West branch was treated to a demonstration, by Ben Shirley of the University of Salford, of the Clean Audio Project. This took place on Thursday 19 October at a Salford University venue.

The roll-out of digital TV should be able to improve sound quality. However as Ben pointed out the increased dynamic range and sound effects and music louder than dialogue can cause problems, especially for the estimated 9 million hearing impaired people in the UK. It is the aim of the *Clean Audio Project* to counter this by providing guidelines and recommendations.

The limitations included: no requirement for extra bandwidth, no need for producers to define different mixes, non-proprietary solutions required, and flexibility in approach rather than providing solutions for a niche audience.

Possibilities included the use of a discrete centre channel for dialogue, metadata transmitted as part of the broadcast to instruct set top boxes how to process the audio, speech enhancement processing techniques, and research on the impact of likely techniques.

Ben described the research methodology used at Salford. Phase 1 involved 40 subjects with a mixture of no hearing impairment and various levels of impairment. Listening tests were carried out in the high specification listening room at the university with subjects rating a series of DVD clips for clarity of the dialogue, overall sound quality and enjoyment of the clip. During the tests various combinations of sound delivery were used and the ratings analysed.

More recent work has included the effects of two-channel stereo reproduction, effects on clarity and intelligibility and speech perception in noise and the effects of acoustic crosstalk.

Ben then rounded the presentation off with a helpful question-and-answer session.

Meeting report

Ken Howell. Midlands Branch
The Acoustics of a Fraud:
Who Wants to be a Millionaire?

On Wednesday 22 March 2006 the Midlands Branch had held their second evening meeting of the year at Scott Wilson Ltd in Nottingham when Phillip Harrison, a forensic consultant with J P French Associates gave an engrossing talk entitled 'The Acoustics of a Fraud: Who wants to be a millionaire?' Phillip talked about his work as a forensic consultant and particularly about the investigations into the infamous case referred to in the title. Thanks are owed to Phillip and to Scott Wilson Kirkpatrick for an excellent evening. After the meeting a large number of people removed to a local curry house to continue the discussions. A report of a similar presentation given by Phillip to the Eastern Branch was published in the May/June Acoustics Bulletin (Vol.31 No.3).

The meeting was attended by 25 people, which included 4 non-members.

Stolen equipment

Arup Acoustics

Arup Acoustics has unfortunately had a number of items of equipment stolen from an employee's car. The items were stolen while the vehicle was parked in the Kings Cross area during the early hours of Wednesday 18 October 2006.

Items stolen included:

- B&K 2260 SLM with 4231 Calibrator – Serial No. 2260 SN 2290731. 4189 SN 2282198. 4231 SN 2292415
- A Toshiba Portege laptop with WinMLS software including full licence.
- A D-Audio USB soundcard - Serial No. 09900030
- A Sony MZ-NH1 Hi-MD – Serial No. 5058597
- A Fostex 6301B loudspeaker – Serial no. 760675

There were also some personal belongings stolen which included:

- Kodak Easyshare P850 Zoom – Serial No. 8893901

If anyone should be offered equipment matching these details could they please contact the Cambridge office on **01233 531100** and ask for Andy Officer, Phil Mudge or Paul Malpas.

Meeting report

Paul Freeborn. North West Branch

In September Jonathan Lartice of Defra and Jim Griffiths of Vanguardia Consulting (previously of Capita Symonds) left the safe haven of the south and braved the dangers of the dark north by travelling to Manchester to speak to a very attentive audience on the subject of the Amended Noise Act 1996. The meeting was well supported with about 40 people attending, meaning that BDP, our hosts for the evening, had to draft in extra seating.

Jonathan is the Defra policy officer responsible for steering this amendment through the legislative consultation procedure, and Jim was responsible as Project Director for the technical research that was used to inform the decision on the 'permitted level'. Firstly Jonathan ran through the background to the legislation then moved on to the Consultation Document and the possible alternatives, in particular for the permitted level. He then handed the baton to Jim who described the technical detail of the study carried out in conjunction with BRE. A detailed project report can be found in the September/October 2006 issue of *Acoustics Bulletin*.

The ensuing discussion time was limited and was mostly concerned with how the amendment would be applied and how it might be misapplied. A question was asked as to why the 'permitted level' was not to be set at the WHO guideline level. Jim pointed out that the level was to be the level above which "this is definitely an offence and no one can dispute it" rather than defining the onset of a problem as defined by the WHO: the level also applied to a single, one-off occurrence.

Concern was also expressed that the permitted level could become a design level. The worry was that people like to latch on to a number and it was thought that the legal profession might try to argue that in a Statutory Nuisance case it would be a valid defence to be below the permitted level. Bearing in mind the response to the previous point this should not be the case.

Perhaps the area that seemed to provoke most discussion was the taking of measurements with the windows closed. Most environmental health professionals feared they would be ridiculed by the public for measuring with the windows closed. Jim said they used windows closed in their research tests in order to aid consistency and control.

Despite the healthy criticisms aired, the general view from the local authority viewpoint was that the amendment was welcomed and would prove useful.

Meeting report

Sam Bell SECRETARY. **Irish Branch**

Dr Gerry McCullagh Memorial Lecture

In recognition of the time and effort that the late Dr Gerry McCullagh put into the promotion and education of acoustics throughout Northern Ireland and the Republic of Ireland, the Irish Branch of the Institute decided to hold an annual lecture where an eminent acoustician would be invited to present a talk on their area of expertise.

To this end Bernard Berry, a good friend of Gerry's for many years, gave his lecture 'Recent developments in environmental noise' on 30 November 2006 at the University of Ulster.

The chairman, Dr Martin Lester, opened the meeting by welcoming Rita McCullagh his widow, Gerry's mother Mrs McCullagh, and Caroline McCullagh, his daughter.

The Head of the School of the Built Environment, Prof Alastair Adair, welcomed everyone to the University and spoke about how Gerry's significant contribution to the School over many years, both in the development of acoustics education and in research activity generally, both mentoring academic staff in supervision and supervising postgraduate students.

Martin then introduced Bernard Berry, IOA Vice-President, now of Berry Environmental Ltd. Bernard spent many years working at the National Physical Laboratory and through this was involved with the creation and revision of many environmental standards.

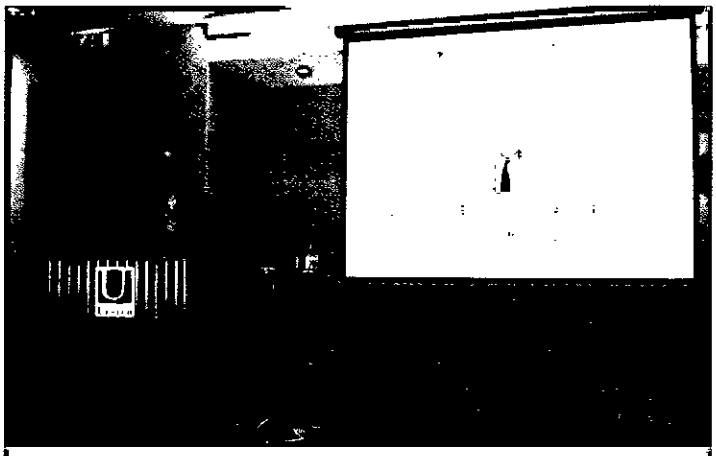
Bernard's lecture was basically in three parts. The first covered a research project for Defra in which the literature on annoyance effects of industrial noise was reviewed and analysed to determine the possibility of deriving a dose-response curve, similar to those for transportation noise sources. The project is fully documented at

http://www.defra.gov.uk/environment/noise/research/industrial/index.htm.

Next, Bernard summarised one of the three Work Packages in the recent DTI-sponsored environmental noise project. This work was a critical review and inter-comparison of methods of quantifying acoustic features in environmental noise, such as tones and impulses. He showed how future revisions of standards such as BS.4142 and ISO.1996 might be influenced by the outcome of the project, which is also fully documented on **www.hta-projects.co.uk** .

Finally, we heard a report on the current status of the new standard under development by the BSI Committee, BS.9142 'Assessment methods for environmental noise – Guide'.

(right to left) Bernard Berry with Gerry McCullagh's mother, Rita his wife and Caroline his daughter.



Bernard Berry presents the inaugural Gerry McCullagh Memorial Lecture

To round off the evening the chairman presented Lindsay Shaw from Lisburn City Council with a certificate for achieving the highest marks in Ireland for 2006 in the Diploma in acoustics and noise control. The award was intended to celebrate Dr McCullagh's involvement in education throughout Ireland and will be awarded annually.

Meeting notice

The Measurement & Instrumentation Group
13 March 2007

The Measurement & Instrumentation Group will be holding a one-day meeting at the Society for the Chemical Industry in London on 13 March 2007, entitled 'Rumble in the (Urban) Jungle'. It is scheduled to coincide with the long awaited revision of BS.6472, regarding the measurement and assessment of human response to ground vibration, which has been a hot topic in the Institute for the last few years.

The draft standard has been out for public comment since August 2006, and this meeting will be an ideal opportunity for you to update yourself with the latest revisions to the standard, current measurement projects, and to network with the movers and shakers in the business. A star-studded line-up of presenters is promised, so make sure you book your place by contacting the Institute office.

Event notice

Eastern Branch - First football match

The first Eastern Branch football match was played between Campbell Associates and Sharps Redmore on 30 October 2006 at Braintree. The line-up for Campbell Associates was Justin Barker, John Campbell, Nigel Crawford, Mark Strutt and Mike Tickner. Sharps Redmore boasted a line-up of Mark Taylor, Keith Metcalfe, Kieran Gaylor, Ian Sharps, Doug Sharps, Tim Redmore, Michael Barrett and Jason Murfitt.

The game was a game of two halves with the second following the first. All the boys gave 110%. Campbell Associates were the winners 15-10 after trailing 3-0 in the early stages as a result of a hat-trick from the 'danger man' Keith Metcalfe. However, the real winner was football. At the end of the day, it got dark and they all went to the pub!

If anyone else is interested in a game please contact either **john@campbell-associates.co.uk** or **keith@sharpsredmore.co.uk** .

Meeting report

Kevin Howell. Midlands Branch

New technology in the noise and vibration industry

Half-day meeting, National Space Centre, Leicester

This was another excellent meeting for the Midlands Branch, held on the afternoon of Wednesday 5 July 2006. Those that attended also had the bonus of a complimentary ticket to tour the Space Centre. Three presentations were made by Steve Thomas of AcSoft Ltd, Martin Williams of Brüel & Kjær and Ian Campbell of Campbell Associates. Although all three presenters addressed the same general topic they cleverly managed to produce three very different perspectives on the issue and should be congratulated for providing a very varied and enjoyable afternoon. The branch committee would like to thank all three companies for providing speakers and sponsoring the event

Long-term unattended noise monitoring, by Steve Thomas (AcSoft)

Steve got the ball rolling with a brief history of noise measuring systems and a description of the great leaps forward made over the last 20 years from the limited capabilities of instruments then to the sophisticated equipment of today. He concentrated on unattended data logging systems, from the systems in the early1980s which relied on paper traces to record data, and manual inputs into spreadsheets, through the late 1980s with the start of on-board memories and the first PC-based sound level meters (the Aria, from 01dB). In the early 1990s we had the first data logging SLMs (with small memories) and the first laptop-based SLM. In the late 1990s the dramatic increase in memory capacity allowed multiple parameters to be recorded. We now have a range of data-logging SLMs with large memories, advanced software and facilities for fast communications via RS232 and USB that can link a network of monitors anywhere in the world. Steve elaborated on these attributes with reference to the latest facilities available with the powerful and versatile OPER@ Noise Networks system, and some ideas on how it is likely to develop in the future.

The Handyman's Story – Designing your own meter and analyser, by Martin Williams (B&K)

Martin reported that B&K was still going strong 64 years after the company had begun in a small Swedish kitchen. He then described the innovative approach that B&K had begun in March 2000 to develop their strategy for future equipment development. They convened a number of 'workshops' for expert users of noise-measuring equipment. Facilitated by external consultants, they debated the issues surrounding noise measurement systems and attempted to point to the needs of the future. B&K tapped into the knowledge and experience of the participants, extracted the main results of the discussions and injected this into the R&D programme, to produce a new generation of equipment. The basic requirements were that equipment should be EASY (to hold, operate and understand), SAFE (it must be clear that it is working correctly and reliably) and CLEVER (it must do all the things you might want, eg record voice commentaries via a separate microphone). Martin then described the latest attributes and options of B&K's 2250 system and the Matron3, and provided some thoughts on the future.

Is your SLM still worth more than you are? by Ian Campbell (Campbell Associates)

Ian made a number of observations on the changes he had seen in the last 40 years as he had progressed from being a new graduate to a 'pensioner' in the acoustics business! Back in 1964 a sound level meter would cost more than a year's salary and it only measured sound pressure level. Now a SLM was smaller, more reliable and did all manner of things, and cost about a month's salary. The cost driver now was technician time, so the primary need was for equipment to gather as much information as possible in a short time. However the data must be reliable, and equipment was now subject to more standards and verification and calibration, and the competence of the operator was now also subject to scrutiny. He outlined some of the current areas of development and the likely features of the next generation of equipment. Ian then demonstrated the dramatic improvements achieved by the latest developments in building acoustics measurements. He observed, however, that one component of measurement systems that has hardly changed over the years is the microphone, and suggested that it would be nice to see a significant advance in this area.

There was an attendance of 30, including 8 non-members.

IOA certificate pass list

Certificate Name: Environmental Noise Assessment
Exam Date: 6 October 2006 - Pass Candidates

University of Birmingham
Cox R K
Gilbert M M
Leask J T M
Muscroft F E M
Newton D P
Slater W W
Walker N
Ward A M
Wilson G
Youart C J

University of the West of England
Colhoun D G
Gregory J R
Hazel S N
Innes A
Kochanski R S
Mulley R J
Pitt S L
Rutter S
Smith C S
Veale C A
Williamson C J
Willis E A

Colchester Institute
Dicks K J
Garrod J A
Griffiths P
Groborz R V
Littlejohn M A
Long N C
Marshall G D
Partridge M
Scott M S
Surmen H
Walby P

University of Derby
Baker A
Birkinshaw D S
Colder R
Evans G J P
Evans M R
Lewin L A
Mellor S B
Pick R H
Pickford A R
Robinson A
Thompson C A
Williams E M

EEF Sheffield
Dawes R
Foden M A
Taylor I H
Taylor E L

Leeds Metropolitan University
Allen S G
Finch S
Gee H L
Kyte L F
Llewellyn C J
Mumford J E
Pearson A
Rennison P A
Skinner R A
Starbuck R O
Vickers R S

NESCOT
Denham D J
Flynn M
Grealey I N
Kennett M R
Miles J W

New members

The Membership Committee meeting on 9 November 2006 recommended the election of the following new members (confirmed by Council 7 December 2006)

Fellow (FIOA)
Jones R R K
Swanwick M
Walsh S J

Member (MIOA)
Chandler N A
George R E
Gomez L
Jordan C
Joseph M L
Matos J C B
Nicholls T M
Ormerod J O
Stokes P D
Sweeney P V
Vilatarsana G
Wells J T
Wong C H A
Worth K D

Associate Member (AMIOA)
Anstee B J
Anstice J N
Barrett M J
Bedford M A
Christie M J
Clothier S N
Connolly R T
Farhan F
Follows E L
Grattan S J
Gregory J
Hickman D
Hill S J
James L D
Keegan M J
Kirk S D
Landeg C
Lewis M J
MacDonald R R
Mann A H L
Matthews O J S
McAlister K
McNally I H
McNulty R
Moore M P
Mynott B P
Neale J R
Nelson O
Noon M P
Scott D M B
Stanbury C
Stringer D
Tan S W
Terry D M
Walton S P
Way P A
Wright D J

Technician
Allison P A
Brailey J G
Frisby A P
Mason T
Petrasso S
Roche N
Stark B J
Yates C

Affiliate
Boyd J M
Dawson M J

Student
Hu B
Myles H S
Robinson M K

Sponsors
Bureau Veritas: Sponsoring Organisation
New Forest District Council: Institutional Subscriber

Beautiful music, horrible sounds

Bridget Shield.

How do you keep an audience of over 2000 lively 12- and 13-year-olds engrossed for an afternoon in the Royal Albert Hall? With a giant keyboard, a lavatory on stage, the sound of vomiting and the biggest whoopee cushion in the world...

These were some of the props used by Trevor Cox in his brilliant lecture for schoolchildren on 5 October. The lecture was organised by the Royal Institution in their first ever collaboration with the Royal Albert Hall. The Royal Institution is well known for its Christmas lectures for young people, but also organises high quality events aimed at communicating scientific issues to the general public. EPSRC also contributed to the event by funding the research that formed the basis of the show and assisting with its development. Trevor currently holds an EPSRC Senior Media Fellowship at the University of Salford.

The aim of the lecture was to raise awareness of the importance of sound and acoustics in our lives, and to illustrate various scientific principles of acoustics. Trevor devised and presented the show with Steve Mesure of the Floating Point Science Theatre Company. Steve is a former geophysicist who set up the theatre company in order to teach and promote science in schools. As well as acting as Master of Ceremonies throughout the show Steve took a (usually undignified) active role in the demonstrations on stage.

The overall theme running through the show was 'The Battle of the Bands'. Trevor very cleverly used this idea both to introduce the subject of acoustics, explaining various acoustic principles and concepts, and to keep the children's attention throughout. He explained how Salford University had been 'approached' by two bands who wanted to appear on 'The X Factor'. Both bands realised that they needed to improve their sound in order to be serious contenders. The first band, 'Phluffy Nice', sounded like an out of tune version of the Singing Nun, while the second, 'Grim Reaper', whose ambition was to be a hard metal band, were a close harmony barber's shop style singing group. Trevor showed how, using acoustic and audio techniques, the recordings of both groups could be manipulated to achieve the sounds they wanted. For example, the concept of frequency was introduced (with the help of the giant keyboard) in the context of adding a significant amount of low frequency sound to Grim Reaper to make them sound more menacing. Phluffy Nice's recordings, on the other hand, were improved by artificially changing the pitch and adding reverberation.

Live demonstrations, sound recordings and video clips were used to illustrate many other principles including hearing, wave theory, room acoustics, resonance and Bernoulli theory.

Trevor explained why we have two ears on the sides of our head (to protect us from the gorilla prowling around the stage), and debunked the myth that low-frequency noise induces the need to go to the lavatory (which involved Steve dropping his trousers to sit on the loo discreetly placed behind a see-through screen on the stage). The Bernoulli principle was demonstrated by Steve and Trevor blowing rolls of loo paper over the audience using leaf blowers, and resonance was illustrated by a beautiful slow motion video of a glass shattering.

The use of the story of the bands was an inspired idea to capture and hold the interest of the young audience. The children were fascinated by the story of the bands and were genuinely interested in the various acoustic techniques used to manipulate their sounds. They voted enthusiastically throughout the show on whether or not the sounds had been improved, and at the end voted for their choice of band (Grim Reaper won by a small margin).

As well as the afternoon lecture to secondary schoolchildren, Trevor had performed a shortened version of the show in the morning for primary schools. In total around 4500 children attended. The performances represented an enormous amount of hard work by Trevor, both on the day and in the many preceding weeks devising and preparing the show. The Institute owes him a huge debt of gratitude for this and his other efforts to promote an interest in acoustics on our behalf. Let us hope that some of the children in the Royal Albert Hall remain as enthusiastic about acoustics as they seemed at the end of the show, and go on to become the acousticians of the future.

Before the lecture Trevor said his aim was to show children that acoustic science is 'intriguing, relevant and fun'. Judging by the loudness of the cheering and the length of the applause at the end of the show, Trevor certainly achieved his aim.

(upper row) high-intensity sound shatters a wineglass; (lower row) the Bernoulli effect demonstrated with a whoopee cushion

Conference report

Reproduced Sound 22

The 2006 Reproduced Sound conference was held again at the Paramount Oxford Hotel, Wolvercote on Friday 3 and Saturday 4 November 2006. As usual, the venue facilities fitted the conference requirements admirably, with a comfortable conference room for the technical presentations. A marquee adjoining the hotel's self-contained conference suite provided a spacious exhibition space, and was used also for refreshment breaks. There were many opportunities for delegates to meet and talk in the main room, in the lobby and in the exhibition. The contributions of the exhibitors to the success of the conference are gratefully acknowledged.

The conference theme, as usual, had its main focus on developments in Electro-Acoustics, room acoustics and intelligibility. In addition to an Award lecture, 26 papers were scheduled to be presented in the six technical sessions by nationally and internationally respected authors. Unfortunately, two of the presenters had to pull out at the last minute but the remaining programme remained intensive, the 'spare' time being taken up with extended presentations and discussions. The programme also included an invited lecture by Keith Howard.

The conference was well attended, with 78 registered delegates. The Electro-Acoustics Group committee was pleased with the response to the programme and is now planning the twenty-third in the series, which will be held in November 2007 at a venue yet to be decided.

The conference was opened at 09:50h on Friday by the conference chairman, Bob Walker, who welcomed the delegates. The formal technical presentations began immediately. The technical sessions continued, with breaks for refreshments and meals, until 18:15h. Afterwards, a sherry reception was held in the exhibitors' marquee, followed by dinner at 19:00h. The second day of the conference started promptly at 09:00h with the technical sessions, which ran through until the last paper of the conference at 17:40h. The Electro-Acoustics Group AGM was held after the last technical session of the day. A sherry reception at 19:00h was followed by the Conference Dinner.

After dinner, the President of the Institute of Acoustics, Colin English, presented the 2006 Peter Barnett Memorial Award to Dr Evert Start, and the Institute Award for Distinguished Service to Bob Walker. Bob then made a brief speech in which he emphasised the joint conference objectives of education and enjoyment. He finished by thanking the group committee for their work, Ken Dibble for the technical support and Paul Malpas for the substantial effort he put into the Friday evening session on coding systems. He also thanked the Institute staff for their organisation of the conference, the hotel staff for providing the venue and, finally but most importantly, the delegates for their support.

Overall, the organisation of the conference went well, with a full programme and some activity taking place all of the time. The delegates certainly appeared to have had an enjoyable and worthwhile conference, with many already looking forward to RS23 in 2007.

Technical sessions, Friday 3 November

Speech intelligibility and measurement

Chairman: Paul Malpas

In his paper *Speech Transmission Index: computer simulation and recent standard developments in Germany*, **Thomas Steinbrecher** (Bose Professional Systems) first described the current position of some German standards for intelligibility measurements. The RASTI method

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One of the exhibitors


The President, Colin English, after dinner, introducing the Institute's Peter Barnett Memorial Award winner, Dr Evert Start


The President, Colin English, and Dr Evert Start after the presentation of the Institute's Peter Barnett Memorial Award


The President, Colin English, and the Chairman, Bob Walker, after the presentation of the Institute's Award for Distinguished Service

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had been dropped. He went on to describe the principles of the Direct and Schroeder methods, the reasons for choosing between them and the standardised measurement parameters. In the standard methods, single STI values over 0.8 were assumed to be sufficiently reliable to indicate good intelligibility. Lower values required averaging of three measurements until their deviations became small enough. To determine acceptance thresholds, a value of mean minus one standard deviation statistically included 84% of values. One of the difficulties with the Schroeder method was in making the allowance for the signal and background noise spectra. A noise free measurement could be used to calculate corrections. In the second part of his talk, Thomas presented the results of STI simulations carried out, using Bose Modeller, with examples from eight rooms and nine different acoustic conditions, and RT values from half a second to 5 seconds.

In *Speech privacy - an inverse intelligibility problem?* **Peter Mapp** (Peter Mapp Associates) posed the question of whether STI measurements could be used to evaluate not intelligibility but the converse, *ie* privacy. As a possible subjective measure, he proposed a five-point scale of privacy, ranging from inaudible to clearly understandable. He described the significant problems in using standard STI meters at the very low signal-noise ratios inherent in barely audible or inaudible conversation and showed the different results obtained using five different STI meters. Several gave substantially different results at the lower levels. He proposed a signal-to-noise ratio of -16dB for confidentiality and -25dB for inaudibility. In the discussion, several members of the audience questioned the use of the STI scale. Peter explained that it had been used only as a starting point for this preliminary work and that, ultimately, more work would need to be done on a dedicated subjective privacy scale.

In his paper *A comparison of STI-PA and swept sine wave STI measurement methods and results* **Anthony N Stacey** (AMS Acoustics) described the specifications for STI-PA measurements and discussed the advantages and disadvantages of two main types of test signals: modulated noise and swept sine wave. He used as an example the public address system installed in a London Underground station. The problems encountered with the highly variable noise as the trains approached and departed were also described. Additional problems were caused by not being able to make measurements under normal conditions, with the public present. Problems were also encountered with equipment non-linearity and clipping.

In *Maximal length sequence measurements - a contemporary methodology for Windows systems*, **Bob Walker** (consultant) presented a paper on the use of modern personal computers with built-in audio systems to make MLS measurements. He began with an introduction to 'fast' correlation methods showing how transform methods could be used to calculate impulse responses. In contrast with the early days of dedicated hardware or 'off-line' processing, modern computer systems were fast enough to make the calculation time practically negligible. Using readily-available FFT libraries also simplified the programming and sped up the operation. He showed a demonstration measurement system that produced the usual time and frequency response plots. One of the stated objectives was to produce a measurement module that could be used by anyone in, for example, an Excel spreadsheet.

Audio networking and distribution

Chairman: Sam Wise

Johannes Reitchel (S-Connect) presented *IP based audio distribution in commercial and professional applications*. The differences between receiver-initiated ('pull') and broadcast ('push') transfers were highlighted. The requirement for some knowledge of network systems was described as 'essential' before such products could be used satisfactorily. He said that it was at least necessary for the users to read the manual!

David Howe (Shuttlesound) presented *Digital studio systems - beyond the CAT5 connector* which began by asking 'What is a digital network?'. The two main contemporary digital audio network protocols, 'Cobranet' and 'Ethersound', were compared. The basic CSMA/CD network protocol and its limitations were also described. The fact that links were non-deterministic, leading to variable latency, and the maximum distance of 200m were significant limitations in practice. David then described how the current changeover to network switches rather than non-intelligent hubs was helping to reduce traffic density. However, the need for fault tolerance remained significant. The ideas behind the 'Spanning Tree Protocol" and the methods used to overcome the inherent IP problems of redundant systems with multiple paths were described in some detail.

Mark Bailey (JBL Professional) presented *Integrated control of distributed systems*, in which an outline of network development and the required structures and protocols were described. The principles of control and 'Universal Plug and Play' were presented, together with the requirements of device discovery. Mark then described how the original specification for computer UP&P was limited to typical computer peripherals and how much extension had been needed before the facilities available from complex audio peripherals, for example, a mixing desk, could be determined remotely. That might require thousands of parameters, far more than the developers of the computer systems had anticipated. A scheme for automatic addressing was essential.

Coding and decoding

Chairman: Mark Bailey

Keith Howard (Hi-Fi News & Stereophile) presented an Invited Lecture entitled *High resolution audio: what has it delivered?* As might have been anticipated from such a challenging title, the contents of the presentation covered a wide range of topics. Keith defined high resolution as 'more than 48kHz sampling and more than 16-bit resolution'. The two current commercial examples were DVD audio and SACD. A large number of commercial recordings had been compared and a selection of the results was shown. The first topic was the available audio spectrum. Several graphs were shown, mostly indicating the limited frequency range of the original recordings. The high frequency noise spectra of the SACD recordings were also evident. Next, the measurements of signal dynamics were shown. These had been obtained by averaging the level over progressively longer blocks. In every case, the levels of shorter blocks were higher than for longer blocks. In some cases, levels up to 16dB above the long-term average were evident for 2ms blocks. The next topic was of slew-rate, recalling the historic days of slew-rate (TIM) distortion. Equivalent full-scale maximum bandwidths of 7.5 and 10 kHz had been found for DVD-audio and SACD respectively. Keith then described the measurement of resolution and used the effects of signal truncation to 16-bit to assess how much signal data remained after the truncation. He had discovered that in practically all cases the residue was random and concluded that recording microphone noise was the limiting factor. He concluded by saying that some odd material had found its way on to high-resolution carriers and that the labelling of recordings was frequently unclear. However, some wideband recordings did have signal content up to 40 or 50 kHz. To prevent clipping, the audio reproduction system must be able to deliver up to 16dB above the average level and many, if not most, 24-bit recordings were effectively no better than 16-bit.

In his paper *Going, going, gone digital - a BBC Radio perspective on 'Hard Disk' playout* **Andy Baker** (BBC) described the multiplicity of BBC radio output channels and their different data-rate requirements. Continuing changes in studio technology had to be accommodated whilst retaining the distribution channel capacities. Storage and playout was now entirely digital. For historical reasons and because the broadcast frequency limit was determined many years ago at 15kHz, the BBC had started with NICAM sound at a sampling frequency of 32kHz. The principle of the new system design had been to minimise the number of tandem coding

and decoding operations. To achieve that, all storage was now at 44.1kHz, with compact disks being stored in the CD format. Transmission encoding was carried out only once, specifically as required for each output channel. The dedicated audio data network, with duplicate and backup stores and secure terminal access limited to authorised personnel, was also described in some detail.

Martin Colloms (Colloms Electroacoustics) asked *Do we need an ultrasonic bandwidth for higher fidelity sound reproduction?* in which he described the part played by the upper frequency limit in the continuing search for higher fidelity. He said that, historically, 15kHz had represented a long-standing practical limit. Some sectors of the industry were now proposing limits above 20 kHz as 'better'. The remainder of the presentation looked at evidence for the benefits of the extended responses. It had been reliably established that young, healthy people were indeed aware of some sensations above 20kHz. However, the whole reproducing chain had to match the extensions of the recording capabilities. Smaller high frequency loudspeakers were inherently less efficient radiators. It was now being accepted by the industry that DVD-audio and SACD systems had failed to make an impression with the public solely as extended frequency response systems. Martin said that any comparative listening tests must be carried out fairly before valid conclusions could be drawn. Unrelated changes in the system had to be avoided if the results were to be meaningful. He described a number of research programmes carried out since 1980 in which listener's sensitivities and preferences had been evaluated. The general conclusions were that an upper frequency limit of 20 to 25 kHz appeared to be all that was required.

Jürgen Peisig (Sennheiser Corporation Research) presented a paper entitled *Audio beam - a parametric transducer for focused sound applications with good audio.* He described how, since about 1963, a number of experiments had been carried out with high-level ultrasonic beams, demonstrating the creation of audible components from the intermodulation as a result of non-linear propagation. The mathematics of non-linear propagation were complex. One result was that the interaction volume acted as a continuous distributed array of time-delayed sources, giving rise to a directivity pattern similar to that of the constituent ultrasonic beams, rather than real audio-frequency sources. That, in turn, could result in a highly directional audio-frequency source. A demonstration was given in which the directivity of the source was clearly evident. It gave rise to perceived discrete reflections from the walls and ceiling of the room, though the low-frequency content was severely limited. The level of the ultrasonic sound was stated to be around 80dB at 4m.

Technical sessions, Saturday 4 November

Transducers

Chairmen: Robin Cross and Julian Wright

In his paper *Assessing the effect of loudspeaker crossover components on sound quality*, **Paul Dodds** (University of Salford) described a detailed and ongoing study into the effects of capacitor construction and materials on perceived loudspeaker quality. He began with the confirmed finding that using different types of capacitors had given perceptible differences in the perceived sound quality. A wide range of electrical measurements had been carried out in an effort to identify electrical differences. Differences in the equivalent series resistance had resulted in the expected changes in level but, otherwise, no other electrical parameter could be identified as being responsible. However, in the work it had been discovered that many capacitors had mechanical resonances in the upper part of the audio frequency range. These were measured using acoustic emissions. It was postulated that the resonances were affecting the sound quality and tests were being carried out. No confirmation of the correlation was yet available.

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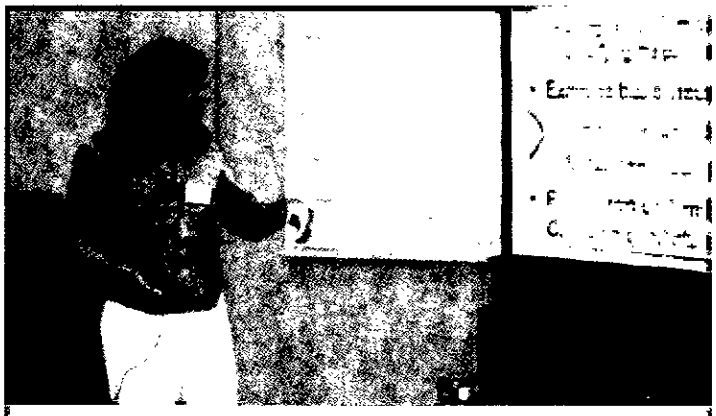
Jamie Angus (University of Salford) presented *Non-uniformly sampled loudspeaker arrays*. In his usual animated style, the principles of directivity calculation were illustrated, with many props to illustrate wave propagation and source directivities. After a brief introduction to the use of Fourier transforms for calculating the far-field spatial response of arrays and the historic use of uniform or logarithmic spacings, Jamie then concentrated on the principle of Gaussian quadrature spacing. This resulted in counter-intuitive spacings, which were wider near the centre than at the ends. He suggested that they were at least different, and might be able to produce more suitable responses for some applications.

Patrick Macey (PACSYS) gave a paper on *Coupled magnetic, structural and acoustic FEA for predicting nonlinear transducer response*, and began by presenting an overview of the many uses for finite element analysis in loudspeaker design. Beginning with the design of the magnet, he said it was possible in principle to derive a complete analysis of a loudspeaker. However, the resulting model would take a long time to create and process and would not allow the identification of contributing effects. The presentation would be limited to modelling the effects of large displacements on the mechanical stiffness of the supports and the electro-mechanical BI product. A preliminary FE analysis provided the nominal values for the main parameters. Patrick then described the derivation of radiation resistance and non-linear stiffness functions due to material bending and stretching, using assumptions about structural damping coefficients. The results demonstrated smoother start-up transients and Patrick concluded that the method showed promise for non-linear analysis.

In *Optimum diaphragm and waveguide geometry for coincident source drive units* **Mark Dodd** (Celestion) described the advantages of the well-known coincident source principle for loudspeakers and posed the question of what the ideal shape of the low-frequency driver cone would be. He described the problems inherent in many alternative approaches to analysis and concluded that time-domain FEM would be most appropriate. He then showed the results of calculations for various portions of hemispherical caps and waveguides of different but matching divergence angles. For infinite waveguides, an 80° cap and matching divergence angle was shown to give smooth on-axis and off-axis responses. For the analysis of finite waveguides, an approximation consisting of a gradual progression from conical horn to infinite baffle had been made. That also resulted in good responses, with smooth directivity patterns, which were constant with frequency. For the power output, the response was smooth and had higher bass levels compared with a rigid piston. The presentation was followed by much discussion, which had to be continued after the session.

Ambrose Thompson (Martin Audio) presented a paper on the calculation of loudspeaker array responses entitled *Automated splay angle calculation for line array loudspeaker systems*. He began by describing a simple design system that could be used to assist during rigging. A more complicated version could be used for system design but it was difficult to remember results and compare the effects of changes. Ambrose then described improvements to the display to show plan views with contour lines of sound level distributions. The optimisation process consisted of calculating the response from a potential array, comparing the results with the target response and adjusting the array to minimise the departures from the wanted response. As an example, the theoretical response for a uniformly-driven 20-box array had been compared with results from a BEM prediction. Again, the presentation was followed by many questions and much discussion.

Jürgen Peissag (Sennheiser Corporation Research) presented *The optical microphone - principle and applications*, in which he described the design and development of a microphone with optical detection of the dynamic diaphragm position. The original motivation had been to develop a microphone for use in physically harsh or dangerous locations,



Jamie Angus starting with an outline of his talk

Jamie Angus using his props to illustrate loudspeaker directivity lobes

for example, explosive atmospheres. The resulting product had then found applications also in electrically harsh environments, for example high magnetic or radio-frequency fields, or close to sparks and welding. The presentation included many details of experiments with optical detection methods and the exceptionally small and close-tolerance components required. Ultimately, micro-machined frames had been devised to hold the optical components in place. Even so, individual adjustment was required for each microphone. The final product had about the same inherent noise level, dynamic range and temperature range as a typical small conventional measurement microphone.

Sound systems

Chairman: Stephen Jones

Paul Malpas (Arup Acoustics) discussed *An experimental approach to designing an effective voice transfer system - audio, acoustics, architecture and ergonomics*. The presentation described the problems encountered in 'protected environment transactions' where staff such as bank tellers or railway ticket sales clerks dealt with members of the public. The security constraints could cause significant intelligibility difficulties. Usually, the ballistic protection required small holes and constricted paths, both for speech and the exchange of money and goods. In many cases, the background noise levels were high on both sides of the partition and the barrier could impose up to 15dB of audio loss. Paul described an extensive investigation involving architects, acousticians, ergonomics specialists and staff representatives to develop a new prototype booth for use throughout London Transport stations. The study had also included the psychological factors affecting the way members of the public actually used microphones. Users had found the finalised design generally satisfactory and it had been accepted as a Design Guide for future use throughout the network.

In *Discrete layered sound* **Shelley Katz** (Layered Sound Technologies)

and **Philip Newell** (consultant) demonstrated the use of flat panel loudspeakers as sources for the side channels in surround sound. The collaboration had begun two years previously as a result of a conversation at a previous RS conference. Special recordings had been made in a well-respected venue in order to demonstrate the benefits of diffuse radiation from the surround channels. For the recording, no processing had been applied to the side-channel information, which was replayed exactly as it had been recorded. Many excerpts of the recording were played, both with and without the side-channel loudspeakers.

Virtual acoustics, modelling and rooms

Chairman: Bob Walker

Peter Rutherford (University of Nottingham) presented *Ancient echoes - rediscovering performance through virtual acoustic reconstruction.* In the paper, Peter described the increasing interest in building restoration, as a result of public demand and increasing public funding. One side effect was the requirement for virtualisations. He said that the demand was mostly for visual recreations, but there was some interest also in audio. The production of suitable anechoic source material was a significant difficulty. The remainder of the presentation was taken up with the description of experiments in convincing musicians and speakers to perform as they would in the real space. Two human speakers were used to make speech recordings for use in a church-like environment. With no acoustic feedback, the results were not good, despite the speakers being experienced in that sort of environment. With a clarinettist, three different degrees of feedback were tried. It was found that only when the visual cues were added to the convolved audio feedback was the performance reasonable in tempo, articulation and dynamics.

In the paper *Modulation transfer function as a measure of room low frequency sound quality* **Bruno Fazenda** (University of Glamorgan) spoke about the problems of prescribing or evaluating low frequency room modes and their perception thresholds. After describing the limitations of reverberation time and frequency response measures, he concluded that the low-frequency Modulation Transfer Function (MTF) would be better correlated with subjective impressions. He presented several comparisons of MTF measurements with room volume, aspect ratio and damping. The results showed that the room volume was not well correlated with room quality and that aspect ratio was little better, though it did show some of the potential problem frequencies. There was a strong correlation between MTF and the room damping. This was also in accordance with some other research on the same topic.

Lara Harris presented *Subjective assessment of the modulation transfer function as a means for quantifying low-frequency sound quality.* In the presentation, Lara compared the MTFs of several loudspeakers with the results of subjective assessments. The test loudspeakers had been simulated electronically by using signal processing to model their responses. A large, high-quality studio loudspeaker had been equalised to provide the 'neutral' reproduction loudspeaker. An inverse filter had been derived from the loudspeaker response using a smoothing window to limit the high-frequency variations. However, the ideal equalisation characteristic had a large gain at a particular frequency, which had to be constrained. The target responses had been derived from earlier studies on loudspeakers. The subjective assessments involved 280 results, in which the objective MTF responses were compared with the subjective Mean Quality Scores.

Sam Wise (Arup Acoustics) presented a paper on the development of a behavioural test facility that involved an extensive and complex audio system to reproduce artificial acoustic environments. The paper was entitled *A simulated ambient acoustic environment at PAMELA - a pedestrian behaviour test laboratory at UCL.* The facility was used for research on pedestrian behaviour to set standards for public

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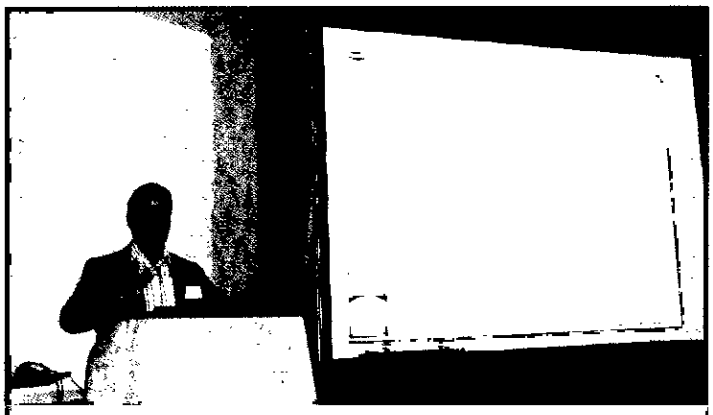

Dr Evert Start presenting the Peter Barnett Memorial Award lecture

Lively audience interaction during the Peter Barnett Memorial Award lecture

infrastructure. It included lighting systems and other features, but originally had not been designed to include much audio or acoustic simulation. It had been found not to be very realistic and it had been suggested that more natural audio would help to create convincing environments. The goal for the audio system was therefore to create realistic acoustic environments. It was necessary for the perceived reverberation time to vary over a wide range, for the system to able to produce high sound levels when required and for the ambience to be not localisable. After considering wave field synthesis and directive horn loudspeakers, a line array controlled by a programmable dsp system was selected. Some of the elements of ambisonic reproduction were incorporated into the final design. The final system included audio acquisition, production and performance capabilities and was capable of being expanded if required.

The final technical presentation of the conference was by **Wolfgang Anhert** (Anhert Feistal Media Group, Germany) and was titled *Prediction of scattering coefficients for use in room-acoustic simulation*. In the paper Wolfgang described how diffusion and scattering coefficients had now been now incorporated into standards. However, scattering coefficients for most surfaces were not known and measurements were limited to quite small sections. Earlier versions of his own EASE software had incorporated some limited guidance on using scattering coefficients. Other prediction methods based on Fourier transforms or BEM analysis were feasible, but were difficult to implement. The main part of the presentation was a description of the new modelling principle used in the latest software version. In the method, a surface was divided into segments, the number depending on the audio frequency and the extent of the surface feature. Each segment was considered to be a complex point source reflector. The present model did not include shading or diffraction but the results compared well with published data on some commercial diffusers, except at extreme angles. The presentation finished with an impressive demonstration.

Evening sessions

The Friday evening programme began immediately after the last technical presentation with a short and informal demonstration by Sennheiser UK of their work on ultrasonics. John Waite and his colleagues expanded on the details presented during the day, which elicited a great deal of interest from the audience.

After dinner, Paul Malpas and Mark Bailey presented an informal workshop on the subject of audio coding and lossy bit rate reduction. After a brief discussion of the types of coding systems now available, the audience was able to chose from a large range of material and coding systems, at different bit rates. Paul had spent a great deal of time in preparing the material, and his effort was much appreciated by the large audience. The system allowed very rapid switching between different excerpts and Mark had to be quick to keep up by pointing out on the screen the one that was currently playing. Needless to say, the subtle differences amongst the higher-bit rate excerpts were not very evident with the large and lively audience under the less-than-perfect listening conditions in the main lecture room. However, a very enjoyable time was had by all present, with much lively banter and useful discussion.

On Saturday, the evening began with another sherry reception, followed by the formal conference dinner. The remainder of the evening was occupied by the Peter Barnett Memorial Award talk by Dr Evert Start of Duran Audio, Netherlands. His title was *Making waves: it takes one to catch one*. The title was intended to encapsulate the concepts of wave field synthesis in creating virtual sound fields. Dr Start began with the basic concepts, showing how a large array of close-spaced sound sources could generate arbitrary sound fields. In particular, virtual sources could be generated, even in front of the array.

Dr Start finished his talk with demonstrations. These involved much audience interaction, with individuals being directed by the remainder of the audience to stand at the apparent source locations. That resulted in a very lively session, with some disagreement about the exact locations, but the consensus was usually remarkably close to the intended source position. Overall, Dr Start had presented an informative and often very amusing history of his involvement in wave field synthesis. A very enjoyable and informative evening was had by the large number of delegates, many of whom stayed until the end at about 23:00h.

Electro-Acoustics Group Annual General Meeting

The EAG AGM was held immediately following the last technical session on Saturday 4 November. As a result of the over-run of the preceding sessions, the time available was limited. At the meeting, the Chairman, Bob Walker, presented a brief revue of the Group's activities over the year. Apart from organising this twenty-second Reproduced Sound conference, the group had also helped with the organisation of a joint one-day meeting with the Speech Intelligibility Group. That had been very successful, with about 65 delegates attending. The Chairman thanked Peter Mapp for his substantial contributions to the joint organisation of that event.

The Chairman asked if there were any proposals for changes to the committee. There were none. The present committee was voted for en block to continue for the next year.

Mr Ken Dibble thanked the Chairman for his chairing of this RS22 conference and proposed that he be asked to continue as the chairman of Reproduced Sound 23 next year. The proposal was approved by all present. The Chairman agreed to do so.

There being no further business, the Chairman then closed the meeting.

An acoustical hypothesis for the spiral bubble nets of humpback whales, and the implications for whale feeding

Tim Leighton, Dan Finfer, Ed Grover and Paul White

Introduction

In 2004, Leighton et *al* [1] proposed that humpback whales used bubble nets as acoustic waveguides to create a sonic trap for prey, as shown in Figure 1. It had been known for decades that humpback whales, either singly or in groups, sometimes dive deep and then release bubbles to form the walls of a cylinder, the interior of which is relatively bubble-free (Figure 1). The prey are trapped within this cylinder, for reasons previously unknown, before the whales 'lunge feed' on them from below. When the whales form such nets, they emit very loud 'trumpeting feeding calls', the available recordings containing energy up to at least 4kHz. Leighton et *al* showed a how a suitable void fraction profile would cause the wall of the cylinder to act as a waveguide, creating a 'wall of sound' with a relatively quiet interior at the centre of the cylinder. They hypothesized that any prey which attempted to leave the trap prey would enter a region where the sound is subjectively loud, be startled, and in response school (the bubble net turning the 'schooling' survival response into an anti-survival response). Furthermore, the trumpeting calls encountered in the 'wall of sound' were appropriate for exciting swim bladder resonances in the prey [2-5]. Either or both effects could encourage the prey to remain within the bubble net, and so trap them ready for consumption.

The circular geometries modelled by Leighton were based on the frequent description in the literature of humpback bubble nets as 'circular' [6-9] - Google returns nearly 12,000 items for the combined keywords *humpback circular bubble net*. Since then however the authors had brought to their attention (by Dr Simon Richards of QinetiQ) the existence of photographs showing the development of a spiral form of bubble nets by humpback whales (Figures 2 and 3). This paper outlines the possible acoustical implications of spiral nets.

The spiral net hypothesis

The authors hypothesize that spiral bubble nets may hold distinct advantages over circular ones [10]. In the circular bubble net of Figure 1, the propagating rays which form the 'wall of sound' are confined within bubbly water. As will be shown below, refraction can trap rays within a spiral bubble layer in a similar way [10]. However in both cases the rays trapped by refraction propagate through bubbly water, where the attenuation is greater than it would be for bubble-free water. It is therefore advantageous in forming a 'wall of sound' that the spiral bubble nets contain a second, complementary path, where the containment of the rays works through reflection, and crucially, the propagation occurs through bubble-free water where the attenuation is less. Furthermore the open end of the spiral forms a more robust entry point for the sound, and does not require shallow angles of the sort shown in Figure 1 in order to create a wall of sound with a quiet interior. The trap is therefore much more tolerant to the positioning of the whale.

There are yet further advantages to the spiral bubble net, compared with the circular one.

The circular net requires closure of the circle in order to create a quiet bubble-free region. Of course the inner end of the spiral could close up upon itself, creating in effect a circular bubble net within a spiral one, with a quiet bubble-free region in the centre in which prey are trapped. However spiral nets do not need such accuracy in their construction: they will still work even if there is no complete closure of the bubble layer surrounding a bubble-free centre; and they will still work even if the centre is not bubble-free. This is because the spiral

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Spiral Bubble Nets - *continued from page 17*

geometry generates a new region, free of bubbles and sound, within the inside edge of the bubble-free arms of the spiral. The ever-closing spiral wall means that, as they progress into the spiral, the reflected rays meet the outer edge of the bubble-free arm of the spiral with ever-decreasing grazing angles, such that the inner edge of the bubble-free arms remains quieter.

Whilst both the bubble-free and bubbly paths in the spiral individually contribute to the wall of sound, the interactions between them create a synergistic effect: there will be ray paths which propagate at times in the bubble layer, and then leave it to enter the bubble-free layer, of the spiral; and reflections at interfaces between bubbly- and bubble-free water will be only partial.

Figure 4 shows the effect of just one ray as it enters the bubble-free arm of the spiral (all modelling in this paper is restricted by the limitations of ray representation, as discussed earlier [1]). When it first meets the outer edge of the bubble-free arm (at the point labelled A, here with a grazing angle of 34°), the subsequent propagation is represented by two rays: a refracted ray in the bubbly arm, and a ray which is reflected into the bubble-free arm. The refracted ray propagates in the bubbly waveguide. As it approaches the edge of the bubbly water in principle it may of course be internally refracted back into the bubbly water. Alternatively a given ray may intersect the edge of the bubbly waveguide, which in the model results in two rays propagating onwards: one is reflected back into the waveguide, whilst another is refracted into the bubble-free water (either within the spiral, or outside it). Propagation within the bubbly waveguide is attenuated much more than propagation in the bubble-free arm. Because of the absence of attenuation in Figure 4, and because of the ability of rays to multiply at interfaces, there is no information in the figure with respect to acoustic intensity.

The ray which at A reflected into the bubble-free arm of the spiral, propagates through it until it next meets the bubbly water at B, with a reduced grazing angle (here, 29°). Again two rays are shown propagating away from B, a refracted ray (which recharges the attenuated sound field in the bubbly water), and a reflected ray which continues through the bubble-free water towards C. Further reflections at C, D *etc* occur with reduced grazing angle, each one recharging the field in the bubbly water. The number of reflections is artificially truncated in the calculation at F.

The ever-reducing grazing angle will keep the inner edge of the bubbly net quiet, and the attenuation in the bubble cloud, and loss of energy from the ray in the bubble-free water each time it reflects, serve to reduce the sound field towards the centre of the spiral. In this way, quiet regions are generated. These are not just at the centre of the net, as with the circular net, but also along the inner edge of the bubble-free arm. Fish here will be in bubble-free, quiet water, but trapped within the spiral 'maze': in 2D, few positions will have an exit visible along the line of sight, and in real 3D nets the locations of the predators must be taken into account. Whilst Figure 4 showed the results (without attenuation) of the launching of a single ray into the spiral, Figure 5 shows a ray plot for the launching of a beam. As before, the plot lacks attenuation and requires the generation of both a refracted ray and a reflected one at interfaces, such that intensity information is incomplete. Note that the only rays with large grazing angles in the bubble-free arm have first propagated through the bubbly layer and suffered losses when refracting through the interface at least twice, and hence will be heavily attenuated.

There are clearly simplifications in Figures 4 and 5, some of which were discussed in [1]. As stated earlier, available recordings of the humpback call emitted during bubble net feeding contain significant energy in the 4kHz range. The ray tracing approach used in the model presented here is appropriate for this frequency range, given the overall dimensions of the net. However, to understand the role of low frequency energy emitted during bubble net feeding, modal analysis would be required.

Figures 4 and 5 are, of course, two-dimensional representations, but the key elements would also pertain to a 3D spiral net. Therefore, should the whale emit its feeding call into the net from below, the propagation path in 3D can readily be visualised from this 2D representation. The walls of the net in Figures 4 and 5 are smooth and generate specular reflection, whilst the degree to which the walls of Figure 3 are rough is difficult to estimate, particularly as the visible shape of the net is dominated by the large bubbles: in contrast, the small bubbles can be less easy to see, but are very potent acoustically. The roughness as perceived by the scattered acoustic field depends on the wavelength (λ) and the grazing angle (θ), such that the Rayleigh roughness criterion states a surface is rough if $kh\sin\theta = (2\pi / \lambda)h\sin\theta >> 1$, where h is the mean height of the surface undulations, and k is the wave number. In the absence of data on the geometry of the net which includes all bubbles, it is difficult to make calculations regarding smoothness. Because of the way the spiral continually

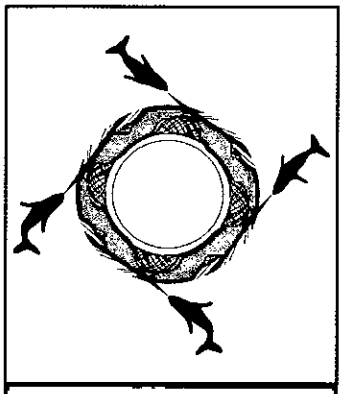

Figure 1

Ray model results for the trapping of sound within a circular bubble net (whose boundaries are shown by red circles). From Leighton et al. [1].

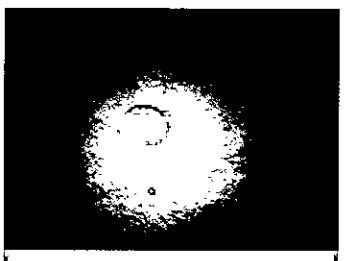

Figure 2

An underwater bubble net generated by a humpback whale. Images from the NMML Galleries are unrestricted. If you use images from this site, please credit the photographer and our organization as follows, Photograph by J Olson, NMFS, reproduced courtesy of the National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Fisheries Science Center, National Marine Mammal Laboratory.

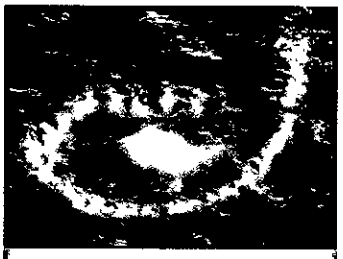

Figure 3a

Figure 3b

Figure 3c

Three photographs of spiral bubble nets showing the formation of a bubble net, with lunge-feeding occurring in the final frame. Note the presence of opportunistic birds. (Photographs by Tim Voorheis / www.gulfofmaineproductions.com. Photographs were taken in compliance with United States Federal regulations for aerial marine mammal observation.)

reduces the grazing angle of rays as they penetrate further within it, then all else being equal, the inner regions of the spiral may therefore appear smoother, so creating robust regions within the spiral that are bubble-free and quiet. However this trend will be tempered by any change in h along the length of the spiral (reflecting the size of bubbles blown and the age of that portion of the net). The surface will appear most rough for the highest frequencies, which we take as 4kHz [1]. For acoustic fields in bubble-free water, this gives a wavelength of 0.375m, so that for test values of h of 0.1m and 1m, the wall will appear smooth for grazing angles less than about 37° and 4° respectively, with commensurately larger angles for lower frequencies. The angles compare well with the sequence of angles recorded in the caption to Figure 4.

Why some nets should be spiral is not clear. It may be a pragmatic or incidental response to practical limitations. Conceivably however the whales could be exploiting the different acoustical properties of circular and spiral nets. These could confer possible advantages to the spiral configuration through the following features.

- A wall of sound can be generated using acoustic paths which propagate in bubble-free water (Figure 4) and hence suffer less attenuation than seen for acoustic paths in bubbly water (to which circular nets are restricted).
- Propagation in the bubble-free arm 'recharges' the heavily attenuated field in the bubbly waveguide as both progress into the spiral, which serves not only to reinforce the wall, but also to attenuate the sound in the bubble-free arm to facilitate the generation of quiet regions in the centre of the net.
- The spiral net contains more scattering interfaces between bubble-free and bubbly water, so that whilst a ray which leaves the circular net is lost from the net, a ray which refracts out of a region of bubbly water in the spiral

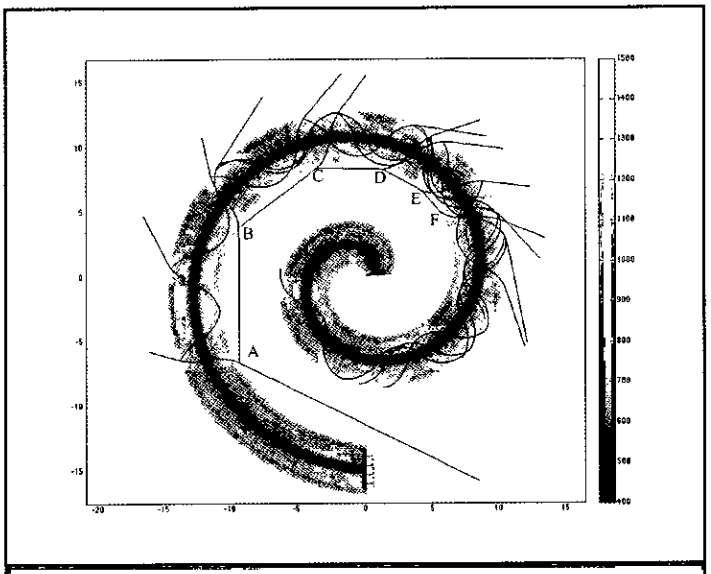

Figure 4

A horizontal plane shows a 2D plan view representation of a spiral bubble net (without a closed centre) is shown, the sound speed (ms-1) being indicated by the greyscale. The Cartesian axes indicate distance in the horizontal plane in metres. Into this net a single ray is launched. This undergoes a series of reflections off the outer wall of the bubble-free arm of the spiral, successively labelled A, B, C etc. At each reflection the grazing angle decreases (34° at A; 29 ° at B; 23° at C; 19° at D; 16° at E; 13° at F). Also, at each reflection, not only does a reflected ray propagate further into the bubble-free arm, but a refracted ray propagates into the bubbly-arm of the spiral. Attenuation, which is particularly severe for the rays in bubbly water, is not of course included.

net can remain trapped within the spiral system. Specifically, when a ray leaves the circular bubble net of Figure 1 it is lost to the 'wall of sound'; but except for rays crossing the outermost interface of the spiral bubble net, rays crossing boundaries in the spiral net remain contained within it.

- A spiral form which contains a closed inner ring of bubbles surrounding a bubble-free centre gives additional acoustic protection to the quiet zone at the centre of the net. High-angle rays need only cross two walls to penetrate the centre of the circular bubble net and degrade its quietness; in contrast, they must cross many such interfaces in the spiral net, reflecting at each boundary and attenuating across the width of several bubbly arms.
- Spiral nets need not be generated to such exacting standards as to contain a closed inner ring of bubbles surrounding a bubble-free centre. They generate quiet, bubble-free zones at locations against the inner edge of the bubble-free arm.
- The geometry of Figure 5 shows how the whale could speculatively obtain feedback on the performance of the spiral net, since the efficiency of the wall of sound could be diagnosed through monitoring the outbound sound as it leaves the spiral.

Discussion

It is no simple matter to test the hypothesis that the acoustic properties of spiral bubble nets may hold some advantages over those of circular bubble nets. If scale experiments are to be conducted, the realism of the model should be critically assessed. For example, it is relatively simple to construct a 1:100 scale model bubble net by submersing expanded polystyrene in water (Figure 6) and obtain measured sound fields which at first sight look convincing (Figure 7). Note that this is a spiral with a closed centre, not an open one of the type modelled in Figures 4 and 5. Because there is only reflection to consider, propagation in such a net is simple to model numerically (Figure 8). The reason for this is that, in this case, the 'bubble net' was made of expanded polystyrene, a solid matrix containing such a high fraction of gas bubbles frozen in place that it acts as a pressure-release interface underwater. No sound propagated in this scaled-down bubble layer, so that the experiment incorporated only the propagation path through the bubble-free arms of the spiral, and did not capture either refraction or propagation within the bubbly arm of the spiral. As a result, the polystyrene model could hardly fail to produce a wall of sound with a quiet interior.

Why use expanded polystyrene at all for this simple demonstration, rather

continued on page 20

Spiral Bubble Nets - *continued from page 19*

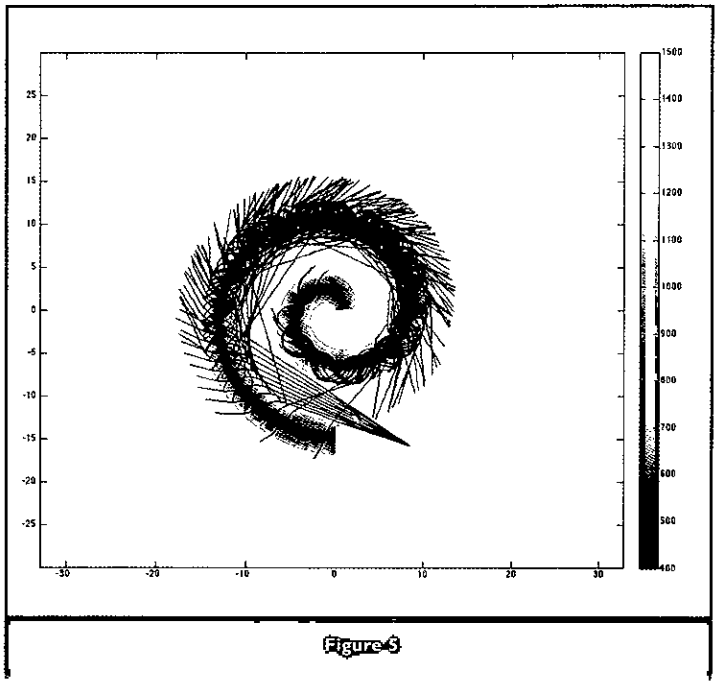

Figure 5

As for Figure 4, a spiral bubble net (without a closed centre) is shown, the sound speed (ms-1) being indicated by the greyscale. The Cartesian axes indicate distance in the horizontal plane in metres. A beam of rays is launched into the spiral. The spiral generates clear regions which are both bubble-free and quiet. Note that whilst the emission of rays from the bubbly arms into the bubble-free arms at the inner regions of the spiral gives the visual impression that these rays will degrade the quietness of these inner regions, the energy contained within them will not be great, as a result of attenuation in the bubbly layer, and also because of reflection losses at the interface between bubbly and bubble-water.

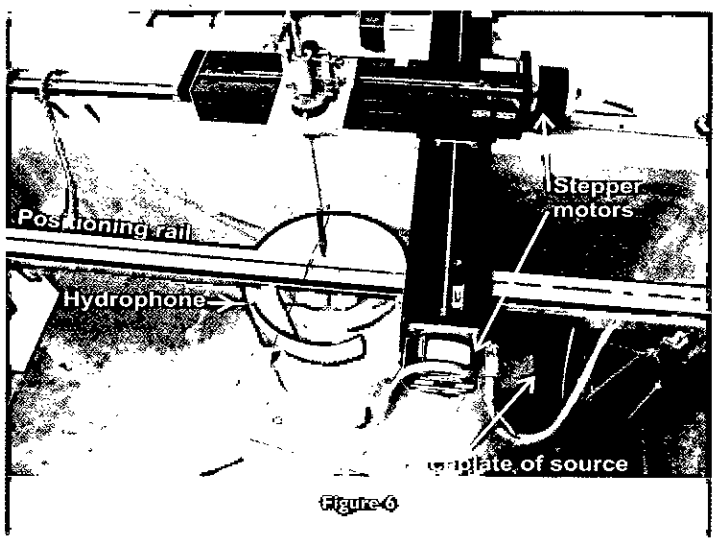

Figure 6

A simple scale model spiral net of 0.3m outer diameter, with a closed centre. The base of the spiral is fixed to an upturned aquarium, such that all except the top 10cm are submerged. The spiral is 0.6m tall and a 1.57m length of expanded polystyrene (of 7mm thickness) was required to complete the full two revolutions of the spiral.

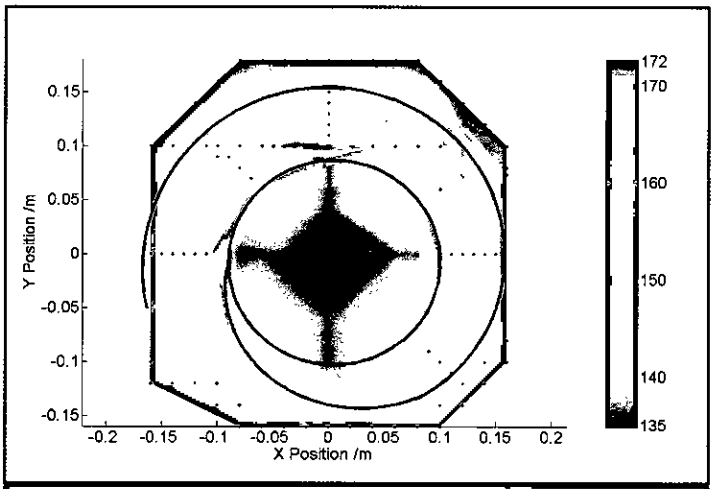

Figure 7

The low-resolution map shows the acoustic field measured within a horizontal plane which passed through the midpoint of the spiral shown in Figure 6. The plan view position of the spiral is superimposed. The sound source was custom-made by Blacknor Technology Ltd., and projected a sinusoidal pulse of 375 kHz basic frequency and ~8 μs free-field duration, with horizontal acoustic axis at the mid-depth of the spiral. One pulse was projected every 2 ms. A calibrated Reson TC 4013 hydrophone (shown mounted on a scanning rig in Figure 6) was used to map the sound field generated in the spiral. The colour represents the rms sound pressure level at each measurement location, time-averaged over the entire 2 ms window from the start of one pulse to the start of the next, so that all the reflections within the spiral were included in the calculation (averages taken over the duration of the main pulse will be higher, but the long window more properly reflects the conditions we wish to mimic). The resulting level ranged from 135 to 172 dB re 1 μPa as shown on the colour bar. The discrete measurement points are shown as black dots in the figure. Between these, the sound pressure level value is then interpolated, and it is this surface upon which the vertices are plotted. This results in interpolations crossing the boundary of the polystyrene. Since all other data are interpolated between these measurement points, they should be treated as offering no more than visual effect, the actual data being only that shown at the measurement point. For example, interpolation occurs between points on either side of the polystyrene wall, and so the map will not be influenced by the zero pressure which occurs in the wall. Furthermore the spacing of points around the inner wall of the spiral is insufficient to show any zones of low pressure there, were it to exist: the interpolation gives little evidence one way or another of this.

than proceeding directly to a miniature net of real bubbles? The reason is that the polystyrene only models the impedance mismatch between high-void-fraction bubbly water, and bubble-free water: it is better knowingly to eliminate a key feature (the bubble resonance) from the scale model than it would be to include it with inappropriate scaling.

The problem is that, whilst a scale model of a net can readily be made to scale the gross dimensions of the net, it is no simple matter to scale the fine structure of the bubble size distribution. The scaling factor used in this experiment is around 1:100. For this, scaling of the gross features is simple: the model net diameter is 0.3m compared with 30m in the wild, and the acoustic wavelength is 4mm compared with the 400mm chosen to represent the longest wavelength of interest in the net [1]. However such a scaling factor causes problems in generating a suitable bubble population. This is because, whilst the bubble size distribution in the net is not known, it is likely to contain bubbles having radii ranging from centimetres to microns, and this cannot readily be scaled. More importantly, a simple 1:100 scaling is insufficient: as Leighton *et al* [1] showed, for sound to be trapped within the bubble net by refraction, the presence of bubbles must reduce the sound speed, which happens when the bubbles controlling the sound speed are driven at frequencies less than their resonance frequency (ie they are driven in stiffness-controlled regime) [2,11]. The resonance frequency of an air bubble in water varies roughly inversely with its radius (for bubble greater than, say, ten microns in radius). For insonification at 375kHz in the scale model, the bubbles which are resonant have radii of less than about 10 microns. Bubbles larger than this would be driven in the inertia-controlled regime [11]. The generation of a bubble net of diameter 300mm which contained no bubbles larger than about 10 microns radius would be difficult and expensive, involving biomedical contrast agents, electrolysis, chemical reaction (Figure 9), or other alternative (Figure 10). Whilst production of a circle (or even a spiral) of bubbles in a water tank is not too difficult, ensuring that the resonance effects (and therefore sound speed profile) of the bubbly water are scaled appropriately is difficult. For this reason, only the reflective element was tested in this preliminary scale model (which was devised for an undergraduate project).

To what extent the humpback whales make use of these acoustical properties is not known, as it is difficult to obtain objective measurements of the sound field, and an assessment of whether whales exploit these features would require a survey which correlated behaviour with acoustics. The geometries of nets used have not been surveyed, let alone the relative occurrence of spiral and circular nets. Indeed lunge feeding is seen with other geometries of net (Figure 10), but without simultaneous acoustic information, reliable bubble data and behavioural observations, and in sufficient quantity, it is impossible to be certain as to the extent, if any, to which humpback whales are exploiting these.

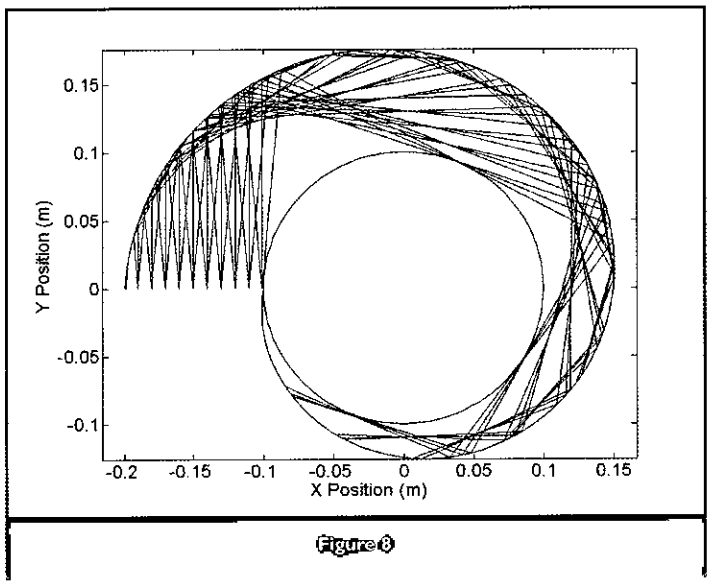

Figure 8

Model of ray propagation within the polystyrene spiral of Figures 6 and 7

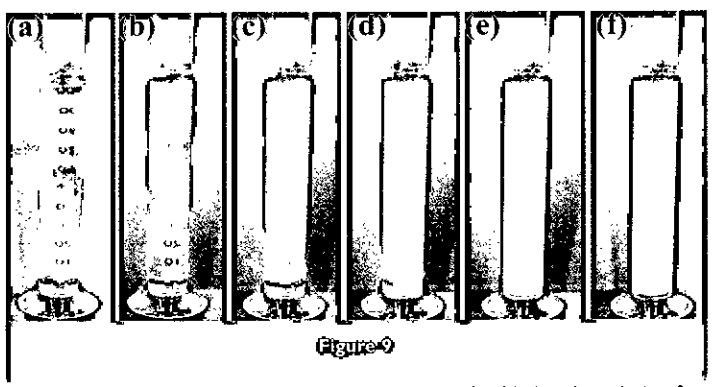

Figure 9

The generation of high concentrations of minute oxygen bubbles in liquid (without the production of any large bubbles) by means of "Sedna's Raven" in a 100 ml measuring cylinder. The whole sequence of photographs (a) to (f) was taken in under a minute. The system was devised with TGL and DCF by Dr Peter Birkin of the School of Chemistry, University of Southampton using hydrogen peroxide over Manganese dioxide (MnO2) for the purpose of scaling oceanic bubble populations. The results still possess the dynamics of bubbly water, whereas froth would not.

There may be volumes of microscopic bubbles which, although they have a pronounced acoustic effect, are not visible in the photographs, but which can persist for many minutes in the water column. It may be that the formation of spiral nets is simply the by-product of some behaviour designed to achieve another purpose, such as efficient motion during the formation of the net, just as the shape of natural spirals whose response to pressure perturbations is key to their function (eg the cochlea, the nautilus shell) has been attributed to expedient (if the perhaps mundane) explanations such as efficient packing.

However, the ever-decreasing grazing angle which will, if the spiral is sufficiently long, eventually generate wall-hugging surface waves; the robustness to the particulars of the entry; and the possibility of feedback from back-propagating fields all show the remarkable effect of the spiral on fields propagating along it. These are suggestive of possibilities that should be explored.

Tim Leighton CEng FIOA, is Professor of Ultrasonics and Underwater Acoustics at the Institute of Sound and Vibration Research, and a member of Council of the IOA.

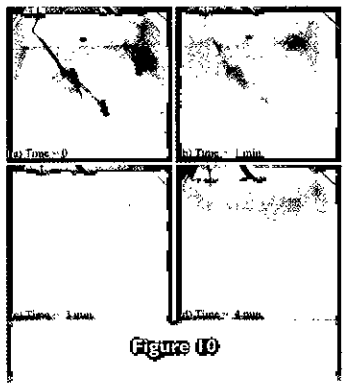

Figure 10

A large-scale generator of small bubbles implemented by the authors, the images corresponding to times of (a) 0, (b) 1 min, (c) 3 min and (d) 4 min after activation of the generator. They show the system filling a tank of normal fresh water (measuring 1.5m by 2.5m by 1.5m) with a dense cloud of minute bubbles, without the production of large bubbles. As a result, the initially clear water turns milky white, obscuring from view the Delta 22 anchor which lies under 1.5m of water and measures 695mm end-to end and a maximum of 310mm between the fluke tips. No chemicals were used.

Figure 11

A whale lunge feeds from what appears to be plane wall of bubbles. However it is not simple from photographs alone to be sure whether the eye can detect the location of all the acoustically active bubbles, and impossible to know what acoustics are being generated.

Dan Finfer is currently studying for a PhD under Professors Leighton and White on the Rayleigh Scholarship scheme at the Institute of Sound and Vibration Research. He is a student member of the IOA.

Ed Grover currently in year 4 of the undergraduate MEng programme at the Institute of Sound and Vibration Research, and took the data of Figure 7 as part of his year 3 project. He is a student member of the IOA.

Paul White is Professor of Statistical Signal Processing at the Institute of Sound and Vibration Research.

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My work experience week with AIRO

Danny Taylor

I am fascinated by Engineering because I love to play music.

In music, the rules of harmony allow a composer to create wonderful expressive pieces with a rich flowing texture. The laws of physics are used in much the same way as this musical 'formula' as they structure the world we live in and allow engineers, much like musicians, to express themselves through their creativity. It is this creative aspect intertwined with the physics of engineering which has interested me in Engineering as a whole, and Acoustical Engineering in particular.

To make sure that I was positive about pursuing a course in acoustical engineering at university I decided to enquire about the possibility of a week's work placement to glimpse the world of acoustics. So pursuing this idea I personally arranged a one-week work placement with AIRO (Acoustical Investigation and Research Organisation). Throughout the week I shadowed five employees, with my work spanning the range from sound insulation tests on wall partitions, through to insulating a vacuum cleaner to control the sound emitted. The latter, I must confess, I enjoyed more.

From the first day I felt welcome at AIRO, and I began by learning about the complexities of noise pollution. An old project was unearthed and I was instructed about the different phases and calculations needed to complete a sound level estimate on a proposed new stretch of road. Having discussed the site I was then instructed on the use of AutoCAD where I constructed a two-dimensional replica of the proposed road layout - a laborious though surprisingly rewarding job. On Tuesday I worked alongside the laboratory technician who showed me 'the ropes'. He explained the uses of the four on-site reverberation chambers, and the reasons behind their design purposes and interior characteristics. He also showed me a demonstration of the typical measurements made in the chambers when testing different wall partitions. We did this by setting up a sweeping boom in the receiver chamber and recording the measurements of a set of loudspeakers producing pink noise in the source chamber, through a partition... though we also experimented.

To explain the fundamentals of sound insulation

Materials required:

- 1 reverberation chamber
- 1 vacuum cleaner (sturdy)
- as much mineral wool as is readily available
- 1 heavy box
- 20 lightweight aggregate blocks

Although this does not sound like the most successful recipe for success, it was a *lot* of fun. Having learned that mass and isolation were the best ways of insulating a noise source (said vacuum cleaner) I was then set the challenge of lowering the noise level in the chamber by 30dB. Many odd structures, one broken vacuum cleaner and several sets of data later I had approximately achieved my goal.

For my work on Wednesday I shadowed a consultant in the field taking measurements for Robust Details, which was an interesting experience. In honesty I had not realised that residential houses went through so many tests before completion, and especially that sound insulation measurements were included. The process involves the testing of walls between adjacent buildings, to make sure that the wall has sufficient acoustical insulation. The manual labour of moving the equipment from building to building made it an extremely tiring day. We did two tests and we were happy to give a green card to the contractor showing that the houses were up to the Building Regulations standard.

Thursday was organised for the testing of my guitar amplifier. I have a 200 watt Peavey bass amplifier which I was given a few years ago, though I have been perplexed by the purpose of some of the knobs.

AIRO, the hosts for Dan Taylor's work experience in acoustics

Danny Taylor

This was a perfect opportunity to find out. With the guidance of one of the principal consultants I set up my amplifier in AIRO's anechoic chamber with a microphone one metre away from the cone of the loudspeaker. By setting the levels of the amplifier at halfway, I was able to tweak the unknown knobs to deduce their purposes. This was done by feeding pink noise through the loudspeaker and measuring the different frequencies picked up by the microphone. For each test I changed one variable and from this I found the characteristics of each setting by the peaks and troughs in a graph plotted as noise level (dB) against frequency (Hz). I was also intrigued to learn that in theory the noise level would drop by 6dB if the microphone's distance from the amplifier was doubled, so I set out to prove it. More readings were taken with the microphone repositioned 2 metres away, and discovered that the theory was correct.

For my final day I worked alongside one of the technicians, who mainly worked on the design and construction of new state-of-the-art systems for different projects. He showed me photos of different sound systems they had installed in cathedrals and churches, and explained the concepts behind the unique loudspeaker designs. This was a more 'hands-on' day where we tested numerous microphones and I was shown why some microphones were better for various purposes, which was highly enjoyable.

I would like to take this opportunity to thank AIRO for the opportunity they gave me, and to thank the employees who made my week enjoyable and interesting. My involvement at AIRO not only equipped me with an intellectual foundation for my future studies but also helped me to choose which fields I would like to focus on, namely internal design for different acoustical effects. These experiences have further convinced me that acoustical engineering is the profession I would like to pursue as it seems to combine my scientific aptitude with my curiosity into the characteristics of sound.

Danny Taylor is an upper sixth-form student at Verulam School, St Albans.

Ignorability and Tonal Content in Aircraft Sound

Ieish Gamah and Ian Flindell.

'More research has been devoted to aircraft noise than to any other environmental noise problem' [1]

Background

Modern jet powered aircraft are considerably quieter than their predecessors from 30 or 40 years ago, yet there is evidence emerging that at least some airport residents may be starting to report higher annoyance than in the past [2]. Anecdotal evidence has also been noted to the effect that most people who live near airports tend to pay little or no attention to most aircraft sound events for most of the time. Even though sound levels have reduced, it seems possible that people may be noticing or otherwise paying attention to a higher proportion of aircraft sound events than in the past. In other words, the proportion of aircraft sound events which are ignored may be going down. If this is true, it could simply be due to an increase in the number of events, but it is also possible that changes in the character or quality of the sound could be having an effect.

What is interesting here is understanding the differences in sound quality which could be contributing towards making some aircraft sound events less capable of being ignored, or in other words, more noticeable, than the rest. There would seem to be a clear subjective distinction between aircraft sound events which have been ignored and aircraft sound events which have been noticed. The threshold of 'ignorability' varies over a wide range from one event to the next, but there could still be some relationship with measurable acoustic features of the sound, which might in turn be useful for noise assessment and control. The broad aim of the research described here is to discover any acoustic features (apart from, and additionally to, loudness) which may affect ignorability. Engineering noise controls could then be targeted at those specific acoustic features which had an adverse effect on ignorability and these controls might thereby contribute to corresponding reductions in reported annoyance over the longer term.

Unfortunately, there are two major difficulties in carrying out meaningful research on ignorability. Listeners cannot express meaningful subjective opinions about sounds to which they have paid no attention. Any experimental method which, for the purpose of obtaining subjective opinions, encourages listeners to pay attention to sounds they might otherwise have ignored is technically invalid. Listeners are, of course, perfectly competent to express subjective opinions about sounds to which they have paid attention, but this does not by itself explain the difference between unnoticeable and noticeable sounds. It seems that ignorability can only be studied by indirect means, either by observing behaviour in situations where listeners have not been told the real purpose of any experiment, or by studying the auditory thresholds of particular features which are assumed to have possible effects on ignorability.

In pilot research on ignorability at ISVR based on distraction tasks, it was found that as soon as people started to understand the real purpose of any experiment on this topic, then they started to pay attention to noise events in ways that were not representative of how they might normally behave, or at least of how it was assumed that they would normally behave. The psychological mechanism for this is well known and is commonly referred to as 'selective attention'. The basic theory is that there is usually too much going on in terms of sensory inputs at any one time for any person to be able to pay conscious attention to everything all at the same time. Selective attention describes the mechanisms by which people seem to be able to reserve limited cognitive functioning for the most interesting or important tasks at any one time, and effectively ignore all other inputs until such time as anything happens to divert attention away from the previous task. In listening trials, paying attention to aircraft sound events that might otherwise have been ignored then becomes a perfectly rational strategy for completing whatever experimental tasks have been set by the experimenter.

The most extreme example of this phenomenon happens when people are asleep. Sleeping people pay almost no attention to anything going on around them. There will, however, always be a limited amount of subconscious information processing going on which can then stimulate arousal and subsequent cognitive appraisal of anything unusual or otherwise requiring attention, such as an alarm clock. Habituation or adaptation to familiar events seems to be important here. Most people have at least some experience of either not waking to a familiar alarm clock or possibly switching off the alarm clock and then going back to sleep without necessarily having a very strong memory of having done so. The same probably applies to aircraft sound events occurring while people are asleep. Quantitative research has shown that whereas a high proportion of such events (but not all of them) lead to measurable physiological responses, only a very small proportion of those events lead to behavioural awakening. Aircraft sound events occurring while people are awake may be remembered, but hardly any aircraft events that occur while people are asleep will be remembered.

Probably the most important feature affecting daytime ignorability is loudness, but this cannot explain the current RIVM [2] findings of higher levels of reported annoyance even though sound levels have reduced. The next most plausible feature affecting ignorability is variation from one event to the next. Aircraft sound events are probably the most variable of all types of transportation sources, simply because of variations in aircraft operations from one day to the next, and because of short term variations in acoustic propagation from what are generally quite distant sources, even if the operations are the same. It seems reasonable to hypothesise that the loudest events would be the most likely to attract attention and that a good way to mitigate against this might be to control variation rather than long-term average sound levels. However, it is difficult to devise any form of research that might be able to test the concept, and it is not clear how any regulation could be devised to ensure compliance with any research findings on this topic either.

There may also be attention-demanding features within the overall character or sound quality of each aircraft sound event. If this were found to be true, it might expose some possibilities for engineering solutions which affect the sound quality more than they affect the sound level: such possibilities would seem to be worth pursuing. Aircraft manufacturers might then be able to emphasise the most ignorable features of future products. without necessarily having to achieve significant reductions in sound energy. It is known from experiments that tonal features increase subjective noisiness by more than is implied by their additional energy content. This is taken into account in aircraft noise certification procedures based around empirically derived tone-corrected sound level indicators such as EPNdB [3], but the precise reasons why human hearing is (or appears to be) relatively more sensitive to tones than to broadband noise are not known. An assessment procedure such as that set out in BS 4142 [4] includes subjective corrections for any recognisable or identifiable features such as tones (or impulses), but again there is no explanation for exactly why there should be a correction for tonal features.

In the present research it is assumed that tonal features, where present, provide additional information which assists source identification, and that it is this additional knowledge about the source which contributes to increased noisiness, most probably by increasing

how relatively noticeable that particular source is, compared with other sources without the tonal features. In addition to static tonal features it should also be noted that Doppler shift conveys additional information about movement of the source. Doppler shift can only be heard if there is tonal content present in the original (*ie* not Doppler-shifted) sound. This additional information about source movement could be very important in terms of selective attention demand and therefore seemed to be worthy of further investigation.

A literature review revealed that a small number of experimental studies were carried out around 30 years ago in which Doppler-shifted tonal content was a feature, but there does not seem to have been anything very much since. This is possibly quite hard to understand when considered in context against the recent results reported below, but most previous researchers seem to have had different objectives in mind and presumably concluded that those objectives had been met at that time.

In terms of biological or evolutionary plausibility the following hypothesis is offered: static single-frequency tone detection in the ear seems to be reasonably well described by well-established auditory critical band theory. This theory is based on the concept that static single frequency tone detection in the ear can be explained by the assumed mechanical properties of the physiological structures present in the peripheral auditory system. Swept tone detection, such as occurs in Doppler shift, appears to be different in that despite the potential survival advantages of being able to identify movement purely from the sound, there appear to be no structures present in the peripheral auditory system specially adapted for swept tone identification.

It therefore becomes interesting to test whether masked detection thresholds are the same or different for swept and static tonal features in broadband background noise. If masked detection thresholds are lower for swept tones than for static tones (and no record can be found in the literature that this has ever been tested before) then it would imply that there are (or could be) additional mechanisms present in the auditory system which may have evolved specifically for the purpose of detecting movement in auditory signals. If the masked detection thresholds are the same or higher, this would imply either that there is no additional mechanism adapted for auditory movement detection, or that if there were such a mechanism present, then the additional sensitivity that the mechanism would have provided (in theory) is offset by the loss in sensitivity that would otherwise result from the swept tone being present and for less time (and thus available for detection) as it is swept through each auditory critical bandpass filter separately.

Research hypothesis

It is hypothesised that if it were possible to enhance the *ignorability or non-noticeability* of successive aircraft sound events, this could in turn lead to a corresponding reduction in real-life aircraft noise annoyance. A further hypothesis is that noticeability could be reduced by first identifying and then removing any specific features present which might otherwise tend to attract listener attention. This might be done by removing tonal features, not just because the tonal features are annoying in the their own right (or could be so), but also because Doppler shifts associated with source movement overhead cannot be heard if there are no tonal features present. It is hypothesised that the presence of perceptual cues providing information about source movement overhead may serve to attract attention, thereby increasing noticeability. This leads to further possibilities (in theory at least) that ignorability might even be enhanced by masking techniques where broadband levels are actually increased.

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Ignorability and Tonal Content in Aircraft Sound - *continued from page 25*

Methods

Following initial pilot tests which indicated at least the possibility of significant differences in masked detection thresholds between swept and static tones in broadband background noise, a series of controlled listening tests was carried out at three different frequencies and three sweep rates. Twelve volunteers with normal binaural hearing were asked to respond 'yes' or 'no' as the experimenter controlled the relative level of swept or static test tones centred on 315Hz, 1kHz and 3.15kHz in 60dB(A) broadband background noise. The experimental conditions were randomised for each listener using a Latin squares method. All listeners heard all experimental conditions. All sounds were presented using high quality electrostatic headphones in a quiet (semi-anechoic) listening room to minimise the possibility of experimental artefacts arising from extraneous background noise sources or from headphone frequency response anomalies. The swept tones were passed through third-octave filters to eliminate artefacts arising from so-called 'off-frequency listening' as the beginning and ending of each sweep necessarily covered a much wider frequency range than each auditory critical band considered separately. The static tones were fed through the same filter network to avoid the possibility of calibration errors affecting the results. The overall sweep durations were 1, 2, and 3 seconds. starting from a full octave above or a third-octave below the corresponding static centre frequency and ending a full octave below or a third-octave above. This meant that the swept tones were within the nominal third-octave filter bandwidths for approximately 110, 220 or 330 milliseconds as appropriate. The measurement of the actual swept tone presenting times was to some extent dependent on the third-octave filter slopes, but this had no significant effect on the results.

As an aside, readers may be interested in a rather curious anomaly observed in the initial pilot tests. The research was started by generating and controlling all the test signals entirely in the digital domain, using high quality audio converters and compatible equipment. Unexpected heterodyning was then observed between the swept tone and the broadband background noise. The problem was eventually overcome by combining the swept tone and broadband background noise signals in a traditional analogue mixer. It may perhaps still be the case, for some audio applications, that analogue is 'best'.

Results

Figure 1 illustrates the main differences observed between the different signals tested. The figure shows negligible differences between the mean detection thresholds observed for the three static tone frequencies tested, with a statistically insignificant (but nevertheless expected) tendency for the threshold at 1kHz to be very slightly lower than for the higher and lower frequencies tested. The mean detection thresholds for all swept tones were significantly lower than for the three static tones, by between 6 and 9 dB. There were no significant differences between swept up and swept down tones, nor between the different sweep rates tested, although there was a trend towards lower thresholds for the higher swept tone frequencies which can be clearly seen on the figure.

Discussion

Before actually carrying out the experiment, there was of course some idea that small differences might be found between the masked detection thresholds for swept and static tones, but surprisingly the difference was as great as 9dB at the highest frequency tested. It is quite surprising that no-one seems to have reported having observed such a large difference before.

If the results can be replicated by other researchers, then there would

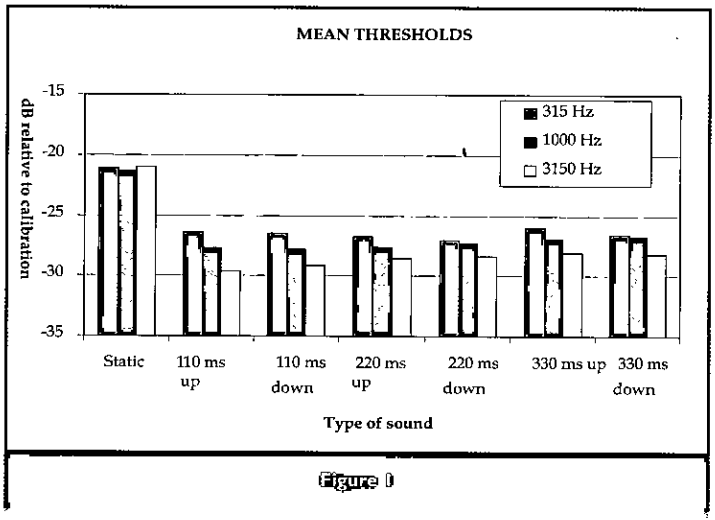

Figure 1

Mean thresholds of ascending and descending swept tone thresholds for 110, 220, and 330 millisecond 1/3 octave sweeps vs steady tone thresholds in broadband background noise.

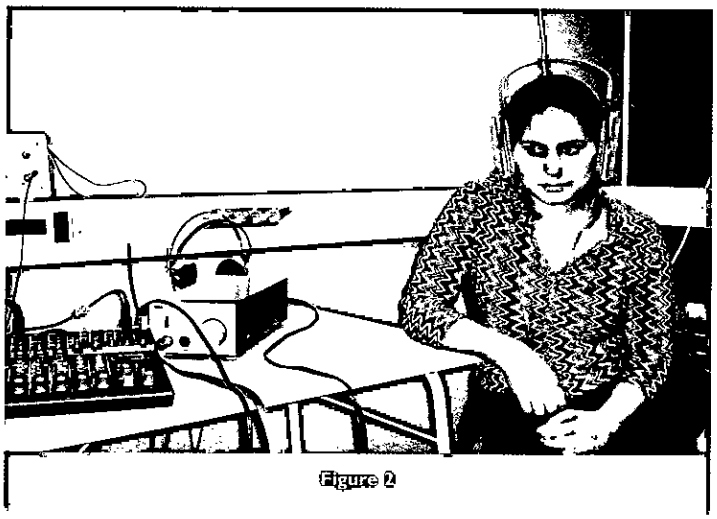

Figure 2

A listening test in progress

appear to be some quite significant implications. It is hard to explain the observed differences in terms of established auditory theory. Because swept tones are only present in each auditory critical band filter for a short time, then existing auditory critical band theory predicts that swept tones should have higher, rather than lower, masked detection thresholds than static tones. This suggests that additional mechanisms may be involved in detecting swept tones. One can speculate that any such additional mechanisms might possibly have evolved for the purpose of detecting auditory movement. Given the present state of knowledge about the structure and function of the auditory system, it seems most likely that these additional mechanisms, if they exist at all, would most probably operate as some form of higher level processing. It would seem that the auditory movement detector, if it exists, can detect apparent motion (in terms of frequency sweep) of an auditory signal being swept across parallel auditory bandwidths at relative energy levels that would not be detectable in each auditory bandwidth filter separately. This is a very interesting concept in terms of being able to understand how it works, but it is even more interesting in the sense that it suggests the possibility of combined or multi-band signals being detectable by the overall pattern of excitation in the auditory nerve, even when the separate components of the overall signal are not separately detectable on their own. This could even require a fundamental change of thinking in the ways that auditory capabilities are currently understood.

There could also be significant implications for civil aviation. Current aircraft noise certification procedures are based around the use of the EPNdB scale for acoustical measurements. The EPNdB scale includes tone correction procedures to account for an assumed additional contribution to subjective or reported 'noisiness'. Aircraft manufacturers have to work to internationally-agreed aircraft noise certification limits which have been steadily reduced over the past 20 to 30 years, in the expectation that the reductions would lead to corresponding reductions in community annoyance response. It should be noted that the EPNdB scale appears to have been developed on the basis of an extensive series of psychoacoustic tests, which involved test signals representative of typical aircraft noise event frequency spectra, but the signals did not include any changes in frequency content representative of the typical Doppler shifts occurring during real aircraft flyovers.

For the sake of completeness, it should be noted that there are other frequency shift phenomena associated with aircraft flyover sound events besides Doppler shift of tonal components, and these may provide additional information about source movement to human listeners but are not represented within the EPNdB scale. These additional phenomena include frequency swept comb filtering resulting from interactions between direct and ground reflected waves, which can be particularly noticeable at typical standing person's ear height.

Returning to the original research question outlined at the beginning of this article, it would appear that by focusing attention on the ignorability of aircraft sounds, which many people might consider to be a somewhat non-mainstream approach, an interesting and previously unexpected sensitivity of the auditory system for swept frequency components seems to have been discovered. To speculate, the perception of auditory movement may have a significant role in selective attention as applied to typical aircraft sound events, and further speculation suggests that existing aircraft noise certification procedures might not be accounting for these effects properly. In other words, it seems that swept tonal content in typical aircraft sound events associated with the movement of the aircraft overhead may be reducing ignorability to a greater extent than might be assumed simply on the basis of the tonal correction procedures already included with the EPNdB scale. This finding seems to be worth following up, and any comments or any news of successful replication of the results would be gratefully received.

Some of the material included in this paper had already been presented at the Institute of Acoustics' Spring Conference 2006, and at the Manchester Non-auditory Workshop on 5 and 6 October 2006.

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The technological, social and economic importance of acoustics

Keith Attenborough (on behalf of members of the IOA Research Co-ordination Committee)

Introduction

This article is based on a proposal for a Foresight project on 'Understanding, Monitoring and Controlling Environments Using Acoustic Waves'. This was drafted by the Institute's Research Co-ordination Committee with the aim of exploiting the precedent set by a Foresight electronic technologies programme concerned with the exploitation of electro-magnetic waves. To be accepted by Foresight, it helps if proposals have a ministerial champion and fit with current political priorities. Unfortunately, by the time the acoustics proposal was drafted, the Foresight Directorate had revised their priorities to be more issues-based than technology-based. Their recent short list for projects includes the Ageing Society, Environments for Health, Learning for Life and Resource Depletion. Consequently, the acoustics proposal has not been successful. Nevertheless, the information gathered in drafting the proposal will not be wasted. It will be used in further communications with the Foresight Directorate to point out the acoustically-related aspects of their more favoured project areas. Also, as result of a suggestion made at IOA Council, the draft proposal has been used to create this article.

Technological importance

Acoustic waves and techniques exploiting such waves have wide application and use a large range of frequencies. Frequencies of application range from seismology (micro Hertz), audio-technologies and noise control, NDE, medical ultrasonics and solid state physics (teraHertz). Use of acoustic waves is particularly useful underwater and in medical diagnosis and treatment, where use of other types of wave motion is either not practicable or relatively harmful. Even in situations where em waves are used conventionally such as buried land mine detection, conjunctive use of acoustic information may lead to improved performance.

Acoustic technologies are important in the civil engineering sector, the aerospace industry, the marine industries and the medical sector. Acoustic technologies are used in the manufacturing and service industries, authorities responsible for occupational and environmental health, hospitals and clinics, and by defence services for many different applications. Associated requirements include the collection of information for product specifications and contracts, demonstration of compliance with regulations, access to markets, assessment of public nuisance, comparison with safe exposure limits, ensuring accurate diagnosis and effective therapy, and enabling accurate underwater positioning, mapping and detection.

UK industries are exploring the use of ultrasound to process a range of foodstuffs, pharmaceuticals and domestic products. Much laboratory work has been carried out on ultrasonic processing for change of state or change in chemistry. High-power applications of sound include cleaning, materials processing and sonochemistry. Several of the companies producing high power equipment which can be utilised within these applications are UK-based. There is considerable potential for further exploitation of acoustic energy in industrial processes. However, few documented large-scale applications are apparent. This is the result of a number of limiting factors including a lack of understanding of the fundamental acoustics of the systems employed, the generation of parasitic noise and (in relation to cavitation, the phenomenon most commonly exploited) the relatively high acoustic pressures required. Scaling up this work for industrial application will depend upon improved understanding of the relevant acoustics, particularly of cavitation. The wider development and application of high power ultrasound will demand reproducible measurements, owing to the need for successfully replication and scaling-up of industrial processes from pilot-plant level, but also in order to monitor and control processes effectively. Progress over the last few years in industrial uses of high power ultrasound has increased with a wider range of applications leading to greater commercial investment opportunities. However, the lack of measuring devices for use in hostile environments has been seen as a barrier to development.

Acoustics forms the basis for technologies for monitoring global warming and fish stocks. Acoustic and seismic techniques for humanitarian land mine detection, a pressing problem throughout the world but particularly in the Middle East, have received significant funding in the US. Acoustical techniques could contribute further to monitoring structural integrity, soil and meteorological conditions and artificial and natural seismic activities. Acoustic technology can often offer savings in power consumption and materials compared with other modalities.

As the standard of living and expectations for the quality of life increase, there are increasing numbers of noise sources and increased awareness of environmental noise problems associated in part with building construction methods.

New sensors, sensor systems and sensor technologies, together with increased computational capacity and improved techniques for solving inverse problems will revolutionise the way in which the acoustical technologies are applied and developed on a ten-year time scale. There is the opportunity to secure a leading position for UK in several applications of acoustics including underwater and medical acoustics and NDE, and to pioneer new applications of acoustics in meteorology and agronomy.

Some current applications and possible future developments are listed in Table 1.

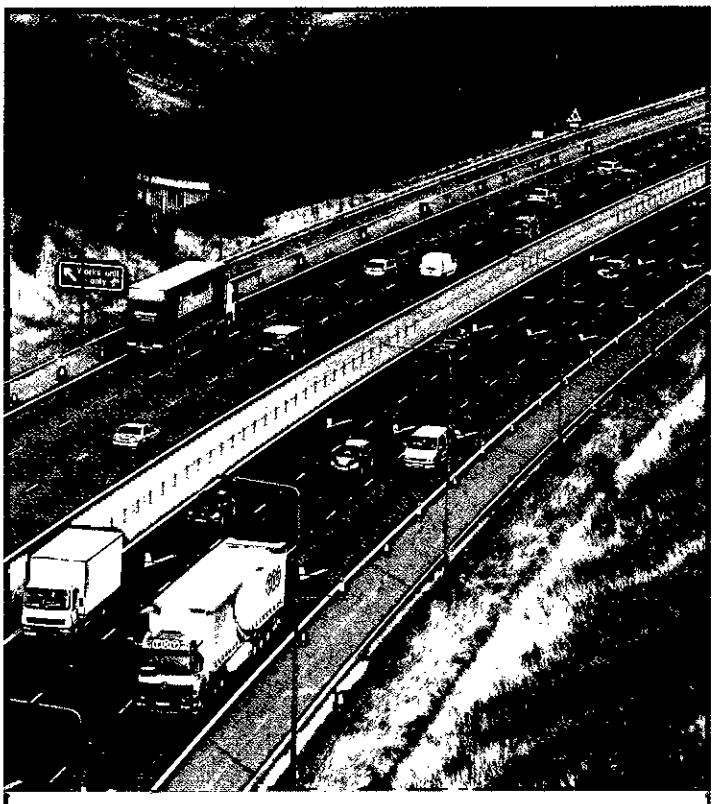
Table 1

Technology	Acoustically-related applications and developments
Sensors and actuators	Distributed sensors, introduction of local computing, multi-variable MEMS-based autonomous measuring systems
	Acousto-optic sensors
	Improved sensors and actuators for active noise control
	Multi-sensor modality developments including data fusion
Sonic treatments for industry	Sonic cleaning, ultrasonic agglomeration, ultrasonic welding
	Biomedical ultrasonic therapies
	Acoustic sensing and diagnosis, and increased understanding of processes for scale-up
Imaging and diagnostics	Embedded sensors for structural health monitoring, SMART materials
	Acoustic target recognition, NDE
	Audiometric applications, medical ultrasonic imaging
	Data fusion with other imaging modalities
	Time reversal and related methods for imaging through complex environments
Environmental applications	Noise and vibration control
	Structural health and condition monitoring
	Humanitarian land mine detection
	Acoustical monitoring in agriculture
	Test ban treaty verification
	Monitoring of biomass and environment underwater

Social importance

Noise (unwanted sound) and its prediction are important to the quality of life. The 1996 English House Condition Survey (EHCS) showed that 4.7 million households (24% of all households) were bothered by traffic, industry or other noises; 2.3 million households (12%) were bothered by noisy neighbours (either immediate neighbours, those in common areas or both); 1.6 million households (8.3%) were bothered by noise from neighbours and attributed it solely to the behaviour of the neighbours; and 0.67 million households (3.4%) were bothered by noise from neighbours and attributed this solely to the poor design of the building or a combination of the poor design of the building and behaviour of the neighbours. In the 1999-2001 National Noise Attitudes Survey, 18% of respondents listed noise among five biggest environmental problems. Overall, noise was ranked in the top ten environmental problems, with 37% bothered by neighbour noise to some extent. Road traffic noise irritated 30% of respondents, 21% reported that noise spoiled their home life to some extent and 8% reported that home life spoilt 'quite a lot' or 'totally'. Moreover, 20% were bothered by aircraft noise to some extent. In the UK 55% of the population are exposed to road traffic noise levels above the value recommended in WHO Guidelines.

Data from the Chartered Institute of Environmental Health (CIEH) indicate that the number of complaints about domestic noise per million people has risen in the last twelve years. In 1987/88 the number of complaints was just over 1,500 per million population, but by 1997/98 the number of complaints about domestic noise had reached 5,051 per million. The 1997/98 CIEH Report states that 148,006 complaints about domestic noise were reported from 225 responding local authorities. In the period between 1986 and 1996 the total number of domestic noise complaints has trebled, although the rate of increase has reduced during recent years. Part of the reason for the rise in noise complaints is thought to be due to changing lifestyles and rising expectations. Heightened awareness of the issue following increased media coverage may also play a part.



In the UK 55% of the population are exposed to road traffic noise levels above the value recommended in WHO Guidelines.

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Noise, at the sort of levels typically encountered in dwellings, can lead to a wide range of adverse health effects including loss of sleep, stress and high blood pressure. Quantifying the risks attributable to exposure to environmental noise and, particularly, neighbour noise is difficult but it is suggested that there are between one and ten deaths per year in the UK (these being suicides or as a result of assaults) attributed to noise from neighbours. The number of less severe problems attributed to noise (such as stress, migraines, *etc*) is estimated to be about 10,000 per year. The same problems are experienced by people living in rooms for residential purposes (eg students in halls of residence, elderly people in residential homes) although there are no equivalent figures for health risks.

Noise has an effect on children's performance at school, with older children in the primary school age range appearing to be the most affected by noise. Children are also annoyed by noise at school. Measurement surveys of classrooms show that classroom noise levels can be high, particularly in classrooms without acoustic treatment, and that this is often due to the noise of classroom activity. One cause of the detrimental effect of noise is the degradation of speech intelligibility in the classroom. In addition to detrimental effects upon children, noise and poor acoustic conditions in classrooms affect teachers' behaviour and teaching methods, and can also have serious health effects for teachers. High noise levels and too much reverberation in classrooms mean that teachers have to speak at an unnaturally high level, causing voice and throat problems.

Noise now features prominently in many product specifications and commercial contractual provisions, and in environmental and urban planning, design and monitoring. The status of how noise exposure is dealt with throughout Europe was reviewed in the EC Green Paper on Future Noise Policy (1996), and resulted in a proposed framework for action to reduce environmental noise substantially. Elements of impact include up to 170 million citizens of the EU who were said to be living in areas where the noise levels were such as to cause serious annoyance during daytime. People reporting noise-induced annoyance experience a reduced quality of life and this is a reality for at least 25% of the population across the EU. Furthermore, between 5% and 15% of the EU population suffer serious noise induced sleep disturbance. Trends in sustainable architecture, involving, for example, greater natural ventilation require new acoustic solutions.

Directive 2002/49/EC has resulted in considerable activity, primarily focused on the production of strategic noise maps for all major 'agglomerations'. In the UK, £13m has been allocated to the National Ambient Noise Strategy. The 'noise maps' associated with the EC Directive are being constructed by Defra. There are questions about data standards, accuracy and quality control of prediction software, and when the completed maps enter into service as decision-making tools, there are likely to be demands for validation prior to implementation of Action Plans. The Commission estimates the cost of implementation as €30 million to €40 million annually.

Hearing loss caused by disease, injury and the natural process of ageing results in a significant fraction of the adult population having a clinically significant hearing impairment. In 1993 it was estimated that 7.8 million people in England and Wales had legally compensable impairment in the better ear. Even after implementation of the latest EC Directive, 10-15% of employees will continue to be exposed to noise that represents a severe health hazard.

Medical uses of ultrasound include foetal monitoring, diagnostic imaging, assessment of osteoporotic bone disease, Doppler blood-flow studies, physiotherapy, the non-invasive destruction of kidney stones (lithotripsy) and also tissue ablation using high intensity focused ultrasound. Ultrasound is now the second most common imaging technology - behind the ubiquitous x-ray - in all of clinical medicine. In the last decade, with the advent of transducer array technology, faster and smaller computers, and a growing emphasis in the medical community for less invasive procedures, therapeutic ultrasound has once again capturing the attention of the medical community.

In line with the majority of the western world, virtually all pregnancies within the UK are the subject of at least one ultrasound examination. Although therapeutic and clinical ultrasound techniques are less risky than many established technologies, there are pressing safety issues associated with localised heating at high power levels. This is particularly true in the case of obstetric scanning, where the potentially sensitive developing foetus is exposed to ultrasonic energy. It is well established that at sufficiently high levels, ultrasound can cause damage to tissue through both heating and cavitation and that some modern types of diagnostic equipment generate acoustic pressures close to those which are considered to be hazardous. These exposure levels have also been the subject of an eight-fold increase over the last 12 years, a development which has been driven by a change in the United States' FDA reporting requirements. A balance needs to be struck by clinical staff between potential hazard and the anticipated diagnostic benefit.

Nevertheless the mechanisms that may cause unwanted problems with ultrasonic imaging have important uses in surgery. Some thirty years ago, Extra-corporeal Shock Wave Lithotripsy (ESWL) was developed as means of destroying kidney stones and it is now used routinely. Today, the use of high intensity focused ultrasound (HIFU) for ablative surgical procedures deep in the body (for instance for the destruction of tumours) is undergoing rapid development world-wide and appears to have a strong future. Following successful clinical trials, a French system called 'Ablatherm' has been approved for use in France and Germany and is used routinely in nine centres, with around 2,000 patients having been treated. Clinical use of HIFU is widespread in China and at least one of their manufacturers is now bringing equipment to Europe for clinical trials on liver lesions. One such system is now at the Churchill Hospital, Oxford. Medical applications which harness the destructive capability of the ultrasonic fields continue to develop.

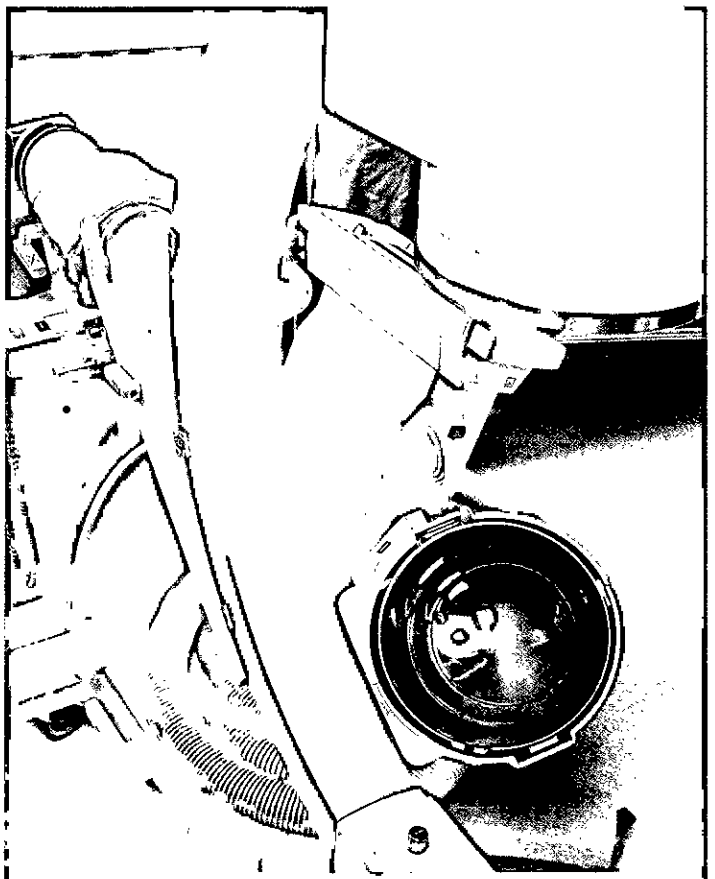
Some other relevant statistics related to the range of uses of medical ultrasound are:

- Around 30 lithotripters, 2,500 ultrasonic scanners, 10,000 ultrasonic foetal heart-beat detectors and 20,000 ultrasound therapy units are in use in the UK;
- World-wide, it is estimated that there are 250,000 diagnostic ultrasound instruments and 250 million examinations per year;
- Use of ultrasound by General Practitioners is growing at a rate of 6.7% per annum;
- The total number of ultrasound scans undertaken in the NHS is over 4 million per annum;
- Nearly all pregnancies in the UK are subject to at least one screening test using ultrasound, and approximately 2 million obstetric ultrasound scans are undertaken in the NHS per annum;
- There are 60,000 hip-fractures per annum within the UK, costing the NHS £1 billion per year: this is relevant to the ultrasonic characterisation of osteoporetic bone;
- There are 10,000 hospital admissions per year for urinary stone disease, 85% of which are now treated by lithotripsy.

Economic importance

There has been research on the use of a monetary value of transport noise in cost-benefit analysis, particularly in France, Germany, Switzerland and Scandinavia. In France, preferences studies applied to the housing market have shown that each additional decibel of noise pollution reduces the value of real estate by about 1%. Assuming it is reasonable to apply these figures to improvements in sound insulation, then a 3dB improvement in standards for dwelling houses would correspond to 3% of the value of the attached housing stock, producing a benefit of the order of £160 million. Typically the direct costs of noise (owing to stress, annoyance *etc*) are obtained by adding a further 50% to this figure.

It is estimated that UK industry spent £120m on environmental noise protection in the year 2001. The 1996 European Commission's Green Paper 'Fair and Efficient Pricing in Transport' estimates that the external costs of noise to society, especially transport noise, are in the range from 0.2% to 2% of GDP. The lower estimate of 0.2% of GDP represents an annual cost to society of over €12bn. Directive 2002/49/EC Assessment and Management of Environmental Noise was



Around 80 lithotripters and 20,000 ultrasound therapy units are in use in the UK

implemented to drive the vision, and to date it has resulted in considerable activity, primarily focused on the production of strategic noise maps for all major agglomerations: so far in the UK, £13 m has been allocated. There are three main UK manufacturers of sound level meters and it is estimated that 4,000 to 5,000 meters are sold in the UK each year.

The cost of hearing impairment is both economic and social. In 1996, the RNID prepared estimates of the number of people of working age with a hearing loss and found that in total, more than 6.5% of the population between the age of 16 and 60 were mildly to profoundly deaf. In 2000, the Better Hearing Institute in the USA published an estimate of the annual costs due to lost productivity, special education and medical care as a result of untreated hearing loss, and set the amount at $56 billion per year ($216 per capita). A similar estimate for the EU predicted the amount to be €106 billion by the year 2005 (€260 per capita), not accounting for the recent enlargement. This figure is roughly the cost of building five Channel tunnels a year between Britain and France.

The basis for prescribing and fitting a hearing aid effectively (digital or otherwise) is the measurement of hearing thresholds using pure tone audiometry. Indeed, *everyone* is likely to have their hearing tested on a number of occasions during their lifetime, to monitor their hearing function generally and for diagnosing the onset of any hearing loss. This is only viable using a measurement procedure, since the onset of hearing loss is unlikely to be apparent subjectively. For this purpose there are in excess of 1,000 audiometers in use in the approximately 200 ENT departments in England and Wales. Many of these departments run hearing aid clinics, providing about half a million hearing aids annually at a cost of approximately £25m (excluding staff costs). In addition, there is a substantial private sector provision of about 80,000 hearing aids annually from some 600 dispensers. Each hearing aid prescription requires at least one set of audiometric measurements.

continued on page 32

The ... importance of acoustics - *continued from page 31*

With the relatively poor performance of other technologies in the marine environment such as those based on electromagnetic transmission, acoustics contributes to essential enabling technologies and plays a vital role in many aspects of the off-shore industries. In 2000, Douglas-Westwood Ltd estimated global marine market sector values of $300bn for offshore oil and gas production, $234bn for shipping, $225bn for naval expenditure and $19bn for research and development. Some activities such as ocean surveying are vital to major sectors, especially offshore oil and gas. More recently, Douglas-Westwood in its Ocean Survey Report 2004-2008 values the world market for ocean survey (for which acoustical systems are essential) at $2.5bn in 2004 and forecasts it will continue its long-term growth trend to reach $2.8bn in 2008. Future growth areas are in deep and ultra-deep water offshore oil and gas markets, with the development of sub-sea processing and new technologies. There has been a strong demand for new sub-sea telecommunication cables as the use of the internet grows internationally. The manufacture, surveying and laying of new cables is an industry for which the UK share has been estimated at £497m per annum in 2000 (IACMST report, August 2002). These deep-water activities increasingly require the use of autonomous underwater vehicles (AUVs), where acoustic technology plays a key role in visualisation, and in their location and positioning. With strong growth in world energy demand, an average growth of 8% in sub-sea oil wells is predicted over the next five years. In the UK, the marine industries are of great economic importance. They are a major employer of about 350,000 people compared with 297,000 in agriculture and 155,000 in aerospace. The European *civil* market for underwater acoustical systems is estimated to be £170m to £200m per annum. The UK is Europe's leading producer of underwater acoustical systems, with some 20 UK companies involved in manufacturing sonar systems. The Inter-Agency Committee on Marine Science and Technology (IACMST) has updated the results of its 1994-1995 analysis on the contribution of marine-related activities to the UK economy. Compared with its earlier estimates of £27.8bn, the 1999-2000 figures show significant growth with the 'value-added' contribution from the marine sector being estimated at £39bn, or 4.9% of GDP, with the overall turnover of the sector estimated at £69bn.

The ultrasonics industry consists of the following major segments: ultrasonic transducers, high power industrial ultrasonics, low power industrial ultrasonics, and medical ultrasonics. In the year 2000, the UK medical diagnostic ultrasound equipment market is estimated as 1,150 units, of value £100m, representing a growth rate of 7.6%. The largest area is obstetrics and gynaecology, taking about 35% of new units. According to Business Communications Company Inc, the USA ultrasonics technology market, defined as uses of devices operating in the frequency range 20 kHz to 500 MHz, currently stands at $3.6bn. This market is projected to have an average annual growth rate of 8.5%, and to reach $5.35bn by 2008. High-power applications of sound include cleaning, materials processing and sonochemistry. The world-wide ultrasonic cleaning equipment market is estimated to be £1.5bn and in the USA it is growing at 6.4% per annum. In the UK, there are 20 manufacturers of ultrasonic cleaning equipment with an annual turnover of £40m. Applications of high power ultrasound are continuing to proliferate, a prime example lying in its use in waste-water treatment where novel devices generating acoustic powers in the range of 10 to 100 kW are being used to breakdown sewage sludge. There is considerable interest in further developing this technology, and major capital equipment of value £100k to £200k is starting to be implemented within plants, driven by the operational benefits accruing from improved sludge de-watering, gas production and solids reduction. Ultrasonic experiments in the laboratory are used to test the resistance of materials to cavitation erosion. BP Amoco estimates that approximately $200,000,000 has been spent to replace eroded pipelines and equipment since 1987. EPSRC recently awarded a grant for research into the use of acoustics to increase the efficiency of the electro-twinning of copper. This industrial process is on a global scale and has been estimated to be a 7.5 billion dollar industry.

Non-destructive testing (NDT) technologies are used in industry to help ensure the integrity and reliability of products being provided to end users. Overall, the field of NDT is in a mature state and plays a significant role in our manufacturing economy, playing a leading role in key industries. Core NDT technologies are evolving in important ways and are more and more user-friendly. The applications in which NDT is used are also expanding rapidly. The potential market for non-destructive testing equipment continues to expand with emphasis on product quality, lean manufacturing, just-in-time inventory practices, and advances in nanomaterials and related manufacturing and testing. In 1999, Business Communications Company Inc (BCC) predicted the USA NDT market would grow at 3.6% to reach $0.95bn by 2004. This growth has been exceeded, and according to a recently updated report from BCC, the USA NDT testing equipment market currently stands at $1.4bn, and is projected to have an average annual growth rate of 5.1% reaching $1.77bn by 2008. Of the various technologies used in NDT, acoustic emission and ultrasonics have shown a consistent higher annual growth rate, typically about 6%.

Concluding remarks

Although it will not give rise to a Foresight project as was the original intention, it is hoped that this brief survey of the impact of acoustics will inform IOA members and contribute to raising the status of acoustics among a wider public. The information in regular 'snapshots' of the importance of acoustics should provide useful ammunition for the Institute. To help with future surveys, the author would be grateful to receive comments from readers about acoustically-related applications and technologies that have been missed or that should have been given greater emphasis.

Acknowledgements

This brief survey would not have been possible without contributions from members of the IOA Research Coordination Committee both past and present. Particular thanks are owed to Roy Preston (former Sector Head at NPL), Norman Bolton (DTI) and Tim Leighton for information and encouragement.

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Working as a graduate at Faber Maunsell

Alan Oldfield AMIOA

Before I started out as a Graduate Acoustic Engineer I had certain expectations of working life, but I never imagined that two years later I would be working in a landmark Grade II listed building, formerly the headquarters of NatWest Bank and now redeveloped to produce a unique office space!

Our own offices are not quite so impressive, but noise surveys do provide a great opportunity to see at first hand the range of buildings that our company designs. For example, last week I went to 41 Lothbury, the redeveloped former bank in the City of London, to measure the noise levels from building services in their heritage rooms, and tomorrow evening I will be measuring sound insulation performances between offices in the newly refurbished Norwich Union headquarters.

I first became interested in acoustics through my involvement in musical activities when I was a teenager, having music lessons at school and playing live with bands and orchestras in my spare time. I was always much better at technical subjects at school, so I ended up taking A-levels in mathematics, physics and chemistry, plus an AS in music technology. Like most people at school I did not know what I wanted to do later on, but I knew I wanted to go to university. I looked for a degree course that would cover a wide range of topics and could lead on to various opportunities. As well as fitting these criteria, engineering seemed to follow on well from my A-level subjects. I did a masters degree in mechanical engineering at Imperial College, London, which gave me a decent grounding in engineering fundamentals.

Since starting at Faber Maunsell, most of my training has been on-the-job and I have gained a lot of knowledge from my more experienced colleagues. Within my first six months I gave a presentation on acoustics to the other graduates and young professionals in the office. This was a good opportunity to practise my presentation skills, but I was very glad my boss was around to help me out with the questions at the end!

Apart from undertaking noise surveys in all kinds of buildings, including offices, hospitals, flats, hotels, universities and schools, I have contributed to the design of these buildings. Faber Maunsell is a multi-disciplinary consultancy and so I have the opportunity to work closely with engineers from different disciplines. A lot of the work of the Acoustics Group is fed from other areas in the business and this helps us to get involved in some prestigious developments.

It is difficult to describe an average day in the office because I work on different aspects of various projects every day. This morning I was reviewing architects' plans of a new laboratory facility, in order to determine partition sound insulation performances and decide on appropriate constructions. I also provided some advice on building services noise emissions to one of our mechanical engineers and started writing a report on noise emission from a telecommunications centre. This afternoon I have made some predictions of perceptible vibration and structure-borne noise resulting from activities in a fitness suite adjacent to student accommodation in a new university building.

I have been an Associate Member of the Institute of Acoustics since I started work after graduating. I have regularly attended the London Branch evening meetings and have found the presentations very interesting. My favourite so far was David Leversedge's talk on the Glastonbury Festival. It is fascinating to meet other acousticians and find out about the work that they do. I also went to the Spring Conference last year, which turned out to be a great introduction to building acoustics.

I am working towards the technical training objectives of the IOA and in the future I hope to become registered as a Chartered Engineer. The IOA is licensed by the Engineering Council to register qualified and experienced members as professional engineers. To become registered I need to demonstrate that I have attained sufficient competence in the areas required by the Engineering Council. We have a graduate development scheme at Faber Maunsell and this provides a structured programme to help us acquire the necessary skills and experience to comply with the Engineering Council's UK-SPEC requirements. We have a large graduate network which besides organising graduate pub crawls and other events, provides a useful forum to discuss training and professional development with graduates in other areas of the business. I look forward to gaining more experience and responsibility as an acoustical engineer with Faber Maunsell and to making a valuable contribution to the industry and society through my work.

I enjoy my work as an acoustical engineer and I am grateful for the learning opportunities at events organised by the IOA. For any young people unsure of their career ideals, or as yet undecided, I would recommend finding a company that is involved in interesting projects and offers training and development opportunities. I would also recommend getting involved in the IOA's activities and events in order to discover more about acoustics.

Parliamentary reports

From Hansard

Commons Written Answers

5 December 2006: Helicopter noise

Mr Burstow: To ask the Secretary of State for Transport (1) what representations he has received on helicopter noise; and if he will make a statement; (2) what plans he has to undertake a review of helicopter movements and noise in London in the next 12 months; and if he will make a statement; (3) what plans he has to implement those recommendations of the London Assembly's recent Environmental Committee Report, London in a Spin - A review of helicopter noise, which fall within his responsibilities; and if he will make a statement.

Gillian Merron: The Department receives complaints from time to time about the noise arising from helicopter operations, particularly in the summer months. The London Assembly Environment Committee's report London in a Spin - A review of helicopter noise was received with interest by the Department. The Department has no immediate plans to regulate helicopters more closely. The recommendations in the report are substantial and I will be meeting with representatives of the Committee in December to discuss these further.

6 December 2006: Roads

Bob Spink: To ask the Secretary of State for Transport what the outcome was of the 1998 two year testing period of low noise, crumb rubber aggregate asphalt by the Highways Agency and the Road Transport Laboratory.

Dr Ladyman: The section of proprietary low noise surfacing asphalt incorporating approximately 5% reprocessed waste tyres was laid on a county road by Surrey county council in 1998. However, it failed prematurely and had to be replaced. A further trial, just under one mile long, was subsequently laid on the A244 Hersham bypass in June 1999, also by Surrey county council. For two years its performance was monitored as part of the Highways Agency's research programme. Following its satisfactory performance, a more heavily trafficked trial site on a short length of the A34 trunk road was offered by the Highways Agency, but the company that supplied the surfacing decided not to proceed.

7 December 2006: Aviation noise

Anne Snelgrove: To ask the Secretary of State for Transport if he will bring forward proposals for legislation to tackle aviation noise from (a) private and (b) small commercial airfields.

Gillian Merron: Section 4 of the Civil Aviation Act 2006 gives the operator of any non-designated civil aerodrome the power to establish and enforce noise controls on aircraft using their facilities. This provision therefore currently applies to every civil aerodrome in Great Britain except Heathrow, Gatwick and Stansted airports. We have no plans to bring forward any further legislation on aircraft noise at this time.

Anne Snelgrove: To ask the Secretary of State for Transport how many complaints about aviation noise were made to each local authority in England in each year since 1997.

Gillian Merron: The Department does not hold this information. Operational noise complaints (as distinct from representations about policy) are properly a matter for individual airports, many of which regularly publish their own summary statistics of complaints or enquiries. Most complaints are directed to the airports or to the CAA; and some to NATS, to airport consultative committees or to local authorities.

11 December 2006: Departmental call centres

Mr Hancock: To ask the Secretary of State for Work and Pensions what telephony equipment intended to protect employees from noise events and acoustic incidents has been procured by his Department's call centres.

Mrs McGuire: GN Netcom2100 headsets are in use in all DWP business units. The Child Support Agency's National Helplines and Jobcentre Plus contact centres also use Plantronics Supra mono headsets; and The Pension Service also use GN Netcom2200 duo and mono and GN Netcom cordless headsets. Staff in DCS and Pension Service centres have also been supplied with GN8210 amplifiers.

Mr Hancock: To ask the Secretary of State for Work and Pensions how many employees in his Department's call centres have reported (a) headset noise interference and (b) acoustic incidents while at work over the last two years; and how many of those employees have had sickness absence exceeding three days as a consequence.

Mrs McGuire: As incidents are handled locally only limited information is available centrally and it is not always possible to identify whether reports relate to contact centre staff. The following information is available for the past two years: Jobcentre Plus, ten reports one of which led to sick absence (duration not known); The Pension Service, two reports one of which led to a sick absence of over three days; and the Disability and Carers Service contact centres, ninety six reports one of which led to a sick absence in excess of three days.

Lords Written Answers

6 December 2006: Aircraft noise

Baroness Miller of Chilthorne Domer asked Her Majesty's Government whether they have made an assessment of the number of children whose learning is negatively affected by aircraft noise; and whether they have made an assessment of the conclusion published in the Lancet in 2005 regarding the negative effects of (a) road traffic, and (b) aircraft noise on children's cognition; and, if so, whether they will take steps to ensure that aircraft noise does not have a negative impact on children's education in (i) schools; (ii) play areas; and (iii) homes.

The Parliamentary Under-Secretary of State, Department for Education and Skills (Lord Adonis): The Government has not made an assessment of the number of children whose learning might be negatively affected by aircraft noise. However, under Directive 2002/49/EC of the European Parliament and of the council of 25 June 2002 relating to the assessment and management of environmental noise, the Government will be making strategic noise maps for major airports, major roads, major railways and agglomerations by June 2007. Based on these maps, action plans will be drawn up to manage and reduce noise and its effects as necessary.

The Government part-funded the European Commission fifth framework research project, Road Traffic and Aircraft Noise and Children's Cognition and Health (RANCH). Details of the findings of this project can be found at **www.wolfson.qmul.ac.uk/RANCH_Project/** and were published in the Lancet in 2005. This research is a valuable part of the evidence base for developing policy on noise.

7 December 2006: Aviation mixed code arrangements

Baroness Miller of Chilthorne Domer asked Her Majesty's Government what assessment they have made of the implications of mixed code arrangements for Heathrow airport runways on (a) noise pollution; (b) night-time flying; and (c) carbon dioxide emissions.

Lord Davies of Oldham: Possible mixed mode operations at Heathrow are still being assessed and will be the subject of consultation next year. This will report on the noise and local air quality implications, with particular regard to the limits set out in the Air Transport White Paper. Other impacts, including CO2, will also be taken into account in the appraisal. The Government has announced night-flight restrictions running until 2012. Further consultation is expected in due course on controls to apply from 2012. Introduction of mixed mode operation does not, of itself, imply any changes to night flight restrictions.

Wakefield Acoustics

60% growth for noise control company leads to manufacturing expansion

From the left Paul Atkinson, project management team member, Jane Dawson managing director and Ian Hargreaves, project management team member

Following growth of over 60% during the past twelve months West Yorkshire based industrial noise control specialists Wakefield Acoustics Ltd is planning to expand its manufacturing operations by over 30%.

The company has outgrown its current manufacturing facilities and having invested a substantial six-figure sum across its business over the past year and is now expanding its manufacturing operation.

Wakefield Acoustics Ltd, based in Cleckheaton, designs, manufactures and supplies a wide range of noise control products and solutions primarily for industrial and environmental applications. The company is one of only a small number of UK companies which provides a complete noise control solution right from initial noise audit, assessment and diagnosis through design, manufacture and installation, recommending the most appropriate products and implementation strategies.

Originally established in 1980, the company operates internationally with consultants, contractors, original equipment manufacturers and end-users to provide bespoke solutions and over the years has become an established partner for noise attenuation to a wide range of blue chip companies throughout the UK and world-wide.

The company's products and services include noise assessments and audits, silencers, acoustic enclosures, acoustic doors, louvres, cabins and sound havens, all of which are helping companies to comply with increasingly stringent health and safety requirements on exposure to noise in the workplace following the introduction of recent European Noise legislation, as well as eliminating noise pollution from manufacturing sites.

The company was acquired in 2005 by managing director Jane Dawson who commented that with over 25 years experience in providing complete acoustic noise control products and solutions, across a wide range of industries, the company had built up an enviable international reputation for being a leader in its field. The investment made in the last twelve months and the forthcoming planned expansion built upon the core strengths of the business. Investment had been made in a number of areas including manufacturing processes and new equipment, the development of a new leading edge 3D AutoCAD system, and IT along with staff training. The investment made and planned was a key element of their growth and development strategy. It was a very exciting time for Wakefield Acoustics, and as part of its business growth the company had been able to create ten new manufacturing jobs in West Yorkshire.

For further information visit
www.wakefieldacoustics.co.uk
or phone **01274 872277**.

BCI Award

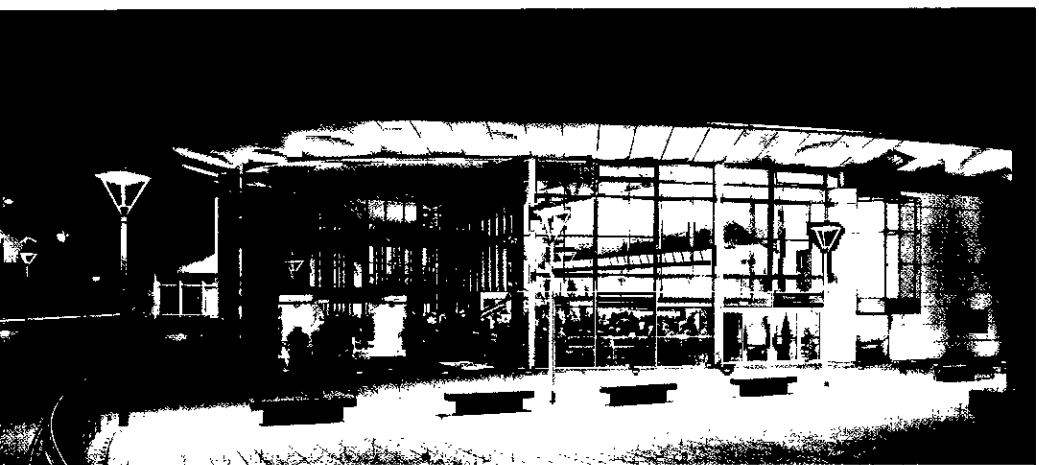
Perth Concert Hall design wins award for BDP

Perth Concert Hall, designed by BDP, won the British Construction Industry special Regeneration Award at a gala ceremony on 26 October 2006 at London's Grosvenor House Hotel. The Regeneration Award is given to the project (of any size) which has made a significant contribution to the regeneration of an underprivileged area, and/or the creation of new facilities making exceptional use of brownfield sites.

The judges commented that Perth lost a scruffy car park and gained an attractive, well-finished, flexible and superbly equipped multi-purpose concert hall. They considered that the project had produced a 'great result' delivered by a close-knit design-and-build team, and the facility was attracting performers and the public from far and wide.

Located in the historic Horsecross, once a thriving market area but more recently marginalised, Perth Concert Hall had to accommodate the exacting requirements of orchestral performances and instrumental recitals while meeting the needs of a number of other functions that demanded different spatial formats and acoustic environments. As a successor to the ageing Perth City Hall, the new Concert Hall was also expected to act as a focus for community activities in Perthshire.

The building is viewed in the round and BDP's free-form plan is described as a unifying response to the irregular edges of the urban fabric bounding the site. The Horsecross area has already witnessed significant urban regeneration, which includes a streetscaping project by the local authority in parallel with the opening of this new facility.



The BDP-designed Concert Hall, Horsecross, Perth - Photo © Keith Hunter

At the heart of the building is a fully flexible 1200-seat concert hall, which features uniquely configured floor lifts and movable seating wagons to provide raked seating and a large-scale flat floor. An open glazed foyer with café and bar, forms a new civic space conceived as an extension of the new external public square.

The client for the Concert Hall was Perth and Kinross Leisure, but both the Concert Hall and nearby Perth Theatre are managed and operated by Horsecross who not only set the artistic and commercial programme for the hall but see themselves as playing a major role in the economic development of Perthshire. Bruce Kennedy, the project architect said that he expected Horsecross to be as delighted as his team was with the Regeneration Award, as it recognised their contribution to the regeneration of Perth town centre.

The project started on site in 2003 and was completed in spring 2005 under budget at a construction cost of £12.3million. BDP was architect, interior designer and acoustical consultant. Other members of the team were C&S, mechanical and electrical consultants; Buro Happold, fire engineering; Carr and Angier, theatre consultants; Gardiner and Theobald, quantity surveyors; GTMS, project management; and Phil Smith, Glasgow Royal Concert Hall, venue adviser. The design-and-build contractor was Sir Robert McAlpine.

BDP's Glasgow office can be reached on
0141 227 7900.

Meeting Notice

The 2007 Off-highway Plant and Equipment Research Centre AGM

The Off-highway Plant and Equipment Research Centre (OPERC) is a non-political, non-profit making international centre of excellence for plant and equipment professionals. Its main objective is to advance off-highway plant and equipment knowledge and share this knowledge among all interested parties. Funds generated by the association are used to produce, publish and make available information that would otherwise be too time-consuming or expensive for a single member to produce in isolation. The 2007 OPERC AGM will be held at the HSE offices at Rosecourt, London on 27 February 2007. During this year's event a series of 20 minute talks will be given on a range of topics including:

- Assessing HAV risk using HAVSAFE(Jim Tonner, Managing Director, Coyles Ltd);
- Plant theft (Mike Revell, Group Director, Plant and Transport, Clancy Docwra);
- An introduction to Doosan Infracore (Kim Dudley, Dealer Manager, Doosan Infracore UK Ltd)
- OPERC's revised traffic light system for labelling power tools (Dr David Edwards, Loughborough University);
- OPERC's new on-line Process Operations health and safety test for the quarrying industry (Nick Clark, Tarmac and Barry Robinson MBE, OPERC Chief Examiner);
- How to protect yourself from dermatitis (Phil Vanes, Polyco).

A series of prize presentations and charitable donations will also be awarded to industry practitioners who have made an invaluable contribution to the health, safety and welfare of others within industry. OPERC Executive wish to thank Carol Grainger and the team at HSE London for supporting this event.

Anyone wishing to attend this event, or wanting to find out more, should visit the OPERC News and Events page, which can be found on the main OPERC website at **www.operc.com/pages/news/070227agmform.asp** . Attendance is free and registration takes less than a minute using the on-line form provided.

OPERC and Loughborough University are grateful for the support of the Major Contractors Group (MCG) and Speedy Hire who have encouraged manufacturers to have tools independently tested at HAVTEC. Without MCG and Speedy Hire support (and now others within industry), HAVTEC users would not have accurate 'real life' vibration data available to allow reliable risk assessments to be conducted and ultimately, employee safety to be protected.

To view the HAVTEC Register now, visit **www.operc.com/pages/havteclogin.asp** .

Fan Noise 2007

Call for papers

The Fan Noise 2007 conference will be held in Lyon, France between 17 and 19 September 2007. This international symposium on fan noise is expected to be as successful as the previous one, held in Senlis in 2003. Those considering attending the symposium are encouraged to present a paper.

A few proposals have already been received, and the deadline for the submission of abstracts is 30 January 2007. Abstracts should be submitted via the conference website **www.fannoise2007.org** . Registration fees will be particularly attractive for authors.

The Organising Committee of Fan Noise 2007: *Alain Guédel (CETIAT), Gilles Allory (Cetim), François Bessac (CETIAT), Jean Tourret (INCE Europe).*

BDP theatre transformation

The Grand Theatre and Opera North, Leeds

Leeds Grand Theatre, the performance base for Opera North, has reopened to great acclaim after a two year transformation programme by BDP.

The Grand Theatre built in 1878 was a major milestone in Victorian theatre building and is listed Grade II*. Once described as 'probably the finest theatre of its size in Britain', the Grand's 19th century facilities no longer met present-day audience and performance expectations. Working conditions backstage and facilities for artists were increasingly difficult and inefficient.

The £16m first phase works on the theatre involved new seating, improved sight lines, better ventilation and improved facilities for the disabled. Backstage, the fly tower and flying systems have been upgraded, and two new rehearsal rooms constructed on an adjacent site are connected to the Theatre by a wide bridge which also acts as a scenery store, accessed form a new get-in lift.

Warren Smith, general manager of the Leeds Grand Theatre, said that big improvements to access, comfort and safety for all theatregoers were uppermost in the plans for the Grand Theatre's transformation of public areas. Behind the scenes there had also been a major upgrade of facilities, which was attracting a greater variety of spectacular shows to Leeds. All these new benefits would enhance the theatrical experience and fully meet patrons' rightful expectation for a 'Grand night out'.

The theatre was designed by George Corson, who also built the adjoining Assembly Room. This was turned into one of the first UK cinemas in the early twentieth century and continued in use until the late 1970s. In the second phase of the project which has just begun, the Assembly Room will soon be restored to provide a new 400-seat venue for music making, showcasing new talent, orchestral rehearsals and educational projects.

BDP Director Charles Broughton said that knowing how important the Grand Theatre was to the people of Leeds, his organisation was pleased to be part of the team which had delivered a first class theatre of national stature and provided a permanent home for Opera North, while preserving its historical roots. BDP provided a interdisciplinary service for the client and owner, Leeds City Council. The total cost is estimated at £23m, part of which is being met by a grant from the Arts Council.

For more information contact Sheri Besford, Building Design Partnership, on **020 7812 8008** Web site **www.bdp.co.uk**

The interior of Leeds Grand Theatre

ICSV

Conference announcement

The next ICSV Congress in the successful series of the International Congresses on Sound and Vibration, organised under the auspices of the International Institute of Acoustics and Vibration (IIAV), will be the fourteenth.

ICSV14 will take place between 9 and 12 July 2007 at Cairns, Australia, in a truly stunning venue, the Cairns Convention Centre. This was voted the world's best congress centre in 2004 (AIPC Apex Award). Participants will be involved in a Congress with a first-rate scientific programme in the fields of acoustics, noise and vibration, and their control.

Cairns is in the very heart of the Asia Pacific region and its International Airport makes it convenient congress location. Cairns is the only place in the world with two adjoining World Heritage treasures: the Great Barrier Reef and Australia's Tropical Rainforest. The Great Barrier Reef is the world's largest marine park and supports the most diverse ecosystem known to man.

The first announcement and call for papers brochure on the ICSV14 has also been sent out by airmail. Please note the following important dates.

1 December 2006
Submission of abstracts (300 words)

28 February 2007
Notification of acceptance

31 March 2007
Deadline for early registration

31 March 2007
Submission of full-length paper (8 pages maximum)

Abstract submission is available via the ICSV14 web site (**www.icsv14.com**).

Vanguardia Consulting

Vanguardia's stadium sound gets the U2 touch

Vanguardia Consulting, the Surrey-based acousticians, sound system designers and noise control specialists, are celebrating the new company's six-month anniversary with the signing of U2's legendary live sound engineer Joe O'Herlihy in a consultancy role.

O'Herlihy, who has mixed U2's live concerts since the band's formative days in Dublin, first met Vanguardia founders Jim Griffiths and John Staunton during their days monitoring noise control at the old Wembley Stadium, during U2's record-breaking *Joshua Tree*, *Zoo TV* and *Popmart* stadium tours.

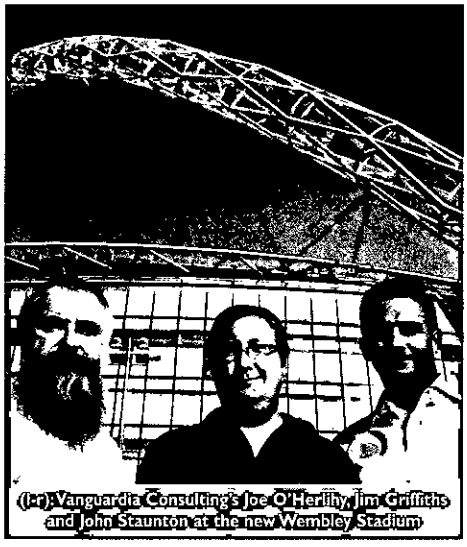
He commented that Jim and John would be at the mix position, saying that such-and-such was the licensing authority and so-and-so was the limit he had to adhere to, but even then their thinking was in terms of trying to do something about it: since then, with a lot of encouragement from them, there had been a huge leap in understanding. Now, as an 'end user' of arenas and stadiums, he was delighted to add his experience to theirs and help to offer Vanguardia's clients a complete solution."

The signing of O'Herlihy underlines that Vanguardia intends to be at the forefront of new attitudes, not only to noise control but to acoustics throughout the architectural and venue operation communities. Clients will know the team's advice reflects what used to be firmly opposing ends of the live music spectrum.

Jim Griffiths confirmed that Joe would be assisting them in fine-tuning Wembley National Stadium and the O2 Arena early next year, and would also work on their other current venue projects such as the Twickenham Stadium and Lansdowne Road Stadium redevelopments, Brighton and Hove Albion's new stadium and GMEX in Manchester.

Vanguardia Consulting opened its doors in May 2006 when Jim Griffiths and John Staunton left Capita Symonds and spent their first summer as Vanguardia managing noise control and licensing issues for most of the UK's biggest outdoor shows. An independent company, it specialises in the acoustic design of venues both inside and outside the building, sound system design, and noise control at live events.

Jim Griffiths, John Staunton and Joe O'Herlihy
Tel: **+44 (0) 1883 718690**
Fax: **+44 (0) 8700 516196**
Web: **www.vanguardiaconsulting.co.uk**



(l-r) Vanguardia Consulting's Joe O'Herlihy, Jim Griffiths and John Staunton at the new Wembley Stadium

50,000 Tests

Under the ANC's ADE Registration Scheme

Compliance with Part E of the Building Regulations 2000 requires sound insulation tests preferably conducted by either a UKAS-accredited or an ANC-registered tester. Just two years after the inception if its registration scheme, the Association of Noise Consultants has just witnessed the 50,000th test conducted by one of its registered testers.

The test took place on a development by Shanly Homes and produced a result of 52dB $D_{nT,w} + C_{tr}$, which is a very good standard compared with the 45dB minimum required by Approved Document E. Jonathan Miller, technical manager of Michael Shanly Homes Ltd's Northern Region said that his company had become used to having testing carried out as a matter of course, so the site managers knew what was involved and could make allowances as part of their programme. It was good to know that the people doing the testing were not only qualified, but are regularly checked. That was one of the reasons why registered companies such as RBA Acoustics were used. The results could be sent to Building Control knowing they would be accepted.

The test was carried out by Anastasios Glinos of RBA Acoustics Ltd, who commented that the increased testing requirement of AD-E, together with better understanding from developers, seemed to be having a significant impact on improved sound insulation in residential developments. Developers and contractors seemed to be very comfortable with the concept of registered testers, as they knew that the work was audited, which gave them far more confidence. Building Control bodies also seemed to be happier in that they knew test certificates would be provided. RBA Acoustics had worked on numerous projects for Michael Shanly, and that long-standing relationship meant that tests could more easily be scheduled to minimise disruption to the construction programme.

A list of all the ANC-registered testers for AD-E throughout the UK can be found at the ANC web site, **www.association-of-noise-consultants.co.uk**

Anastasios Glinos of RBA Acoustics prepares to conduct a sound insulation test

ACOUSTIC CAREER OPPORTUNITIES at PDA

PDA is looking to recruit three consultants to join our existing team based in our new head office in Thelwall Village, Cheshire.

The PDA group was established in 1988, and has built a well respected reputation for the quality and speed of service to our clients. We are currently working on a diverse range of architectural contracts and have many projects involving industrial, environmental and legal work.

CONSULTANTS

The positions offered would suit graduates, or ideally consultants with 1 to 2 years experience. Applicants must have good technical and communication skills.

PDA Offers:

A pleasant working environment in a rural location, a competitive salary package and 5 weeks annual holidays along with excellent opportunities for career progression.

For more information please contact Phil Dunbavin on 01925 759380 or send your CV by email: philipdunbavin@pdaltd.com or by mail to:

Mr. P. R. Dunbavin
Group Managing Director

PDA

PDA Ltd
Beech Farm, Lymm Road, Thelwall, Warrington WA4 2TG
Tel: 01925 759380 Fax: 01925 759320
Web: www.pdaltd.com

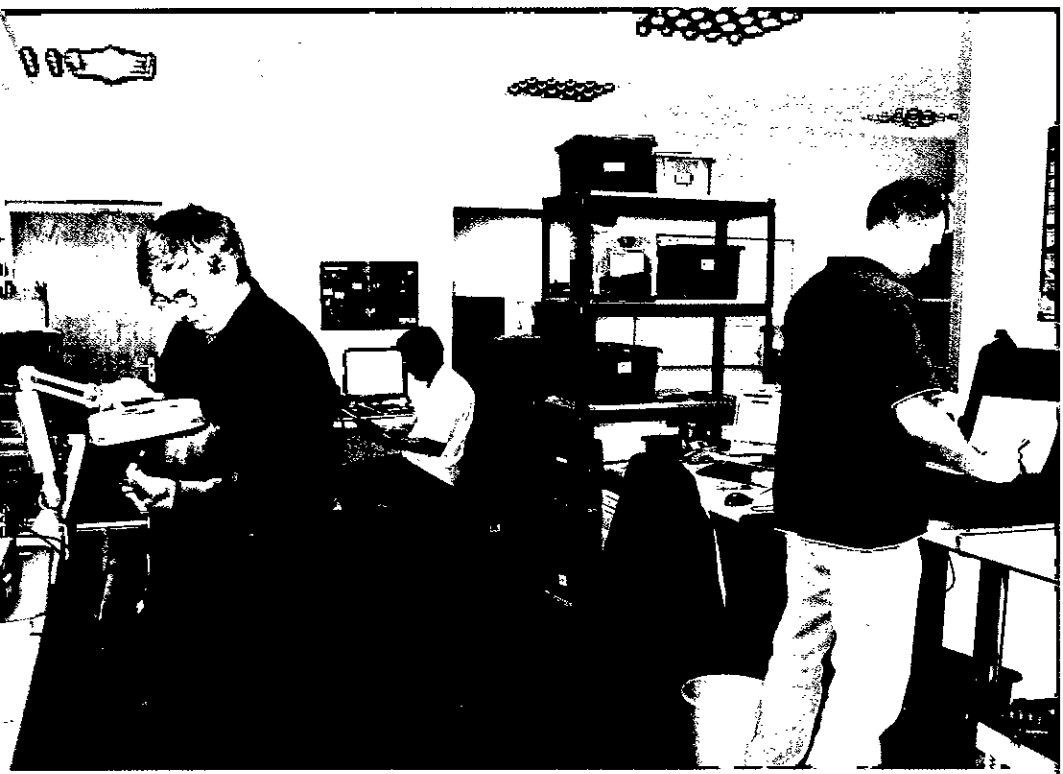
All applications will be treated in the strictest confidence

New Appointee to head technical support services

Frank Cliff

Campbell Associates (CA) has a well-established support and calibration facility for sound and vibration instrumentation, with active representation for Norsonic and GRAS equipment and an 'all makes' policy in the calibration laboratory. A technical support team provides applications and support advice to both existing and potential users of this kind of equipment.

Frank Cliff has been appointed to the new post of Technical Support Manager and will be working with Darren Batten and Mike Tickner to strengthen further the service offered. Frank has considerable experience with the management of calibration laboratories, having held previous senior positions with both Brüel and Kjær UK and Casella CEL. These covered the detailed requirements for the accredited calibration of sound and vibration instrumentation. He has now moved on to gain further experience in the application of these systems. Frank has a BSc degree from the Open University as well as postgraduate qualifications in quality and laboratory management, all following on from his service in the Army.



Technical Support Services at work (left to right) Frank, Darren, Mike

The calibration service offered by CA has expanded considerably over the past three years and with the expertise Frank will bring to the organisation, further developments of the facility will be put in place. With the growing use of legal metrology in connection with sound and vibration control regulations the importance of calibration cannot be underestimated. The periodic verification of sound level meters in particular is now referred to in a number of UK noise control regulations, and in support of this CA clients will have the necessary documentation to support any legal actions that may follow from measurements they make.

For more information please contact Ian Campbell (for technical matters):
ian@campbell-associates.co.uk
For commercial and publication issues use
info@campbell-associates.co.uk

Arup Acoustics

Philip Wright

Philip joined Arup Acoustics in London in May 2006. After completing his BEng in Electroacoustics, he began his working life at the ISVR, Southampton University, where he undertook research into human response to sound.

He was awarded a PhD for his work on source identification in noise measurements.

Philip then worked for a year at the Civil Aviation Authority on aircraft noise measurement methods, before joining BRE, where he spent four years doing government research.

He was the manager of the national noise incidence study for DETR, and noise mitigation study for the Highways Agency.

He also acted as an advisor to the DETR on environmental noise, and contributed to the 2000 revision of Approved Document E.

Philip started his career as an architectural acoustics consultant with Sandy Brown associates, with whom he worked for five years on a large number of diverse projects, including concert arenas, conference facilities, TV studios, offices, schools, and museums.

At Arup Acoustics he is working on the design of Milton Court, which includes a new concert hall and theatre for the Guildhall School of Music and Drama, as well as other university, museum, residential and commercial projects.

How quiet is a quiet area?

I was interested to hear a paper at the recent Autumn Conference from Greg Watts of TRL, presenting a proposal for identifying quiet areas in accordance with the Environmental Noise Directive (END). This paper discusses the requirement of the END for the identification and protection of 'Quiet Areas' in both open country and agglomerations. From research conducted by the authors, it is evident that there is no broad agreement either nationally or within the EU on the definition of a Quiet Area, either in rural or urban situations, and a proposal is made in this paper for a suitable approach for identifying and protecting Quiet Areas, both in the short term and long term.

The authors recognise that there are a very large number of parks and open spaces in agglomerations in the UK, and that it will be necessary to produce a list with a manageable number of areas for protection. A proposal is made for a 'filtration' process, where a number of factors will be considered, including geographical, land type and ambient noise level. It is suggested that noise levels in agglomerations can be obtained from noise maps, produced as required by the END. It is pointed out however, that noise maps, (intended to identify 'noisy' areas for the purposes of noise reduction action), do not highlight areas below 55dB L_{den} and then proceeds to suggest that a Quiet Area in an agglomeration could be considered as an area below 55dB L_{day}.

While one can follow the logic for suggesting 55dB, it would seem that the proposal is based on the availability of current noise data, rather than a clear consideration of what would be considered 'quiet' in an urban setting. While it is clear that an urban dweller's perception of 'quiet' does not relate solely to an absolute noise level, the writer has a concern about the acceptance of 55dB as the upper limit for a quiet urban area. In my own experience, 55dB(A) would not present a desirable acoustic environment in which to relax. Indeed the WHO 'Guidelines for Community Noise', indicate that a daytime noise level of 55dB(A) would trigger 'serious annoyance' to persons in an outdoor living area. This writer lives in a suburban area within a few hundred metres of a major arterial road and has measured a daytime ambient noise level of just under 50dB(A). While that noise environment would not be described as unacceptable, traffic and other urban noise is clearly audible and one's subjective perception would be inclined to agree with the WHO indication that a level of 50dB(A) indicates the onset of moderate annoyance.

The concern arises that if the definition of an urban 'Quiet Area' becomes officially recognised as 55dB(A) or less, then it is likely that any noise environment with a daytime noise level of up to 55dB(A) will become accepted as 'quiet' in planning issues. It would seem that there is a danger that if the TRL proposal is accepted by Defra, a situation may arise in urban areas where it would be impossible to prevent a general upwards creep of ambient levels in locations where the noise level is currently noticeably less than 55dB(A). Do we need to rethink this?

Oliver Hetherington

CMS Acoustics

Introduces High Impact Mat

CMS Acoustic Solutions has launched High Impact Mat, a durable commercial and industrial floor covering specifically designed to withstand heavy pedestrian or mechanical traffic.

The product offers a non-slip elastic alternative to traditional floor coverings, can resist wear and tear from forklift trucks and trolleys, and also provides a pleasant, anti-fatigue surface on which to walk. It has been tested by a UKAS accredited laboratory, and demonstrably provides excellent acoustic performance.

Paul Absolon, technical director of CMS Acoustic Solutions, commented that the introduction of High Impact Mat had further increased their extensive range of products specifically designed for commercial and industrial applications.

Because of its resistance to mechanical stress and 'spike traffic', this highly sound-absorbent and impact-deadening product can withstand treatment which could destroy other flooring systems. It exceeds the highest safety standards for slip resistance (BS.7976: Part 2 'Slip Resistance Determination') and is made from a non-reflective material composed of 100% recycled tyre rubber, EPDM granulate and PUR binder. High Impact Mat is thus an environmentally friendly alternative to traditional PVC, carpet, linoleum or rubber flooring products.

It is supplied in rolls and sheets, and is simple to install to outdoor or indoor floor surfaces. There is a wide range of colours and finishes, and custom colours can be produced to match individual requirements.

CMS Acoustics is the exclusive UK supply partner of the high performance Regupol range, manufactured in Germany by BSW. All products are distributed from centres in Warrington and Colchester, where clients can benefit from the option of immediate dispatch.

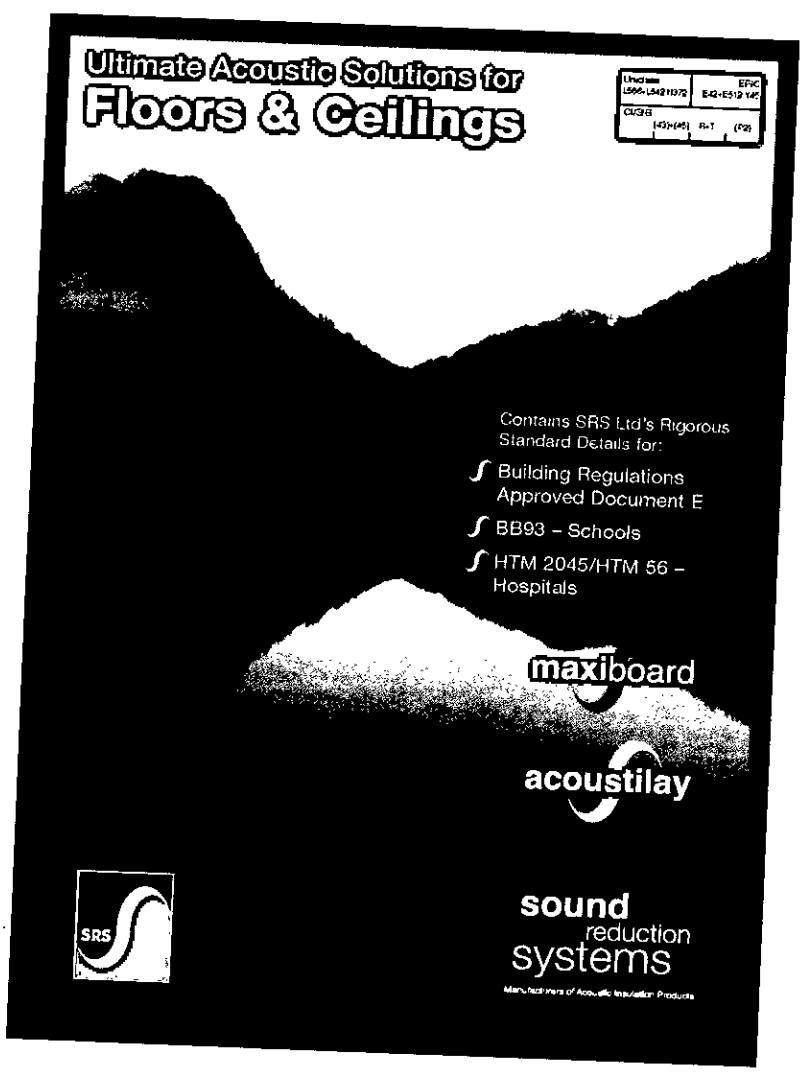
SRS Ltd

Essential 'Ultimate Acoustic Solutions' guide

Sound Reduction Systems Ltd, the sound insulation experts, has launched its essential acoustic insulation guides for buildings. The new brochures are designed to offer a complete guide to the acoustic insulation of walls, partitions, floors and ceilings in both timber and concrete-framed structures, and include test data from a wide range of constructions, as well as detailed installation guidance. They also define the acoustic standards of Approved Document E, BB93 (schools) and HTM 2045/HTM 56 (hospitals), making them valuable specification tools as well as reference guides.

Illustrated with 3D models and using a unique navigation system to link acoustical data to fire data and installation guidance, the brochures enable the user to find the relevant information quickly. Director Alex Docherty, said that the new brochures were designed to make the specification and installation of SRS products as simple as possible. They were also packed with useful information concerning sound insulation, making them a valuable addition to any technical library.

For a free copy, telephone **01204 380074**, e-mail **info@soundreduction.co.uk** or visit the website **www.soundreduction.co.uk** where all the literature is available for download.



SRS Ltd

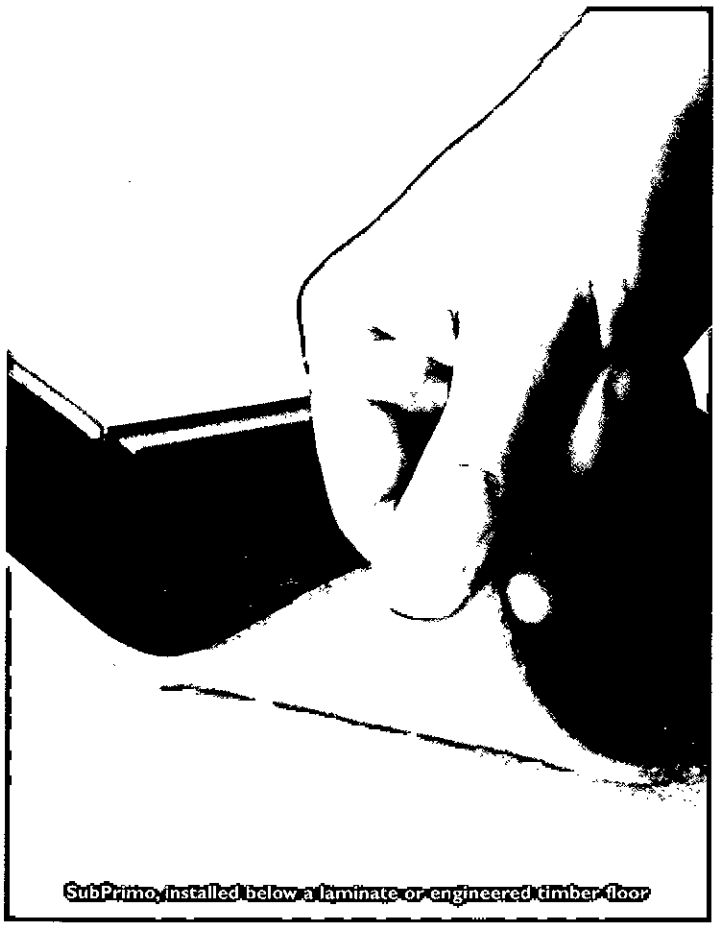
Laminate and engineered timber floors to meet Part E new-build criteria

SRS's newly developed 'total party floor solution' enables owners and tenants in multi-occupancy residential buildings to have a hard-surface décor whilst ensuring that their neighbours below have an acceptable level of peace and quiet by compliance with the requirements of Approved Document E to the Building Regulations 2000.

The company's latest product, SubPrimo, installed below a laminate or engineered timber floor in combination with the now well-established Maxi 60 ceiling system, has been dubbed the 'total party floor solution. It has yielded excellent airborne and impact sound insulation values significantly surpassing the requirements of Part E. The criteria for Part E compliance in a new building are a minimum airborne sound insulation of 45dB $D_{nT,w} + C_{tr}$ and a maximum impact sound pressure level of 62dB $L'_{nT,w}$. The total party floor solution achieved figures of 54dB and 49dB respectively.

Commenting on this latest system, Technical Sales Director Dr Roger Manifold said that it would allow owners and tenants to have the aesthetic hard surface floor finish that they wanted, without subjecting their neighbours below to noise intrusion.

For further information on the system, the SubPrimo product, or Maxi 60 ceiling systems contact Sound Reduction Systems Ltd direct on **01204 380074**, or fax **01204 380957**. The address for e-mail enquiries is **info@soundreduction.co.uk**

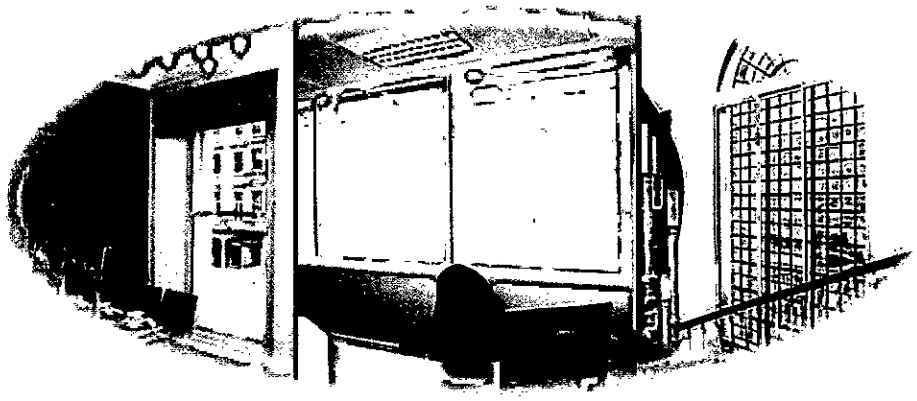


SubPrimo, installed below a laminate or engineered timber floor

Selectaglaze

Leads the way on the web

Selectaglaze, the country's leading designer, manufacturer and installer of secondary glazing systems, has launched its all-new web site at **www.selectaglaze.co.uk** .



Always at the forefront of research and development, Royal Warrant holder Selectaglaze's new site introduces comprehensive technical details and test results covering the company's extensive range of units, including those designed for added security and protection against bomb blast, physical attack and fire. The site also introduces an easy-to-follow ordering section specifically for the trade sector.

With over 40 years' experience, Selectaglaze works closely with architects and specifiers and draws on these close links when producing product information. Increasingly, industry professionals rely on web sites as a means of research and Selectaglaze feels an obligation to ensure they are provided with all relevant information, as comprehensively, easily and efficiently as possible. The launch of Selectaglaze's new web site coincides with the release of the company's Updated Product Guide, which is available free on request from the site.

Scientific and Technical Software

New web site (www.sts-soft.com)

The STS web site has been completely reshaped. The changes involve not only a completely new look, but also a lot of new features introduced the better to support current and prospective customers. Specific pages are available for FAQs, to download 'demo' versions of software and documentation, and to provide direct technical support to customers.

With the new web support feature, current customers can post a technical support request and get a response from staff, usually within 24 hours. Models and technical documentation can be easily shared with the company's technical staff with the maximum efficiency and confidentiality, ensuring a new level of technical support.

Also people that are not yet customers have access to a dedicated and completely free version of web support in order to help them to understand if and how STS products can be applied to their specific applications. The web address is **www.sts-soft.com**

VNoise 2.45

A new VNoise release is now available. The main new features are:

- *Random vibroacoustics analysis*: It is now possible to obtain PSD, rms and cross spectra of acoustical quantities and of structural quantities such as internal stresse, force, displacement, velocity and acceleration.
- *Contribution vectors and multiple load case analysis*: Large efficiency improvements have been obtained by optimising the disk access mechanism.
- *Efficiency improvements and bug fixing*: More speed has been obtained in edge and intersection evaluation routines, mesh coarsening, and coefficient evaluation routines. Some bugs introduced in previous releases have been fixed.

For more information contact Ing. Paolo di Francescantonio, head of software development at STS Scientific and Technical Software.
Tel: **+39 0332-333871**, fax: **+39 0332-341113**
e-mail: **pdifra@sts-web.it**

Larson Davis

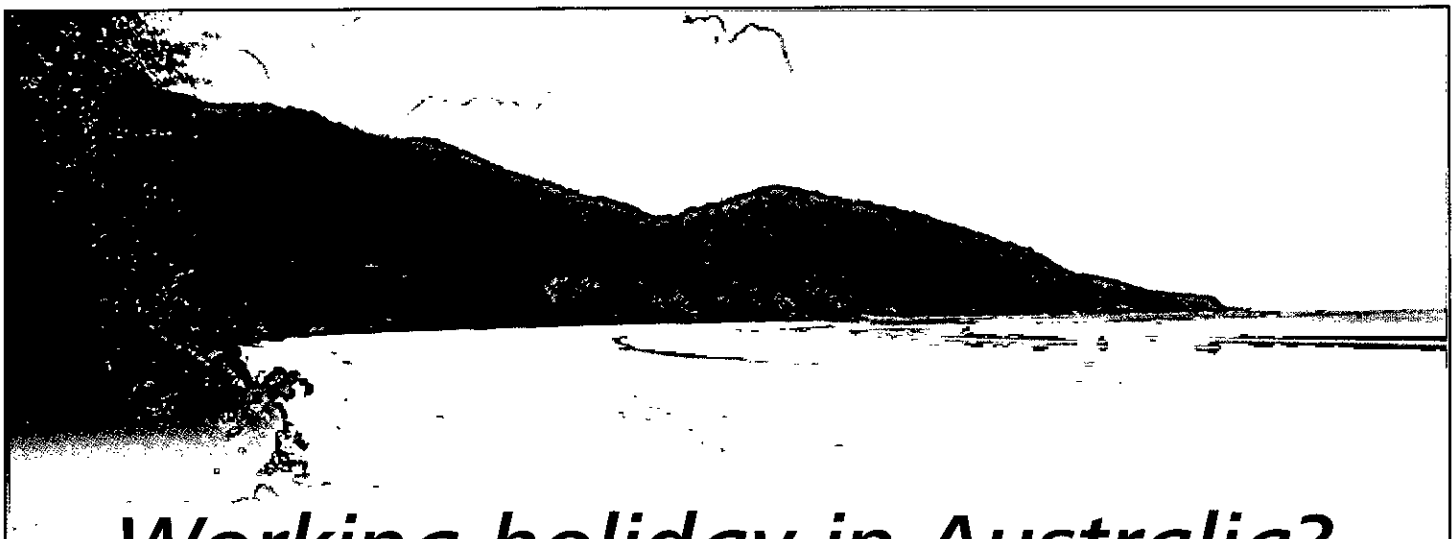
Announces an impulse sound level meter for firing range noise

The Soundtrack LxT from Larson Davis is claimed to be ideal for measuring the extremely high peak sound pressure levels generated by gunfire. Many sound level meters cannot consistently measure above 140dB, the Soundtrack LxT with optional quarter-inch microphone accurately measures peak levels exceeding 170dB.

The unit features a high performance peak detector circuit with extremely fast 'rise time' response to short-duration impulse events, such as those generated on a firing range. The instrument is housed in a rugged case, and has a high contrast LCD display, viewable in all conditions, including direct sunlight. Controls are simple and clearly marked, and being lightweight it may be operated with one hand.

The Soundtrack LxT offers an innovative approach to sound measurement for compliance and worker noise exposure monitoring. Available in Type 1 or Type 2 versions, it provides an easy way to manage route-based or task-based workplace noise surveys. With operator route prompts and digital voice annotation, surveys are done quickly and easily by operators at all skill levels. Optional integrated real-time octave and third-octave filters perform frequency band analysis instantly without tedious 'step-through'. The product is backed by a two-year warranty and PCB's 'total customer satisfaction' guarantee. For more information visit **www.LarsonDavis.com**

The Soundtrack LxT



Working holiday in Australia?

ARE YOU FED UP WITH THE GREY DAMP WEATHER?

THE POLLUTION?

URBAN CROWDING?

Young, keen, qualified & experienced Acousticians can enjoy a 2-year working holiday in Australia with the Asia-Pacific's largest & most professional and diverse Acoustic Consultancy.

Within 2 weeks you can be lying on the beach, enjoying the surf and knowing that the cloudless, bright skies will continue through most of the year. The air is clean and crisp – the water warm.

In summary, it is working in Paradise.

Suitable candidates will have their travel to Australia funded, and assistance with VISA and housing provided.

- Competitive salaries / diverse work challenges
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For the opportunity of a lifetime, contact Michael Smith on:
+ (614) 11 246 387 anytime or email michaeljs@vipac.com.au

ViPAC
www.vipac.com.au

The new Rion NA-28

The best sound level meter in the world?

In November 2004 Rion's main European Distributors were invited to Rion's Headquarters. Tomoharu Wakabayashi, Manager of the Rion Measurement Instruments Division, gave a presentation upon their priority project. The division had been given the task to design and put into production the best sound level meter in the world. The result of this project, the Rion NA-28, is now available in the UK.

So why do Rion think they have designed the best sound level meter in the world? First, because the technology is new from the ground up. Rather than bolting a sound level meter on to the chipset for a hand-held or palm-top computer, the company developed a new digital signal processor (DSP). The result is a fast and powerful sound level meter and analyser with a superb display and astonishing battery life from normal alkaline batteries.

One of the first noticeable features of the NA-28 is the high-contrast TFT-LCD colour display. It has been a staggering engineering achievement to provide such a clear and bright colour display and 16-hour battery life using four alkaline 'C' cells.

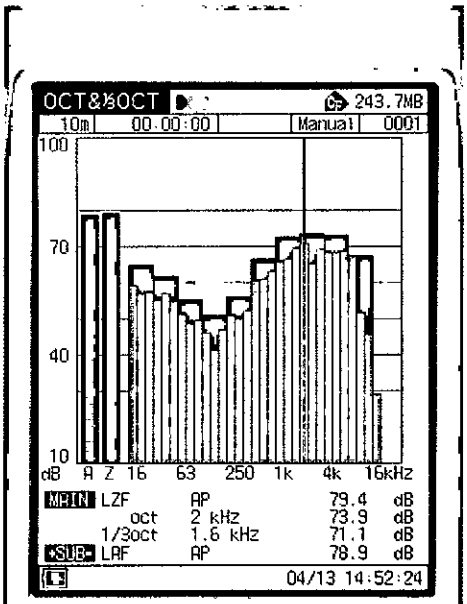
Further investigation reveals that the meter can auto-store up to 300,000 data sets (L_{eq}, L_{max}, L_{min}, SEL and five percentiles in octave and/or third-octave bands) onto a 1GB compact flash card. It measures and stores third-octaves and octaves either simultaneously or separately. There is also a sub-channel and the meter has 110dB linearity when used in broad-band mode, or 95dB in frequency analyser mode.

Data transfer, as usual with Rion products, is simplicity itself. The data are stored as text files on compact flash cards, avoiding the need for special software of questionable reliability on a particular PC. The compact flash card plugs in and can be opened with Excel (or the NA-28's USB link - a computer sees it as an external disk drive).

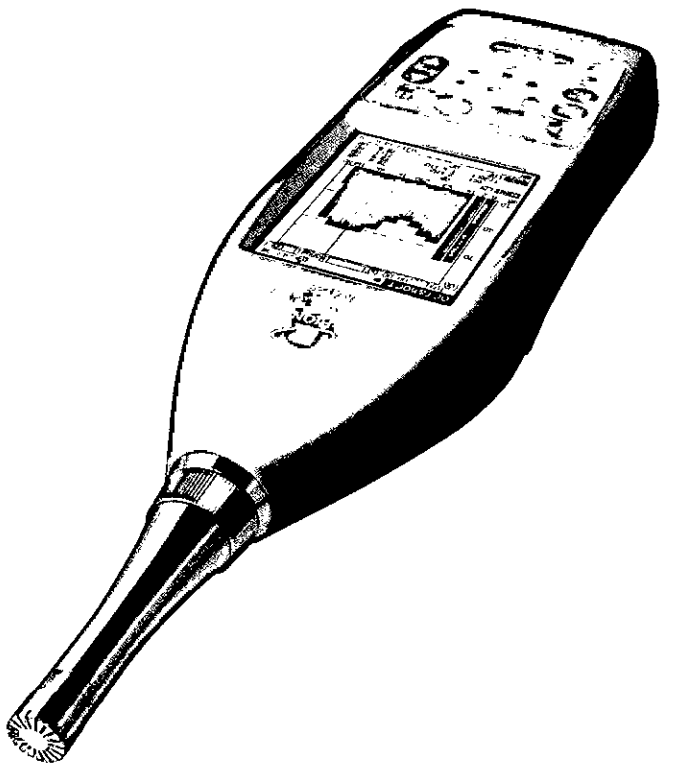
The main functions are on a simple keypad (and the key functions written clearly in English – no 'symbology'), so using the instrument is simple and intuitive: ANV think the user may never actually need to refer to the instruction manual.

The NA-28 is available now as a fully functioning logging Class 1 sound level meter with octaves and third octaves. The Building Acoustics (ISO140 and Approved Document E, recognising the subtle differences between the two) and uncompressed .wav file recording are expected to be available in spring 2007.

Rion believes this is the best sound level meter in the world. To see if you agree contact ANV Measurement Systems (tel **01908 642846** or **info@noise-and-vibration.co.uk**) for a demonstration.



The Rion NA-28 - display



The Rion NA-28

Introduction of 'response equalisation extreme' feature

enhances the PULSE 11 platform

The latest release PULSE 11 of the sound and vibration data acquisition and analysis platform introduces the Response Equalisation Extreme (REq-X) feature unique to Brüel & Kjær. The new REq-X extends the measurement capability of the platform, facilitates the first-time acquisition of valid data, and eliminates annoying measurement re-takes. The frequency-response curves of transducers (like accelerometers and microphones) are extended and flattened in real time during data acquisition.

The PULSE multi-analyser platform for pressure, sound, and vibration data-acquisition and data-analysis has a long and successful history in many research and development fields, such as aerospace, automotive, environmental and production testing. The advantages of using PULSE 11 are more accurate measurements, wider frequency range, and the ability to use the same transducer to cover more applications.

Response equalisation extends the frequency range in which a single transducer can be used and improves the accuracy of the measurement. This also means that the same microphone can be used for different sound fields, whether free field, pressure-field or random. Furthermore, the microphone can be corrected for various microphone accessories (for example, a windscreen) to obtain better accuracy.

Accelerometers' upper-frequency limit is extended by 50%. Until now it has been recommended to restrict the use of accelerometers to frequencies up to one-third of their resonant frequency. Using PULSE 11, the recommended upper limit of frequency can be extended upwards to half the resonant frequency.

Applications include acoustics, machine diagnostics, electro-acoustics, structural dynamics and vibroacoustics. For an overview of the many applications visit **http://www.bksv.com/3920.asp**. The PULSE 11 platform includes acoustic transducers, vibration transducers, signal conditioning amplifiers, modal exciters, data acquisition and analysis systems, and data management and reporting tools. In addition to multi-channel data recording, the acquisition and analysis features include fast Fourier transform (FFT) and constant percentage bandwidth (CPB) analysis.

For further information contact Rebecca McCullough on **01438 739000** or e-mail **ukinfo@bksv.com** . The Brüel and Kjær corporate web site is at **www.bksv.com**

Noise mapping and planning

for non-acousticians

New software is available for those who may not have in-depth knowledge of acoustics but want accurate results of a noise calculation in the smallest amount of time, with the maximum amount of professionalism. SoundPLAN-*essential* was conceived with this in mind. It is a compact version of SoundPLAN, a program known for its power, fast data processing and graphics. It is said that SoundPLAN-*essential* is so easy to use, even engineers without special training for noise control will have no trouble with it. And, as it includes noise contour map capabilities, presentations are easy to create and easy to understand.

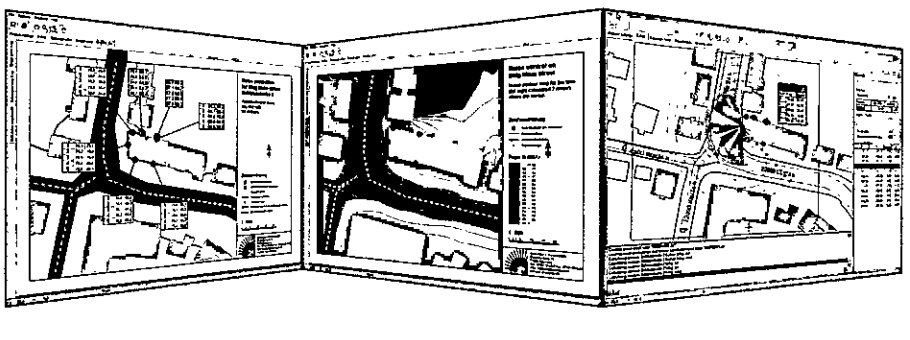
The new compact version is a single document application including all the basic information for noise control planning. It calculates noise from roads, railways or industry. All three source types are included in the software, but the calculations are completed for a single noise type at a time. Specific calculation guidelines and assessment methods specific to a country are installed automatically, so each user installs his country specific setup.

SoundPLAN-*essential* calculates any amount of data, so it can process any job. Data is imported from GIS and CAD, or digitised on top of bitmaps. It includes all the basic tools and editing functions. Noise processes are described in result tables and graphics. The emission level calculations and results of the noise propagation are presented in tabular form in predefined tables. Grid noise maps are used to produce colour contours for day, night and L_{den} time slots, depending on the standard. The grid noise maps and noise contour maps show the dB values using bands of colour or the dB value itself.

Noise walls and berms are a popular means of reducing noise. The results tables and graphics show the dB values without and with these noise protection measures in place. Single receivers, noise limits and regular contour lines are calculated. A 'single receiver' calculation shows the noise levels, assesses the correct time slots and applies the level additions for the noise descriptor required in the country for all receivers and floors. The level chart shows the magnitude of the noise received. A single receiver map shows the results from single receiver calculations, and presents the noise limit contour lines for the calculated time slots.

The left side graphic shows receivers on a building with a table listing the noise levels during the day and night time slots. The grid noise map in the middle was made with a user-defined calculation area. The right side graphic is a single receiver calculation.

Whether modelling noise from roads or car parks, or evaluating noise protection walls, SoundPLAN-*essential* allows standard cases to be processed quickly, efficiently and inexpensively. For occasional users and non-acousticians, it is the way to save time and money for noise reduction planning.



sample graphics output from SoundPlan-essential

Instrument storerooms just got bigger

Ashtead Technology Rentals

Ashtead Technology Rentals has announced an investment of over £500k in health and safety instruments for hire. Ashtead's James Carlyle says that everybody's instrument storeroom just got bigger - there is no need for companies to buy new equipment, because Ashtead already has!

Most people mainly think of renting when something they need is expensive is only likely to be needed for a short period. However, renting avoids ownership costs such as storage and maintenance, and provides flexible access to the most appropriate instruments for a time period that meets the requirements precisely.

Ashtead Technology is a member of the Ashtead Group plc, one of the largest equipment rental companies in the world. Ashtead Technology Rentals has grown enormously since its inception by responding to customers' needs and investing in the latest technology. James Carlyle attributes this success to three issues: technical advice on what to rent and how to use it, high instrumentation availability, and the fact that all rental equipment is tested and ready for use.

Ashtead's fleet of instruments for health and safety assessments includes toxic gas detectors, dust and particulate monitors, HVAC monitors, clean room technologies, and instruments for the measurement of noise and vibration, from many world-leading manufacturers such as RAE, MSA, Draeger, Thermo, Quest and Casella.

Ashtead customers are able to identify quickly the ideal instrument for their application either by phoning an Ashtead engineer or typing a key word in the search box on the company's web site. For example, a search for the word 'gas' instantly provides the details of over 130 products.

For more information, contact James Carlyle, general manager, on **0845 270 2707** or e-mail **EMAIL ADDRESS**. The web address is **WEB ADDRESS**.

Renting avoids ownership costs such as storage

Ivie LEQ-35 Survey Meter

Ivie Technologies

Ivie Technologies has introduced a fully featured, compact, user-friendly L_{eq} survey meter. This Type 1 handheld meter is intended for 'survey use' making measurements of up to several hours, where the instrument is usually attended (Type 1 performance is available when using the IE-5P half-inch diameter preamplifier and microphone capsule). Ten user-adjustable event markers are provided to annotate events in time.

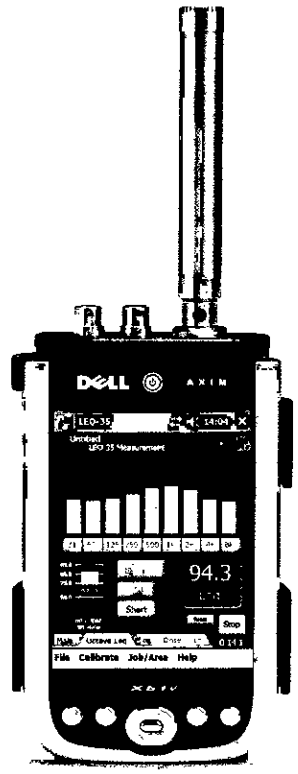
The LEQ-35 meter offers a vivid colour display and intuitive GUI layout with button/tab interface. Measurement information is broadly customisable and information is imparted clearly and quickly, and the instrument's ultra-compact nature makes it ideal for portability and field use. The standard package comes with Ivie's respected and versatile IE-35 audio analysis software application. It is available in Type 1 and Type 2 configurations.

Easily configurable displays allow viewing of an L_{eq} strip chart display, dB sound pressure level meter (dB(A) fast response), and user selectable data for F, S, I, P, L_{eq}, A, C, or Z weighting. A logical system for saving measurements by area and location makes data collection and management highly efficient. Saved data can be downloaded to Ivie's own PC LEQ Report software for event editing and L_{eq} recalculation, and can be output to any external software accepting ASCII comma-delimited format.

The LEQ-35 also provides a nine-octave band L_{eq} real-time analyser with selectable marker for each octave band, selectable octave short of cumulative Leq, and fully user-configurable L_n information. In addition, the unit serves as a dose meter, displaying noise dose, projected dose, TWA, Pascal-squared hours, and C-weighted peak level, with user-selectable exchange rate, threshold and criterion.

The LEQ-35 is accompanied by full regional and factory technical support.

For more information:
AC Fluid Technology Ltd.
01564 825145
www.AC-fluid.co.uk



Ivie LEQ-35 Survey Meter

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Applications for Sponsor Membership of the Institute should be sent to the St Albans office. Details of the benefits will be provided on request.

Committee meetings 2007

DAY	DATE	TIME	MEETING
Thursday	11 January	10.00	Meetings
Thursday	25 January	10.30	Diploma Tutors and Examiners
Thursday	25 January	1.30	Education
Thursday	1 February	10.30	Membership
Thursday	15 February	11.00	Publications
Thursday	8 March	10.30	Engineering Division
Tuesday	13 March	10.30	Diploma Examiners
Thursday	15 March	11.00	Medals & Awards
Thursday	15 March	1.30	Executive
Thursday	**29 March**	**11.30**	**Council**
Thursday	5 April	10.00	Meetings
Thursday	19 April	11.00	Research Co-ordination
Tuesday	24 April	10.30	CCWPNA Examiners
Tuesday	24 April	1.30	CCWPNA Committee
Thursday	10 May	10.30	Membership
Thursday	24 May	11.00	Publications
	TBA	**TBA**	**Annual General Meeting ****
Tuesday	5 June	10.30	CMOHAV Examiners
Tuesday	5 June	1.30	CMOHAV Committee
Thursday	7 June	11.00	Executive
Tuesday	19 June	10.30	CCENM Examiners
Tuesday	19 June	1.30	CCENM Committee
Thursday	**21 June**	**11.30**	**Council**
Thursday	28 June	10.30	Distance Learning Tutors WG
Thursday	28 June	1.30	Education
Thursday	5 July	10.30	Engineering Division
Tuesday	10 July	10.30	ASBA Examiners
Tuesday	10 July	1.30	ASBA Committee
Thursday	12 July	10.00	Meetings
Tuesday	7 August	10.30	Diploma Moderators Meeting
Thursday	6 September	10.30	Membership
Thursday	13 September	11.00	Medals & Awards
Thursday	13 September	1.30	Executive
Thursday	20 September	11.00	Publications
Thursday	**27 September**	**11.30**	**Council**
Thursday	4 October	10.30	Diploma Tutors and Examiners
Thursday	4 October	1.30	Education
Thursday	11 October	10.30	Engineering Division
Thursday	18 October	11.00	Publications
Thursday	1 November	11.00	Research Co-ordination
Tuesday	6 November	10.30	CCENM Examiners
Tuesday	6 November	1.30	CCENM Committee
Thursday	8 November	10.30	Membership
Tuesday	13 November	10.30	ASBA Examiners
Tuesday	13 November	1.30	ASBA Committee
Thursday	15 November	10.00	Meetings
Tuesday	20 November	10.30	CMOHAV Examiners
Tuesday	20 November	1.30	CMOHAV Committee
Thursday	22 November	11.00	Executive
Thursday	29 November	11.00	Publications
Tuesday	4 December	10.30	CCWPNA Examiners
Tuesday	4 December	1.30	CCWPNA Committee
Thursday	**6 December**	**11.30**	**Council**

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.

Examination dates 2007

DATE	EXAMINATION
18 May	Certificate of competence in environmental noise measurement
23 March	Certificate of competence in workplace noise assessment
27 April	Certificate in the management of occupational exposure to hand arm vibration
8 June	ASBA Examination
14/15 June	Diploma Examination
5 October	Certificate of competence in environmental noise measurement
12 October	ASBA Examination
9 November	Certificate of competence in workplace noise assessment
19 October	Certificate in the management of occupational exposure to hand arm vibration

Conferences & meetings

Diary 2006 & 2007

4 January 2007
Building Acoustics Group
HTM-08-01 Acoustics Consultation Workshop - St Albans

24 January 2007
Building Acoustics Group and Noise & Vibration Engineering Group
Vibration and Re-radiated Noise from Trains - London

6 March 2007
Underwater Acoustics Group
The Art of being a Consultant
London

13 March 2007
Measurement & Instrumentation Group
Rumble in the (Urban) Jungle - the measurement and assessment of environmental vibration impact
London

20 March 2007
Environmental Noise Group
Wind Farm Noise - Swaffham, Norfolk

10-12 April 2007
Underwater Acoustics Group
4th International Conference on Bio Acoustics - Loughborough

24-25 April 2007
Spring Conference 2007
The Sound of Sustainability - Going for Gold
Cambridge

5 June 2007
Envitonmental Noise Group
The Art of being a Consultant
Manchester

11 July 2007
Measurement and Instrumentation Group
It's practically a quality measurement - are your measurements fit for purpose?
NPL, Teddington

18-19 September 2007
Underwater Acoustics Group
Detection and Classification of Underwater Targets
Edinburgh

Further details can be obtained from Linda Canty at the Institute of Acoustics
Tel.: **01727 848195**
or on the IOA website:
www.ioa.org.uk

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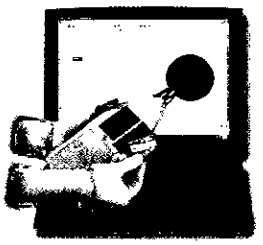

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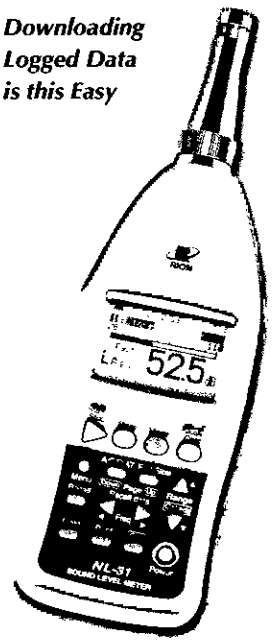

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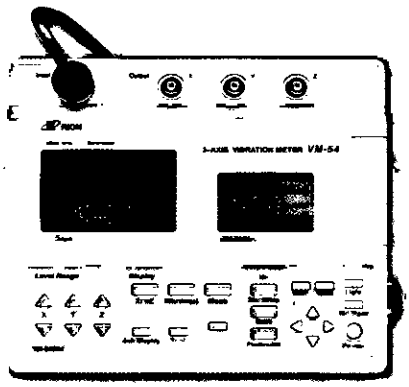

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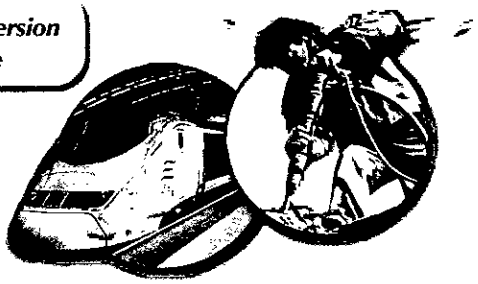

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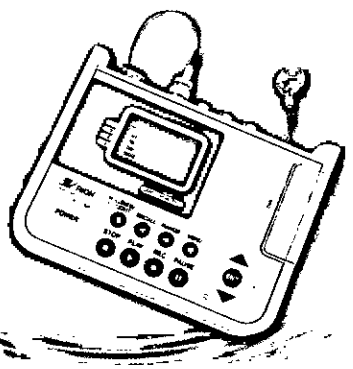

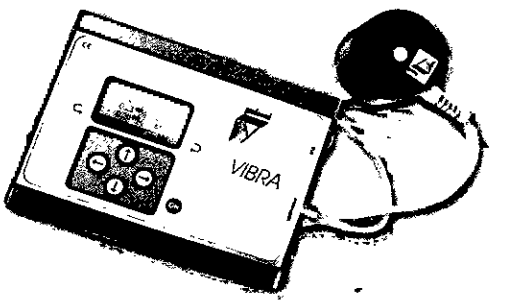

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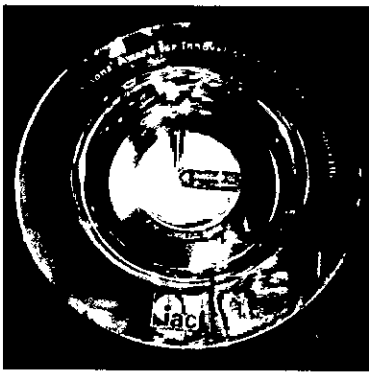

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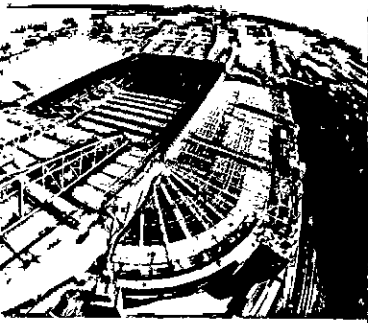
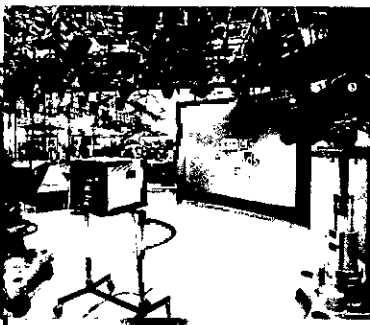
Award date: October 2007





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