Vol 31 No 6 NOVEMBER/DECEMBER 2006

ACOUSTICS BULLETIN

in this issue... **Improved railway noise prediction**

plus... **Autumn Conference 2006 report**

Acoustic design in hostile offshore environments

Who really invented the telephone?

Institute of
Acoustics

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e-mail: ioa@ioa.org.uk
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Designed and printed by:
Point One (UK) Ltd., Stonehills House, Stonehills, Welwyn Garden City, Herts, AL8 6NH
e-mail: talk2us@point-one.co.uk
web site: www.point-one.co.uk

Annual subscription (6 issues) £110.00
Single copy £20.00

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Institute of Acoustics

The Institute of Acoustics was formed in 1974 through the amalgamation of the Acoustics Group of the Institute of Physics and the British Acoustical Society and is the premier organisation in the United Kingdom concerned with acoustics. The present membership is in excess of two thousand and since 1977 it has been a fully professional institute. The Institute has representation in many major research, educational, planning and industrial establishments covering all aspects of acoustics including aerodynamic noise, environmental, industrial and architectural acoustics, audiology, building acoustics, hearing, electroacoustics, infrasonics, ultrasonics, noise, physical acoustics, speech, transportation noise, underwater acoustics, and vibration. The Institute is a Registered Charity no.267026.

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Institute Council

Dear Members

I have just returned from the Autumn Conference which was an undoubted success in many ways. The organising committee had chosen a highly topical theme and this ensured that there was such an interesting range of papers, with some highly respected speakers. It was not surprising, therefore, to hear that the available places sold out well ahead of the conference. I am grateful for the efforts of all those who helped make the event such a success and particular thanks go to our speakers from overseas.

In September I also attended the equally successful conference organised by the underwater acoustics group in Lerici, Italy. A curious theme running through the papers at the Autumn Conference was the deliberate absence of formulae and mention of decibels, with many speakers preferring to concentrate on human response to noise. In contrast, the conference in Italy was on the subject of synthetic aperture sonar and the papers presented were necessarily more mathematical. However, both of these conferences demonstrated just how well the Institute can deliver continuing professional development and contribute to the dissemination of knowledge amongst our members.

Over the years that I have served on Council I have been worried by the increasing number of complaints that have been made regarding members' professional behaviour. Each of these complaints is meticulously examined by membership committee, which is a time consuming and onerous task. This trend may simply be a reflection of the more litigious society that we now live in, as I am relieved to report that complaints are very seldom found to be justified. This situation does, however, serve as a reminder that all our code of conduct does require all members to 'avoid undertaking work which is beyond their capabilities'. Having read the details of all of the recent code of conduct cases, I suspect that some members are working at the limits of their knowledge and perhaps more background study would have helped avoid the complaints being made. I would therefore encourage everyone to ensure that they undertake the appropriate CPD and there is often no more enjoyable way to do this than by attending our conferences. The times between the formal sessions provide invaluable opportunities to discuss issues with the people who developed the research and guidance that we use and thereby allow you to develop a real depth of understanding of your chosen area of acoustics.

Finally, this is the last issue of the Bulletin for 2006, may I wish you all a very happy Christmas and a prosperous and peaceful new year.

Colin English

PRESIDENT

The Institute of Acoustics Engineering Medal

Citation for Brian Hemsworth

Brian Hemsworth graduated with an Honours degree in Aeronautics and Astronautics from the University of Southampton whilst he was with Hawker Siddeley Aviation Ltd.

He subsequently joined the Research Division of British Rail where he devoted his energy and skills to the application of acoustics to railway engineering. His primary interest was fundamental research into the mechanisms of railway noise and vibration generation at the wheel/rail interface and its propagation.

He was a member of the UK Department of Transport Working Group that prepared the Technical Memorandum on railway noise prediction, 'Calculation of Railway Noise 1995' and subsequently the Noise Insulation Regulations for Railways in 1996.

He has given evidence at Public Enquiries and before Parliamentary Select Committees for many railway projects.

Following the demise of British Rail, he turned his focus to Europe, working for the European Rail Research Institute coordinating the noise research programme for the International Union of Railways.

Brian is internationally recognised as an authority on railway noise and vibration and has disseminated his knowledge and experience widely at such events as the International Workshops on Railway Noise which he organised. He has also been active politically in preparing lobbying strategies for the Community of European Railways for proposed European legislation and in the UK as an active member of the Railway Forum.

He is a member of the Institute of Sound and Vibration Research Scientific Advisory Committee and an external lecturer for the Institute of Acoustics Diploma Course in Acoustics and Noise Control at the University of Derby.

For his contributions to the understanding of railway noise and vibration, the Institute of Acoustics is very proud to present the Engineering Medal to Brian Hemsworth.

Brian Hemsworth receives his medal from Colin English

Central Branch meeting

Louise Beamish. Synergies and conflicts between Environmental Health Officers and noise consultants

The third Central Branch meeting was held at the Brüel and Kjær Stevenage office on 19 September. The motion for the meeting was "This house believes that noise consultants routinely produce noise reports which satisfy the needs and expectations of Environmental Health Officers".

Speaking for the motion was Nigel Cogger of the English Cogger Partnership and speaking against was Andrew Godman of North Hertfordshire District Council.

Nigel began by setting out guidance documents and the areas of potential confusion and conflict between consultants and Environmental Health Practitioners (EHPs). It was suggested that consultants and EHPs used guidance documents in different ways, with consultants often taking a liberal approach and EHPs taking a more literal stance.

Andrew generally agreed with the motion and highlighted steps that could be taken to avoid conflict, such as pre-application meetings.

The presentation was followed by an interesting and lively debate with a number of issues raised on both sides of the motion despite the meeting being overwhelmingly attended by consultants. It was certainly an interesting meeting to attend and it was valuable to listen to the discussions following the presentation.

The meeting closed with the motion carried, but not by the clear margin that might have been expected given the number of consultants in the audience.

Thanks are due to the speakers, the chairman and to B&K for hosting the meeting.

Andrew Godman presents the arguments against the motion

Central Branch meeting

Ewan MacGregor takes the platform

The second meeting of the Central Branch on 6 June was a presentation by Ewan MacGregor on the potential liabilities and claims faced by acousticians. An audience of 25 listened attentively as Ewan explained some of the basic concepts of common and contract law, collateral warranties, deeds of appointment and the role and types of professional indemnity insurance.

The difference between a common law requirement to exercise reasonable skill and care and legal liabilities established through legislation such as the CDM Regulations was explained and the audience heard about simple contracts with potential liabilities applying for a period of six years, and deeds of appointment with claims possible for up to 12 years.

It came as a surprise to many of us that even if advice is given without a fee being charged, liability still applies and Ewan cautioned that it is often the quick and seemingly innocuous on-the-spot advice, perhaps where a client asks if an alternative solution is suitable, that can lead to difficulties. Several members probably began replaying various phone calls in their minds at this point.

As the sound of nails being bitten rose and faces paled, Ewan gave examples of real life claims (none of which involved acousticians - phew!) but nonetheless gave the meeting a valuable insight on just how liabilities could escalate. Nervous looks were exchanged in the NHBC boardroom as we listened to the tale of a leaky air conditioning unit which dripped onto ceiling tiles requiring their replacement, and then dripped into the back of a computer on a desk below, destroying it. The computer was being used by a trader who had just bought 10 million pounds worth of shares. The trader was just about to press 'return' to conclude the onward sale of these shares for £15 million when the computer failed. The meaning of 'consequential loss' was much cleared after hearing this scenario.

The packed house had a good many questions following Ewan's excellent presentation and as the meeting concluded (for those not continuing onto the local hostelry) it was easy to understand why at the end of Crimewatch, Nick Ross reminds viewers not to have nightmares!

Feedback from members at and after the meeting suggested that this was a topic of great interest!

Meeting report

Edward Weston. London Branch

On 20 September 2006 at Capita Symonds, the London Branch held their first evening meeting after the summer break. Around 40 members attended the presentation by Amber Naqvi of Sonic Element, on his recent research on critical listening room design and a novel sound field simulation technique.

Amber reminded us that traditional methods of sound field simulation usually involve elaborate and costly electroacoustic systems within anechoic chambers. He has devised a new method which does not require an anechoic environment, but uses an array of flat panel (DML) loudspeakers to alter the quantity and distribution of early reflections from loudspeaker sound sources. In this way, he has been able to obtain the standardised reference listening room conditions specificed in ITU-R BS1116, but recognises that despite meeting these criteria, rooms still have their own characteristic sound.

Observing the work of Olive and Toole, and using computer modelling software (CATT), Amber successfully produced a perceptual reflection-free-zone at the listening position (ie no early reflections). Following suitability tests of the DML loudspeakers, he succeeded in introducing measurable synthesised early reflections, assisted by the experimental findings of Bech for the Archimedes Project. Through subjective listening tests, he also concluded that the addition of synthesised reflections could be perceived in terms of a difference in spatial character of the sound - a widening of the source. These findings were as expected, owing to the symmetry of the apparatus, and corresponded with those of Olive and Toole, and Bech.

The second part of the presentation explained how wave field synthesis (WFS) improves current 3D sound simulation techniques, extending the relatively small 'sweet spot' to cover the entire room. This is achieved using a large number of secondary sound sources around the room's perimeter. The example used to illustrate this was the V-Lab at the University of Surrey. This facility is a room fitted with 340 loudspeakers, a 120-degree concave back-projected screen, and various sound absorption and attenuation measures. Amber described the practical considerations necessary (control of room acoustics and building services noise) to make the facility a success.

For more information on WFS systems, see
www.iosono-sound.com

Award for distinguished service to the Institute

Jeff Charles FIOA

Jeff studied physics of the University of Durham, graduating in 1962. Shortly afterwards he made his move into acoustics when he made his way south to the ISVR at the University of Southampton where obtained his MSc in advanced acoustics 1965.

Jeff then spent six years in industry, with the Electrical Research Association and C A Parsons & Co Ltd, before returning to ISVR in 1971 to work in the Wolfson Unit for Noise and Vibration Control. Two years later he made the move to Bickerdike Allen Bramble where he extended his consultancy into the world of architectural acoustics. He headed the Acoustics Team as a Partner between 1977 and 2002, since when he has been working full-time as a consultant to the firm.

It was a rather unusual move to work as a consultant in an architectural practice; most of us work in independent practices or with engineering companies. Many may have regretted the move as he was faced with challenges that he may not have expected. In his early days as a partner to several architects he had to steer the practice through a number of unexpected events. On one occasion, a former partner dissolved the partnership and departed over a weekend, taking his share of the staff and furniture away with him. Shortly afterwards, a partner died leaving behind complex financial affairs resulting from his personal relationships with several women. Jeff became the great sorter-out of such problems and, during his period as a partner injected an air of greater management control and stability into a growing practice.

Throughout his time at Bickerdike Allen, Jeff published widely and was awarded the Tyndall Medal of the Institute of Acoustics in 1986.

The distinguished service award, however, recognises Jeff's work for the Institute. He assisted in setting up the British Acoustical Society, which was the forerunner of the Institute of Acoustics. He founded the Southern Branch and sat on the Meetings committee for over 20 years, including six years as chairman. In that role he helped organise numerous conferences and meetings. He also served on the Building Acoustics Group's committee and was also chairman between 1989 and 1995.

Perhaps the most important contribution that he made was in the role of Deputy Chief Examiner for the IOA Diploma until 1997. That job involves overseeing the general module and the then Chief Examiner recalls that Jeff took it upon himself to answer all of the questions once they were received from the tutors, to ensure that they contained no errors.

It is not recorded if Jeff awarded himself a Diploma for his troubles, but he has certainly done more than enough for his Award for Distinguished Services to the Institute.

Meeting report

Judy Edrich. PLASA 2006

The Institute of Acoustics exhibited at the Professional Sound and Lighting Exhibition (PLASA 06) from 10 to 13 October 2006. Thanks to the generosity of the Institute of Sound and Communications Engineers (ISCE) who offered to share some of their well-constructed stand, the IOA was able to have a presence at PLASA 06, which is one of the major professional sound and lighting events of the year. PLASA is the place where people can see the latest innovations in lighting, sound, rigging or staging, and is an international event attracting buyers and specifiers from all the world of entertainment, event, corporate, architectural and installation industries.

Visitors to the stand showed a keen interest in the work of the Institute. They were particularly interested in our Diploma in Acoustics and Noise Control and the Certificate in Workplace Noise, as well as in technical matters and membership. Judy Edrich, publicity manager, and Joan Smith, membership manager, manned the stand and fielded enquiries which came in at a steady trickle. Chief Executive Kevin Macan-Lind also spent a day 'meeting and greeting', and it was good to see several IOA members who dropped in for a chat and a glass of nice cool water (courtesy of ISCE).

Not content with just spending time on the stand both Judy and Joan took the opportunity to roam around the exhibition visiting relevant manufacturers and spreading the word about the Institute, and in particular the forthcoming Reproduced Sound 22 Conference in November 2006. It was encouraging to see the interest shown by some of the companies visited.

The PLASA show itself was an unprecedented success producing a high quality of visitor and was a great opportunity to raise the profile of the Institute. We would very much hope to be able to continue to have a presence at PLASA exhibitions in the future.

Ros Wigmore (Secretariat Manager ISCE) and Kevin Macan-Lind (Chief Executive IOA) on the ISCA/IOA stand at PLASA 06

New members

Council at its September 2006 meeting accepted the following into membership of the Institute of Acoustics in the grades stated.

Fellow

Abbott P G
Jones S A S
Peat K S

Member

Baxter S R
Cartman D R
Choy T S
Cox B J
Craven N J
Curtis A C
Egan W
Fermer A D
Greaves M J
Greenland E E
Griffin D J
Holt N M
Lee M K H
Moller H E
Morgan A J
Paterson S
Pope D C
Potts M D
Radcliffe S A
Reid C M
Rodriguez X R
Shepherd J K
Swankie G N
Tang W H
Thorne M A
Tyndale-Biscoe R
Weston E L
Zhang B

Associate Member

Bailess T D
Bangura P
Barrett S L
Boddeti U R
Broadway J
Carter R S
Coleman M T
Cook J A T
Davidson S E
Davis C A
Degos D
Dodds D E
Duncan J A
Duque SF
Eaves D M J
Glass A D
Goncalves J
Haines G
Hullock T E
Hunter G J
Islam A
Jones H R
Kennedy R P
Kerry P G
Kirsopp N
Laws G J
Liao J
Livesey H A
Lotinga M J
Maclagan M
McKelvey C
Milham G J
Mills J P
Montague L P
Mycock H
Nash D J
O'Kelly D K
Parr S M
Pickup P D
Ramadorai R
Reece L A
Reid M
Snowdon H C
Thomas J
Trzcinski-Clement F
Villa S
Viswanatha N
Walker J
Ward J
Weaver M E
Worrell L M
Zheng F

Affiliate

Pitt S L
Sondo V A

Technician

Barker J L
Colder R
Mape J E
Reddecliffe M D
Smith L M

Student

Azarpeyvand M
Batsikas G
Betts J
Bracher C R
Khan A

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Editor's notes

Ian F Bennett CEng MIOA.

With this being the last issue of 2006, the time has come to look forward to the next year of Acoustics Bulletin. During 2007 we intend that each issue will have a 'theme' pertaining to a particular branch of acoustics, so that all the special interest groups in the Institute can have the opportunity to tell their fellow members what they are up to!

The themes will be:

January/February 2007:
Physical acoustics and medical applications

March/April 2007:
Environmental acoustics

May/June 2007:
Entertainment noise and musical acoustics

July/August 2007:
Building acoustics

September/October 2007:
Measurement and instrumentation

November/December 2007:
Transportation noise, noise and vibration control

Of course, the themed issues will not be exclusive to that subject area, and the regular features will still appear. Offers of contributions are invited, whether or not the intended piece fits into one of the above categories.

I have been asked by Kevin Macan-Lind to pass on to members a request from the Medals and Awards Committee. Any member publishing a paper at a non-IOA event is asked to alert Head Office, and to submit the paper electronically so that it may be archived at St Albans for future reference.

Although it is still far too early at the time of writing, I wish all our members and readers the compliments of the season and a happy and prosperous new year!

Intelligible Measurements

Ian Campbell. Meeting report

The first joint venture between the Measurement & Instrumentation and Electro-acoustics groups produced a near-capacity turnout of 90 for the meeting held at the Royal Society in London on 27 September 2006. The high attendance was probably due to the fact that the topic of speech intelligibility and its quantification has obtained a higher profile recently, with new regulations picking up on recent work in the standards field, and the growing pressures in the safety and quality-of-life areas of interest.

Sitting listening to the discussion reminded me of my early days in acoustics where we were arguing about the adequacy of dB(A) as a measure of the subjective reaction to noise, be it in terms of loudness, intrusiveness or (dare we say) annoyance. There is no doubt that there are more sophisticated metrics for these concepts, but they are complex and time-consuming. The good old dB(A) has carved a niche for itself based on its simplicity, and it is easy for the non-professional to understand: as a result it has become the front-line metric, allowing the specialist consultants to apply their more sophisticated techniques to the difficult and marginal cases uncovered by the screening process. So it is with intelligibility: we have the 'gold standard' of word tests and indices such as SII that take the complete process into account, including the diction of the speaker, the transmission path and the abilities of the listener. A simple review of the number of variables and the complexities of masking, non-native speech, etc shows how complex these measurements are, but there is no doubt that they are going to deliver results that bear a good correlation with the subjective reaction. Acoustical engineers can only really concern themselves with the transmission path, whilst the adequacy of the speaker and listener are within the remits of colleagues from other disciplines. As a result the speech transmission index STI has been developed and standardised to cover this area. Subsets of the standard have been developed to suit screening tests for public address systems (STIPA) and telecoms installations (STI-TEL), and the discussions seem to revolve around the cut-off points between the screening tests using STIPA, the full STI test, and subject-based word testing. Certainly with the limited number of suitably qualified consultants in this area the front-line screening will have an important role to play in directing their expertise to the critical areas, but the key question is: can we be sure STIPA will not give too many false positives, allowing unacceptable situations to be passed as acceptable?

The meeting started with a review paper from **Peter Mapp** (Peter Mapp Associates) which charted the history of the science of speech intelligibility testing, ranging from the early days of Epidaurus in 300BCE, through the early experiments using modulated gas flames to visualise the speech envelope, and Sabine's work in the fog auditorium, to the introduction of the early dedicated measurement systems. These have centred around the standardised STI system but with a full STI test taking at least 15 minutes to complete they did not come into widespread use until the introduction of the B&K meter to implement the rapid test (RaSTI) in 1985. The compromises to obtain the quick test, however, were somewhat overdone and Peter demonstrated that the errors obtained between full STI and RaSTI could be significant. This resulted in refinements to the method to bring about the STIPA and STI-TEL methods with several manufacturers introducing STIPA meters: these early meters naturally had some problems as there was no independent test regime, in contrast with the case with conventional sound level meters. Peter's consultancy performed a number of tests on these early meters and was able to feed back information to the manufacturers on the shortcomings that he found. As a result, many problems have been dealt with and the meters are now performing as expected. It has to be borne in mind that many of these meters use standard CD players to generate the test spectrum, and the quality of such players is the keystone of the entire measurement chain. In the discussion following the paper Leon Pieters raised the question of hearing aid users, who were limited to an f_{max} of 5kHz, whereas the STI method allows components up to 8kHz to be considered.

A contribution from **Ken Worrall** (HM Government Communication Centre) showed that for the complex applications they dealt with, full word testing was the best method. These tests ranged from complex communication in military environments through to the assessment of hands-free systems in passenger vehicles. The refinements that had been developed had the effects of reducing the uncertainty associated with the full word score tests and the test methodology looked at the complete chain including the quality of the talker, the transmission chain, including the vocoders used in the mobile telephone network, and the ability of the listener. These included interleaved word test algorithms (now preferred to the traditional sequential presentation of the word lists) as they allowed the test to be spread over a longer period of time and to tolerate breaks in the test. The overall program known as TACIT (Technique for Automatic Cognitive Intelligibility) had allowed intelligibility testing to move up the quantification agenda from the test of 'last resort' to one that could be used on almost daily.

The first of the three overseas contributors was **Glen Leembruggen** (Acoustic Directions, Australia) who reported on a project initiated at an earlier IoA Reproduced Sound Conference, where it was suggested that the effects of tonal imbalance in sound systems could have a significant effect on intelligibility. It was noted that small changes, for example a 1dB boost in the 1k and 2k Hz octave bands, or the removal of colouration due to resonances by a notch filter of 2dB at 415Hz, could bring a noticeable improvement in intelligibility. The programme of work allowed for the SII and STI to be compared when gross frequency distortions were introduced into the system, and the results compared with subject based word tests. The tests were confined to quiet reverberant conditions, and seven different spectrum shapes were considered which accounted for high, low, notch and band-pass types of spectral imbalance, with attenuations sometimes exceeding 20dB. With one or two exceptions the SII and STI results rendered similar results, but the check word scores did not track the quantitative assessment very closely. An interesting side conclusion was that in the word tests the subjects of Australian origin did not do as well as those from the UK, just one of the many complications associated with the study of these phenomena. Glenn's work will continue to develop reasons why with such gross distortions the metrics do not respond better.

A key paper was presented by **Sander J van Wijngaarden** (TNO Defence and Security, Netherlands) whose organisation had been the key driver behind the standardisation of the STI and associated metrics of speech intelligibility. The work tracked the development of standards over the three issues that had been published to date and drew some useful conclusions that will guide practitioners in their application. The first edition was based primarily on the RaSTI concept and the clear message was that this was now obsolete and should no longer be used. The second edition added more detail on mutual octave band dependency with

Tau Woo registers and heads for the pre-meeting discussion area revised specifications for test signals and more complete description of the algorithms, whilst the third edition dealt more comprehensively with the effects of masking as well as introducing the STIPA survey method as a replacement for RaSTI. When making survey measurements it was important to understand the limitations of the method and these were dealt with in terms of the need to recognise situations where:

- There was a strong fluctuation in the noise level: at low levels there was an underestimate and at high levels an overestimate of the intelligibility;
- Where the noise and speech were spatially separated, the result was an underestimate because the method was monaural;
- Systems that used voice compression (vocoders in GSM telephone networks etc) would produce an overestimate as a result.

A useful table was produced to show the range of conditions the various metrics would be able to cover and the test time taken.The full 15-minute test would cover all eventualities but with the exception of some instances of nonlinear distortion the 30-second STIPA test would yield comparable precision. A review of further development work being undertaken was also given and this included methods that use speech signals for an automated test to allow the mobile telephone network to be brought into the testing regime. The discussion that followed the presentation dealt with how the metrics would deal with differential hearing loss, and the treatment of early reflections and reverberation.

An ongoing PhD research project was reported on by **Emma Greenland**. This was concerned with the implementation of the recent BB93 on Acoustics in Schools, with particular reference to the requirement that the STI in some classrooms was to meet set standards. The school building stock was reviewed to identify the scale of the problem and to see how older designs could be brought into line with current requirements and teaching methods. Following a review of the technical requirements of the various standards, and the number of tests that were going to be necessary to quantify teacher-to-student, student-to-student and student-to-teacher communication, a test protocol was devised.To allow this to be carried out within the available budget a new design of artificial head and voice was developed for use in the measurement part of the project. The measurements were made in unoccupied classrooms and then corrected for the background noise associated with the various activities that went on in the teaching space. Uncertainty data was presented that would allow the survey methods or other metrics to be used to predict the full STI value.

The final overseas contribution came from **Ludger Holtzem** (NTI, Liechtenstein) and was concerned with the calibration of meters for the measurement of STIPA. The discussion was restricted to the modulated noise method as this was considered more practical than impulse response, as no synchronisation is needed between the signal and analyser. The generation of the test signals was dealt with first, especially the need

continued on page 12

Royal Society - the environment for scientific debate

Intelligible Measurements - *continued from page 11*

to use a good quality CD player or a digitally-generated test spectrum. With electrical feeds to a PA system the errors associated with an acoustic link were avoided, but where a complete system was to be verified then attention had to be paid to the quality of the voice simulator used, as there was a requirement to generate a spectrum having the correct balance between the frequency bands under test within 1dB. In the subsequent measurement chain the accuracy of the generated test field must not be compromised and hence the complete measurement chain must support this level of accuracy over the compete range of environmental conditions in which intelligibility was to be assessed: for example, the temperature could easily cover the range of 0 to 45 °C. The discussion that followed again touched on the need to verify that instruments were fit for purpose and for their limitations to be understood. Sander van Wijngaarden added that TNO had tested a number of instruments, but only in respect of how they implemented the intelligibility criteria. To date, no testing had been done to determine how good the instruments were at actually measuring noise.

Matt Aitchison (QinetiQ) reported on the improvements in intelligibility that could follow for headset users from the move from monaural to stereo presentation and then moved on to the further benefits of full 3D audio presentation. As his company was primarily concerned with military vehicles and complex coded communication systems, the team had to develop its own test synthesisers as it was just not practical to get real test environments for the number of subjects necessary. With full 3D presentation of audio the subject would have a true spatial picture of where a sound was coming from, and not just a position within the head, as would be the case with traditional stereo presentation. In conjunction with this project it was necessary to develop head tracking systems to be able to monitor the subject's movements in response to the presentation of the audio stimulus. The discussion that followed centred on the application of 3D audio, and naturally its application to computer gaming was raised.

The changing pattern of tertiary education, following the large increase in overseas students at our universities and the introduction of top-up fees for home-grown students, was the driver for the work reported by **Peter Rutherford** (Nottingham University). The basic thesis was that if the student could not understand the lecturer then they would not consider the course good value for money, and would go elsewhere for their studies. A review of the acoustic conditions in the University's stock of lecture theatres identified areas that would need improvement. Some original investigations were undertaken to determine a level of intelligibility that would be needed to satisfy the students' need for understanding. It was concluded that native English speakers would accept a lower standard than those who were studying in a second language; in some respects the additional degradation of understanding from poor acoustics was the last straw that broke the proverbial camel's back. When it came to the allocation of resources for improvements, money could either be spent on a better acoustical environment, or on improving the standard of English of foreign students.

The degradation of speech intelligibility when wearing hearing protection has been studied on a number of occasions and this topic was taken a stage further by **Tim South** (Leeds Metropolitan University). He has been looking at the effects on intelligibility of the use of industrial respirators. The growing use of personal protective equipment (PPE) which covers the face and mouth was growing, with the police using riot helmets with face protection, and the fire service and others using full respirator systems. Manufacturers tested the PPE they produced for its effectiveness in the intended application, but the ability of the wearers to communicate could also be a safety-critical function. This had been recognised in ISO 9921, and its recommendations for the vocal effort needed in various emergencies, and the appropriate levels of speech intelligibility, were reviewed. In developing a test protocol a number of new factors had to be considered, as the PPE affected the way the wearers heard their own voices, and the associated pumps and filters introduced internal noise: these factors affected the vocal effort used by the subject. Additionally, a respirator would change the directivity pattern of the human voice, so the resulting STI was reported in the study for different angles of incidence for each type of respirator considered. With some designs of respirator it was found that the STI actually decreased with increasing vocal effort, because the increased air pressure inside the respirator resulting from loud speech caused valves in the PPE to malfunction. In conclusion, there was more work to do in developing an acoustic manikin that would accept these types of PPE, and to understand the effect of positive pressures on the mouth and ear simulators used in the test set-ups.

The effectiveness of the speech intelligibility metrics at low levels was being investigated by **Christos Nestoras** (London South Bank University) and as this was an ongoing research project the presentation was limited to reporting the outline, the theory behind the work, and the measurement protocols that would be used.

The final session was a review of the standardisation work currently in progress and an opportunity for the delegates to continue, with the international panel of speakers, the discussions commenced during the breaks on the various technical points that arose during the meeting. These were complemented by some workshop-type tutorials on how intelligibility measurements could be made in the seminar room: some good STIPA results were obtained and no doubt this helped the participants in obtaining from their day at the Royal Society a much better understanding of the current science behind the quantification of speech intelligibility.

Emma Greenland uses a very traditional setting to discuss modern teaching spaces

The Sixth International Conference on Auditorium Acoustics

Mike Barron, Trevor Cox and Raf Orlowski

Auditorium acoustics meetings organised by the Institute have been running since 1992. While previous meetings all had individual titles, in this case we had graduated to the Sixth International Conference on Auditorium Acoustics. Going 'international' is a much loved progression for establishments like regional airports, for whom a 12-seater flying to a channel port is probably sufficient justification. In the case of this meeting, not only in the past have there been more foreign attendees than British ones, but for the first time the meeting itself was actually held abroad.

The meeting was held in Copenhagen on 5 to 7 May 2006, based in the Scandic Hotel in the middle of Copenhagen. Of about 150 delegates, less than a quarter came from the UK. The foreign location would not have been possible without the generous cooperation of the Danish acoustical society (Dansk Akustik Selskab). Our particular thanks go to Claus Møller Petersen, current president of the Danish society, and Anders Christian Gade, who was at the centre of arrangements for the visits during the conference.

Since the start, the recipe for these auditorium acoustics meetings has been that they were linked to a new (or refurbished) auditorium. At all meetings, there had either been a visit to the auditorium or attendance at a performance, or sometimes both. For the first meeting in 1992, the auditorium was the new Birmingham Symphony Hall. Then in 1995 it was the turn of Glyndebourne Opera, in 1997 the Waterfront Hall, Belfast, in 1999 Bridgewater Hall, Manchester and most recently the refurbished Royal Albert Hall, London in 2002. The choice of Copenhagen this year was stimulated by a desire to spread our wings (for which we have to thank Stephen Chiles) and because of the considerable auditorium building going on in Copenhagen at the moment. The new buildings in Copenhagen are replacements for the Royal Theatre and a new broadcasting complex for Danish Radio.

The Royal Theatre in Copenhagen of 1874 bears some similarities to our Covent Garden constructed 16 years earlier, though with around 1200 seats it is distinctly smaller. It had until recently been the home of the Royal Theatre Company, the Royal Ballet and the Royal Opera. While pondering how to provide larger facilities for each of these companies, Denmark's richest man, Mr Møller (head of A P Møller Foundation and former owner of Maersk, the largest shipping line in the world) offered to make a gift of a new opera house to the people of Denmark. The new Copenhagen Operean is located on a prime site, formerly owned by Mr Møller, on the waterfront facing a main Copenhagen axis that runs diagonally across the square containing the Royal Palace with a prominent church at the end. A new Royal Theatre building is currently under construction on the opposite side of the water to the opera house.

Contrary to the situation in London, the Danish broadcasting authority has had a thousand-seat concert hall since 1945, where the public could attend performances. With the move of all broadcasting facilities to a new site in Copenhagen, a new 1800 seat concert hall is being built. The new hall follows the vineyard terrace format and will be the largest classical music venue in the city. It is under construction, due to open in the summer of 2007; the acoustic consultants are Nagata Acoustics of Japan.

The main focus of the meeting was the new opera house, which opened last year, with Arup Acoustics as its acoustic consultants. A visit to the house was arranged on the second day of the conference but sadly it was not possible for many to attend a performance. During our visit, the Royal Opera was performing Wagner's Ring cycle for the first time in 100 years and tickets were only being sold for all four operas, each performed two days apart.

This meeting attracted the highest number of delegates so far in our auditorium acoustics series. While this was extremely welcome, we

the one-tenth scale model of the Danish Radio Concert Hall

also had more papers submitted than could be fitted into the programme for oral presentations. About 40% of the papers had to be presented as posters and much thought was required in order to decide which were more suitable for this form of presentation. To ensure that as far as possible posters were given the respect they deserved, a ½ hour session on the Friday was specifically devoted to viewing the posters, most of which remained pinned up for the rest of the conference.

The conference itself began in earnest on the Friday morning with welcomes from both the acoustical society presidents: **Claus Møller Petersen** for the Dansk Akustik Selskab and **Tony Jones** for our own Institute. **Mike Barron** then added his own welcome and mentioned some administrative details, before presenting the first paper of the conference with his colleague **Jens Jørgen Dammerud** (both at the *University of Bath*). They reported on early studies as part of a three-year project on the acoustics of concert hall platforms. The project will involve both objective analysis and work with the Bournemouth Symphony Orchestra. They discussed what was to be found in the literature, what appear to be the key issues of stage acoustics, as well as results of diffraction measurements they have made on typical surfaces around stages. The remaining papers of the first session were also loosely linked to acoustic conditions around performers.

For the second paper we turned to the new Copenhagen Opera. **Eddy Brixen** (consultant and presenter) and **Claus Wolter** (*Royal Danish Theatre*) described an electro-acoustic foldback system for performers on stage in the new opera house. This was in place at the opening of the house, allowing for a smooth transition into their new environment. The system is apparently in use for most performances.

Peter d'Antonio (*RPG Systems*) presented a paper co-authored by **Trevor Cox** (*University of Salford*) on the design of canopy arrays for concert spaces. They discussed how their quantitative analysis of sound reflection from finite objects, such as curved panels, can be used to design an optimised array to be placed above a concert platform. This optimisation involves impressive numerical techniques, but from the questions after the paper it was clear that there was not unanimity over the subjective and objective criteria for such arrays.

After a coffee break, we were fortunate to have a presentation by the director of DR Byen (*Danish Broadcasting*) **Kjeld Boye-Møller** about the new Broadcasting Centre in Øresund, in the south-east of Copenhagen. The architect for the overall scheme, Vilhelm Lauritzen, selected by competition in 2000, devised a four segment arrangement of rectangular plan buildings. Three of the segments were designed by

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three other architects. Segment 4 which contains the concert hall is designed by Ateliers Jean Nouvel. This segment consists of a series of broadcast studios in the basement (orchestra, big band and choral studios) with the concert hall positioned above them. The Centre is currently under construction due for completion in 2007 as already mentioned.

Yasuhisa Toyota (with co-authors **Motoo Komoda** and **Ayako Hakozaki**, all of *Nagata Acoustics*) proceeded to describe the acoustic design of the new concert hall. Nagata Acoustics are known for two completed vineyard terrace form concert halls: in Sapporo in northern Japan (1997) and the Disney Hall in Los Angeles (2003). For the Danish Radio concert hall the audience numbers are a comfortable 1600 plus 200 choir. The long section is reminiscent of the Berlin Philharmonie of 1963 with its tent-like profile, but the seating climbs high up above the stage. The internal plan is in fact asymmetrical with seating separated by plane surfaces. The design has been tested with a 1:10 scale model reported later in the meeting.

For the remainder of the second morning session, we turned to the new Copenhagen opera house. **Rob Harris** (*Arup Acoustics*) tackled a subject often ignored in acoustic design: noise control of stage engineering systems. This is particularly important when there is a main stage surrounded by five other stages, with the facility for floor sections to move on wagons. Rob considered all the moving elements which should be operable during a performance: power flying, stage wagons, stage elevators, scenery doors and the house curtain and concluded that the 'silent move' was becoming a reality.

Jeremy Newton (also *Arup Acoustics*) compared the acoustics of the new Copenhagen opera house with the house in the Wales Millennium Centre, Cardiff; both were completed in the autumn of 2004. Of the two, the Welsh house, known as the Donald Gordon Theatre, is slightly larger with 1800 as compared to 1650 seats in Copenhagen. Their plans are basically different however, fan-shaped in Cardiff and traditional horseshoe in Copenhagen; their reverberation times 1.4 and 1.5 seconds respectively. Jeremy provided many interesting details contributing to a fascinating comparison. Both houses have been praised for their acoustics.

After lunch, we heard from **Bengt-Inge Dalenbäck** about real-time walk-through auralisation, as implemented in CATT-Walker. The technique is based on full-length B-format FIRs (finite impulse responses). These FIRs are calculated and stored for a range of positions in the space to be modelled. The technique uses interpolation to allow listening over headphones to a walk through the space in real-time.

Lamberto Tronchin from *Bologna University* presented two papers relating to virtual presentation of sound fields recorded with a dummy head in an acoustic listening room. The first paper considered the subjective accuracy of spatial impression following recording and replay through a stereo-dipole using cross-talk cancellation in the listening room. The second paper considered the accuracy of creating virtual sound fields of two actual opera houses and two concert halls. Accuracy in terms of sound level spectrum and early decay times was good. Some of the techniques used may be relevant to 'home theatre' sound reproduction.

The poster session followed with an hour and a half to browse with a cup of tea in hand. In all about 25 posters were presented. Many of the posters described recent consultancy on existing or new buildings. The following mentions a few of the poster topics.

From the *University of Sheffield*, **Chourmouziadou** and **Kang**'s poster described techniques for computer modelling in ancient Greek theatres that take account of diffusion and diffraction; these can be more significant in open-air auditoria due to the small number of reflections present. **Daniel Commins** (*Daniel Commins Workshop*) and the architect **F Didier** reported on the opera house at the Château de Versailles which is nearly all constructed in timber. It includes a common feature in opera houses of the time but whose function is now unknown: a half-cylinder cavity below the orchestra pit.

The poster by **David Griesinger** of *Harman Specialty Group* presented intriguing ideas about the importance of perceiving harmonics of the singers' voices in opera houses. He considers these harmonics contribute towards creating a sense of intimacy. Hearing his recordings helped make sense of the complex issues involved.

A compehensive description was given on the poster by *Nagata Acoustics* (authors **M Komoda, A Hakozaki** and **Y Toyota**) about the scale model testing for the new Danish Radio Concert Hall. A scale of 1:10 was selected; the model was built of timber which was thoroughly varnished. Testing included: optical checks using mirror paper, subjectively checking echoes using a directional loudspeaker and model dummy head and objective measurements with the model flushed with nitrogen. A good density of early reflections is anticipated.

The Düsseldorf Tonhalle with 1950 seats has laboured with a form close to a hemisphere since its construction, with predictable focussing problems. **Klaus Lorenz** and **M Verkammen** (both of *Peutz Consultants*) explained how the hall was refurbished with an acoustically transparent ceiling hiding highly diffusing surfaces applied to the dome.

Nicola Prodi and **Roberto Pompoli** (*University of Ferrara*) discussed

The Copenhagen Operean was the main focus of the meeting the coupled volume issues that arise in opera houses, including measurements with varied amounts of absorbing material in a stagehouse. **Magne Skålevik** of *Brekke & Strand, Oslo*, reported on 'Low frequency limits of reflector arrays' as relevant to arrays above an orchestra platform, for instance. His study included both theory and results of model studies.

Michelle Vigeant, Lily Wang (both of the *University of Nebraska*) with **Jens-Holger Rindel** (*Technical University of Denmark*) described using the Odeon computer simulation with attention to source directivity; tests showed that this improved the subjective quality of reproductions. A related study was reported by **Ingo Witew** and colleagues from the *RWTH Aachen University*, **Paprotny** and **Behler**, regarding simulations using multiple recordings from an orchestra in an anechoic chamber. A 12 independent source representation was preferred overall.

And finally, the poster by **Thomas Wulfrank** and **Raf Orlowski** (*Arup Acoustics* - Thomas is now with Kahle Acoustics) gave a very thorough analysis of the issues addressed in a recent refurbishment of the Wigmore Hall, London, including an interesting subjective test in the hall to assess whether raking the rear stalls would be beneficial.

To complete the day, there were three conventional presentations. **Dario Paini** of the *Politecnico di Milano* (with co-authors **Anders Christian Gade** and **Jens-Holger Rindel** from the *Technical University of Denmark*) compared the acoustic issues relevant to outdoor performances with the better documented equivalents in enclosed auditoria. For instance, the absence of raked floors presents major limitations in outside locations. They concluded that echoes were often an issue in outdoor locations, particularly in city squares, and that Centre Time and Strength G seemed the most useful parameters.

Jean-Dominique Polack of the *Université Pierre and Marie Curie, Paris*, started by posing the question: are concert halls random number generators? Jean-Dominique applied a simple theory to measurement results from a group of nine American concert halls and concluded that the answer to his question was no. A subsidiary result was that a possible target value for music rooms of all sizes is to have a mean absorption coefficient of 0.3.

Trevor Cox together with authors **P Kendrick** (both *University of Salford*), **Y Zhangy** and **J Chambers** (*University of Cardiff*) and **F Li** (*Manchester Metropolitan University*) have been working on extracting room acoustic parameters from music. The maximum likelihood procedure shows promise in extracting the reverberation time, early decay time (EDT) and Centre Time; some types of music are more promising for these approaches than others.

With an early start on a sunny Saturday morning, we were bussed round to the new opera house. The opera house dominates an area that is basically open, allowing generous space for people to walk around it. The glass-clad foyer space offers marvellous views overlooking Copenhagen's most important waterway; this is a very different experience from most opera houses and theatres in large cities squeezed between other buildings. The opera house is the new home for both the Royal Opera and Royal Ballet. On our tour, many people commented on the high standard of finish throughout the whole building. This extends to the use of gold leaf on the ceiling of the auditorium (1.4kg of gold); but one wonders how many of the audience can actually appreciate this feature? We were taken to the extensive backstage areas. It has now become common for grand opera to have five supplementary stages arranged around the main stage; this allows for rapid scene changes with large sections of scenery on wagons that move from one stage space to another. The auditorium itself with 1650 seats and three balconies follows the horseshoe plan; again a space that is beautifully detailed. The Danes are fortunate to receive such gifts.

After the visit to the Opera House, the papers began late on Saturday morning with **Niels Jordan** (*Jordan Akustik*) and **Jens Holger Rindel** (*Technical University of Denmark*) talking about the refurbishment of the 1957 Alberta Jubilee Halls in Canada that are fan-shaped in plan. The problems encountered will be familiar to many designers: the ceiling

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was too low, there was a lack of early lateral reflections and excessive EDT. By breaking up the audience blocks, shaping the walls and exploiting the ceiling voids to increase volume, the acoustics of the hall were much improved.

Wolfgang Anhert (*ADA Acoustic Design Ahnert*) gave a historical review of the Frauenkirche in Dresden. The 16th century church was destroyed in the second world war, but has now been restored to its former glory. The acoustic design was difficult since the allowable changes to the internal structure were limited because of the desire to faithfully reproduce the old church.

Jens Holger Rindel presented a complex virtual reality reconstruction of performances at the ancient Roman concert hall in Aphrodisias in Turkey. Acoustic challenges included having to make anechoic recordings of the original musical instruments, modelling the acoustics of the enclosed hall and realistically auralising the sound from the crowd.

Raf Orlowski (*Arup Acoustics*) reviewed the design of the Syddansk Universitet Kinvertsal in Sønderborg, Denmark. What stood out in this talk was the conditions for the test concert. This was undertaken in full evening dress while the hall was still a building site and full of scaffolding.

In the afternoon, the presentation by **Adrian James** (*Adrian James Acoustics*) included an anechoic hedge. This amusingly presented paper was, however, on a very serious topic: the hearing loss suffered by classical musicians. His assertion that the literature only showed mixed evidence as to whether classical musicians suffered hearing damage caused some disquiet in the audience!

Luca Dellatorre (with colleagues from the *Politechnico di Torino*) examined the perception of professional and non-professional musicians using questionnaires for performers in three Italian halls. They found that some musicians wanted a drier acoustic during rehearsal to enable them to hear their mistakes more easily.

Georgios Natsiopoulos, co-authored by **Mendel Kliener** (*Chalmers University, Gothenburg*), gave the most theoretical paper of the day when he examined the use of a boss model to model the effects of columns and other surface modulations in halls. The mean error of the prediction models was about 3dB.

Kanako Ueno (*University of Tokyo*) used 3D auralisation techniques to create a real time environment for musicians to examine the conditions that they want to be able to play well. This extensive study used two anechoic rooms to enable ensemble performance to be examined.

Jürgen Meyer took a historical view of rooms used for chamber music. By examining historical photographs, he showed how the reverberance of rooms used for chamber music has changed over the centuries. He discussed the importance of considering the reverberance of the musical instruments as well as that of the room when considering the correct acoustic for chamber music.

Maarten Luykx (*Peutz Consultants*) confused everyone by producing a picture of what looked like the Copenhagen Opera House, but it actually turned out to be a new concert hall in Amsterdam by the same architect. By using a moveable ceiling, the volume of the room could be increased by 50%, changing the reverberation time from 1.8 to 2.5 s.

To finish the day, **Duncan Templeton** (*BDP Acoustics*) recounted a poor opening night in a 'fried egg'. The management didn't believe the air conditioning was working because it was so quiet, and ended up turning it up so much the noise affected the concert. (Fried Egg is the nickname of the new Perth Concert Hall because of its shape and green roof).

Henrik Möller (*Akukon, Helsinki*) from Finland gave the first paper on Sunday and started by apologising to the delegates for disturbing them so early in the morning! His paper was a joint one with **Jerry Hyde** of the USA and discussed sound strength in small halls. Their careful analysis of this important subject is informing their design of a new, small hall in Finland.

John O'Keefe (*Aercoustics, Toronto*) described the design of a 700 seat theatre at the Esplanade in Medicine Hat, Canada. He discussed the challenges of using computer modelling for simulating partially open surfaces such as an orchestra shell and showed comparisons with measurements in a scale model. John also described a procedure he has developed for calculating noise from displacement ventilation systems.

Tapio Lokki from *Helsinki University of Technology* presented a paper on the geometry reduction in room acoustics modelling which he co-authored with colleagues **Samuel Siltanen** and **L. Savioja**. The method they have developed simplifies complex architectural models in AutoCad, for instance, which can then be analysed using the Odeon software.

The trusty method of acoustic scale modelling was given a further airing by **Anders Christian Gade** (*Technical University of Denmark*). He described tests he had done in a 1:10 scale model of the new Danish Radio Concert Hall. In addition, he showed model experiments on the curved auditorium wall for the new Drama Theatre in Copenhagen which were aimed at designing suitable diffusion to avoid focusing.

Stephen Chiles (*Marshall Day Acoustics*), an important catalyst in the organisation of this conference, had come all the way from New Zealand to give his paper on the optimisation of balcony overhangs. His theme was to augment Beranek's simple rule of the ratio of height to depth by investigating the concept of minimum vertical angle proposed by Barron. He used acoustic scale modelling (again!) to develop his proposition that the receiver vertical angle of view is a good design guide and suggested that an angle of 50 degrees will provide good conditions.

A spare slot in the programme was admirably filled by **Anders Christian Gade** who gave a slide show of the design and construction of the new Drama Theatre in Copenhagen.

Next was a double-act by architects **Susie Bridges** and **Norman Bragg** from *Renton Howard Wood Levin (London)* whose presentation was in collaboration with Richard Cowell of Arup Acoustics. They provided a refreshing account of variable acoustics from an architect's viewpoint using illustrations from numerous projects they have been involved with. They concluded by looking at the advantages and disadvantages of mechanical and electro-acoustic systems and pointed out that some spaces such as the Wigmore Hall work best without variable acoustics.

Chris Walls of *Munro Associates* presented a paper co-authored with **Andy Munro** about the Sutluce Congress Centre and Concert Hall in Istanbul, Turkey. He showed how they used a combination of geometric and electro-acoustic enhancement to solve the acoustical challenge of a very large fan shaped auditorium seating 3400.

Claus Petersen of *Carl Bro a/s* described acoustical improvements in Parken, the Danish National Football Stadium in Copenhagen. The paper was prepared jointly with S. Ballisager. They used numerous analysis techniques to optimise the acoustics for large music events including Odeon modelling and auralisation and achieved a successful outcome.

Finally, the imposing figure of **Tor Halmrast** from *Statsbygg*, Norway, took to the podium. Tor was one of the few speakers who did not wear the microphone headset provided. He put paid to the concept that 'one size fits all' which was evident from the size of his head - he settled for a lapel microphone instead. Tor described his work as a 'client acoustical adviser' on numerous projects in Scandinavia and concluded with a key phrase 'The importance of being early', meaning that many decisions are taken before the acoustic consultant is chosen.

In the afternoon, a trip was organised to the construction site of the new Danish Radio Concert Hall. Before donning safety boots and hard hats, a video presentation was given with plentiful details about tons of concrete and acreages of glass as well as some useful acoustical facts. The tour guide was supported by Anders Christian Gade, who gave some valuable insights into sound insulation challenges encountered during construction - floating floors were a good example. In addition to the tour, it was possible to look around the 1:10 scale acoustic model of the concert hall and also to chat to the lead acoustic consultant for the hall, Yasuhisa Toyota.

After the tour, there was still time for some delegates to drink a glass of Carlsberg before the flight home and to ponder whether this was probably the best auditorium acoustics conference in the world!

Autumn Conference 2006

Environmental noise, WHO, Guidelines and Mapping

The Cranmer Suite at the Oxford Hotel, Wolvercote, Oxford again provided the backdrop for the Institute's Autumn Conference, which was held on Monday 16 and Tuesday 17 October 2006. All the papers were presented in the large, modern conference room, which was transformed into the Conference Dinner venue early on the Monday evening. Again, the hotel staff demonstrated that the venue conversion was a reversible function, with the Tuesday morning lecture room showing no signs of the previous evening's jollity. The exhibitors' stands this year were in a semi-permanent marquee, which was well heated, light and airy by the time the conference began, although I understand the exhibitors found it rather chilly when they arrived to set up on the Sunday evening. Nevertheless, several instrumentation manufacturers and importers, consultancies and software companies supported the Institute by taking stands: their contribution to the success of the conference is gratefully acknowledged. As far as I know, no attempt was made to measure the sound transmission loss of two layers of canvas, but distant road traffic on the A44 was an audible backdrop to the exhibition.

The conference was entitled 'Environmental noise, WHO, Guidelines and Mapping: the interposition of a second comma between 'WHO' and 'Guidelines' may have been accidental, but the advance flyer and the delegate package were consistent.

The organising committee was able to gather together an interesting and varied programme within the bounds it set itself, with 18 presented papers including an invited lecture by Prof Birgitta Berglund and the 2006 IOA Engineering Medal Lecture by Brian Hemsworth. The Institute thanks all those involved for their hard work, especially Ken Collins,

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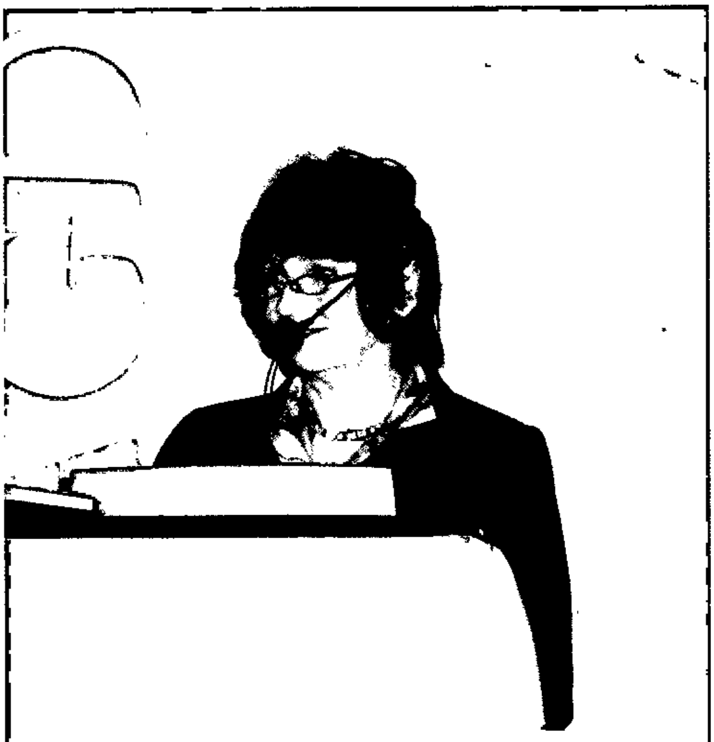

Prof Birgitta Berglund presents her invited lecture

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chairman of the Environmental Noise Group, who opened the conference proceedings promptly at 10:30h.

Presented papers

From WHO Guidelines for community noise to healthy soundscapes was the title of the invited lecture by **Prof Birgitta Berglund** (Stockholm University). Prof Berglund was one of the principal authors of the latest WHO guidelines for community noise, and she suggested that we may learn from Albert Einstein that 'a completely new way of thinking is required for solving the problems we have created with the old way of thinking'. The World Health Organisation's remit was to protect health, but old way of thinking had been to do this by controlling noise emissions, one at a time at source; reducing noise transmission by sound-obstructing measures; and addressing noise immission by noise mapping and zoning around roads, airports and industries. Engineering, administrative and legal measures all had a part to play. However, since 1995 the EEA, WHO and EU had all recommended education and information as noise management measures. These included the raising of public awareness of the health impacts of noise, enforcement action taken, sound levels generally, and noise complaint procedures, research and development, and the initiation of behavioural change. These alternative ways of accomplishing sustainable development were still young, and it was too early to evaluate their efficiency, but the old way of thinking did not reverse the unsustainable trend in increasing noise pollution.

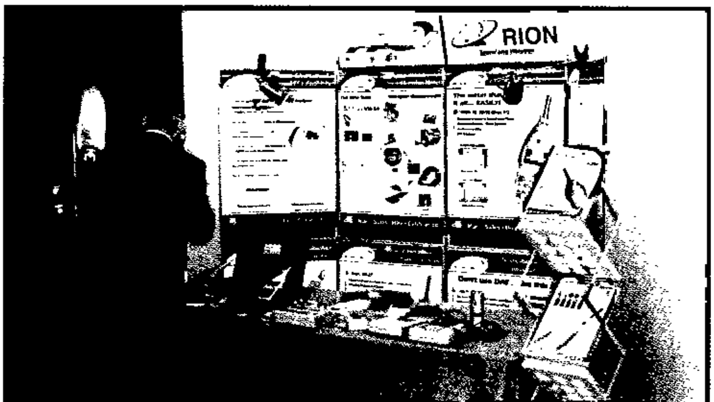
Stephen Turner (Bureau Veritas) then recounted the *IEMA/IOA Noise Assessment Guidelines*. Over ten years ago, the IOA and the Institute of Environmental Assessment (now IEMA) formed the Noise Impact Assessment Working Party. This arose from some workshops held by the Environmental Noise Group of the IOA when it was identified that the quality of noise impact assessments was very variable and that there was a lack of information available to help those undertaking noise assessments. Much work was put into the guidelines by the working party, very much as a spare time activity. In early 2002 a draft document was published for consultation by the IOA and IEMA, giving around 100 pages of information and advice regarding the process of undertaking a noise assessment, either as part of a full Environmental Impact Assessment, or in support of a small planning application. The document proved popular, but the sought-after comments were slow to arrive. Although it had not yet been published, Stephen took the opportunity to show some elements of the guidance document and to remind the conference of its approach. The first of the two parts covered the principles of environmental impact assessment and noise rating, and discussed the noise indicators in common use for various purposes. The second part considered noise impact assessment in practice. Following an introduction to assessing noise impacts, there were chapters which dealt with baseline noise levels, noise assessment, noise mitigation, presentation of results, and review and follow up. It was possible that some practitioners would find these guidelines disappointing, as the latest version did not state what was, or was not, an acceptable magnitude of noise change; they did not define what decibel change would cause a particular impact; and they did not provide any simple step-by-step process to produce a result. Noise impact assessment was a complex issue, and many factors had to be considered: and the guidelines described those factors.

The origins, aims and ambitions of the BS.9412 Assessment methods for environmental noise were explored with his customary panache by **Bernard Berry** (Bel Consultants Ltd). BS.9142 had its origins in the early 1990s when the UK representatives on the ISO Working Group revising ISO1996 put forward a proposal for a fundamental revision. The proposal was well received and it was thought that the entire Group was in favour. However, once the Group had left the meeting at BSI HQ in Chiswick the ideas were forgotten. Bernard recounted the saga of how the BS.9142 Standard was originally designed and drafted, and how it had been developed. He illustrated some of the problems facing the process of standardisation in the UK today, and made some thought-provoking comments, keeping the packed audience on their intellectual toes.

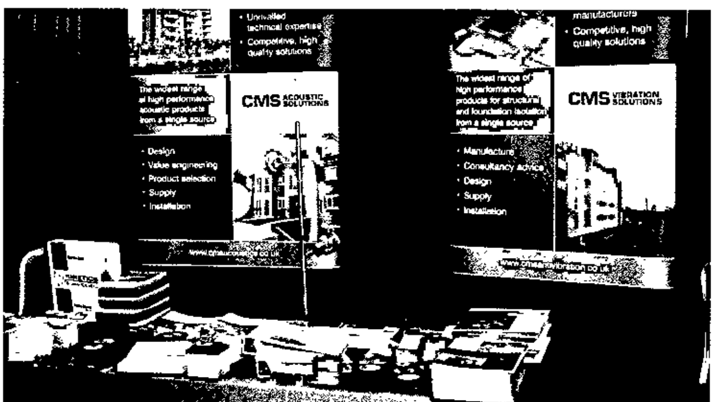
The use of WHO guidelines in setting noise limits was the first 'subtitled' session, chaired by Steve Mitchell. The first of the three papers was given by **Martin van den Berg** (Netherlands Ministry of Housing) with the title *Two ways to derive design targets from noise emission*. The two different

A coffee break in the exhibition marquee

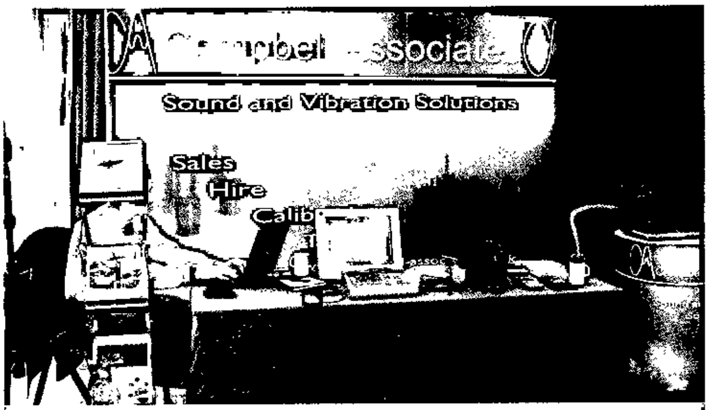
Exhibition stand: Casella CEL



Exhibition stand: ANV Measurement Systems



Exhibition stand: CMS Acoustics



Exhibition stand: Campbell Associates

Exhibition stand: ProsCon Environmental

approaches were conventional cost-benefit analysis and a health based approach. The former was not able to express all the benefits of a particular noise control strategy, but a health-based approach could not tell the whole story either. Martin therefore sought to apply both together. The problem with considering health and wellbeing was that although it was taken for granted that there could be long-term effects, it was difficult to find reasonable targets to protect the population whilst giving the right weight to society's other needs and goals. He contrasted the planning limit values for road and rail traffic noise in different countries, and drew some comfort from the fact that there seemed to be a common understanding of what was desirable in the long term, even though different noise indicators were used. An efficient approach for noise abatement was to start at the source. The experience of the past 30 years showed that although efficient in theory, it was certainly not the easiest way to proceed. There were some small successes, but on the whole the progress had been limited, notwithstanding good intentions and the expenditure of considerable technical resources. Until now progress had been by small successive steps, which perhaps had not brought the improvement hoped for. In order to know how long this would go on, a final target had to be defined. Martin described two procedures to derive these targets for regular noise sources and made a first estimate of possible outcomes.

Next, **Ian Flindell** (University of Southampton) presented his take on *What [do] noise targets, guidelines and limits really mean.* Never one to respect 'sacred cows' or custom and practice, Ian was able to tell the audience where some of the more familiar numbers used in environmental noise assessment really came from, and posed several challenging and thought-provoking questions about what practitioners should be doing.

After a mid-sessional tea break during which some of Ian's more controversial assertions were dissected, **Dani Fumicelli** (Faber Maunsell Ltd) discussed *WHO Community noise guidelines - help or hindrance to achieving sustainable development?* in a paper co-written with Nigel Triner (also Faber Maunsell Ltd). The Government had identified a

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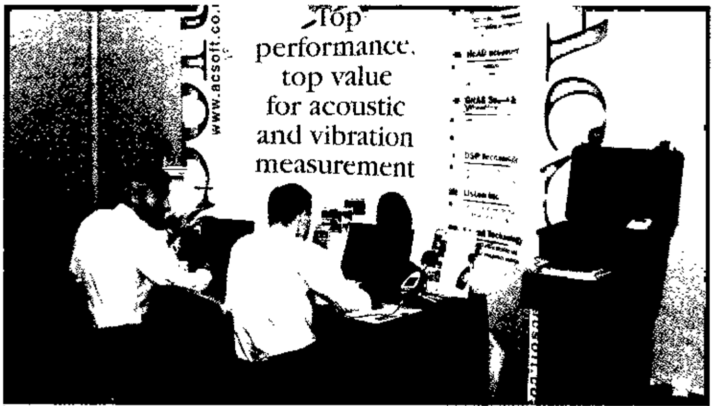
pressing need for large numbers of new homes to be created and was committed to sustainable development, with the assumption that brownfield sites would be developed in preference to greenfield sites. This had led to tensions and conflicts between overall planning objectives and the advice contained in the WHO noise guidelines, because the preferred urban and brownfield sites for housing development could be in acoustically challenging locations. Consequently, a more flexible and creative approach was fundamental to achieving a balanced approach to sustainable development, if the WHO guidelines were used to assess the acoustical acceptability of development proposals, whether by national or regional government, Local Planning Authorities or developers. Danny asserted that WHO guidelines should be seen a starting point in the assessment of noise impacts, rather than the final word on the issue. Whilst the WHO guidelines represented suitably aspirational targets we should not be afraid to move away from them where it was impracticable to achieve the recommended noise levels and resulting noise impacts were unlikely to be substantially adverse.

There followed an open discussion on the use of the WHO guidelines in setting noise limits, which examined in some detail the uses and abuses to which the guidelines have been, and are often, put. A detailed account of the discussion will appear in a future issue of Acoustics Bulletin, but the basis was a set of 18 topics or questions compiled by the chairman, Ian Flindell, as a result of suggestions from the floor. The topics were:

1 Birmingham City Council's 'alternative' to PPG24;
2 Clarification of the night-time L_{Aeq} guidelines (30 or 35 dB);
3 The monitoring of health effects of noise;
4 How opening windows and alternative ventilation should be treated;
5 The use of unsealed windows to permit rapid or 'emergency' ventilation;
6 Secondary benefits of housing developments (in noisy areas);
7 Should mitigation measures be included in a site assessment?
8 Sensitive people (eg children) in planning;
9 Separation: what is it?
10 'Respite quiet' areas in the assessment;
11 Why BS.9142 and IOA/EMA guidelines?
12 Should there be more focus on receivers?
13 Why was there so much reliance on annoyance or complaints?
14 Status of the WHO guidelines;
15 Does choice affect the assessment?
16 Prediction methods;
17 Individual *versus* community effects;
18 Long term *versus* short term indicators.

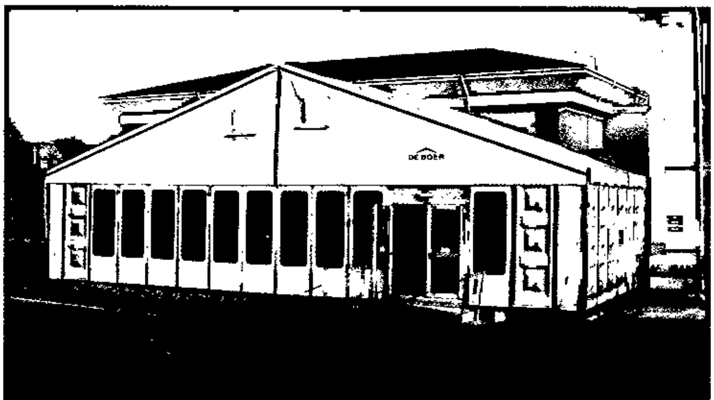
The final presentation of the day was given by **Brian Hemsworth** (noise consultant) whose Institute of Acoustics Engineering Medal Lecture was on the subject of *Railway noise: a personal journey*. Brian's journey (by train wherever possible, of course) has taken him all over world to compare notes and practices with railway operators, and he was able to give the audience the benefit of his insight into how railway noise is created, propagated and controlled. His journey took him through noise research pertaining to railways, via the Channel Tunnel Rail Link (CTRL) and noise legislation to public consultation on noise matters. Some of the more interesting points he covered were that the changeover from iron tread braked rail vehicle wheels to disc braked wheels had produced an unsought benefit of 10dB reduction in rail/wheel noise. This was not, as I at first thought, because the braking system was inherently quieter, but because the more modern disc brake pads did not leave flats on the tread surface of the wheels. The 'threepenny bit' profiles (50p piece for our younger members) had been causing considerable speed dependent rail/wheel noise and once the source was eliminated, the problem became much smaller. Brian discussed the public response to railway noise, and hinted at the difference between attitudes to rail and road noise, whilst considering the best way to monitor the former.

Brian's discourse on the CTRL included the possibly apocryphal story that on the British side of the project, £380M had been spent on the terminal at Waterloo International, and very little on the railway linking it to the tunnel: on the French side, about the same sum had been spent on the high-speed rail link, but an additional escalator was installed at Gare du Nord. Returning to the acoustics, a time profile for the pass-by

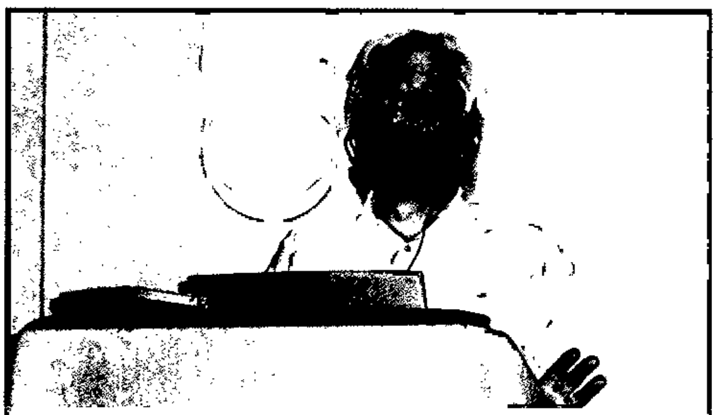


Exhibitor stand - Acsoft

Exhibitor stand - Brüel & Kjær



The exhibition (and coffee breaks) were held in a marquee this year



Ian Flindell delivers his paper

An attentive capacity audience

The PA system was provided and operated by Ken Dibble

of a high-speed train (the TGV Atlantique, which is very similar to the Eurostar) clearly showed the 'two-peak' effect of the tread braked front and rear cars, compared with the disc braked passenger cars. The prediction of noise from Eurostar has been an important element of the public consultation into the CTRL, now nearly completed.

After looking at the legal side of railway planning - was a change to freight trains a 'change of use' or merely an operational difference? The CTRL Inquiry decided that trains were trains were trains, regardless - Brian showed a number of possible noise reduction measures. These included bogie shrouds, elastomeric damping of track, wheel web shields, wheel tuned absorbers, and low trackside barriers, and he suggested how a cost-benefit analysis could support the introduction of further noise reduction. Despite resistance on the part of both the train operators and the permanent way owners, it was possible to achieve a further 10dB of reduction in noise, as an alternative to the 8m or higher barriers used alongside highways in the Netherlands. He concluded his very well-received lecture with some remarks about the Environmental Noise Directive and its likely knock-effects, which would lead us gently into the second day's presentations. With the clock having reached 18:05, an adjournment to the bar was called for.

Evening programme

The Annual General Meeting of the Environmental Noise Group was to have followed Brian's paper, but was postponed owing to circumstances beyond the committee's control. The rearranged AGM will be publicised in due course.

A drinks reception in the exhibition marquee was followed by the Conference Dinner on the Monday evening. Those of us who had been to the venue before were not disappointed by the quality of the food or the service, and the house wines (as always) lived up to expectations. After dinner Colin English, attending his first Autumn Conference in the capacity of President of the Institute, gave a brief speech and introduced Ed Clarke, President of the Association of Noise Consultants (ANC), who presented **Claire Churchill** with the ANC's award for the best Diploma project 2006. Colin then presented to **Jeff Charles** an Award for Distinguished Service for his outstanding contribution to the life of the Institute.

The Tuesday sessions got under way under the chairmanship of Ken Collins (deputising for John Hinton, who we understand had been the victim of a 'fishing accident'!) with seven papers concerned to a greater or lesser extent with Noise Mapping. The first was by **Graham Parry** (Temple Group Ltd) who reported on *The Noise Mapping England project - the consultant's role, methodology and technical challenges*. His company had been awarded Contract Area 1 of the Noise Mapping England Project, which covered the Bournemouth and Bristol conurbations. The paper examined some of the various challenges of producing the noise maps. He gave details of the methodology adopted for data handling and examined the rationale for both the approach used and the specific noise modelling software chosen for the contract area. He considered the ways in which the additional data were captured for noise barriers, and the sensitivity checks built in to examine attributes of the various datasets. The scale of the reporting requirements and the various lessons learnt from the 'research project' made for an interesting account of noise mapping in the real world.

Integrated GIS and Lima mapping of the Liverpool/Birkenhead and Manchester conurbations was the subject of **Neil Thurston**'s paper, prepared jointly with his colleague Ian Hepplewhite (Entec UK Ltd), Peter Hepworth and James Trow (both Hepworth Acoustics Ltd) and Simon Shilton (Acustica Ltd). The presentation described the work of Entec and Hepworth Acoustics, who were commissioned by Defra to develop detailed noise maps for the Manchester and Liverpool/Birkenhead conurbations. The total area to be mapped was 832km^2 and this was one of the first set of road noise maps to be delivered to Defra under the Noise Mapping England project. A series of project tasks included a detailed field survey of noise barriers across the two areas; GIS processing and analysis of detailed terrain, buildings and traffic survey datasets; and the development of detailed resolution noise models. Owing to the large geographical area and detailed resolution required, the project team used specialist Lima noise mapping (produced by German firm Stapelfeldt) linked to ArcGIS software. In total, more than seven million calculation points were used at a horizontal grid resolution of 10m, resulting in highly detailed maps for the two contract areas. These outputs were delivered to Defra together with technical reports describing the processing steps undertaken and modelling techniques adopted.

Alan Bloomfield (Greater London Authority) was then able to compare and contrast a similar project, with his co-authors Stephen Turner and Peter Robson (both Bureau Veritas) in *The West London Noise Study: use of computer-based modelling in an attempt to understand the impacts of combined noise sources*. Defra published in 2002 the results of the 2000/01 National Noise Incidence Study (NIS) carried out by BRE. This used 24-hour measurements made at over 1100 sites across the UK. The selection of the measurement sites was designed to give a representative picture of the exposure of dwellings to noise. It was a complex process which began with a random selection of local authority

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areas, but with a probability weighted by their populations. Within each authority, there was further selection of two wards and then ten residential addresses within each, also at random. These residential addresses became the noise measurement sites. Measurements were only made during normal weekdays and avoided school holidays. In London, which has 33 local authorities, the selection process resulted in all the NIS measurements being made in the more populous outer boroughs - seven in all. No inner or west London boroughs were included. Whereas the NIS approach could be used in inner London, it was recognised that in west London a similar approach might be unrepresentative because of the influence of the noise from aircraft using Heathrow Airport. The Greater London Authority commissioned the West London Noise Study to obtain an indication of how noise levels in West London compared with the rest of London and the country. Alan described the alternative methodology, which was based on computer modelling to provide results for the main operating modes of Heathrow Airport.

Uncertainties in noise mapping some effects on noise action plans were examined by **Simon Shilton** (Acustica Ltd) in his paper written jointly with Stephen Turner (Bureau Veritas). With the completion of END noise mapping results less than 12 months away, questions relating to noise action planning had to be addressed in order to deliver positive results for the legislators, and more importantly, the population in general. It was proposed that the noise mapping process could impact on the development of noise action plans in two key areas, both of which would determine whether the noise maps were fit for the purpose of noise action planning. Firstly the decibel results obtained would be affected by the input data consistency, resolution, currency and accuracy. Secondly the usefulness of the maps would be affected by the resolution of the models, and the ability of the calculation methods employed to replicate the scenarios envisaged within a noise action plan. Simon discussed the potential effects on noise action plans of inaccurate noise map results, and examined the management of uncertainties as a means of reducing risk. He went on to discuss some potential national or local level noise mitigation scenarios, and asked if current noise calculation methods were able to provide the answers required by the decision makers.

After the briefest of coffee breaks the session continued with *Appropriate descriptors for quiet areas* by **Greg Watts** (TRL Ltd). The European Directive on the Assessment and Management of Environmental Noise (END) had identified the importance of so-called 'quiet areas'. The END required member states to produce action plans in order to protect these areas against any increase in noise in the future. The Department for Environment, Food and Rural Affairs (Defra) commissioned TRL to carry out a review of existing knowledge and to develop the appropriate methodologies for identifying 'quiet areas'. The proposals presented in this paper were the recommendations of TRL, which were currently under review by Defra and should not be regarded as Defra policy. There were over 27,000 parks and open spaces in the UK, and there was thus a need to reduce the number to a manageable size which could be identified by Defra for future protection in accordance with the END. Geoff's proposal recommended a series of 'filters' based on acoustical, land use and area criteria to identify suitable areas for designation as quiet areas. In the longer term a consultation procedure was suggested which took into account the views of local people. This more subjective approach recognised that noise exposure, land use and area criteria alone might not identify those parks and open spaces which were most highly valued for their quietness.

Visual and acoustic stimuli for noise evaluation and mapping were conveyed by **Robert Pheasant** (University of Bradford) on behalf of his co-authors Brendan Barrett (also Bradford) and Greg Watts (TRL Ltd). The word 'tranquillity' appeared in numerous policy and planning documents and was frequently cited as a vital indicator of environmental quality. Currently there were no quantifiable or structured mechanisms to evaluate the tranquillity of open spaces with respect to the characteristics of noise and visual stimuli. This was largely due to the fact that within the context of a 'tranquil environment', little was known about the interaction of the different sensory modalities and how they

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The drinks reception provided an opportunity for less formal discussions...

... with the aid of a suitable libation

Jeff Charles receives his Award for Distinguished Service from the President, Colin English

Jeff and Doreen Charles proudly display the award and certificate

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influenced the construction of tranquil space. A study was presented in which photographic and video stimuli, taken from a representative sample of English urban and rural environments, were used by subjects to make subjective assessments about the influence of natural and manmade sounds on tranquillity. The results could then be compared with objective measures determined in the laboratory. It was expected that the work would be of particular interest to agencies charged with large-scale landscape management responsibilities, such as the National Park and Local Authorities, as well as those responsible for public amenity throughout the UK.

The last address before the discussion session was by **Darran Humpheson** (RPS Ltd) and Ian Flindell (University of Southampton) and on the subject of *Aircraft sound level modelling assumptions*. The calculation procedures adopted within the US Federal Aviation Authority's Integrated Noise Model (INM) were widely accepted to be fully compliant with EC requirements, and the results of any calculations carried out by using the INM were often assumed to be equally compliant. However, as with any calculation model, the accuracy of the results depended not only on the calculation methods used but also on the input data used to inform the model. Ideally these data should include every single aircraft's flight track, height data and operating conditions, but owing to practical difficulties in obtaining accurate data, and the logistics of modelling every single aircraft operation, it had become standard practice to adopt a limited number of standardised flight track, height profile and aircraft operating conditions, generally considered as being representative of average or typical operating conditions. To investigate possible sources of uncertainty in these standardised data, the effects were investigated of making alternative input assumptions in a generic INM model about aircraft flight track dispersion, height profiles and operating conditions, and the sound levels on the ground were calculated. The differences in the sound levels were reported for a number of representative locations around the generic 'airport'.

After a well-earned lunch the delegates were treated to a session on Entertainment Noise under the chairmanship of Stephen Turner. *The acoustics of a small pacific country* were disseminated by **Malcolm Hunt** (Malcolm Hunt Associates) and it was no surprise to discover that the eponymous SPC was in fact New Zealand. Like other developed nations, New Zealand experienced significant noise and pollution effects as a result of human activities. Malcolm described policies and methods used to manage the effects of environmental noise within the country. The methods he discussed were related to the protection of typical urban noise-sensitive environments, as well as national parks and natural areas where quietness and lack of intrusive man-made sounds were highly valued. Methods such as New Zealand Standards appeared to be successful in dealing with the multi facetted challenge of managing environmental noise in a modern society, but there were indications that the methods and standards currently employed did not cover the full range of possible noise sources. Areas of further development were identified to ensure that future challenges and increased expectations were adequately dealt with.

Jim Griffiths (Vanguardia Consulting Ltd) next imparted *A review of the Noise Council Code of Practice on environmental noise control at concerts*, a paper co-written by his colleague John Staunton (also Vanguardia). With more than ten years having elapsed since the publication of the Noise Council's Code of Practice for Concerts the guidance in the Code had now been adopted at the majority of outdoor venues in the UK. The paper reviewed the guidance and discussed the merits and concerns of the methodology and criteria based on case studies. Recommended enhancements and additions were also presented.

A notably well-informed **Chris Skinner** (BRE Ltd) addressed *Noise from pubs and clubs - research to develop a new night noise offence* by speaking about the knock-on effects of changes to the licensing laws in 2005. These changes meant that licensed premises could be open later and for longer. The Environmental Audit Committee had made a recommendation to extend the provisions of the Noise Act 1996 from dwellings to other premises, and bringing licensed premises within the scope of the Noise Act 1996 was intended to complement existing powers. The research project, undertaken jointly by Capita Symonds and BRE, was designed to investigate different methods of noise assessment and to provide a recommendation for the assessment methodology to be used for licensed premises under the extended noise act. Chris presented the findings of the project and gave details of the laboratory-based testing undertaken to compare several different candidate noise assessment methodologies.

The unenviable task of concluding the formal presentations fell to **Jonathan Lartice** (Defra) who passed on his knowledge on the *Noise Act 1996 (as amended) - the new night noise offence, from research to policy*. From his perspective as a Local Environment Policy Officer Jonathan was able to trace the thinking behind the latest legislation intended to protect the public from anti-social activity, and he examined the way in which nuisance noise could be measured, assessed and controlled for the benefit of the community.

A final discussion session then brought the conference to a close.

Prof Berglund participating fully in the technical debate

The Chief Executive and the Editor
(obviously, neither can be blamed for the photography here)

The Paramount Oxford Hotel, Wolvercote,
again the venue for an IOA Conference

Improved railway noise prediction

Rick Jones and Andy Hardy. Research into UK rail roughness

Introduction

Accurate railway noise prediction methodologies are currently of great importance because of the European Commission's aim to understand noise exposure across the Community through the noise mapping requirements of Directive 2002/49/EC (The Environmental Noise Directive, or END). Rolling noise, which is the dominant source across most of the speed range, is a function of the combined roughness at the wheel/rail interface, and can therefore be very sensitive to rail head roughness when wheel surfaces are smooth. Most current models of railway rolling noise assume that the rail head is comparatively smooth. This is the case with the 1995 UK method *Calculation of Railway Noise* (CRN)[1], which was designed for application in connection with the *Noise Insulation Regulations for Railways 1996*[2], in particular for new or additional railways where rails will tend to be new and smooth.

Unfortunately, rail head roughness is in reality very variable, and can lead to rolling noise levels that are 20dB or more in excess of those predicted by models based on smooth rails. This is particularly the case in the presence of rail head corrugation, a periodic wear pattern with a typical pitch of between 30 and 80 mm.

The railway noise model emerging from the EC projects HARMONOISE and IMAGINE will overcome this failing by requiring combined wheel and rail roughness as an input, but this is not yet available.

If, as is expected, the UK uses CRN to map railway noise for the 2007 round, there will be large discrepancies at some locations between predicted levels and those that actually occur if rail head roughness is not taken into account. The Department for Food, Environment and Rural Affairs (Defra) has recognised this and commissioned the study described in this article to address the issue.

The aim of the study was to look at the effects on noise prediction of the true distribution of rail head roughness across the UK network, in order to determine if it was feasible to derive roughness corrections for CRN to apply at the end of the standard calculation process.

'Acoustic Track Quality' and its use in modelling

The CRN model for rolling noise is based on the concept of a Sound Exposure Level (SEL) based source term for each vehicle making up the railway traffic. These source terms have been derived from measurements of rolling stock travelling on rail in good (ie smooth) condition. In addition, CRN has separate source terms for diesel locomotives on power. The SELs thus identified are combined and adjusted for traffic flow rates (volumes), speeds etc, to produce a source that can then be input to the propagation element of the model to predict the level at a receiver position.

In order to understand the distribution of rail head roughness in the UK, measurements were taken of rolling noise on board a railway coach close to a disc-braked (smooth) wheel over a large proportion of the network. Information on speed was simultaneously gathered. Figure 1 shows the characteristics that emerge from this approach.

It can be seen that at any particular speed there is a range of sound levels, with the highest levels representing very rough, probably corrugated, track and the lowest levels occurring on the smoothest track. If the speed/level relationship of the lower bound of this data is used to indicate a general level -v- speed function, this can be used to normalise the data to a specific speed in order to produce a single-figure indicator of rail head roughness. For this study the values were normalised to a speed of 160km/h.

To establish the relationship between trackside levels that CRN would predict and the levels measured under the vehicle floor, the transfer function between under-floor levels and trackside levels was measured at specific locations. CRN was used to predict the trackside level that would occur at 160km/h from the instrumented coach (on the smooth track assumed by CRN). The measured transfer function was then used to translate the CRN trackside prediction to an under-floor level. This under-floor level therefore represents the value that would arise if the coach were travelling at 160km/h on track of the roughness assumed by CRN.

If the under-floor CRN track value is subtracted from the actual under-floor

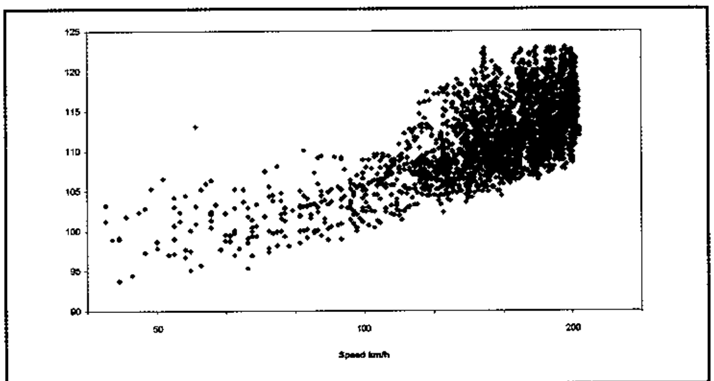

Figure 1

The characteristics of sound as a function of speed (on a logarithmic scale), measured under a railway coach adjacent to a disc-braked wheel over the UK rail network

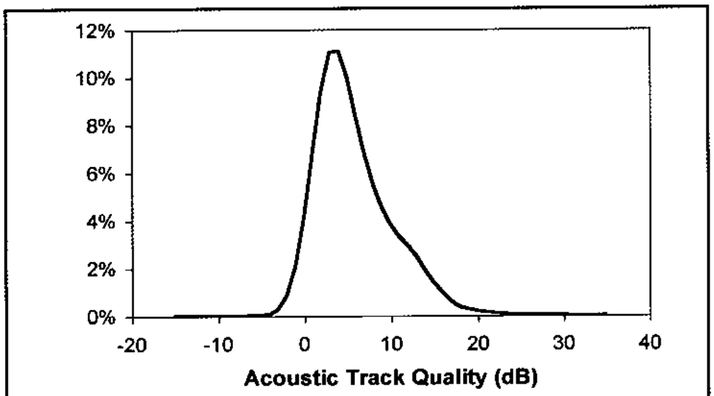

Figure 2

The distribution of Acoustic Track Quality over the UK rail network

value, this provides an indicator of the track roughness relative to CRN track, which is termed 'Acoustic Track Quality' (ATQ) for the purposes of this study. Figure 2 shows the distribution of ATQ over the network. A value of zero indicates track with a rail head roughness identical to that which CRN assumes. It can be seen that the majority of the track (around 90%) is rougher than this, with a small percentage being over 20 dB rougher, which will be the case where the rail is highly corrugated.

The local rail head roughness at a specific site can be quantified in terms of ATQ, either measured under the floor of an instrumented, smooth-wheeled, vehicle, or by measuring the pass-by noise, at the trackside, of a similar vehicle of known acoustic characteristics, in terms of its CRN source term. In the latter case the difference between its CRN source term and its measured source term provides local ATQ directly.

Local ATQ can be used to adjust the pass-by noise of sources at specific sites. In the case of a smooth-wheeled typical passenger coach this is simply achieved by adding ATQ to the CRN source term (in fact to the vehicle-specific factor that is added to the basic SEL -v- speed relationship). The situation is less straightforward for rougher-wheeled stock (eg vehicles with cast-iron tread brakes) as wheel roughness can dominate total combined roughness when track is smooth. In this case, an adjustment of the form shown in Figure 3 is required. In considering this figure, it is of interest to note that the CRN factor

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Improved railway noise prediction - *continued from page 25*

for the Mk 2 coach is 14.8dB, the value that occurs when ATQ=0, *ie* on CRN track.

Post-calculation roughness correction for CRN

The ATQ concept was fundamental to the study commissioned by Defra in order to derive a post-calculation roughness correction factor for CRN.

The study was statistically-based, and involved the definition of 18 example locations on the UK railway network, chosen to represent the wide range of railway traffic types that occur on the network. These included sites with only diesel trains, sites where multiple units operate (electric or diesel stock with distributed traction and no separate locomotive), and those where electric trains dominate. At each of the sites CRN was used in its standard form (including diesel engine noise) to calculate L_{den} and L_{night}, as required under the Environmental Noise Directive, 25m from the track. The rolling noise element of the prediction was therefore based on an assumed CRN track roughness. At the same time, the calculation was repeated over a million times at each site, with exactly the same traffic type, flow and speed profile, but with a track roughness selected at random from the distribution shown in Figure 2. The flow diagram of this process is shown in Figure 4.

The data thus derived were examined to establish the level of statistical correlation between a range of parameters and ATQ-corrected CRN predictions minus standard CRN predictions. These parameters included CRN-predicted L_{den} and L_{night}, the average speed of trains past the site, the number of wheels with cast-iron tread brakes, the number of powered wheels, the number of diesel locomotives and the number of multiple units.

The parameter that exhibited the highest correlation with the ATQ-corrected CRN predictions minus standard CRN predictions was the average speed of all the individual trains passing each site (the 'flow-weighted' speed), for both L_{den} and L_{night}. Figure 5 shows the best-fit line for L_{den}, which has the equation:

$$\text{correction} = 8.33 \log_{10}(\bar{v} + 21) - 15 \text{ dB} \quad [\text{above } 42\text{km/h}] \qquad (1)$$

where $\bar{v}$ is the flow-weighted speed in km/h. At low speeds, traction noise will dominate so no correction is required below 42 km/h.

The statistical analysis showed that 70% of the data is within ±1dB of the best-fit line, and 95% of the data is within ±2dB.

The function presented in equation (1) can therefore be used as a 'back-end' correction to CRN, after the complete standard calculation has been carried out (including traction noise elements), in order to provide predictions significantly more representative of real UK rail conditions than the standard procedure.

If local ATQ is known at a specific site, however, and if accurate local modelling is required, eg for action planning, it is recommended that the CRN calculation be carried out by correcting the source terms of individual vehicle types in the manner described in Section 2 of the guidance rather than using the 'global' correction approach.

Conclusion

The study applied a statistical approach to the problem, and resulted in a roughness-correction equation providing a speed-related adjustment for L_{den} and L_{night} which may be applied at the end of a CRN-based prediction for a specific site. This correction allows the noise mapping of railways to reflect the true railway noise environment more accurately overall. The study also showed, however, that local rail head roughness may be measured pragmatically and used to provide an even greater level of accuracy, which will be of use in action planning at specific sites.

R R K Jones MIOA is with AEA Technology Rail (DeltaRail Group), Derby, UK
A E J Hardy (Affiliate) was also with AEA Technology Rail at the time of the study

Acknowledgements

The authors wish to express their gratitude to Defra for their sponsorship of this work. The opinions expressed within this paper are solely those of the authors and do not necessarily reflect those of Defra.

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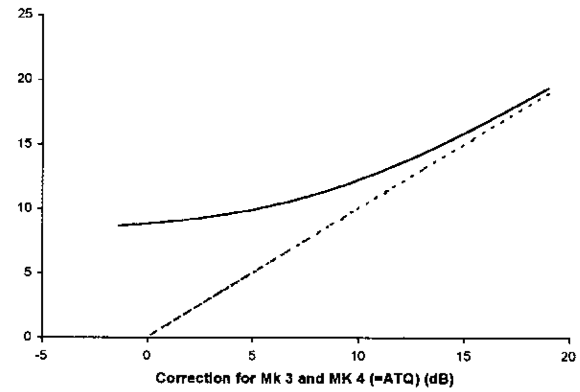

Figure 3

The relationship between the CRN correction for a cast-iron tread-braked Mk 2 coach (ie rough wheels) and the correction for a disc-braked Mk 3 or Mk 4 coach (ie smooth wheels). Unbroken line: correction, dashed line: parity.

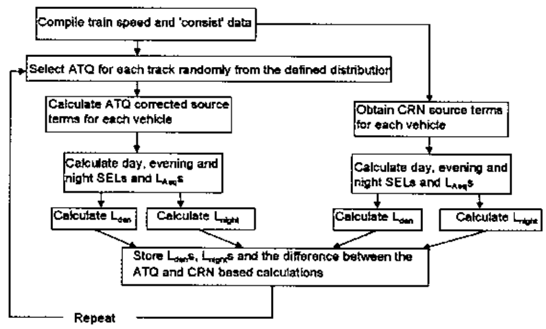

Figure 4

The calculation approach

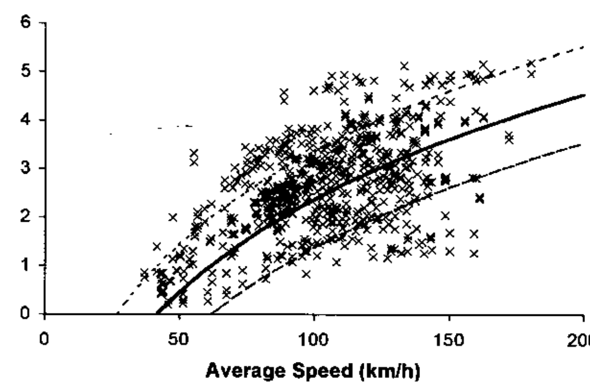

Figure 5

The best-fit relationship between the flow-weighted average train speed and the ATQ-corrected CRN prediction minus the standard CRN prediction, for L_{den}, including lines +1dB and −1dB from the best-fit line.

Acoustic design in hostile offshore environments

Ken Marriott.

Introduction

This article has been written to give acousticians in disciplines other than industrial acoustics an understanding of the work industrial acousticians carry out in their normal everyday activity. It also highlights some of the present difficulties inherent in relying on equipment vendors in order to get a complete and consistent acoustic engineering design.

Project case study

The acoustic design considered here is based on the work carried out during the design and construction of two oil and gas topsides for use off Sakhalin Island which is located off of the east coast of Russia, north of Japan.

The map in Figure 1 shows the Sea of Okhotsk where both new platforms will be located. This will bring the total to three platforms in all, including the refurbished platform shown in Figure 2, where ice is shown surrounding the platform. The two new topsides are the largest and heaviest 'float-over' that have been designed. The term 'float over' means that the topsides are floated out by barge to the location of the shafts or legs, at which point water is pumped into the barge. It then sinks sufficiently for the topsides to rest on its supporting structure. The barge is then floated out from underneath the topsides and the water is pumped out, refloating the vessel.

Figure 3 shows an oil and gas topsides on a barge in the shipyard ready to float out of the yard. The tubular steel structure under the topside is a disposable item on which the platform is constructed and transported.

The main difficulties encountered in the design of platforms in this area of the world are:

- Severe weather conditions which means there are ice floes for six months of the year and temperatures that fall to levels lower than -40°C;
- Seismic activity at any time;
- Limitations on total mass of the topside.

Figure 4 is a photograph of the refurbished rig in the sea around Sakhalin Island showing the ice build-up on decks around the life boat area. Figure 5 is a virtual image of one of the platforms from the design computer model.

The sources of noise to be controlled on platforms can be grouped together:

- Sources associated with the heating, ventilation and air conditioning in the accommodation and other areas;
- Process equipment such pumps, compressors, hydraulic accumulators, gas turbine, diesel engine generators, piping and valves etc;
- Drilling equipment which includes mud pumps, cementation plant, shale shakers, drawworks etc;
- Operational activities such as well clean-up which involves continuous gas flaring for several weeks on end.

An indication of the sound pressure levels experienced during flaring may be seen in the sound level grid shown in Figure 6.

Sound level criteria are given to be met for all location on the platforms accommodation areas, process areas the most stringent being in the accommodation area.

As with the design of all such platforms, fire protection considerations dictate that the accommodation is located as far away from the drilling and flaring areas as is practically possible, bearing in mind that space is limited. The image of the platform in Figure 5 shows the

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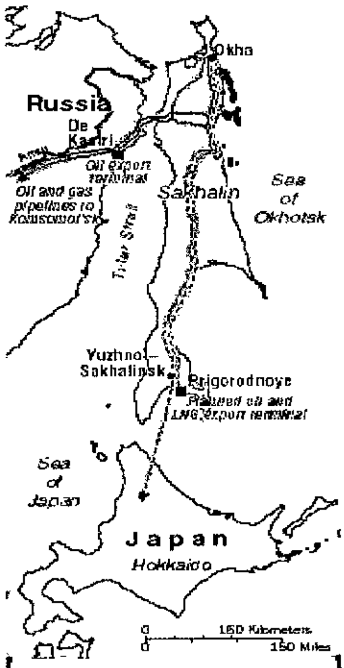

Figure 1

Location map of Sakhalin Island

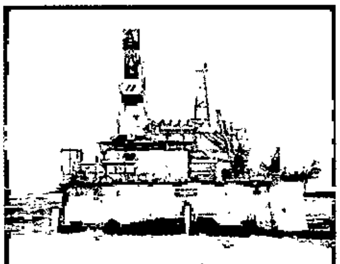

Figure 2

Existing platform, Sea of Okhotsk

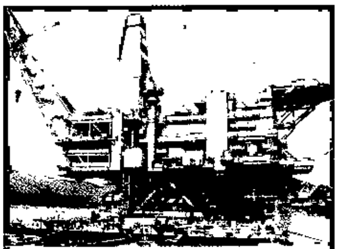

Figure 3

Topsides under construction

Acoustic design in hostile offshore environments - *continued from page 27*

accommodation located at the end with the helicopter pad.

All the process plant and other equipment such as gas turbines and diesel engines have to be laid out to fit in the remaining available space. This means that acoustic measures have to be designed around this layout.

It will be noticed that the lifeboats are also located at the accommodation end of the platform under the helicopter pad, which means that emergency musters of personnel could be taking place in this area. Speech intelligibility is of great important in muster areas.

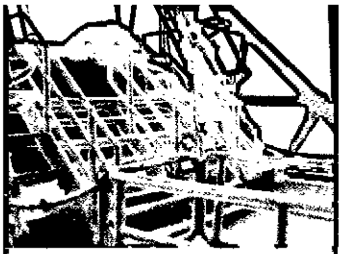

Figure 4

Extreme low temperatures are commonplace

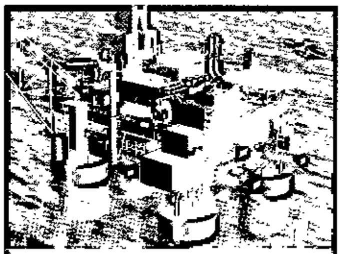

Figure 5

Computer-generated image of completed facility

Accommodation

The most acoustically sensitive location is the accommodation which therefore needs to be acoustically isolated as far as practicable. The accommodation can be isolated in one of three possible ways.

- The module can be isolated from the main structure by passive isolation.
- A 'flotel' or support ship can be deployed alongside the rig.
- The accommodation can be integrated into the structure.

Because of the extremes of temperature, ice and snow loadings, and seismic activity the last of the three options was adopted. This resulted in a need for isolation measures on all items of equipment over 0.4 tonne (so far as possible) to limit the sound energy passing through the steel structure and re-emerging into the accommodation. All types of isolation mount used had to be suitable for seismic applications.

The other sources of noise needing to be addressed within the accommodation areas are those produced in the heating and ventilation systems.

It is common practice to use mixed flow and centrifugal fans in offshore designs, and this can sometimes give rise to high levels of low frequency sound in the cabins. In some cases the innovative approach of adopting 'active' attenuators has been used to control low frequency noise. Active attenuators are in general appearance similar to conventional passive (splitter) attenuators but they have microphones and speakers located in the ducts. By using digital sensing and correction software to cancel the sound at selected frequencies, the

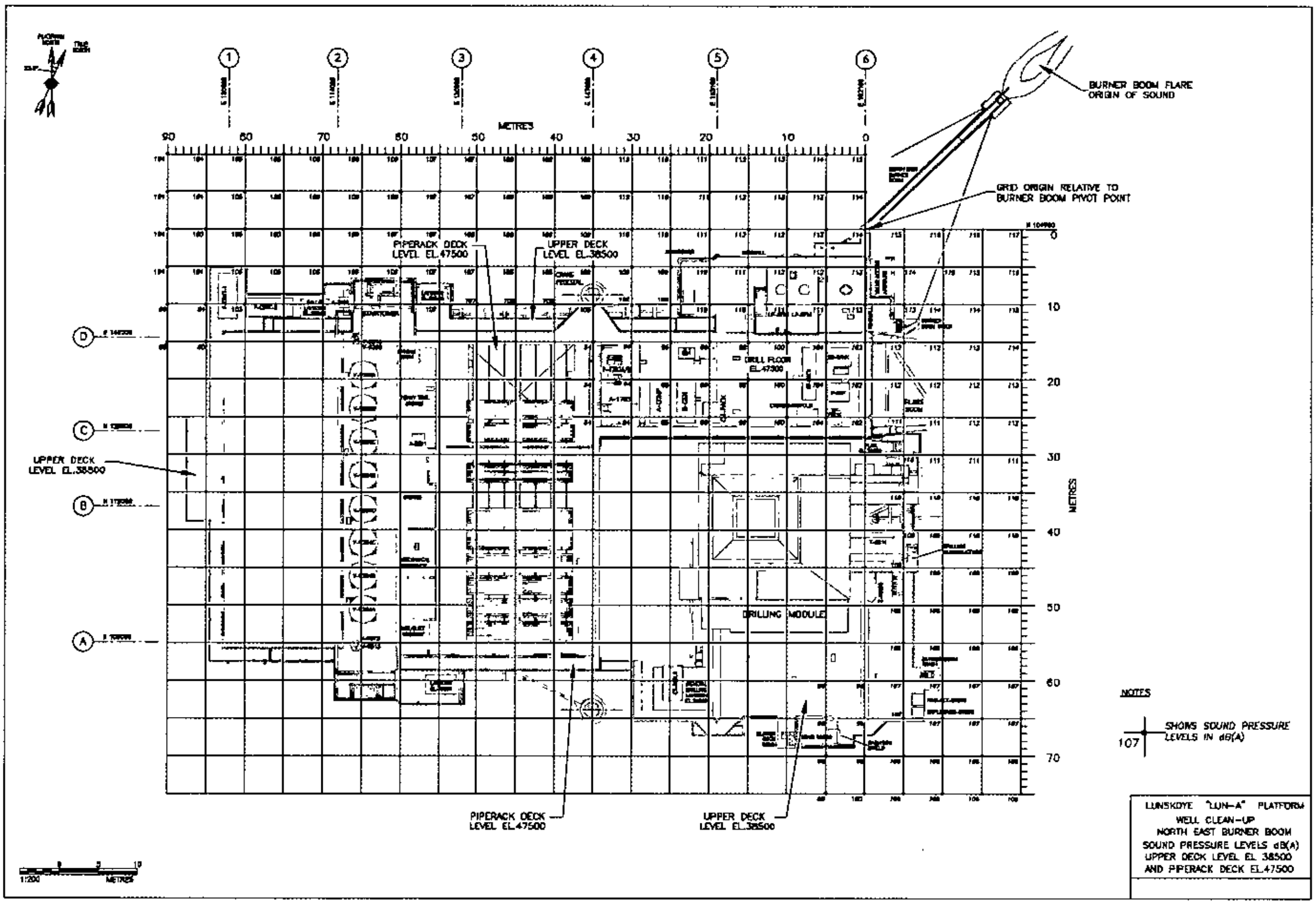

Figure 6

Predicted sound pressure levels during well clean-up flaring

Figure 7

Internal view of an active attenuator

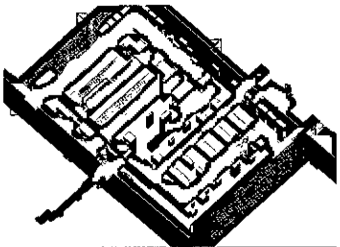

Figure 8

3D view of HVAC system layout

level of noise passing through the attenuator is reduced - the term 'active' relates to an active sound field. A typical active noise attenuator showing a splitter with microphones and speakers appears in Figure 7.

High level noise sources

Moving on to the sources of sound that are particularly noisy we will consider here what may be considered the most disruptive:

- The draw-works used in relation to piling, in order to install the conductors into the sea bed ready for the drilling phase. This is carried out either by vibration piling or drop hammer techniques and goes on for weeks.
- Well clean-up flaring, which can also be a long-term activity.

It is generally found that little can be done to mitigate the sound from these sources.

Application of 3D acoustic modelling

During normal operations when the topsides act as a process plant, drilling module and accommodation, acoustic measures need to be applied. The approach in dealing with this is to model each area containing mechanical equipment to select which items of plant would be best treated with acoustic measures. Because of the weather conditions most of the equipment is fully or partly enclosed within the structure, including the drilling area, which means that the acoustic conditions are relatively 'live'. A three-dimensional acoustic model is needed for the analysis to decide when and where to apply acoustic measures.

The computer model uses data for the acoustic conditions of the equipment spaces and the sound power level allocation for the equipment in each space. Then by taking the x, y, z coordinates and directivity of all sources, the program predicts sound pressure levels in equipment rooms. Some rooms have a high density of machinery and ductwork, which means that the program used for the modelling needs the facility to allow for the apparent absorption provided by the scattering effects of the numerous surfaces.

Figure 8 gives some idea of the quantity of equipment to be found in some plant spaces. The input to this computer program model would be the sound power levels of all the equipment in a given room or location.

It is worth mentioning that valves, orifices and associated piping need to be included in this sound power input. If an allowance for these items is omitted the results can be misleading or erroneous in some cases.

Where there are valves working with pressure ratio across them greater than 3, the valves and associated pipework are normally checked for shock and vibration, in order to avoid fatigue in the pipework.

The output from the modelling program is a grid matrix that gives the sound pressure level in dB(A) across the equipment space, together with a list of the contributions from all the noise sources including mechanical equipment, pipework and heating and ventilation

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Acoustic design in hostile offshore environments - *continued from page 29*

equipment at any given point on the grid. A list of sound pressure levels of all items of equipment at any point can be requested from the program, with the sources listed in rank order. This makes it clear which items need acoustic measures.

Acoustic measures

The term 'acoustic measures' in this context includes all forms of sound level reduction methods such as pipe insulation, ventilation duct attenuators, acoustic enclosures and hoods, or simply the definition and marking of distances or locations from equipment for ear defender use. It must be remembered that the use of ear defenders is not an acoustic control measure.

The inclusion of vibration isolation mounts means that a significant amount of sound that might have been transmitted into the floor and walls, and then re-radiated to the surroundings, has to some extent been controlled.

There are many locations where the resultant sound pressure levels are low in normal operation, but in particular circumstances the sound pressure levels can rapidly increase to very high levels. These areas need to be identified as ear defender areas.

Figure 9 is a typical contour plot at 1.7m above the floor of a plant room, but not showing the actual equipment locations, although these are fairly obvious from the image.

The western grey whale

During the design of the platforms serious environmental concerns arose regarding sound energy from the platform being transmitted into the sea, where it might affect the western grey whale.

A curious feature of the structural design in this instance was that the topsides were located on pendulum bearings at the top of each leg for seismic reasons, and the impedance mismatch offered by these bearings minimised the sound energy entering the sea. Pendulum bearings are similar to having a fixed ball resting in a saucer, one fitted between each topside support and the top of the leg, so that during seismic activity the topside will ride in a pendulum motion as the fixed balls move up the edges of the saucers.

There are always difficulties

Although all the work on this project was successful there were many difficulties to be overcome during the design and construction. Unfortunately, most of the difficulties were traceable to poor vendor documentation and support: in some cases equipment was found to be unsuitable for the application. As far as acoustical information was concerned, it seems that many equipment vendors find it difficult to supply consistent and correct information for their products. This leaves the acoustic consultants responsible for the design to try to make sense of whatever data are available, and in some cases their own predictions of the sound levels have to be used in the design. This strategy is adopted to enable the work to progress, but the approach lacks the confirmation of consistent and complete data between the vendor and the designer that would be expected. The problem is encountered on many onshore projects.

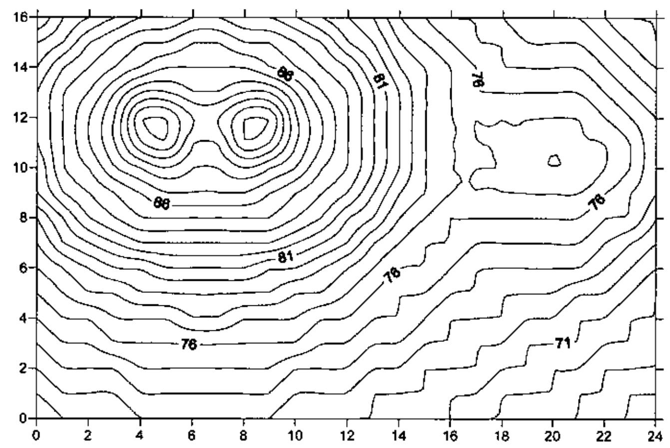

Figure 9

Noise contour map

The areas that were found difficult on this project included:

- Some vendors found it difficult to provide sound power level data for their equipment;
- Sound level tests had been carried out by untrained personnel using unsuitable equipment;
- Incorrect locations were given for centres of gravity;
- Vendors were unsure of the mass of their equipment;
- Dimensional details shown on drawings were incorrect;
- Although sound levels both with and without acoustic measures were requested on the vendor sound level data sheet, the request tended to be ignored;
- When data sheets were filled in they sometimes gave only one figure - 85dB(A) at 1m - even when sound pressure levels were not requested. This figure is probably of very little use.

It has even been suggested to some vendors if they wish to prevent acousticians becoming extinct they should use acoustic consultants to carry out calculations, fill in forms and take proper sound level surveys. The names of independent consultants who would undertake this type of work were offered, but very few (if any) vendors wanted to take that advice.

All this demonstrates that greater importance should be placed on acoustics as a requirement from equipment suppliers, who should make use of appropriately experienced local acousticians. A greater awareness amongst equipment suppliers of what can be gained by employing experts in acoustics is needed to make progress here.

Other areas where acoustics design and advice are required

The main sound level control methods and measures are discussed above, but during the design process, advice and detailed design is required in several other areas: just a few are listed below to give an idea of the range of subjects.

- Vibration levels in crane cabins;
- Prediction of helicopter sound levels;
- Risk of resonance in structural panels;
- Sound propagation of warning speakers;
- Induced vibration in pipes attached to machinery;
- The use of bird scaring devices;
- The significance of induce vibrations in the platform due to ice floes;
- Use and siting of telephone hoods.

General health and safety note

Last but not least, acousticians who need to attend construction sites to deal with acoustical problems should be fully aware that shipyards are dangerous places, and remain alert at all times to the safety aspects of the work.

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If high aircraft noise exposure increases heart attack risks, what do we do about it?

Peter Brooker.

Introduction

Is high aircraft noise exposure actually dangerous to people's health? Is there a good way of identifying 'significant danger'? What are the policy implications for government and airport operators of people being exposed to significant danger?

One of the most difficult questions faced by medical researchers is often that of judging whether an exposure to some potential hazard causes a disease or some other kind of impairment or ill health. There is a huge literature on 'Epidemiology' – the scientific study of factors affecting the illnesses and health of individuals and populations.

There are inherent problems in measuring possible causation effects of aircraft noise: 'causation' may often mean an increased probability of an effect. There are generally large variations in individual responses and 'statistical confounding factors' are often present (Hill, 1965). Confounding covers possible alternative explanations and mechanisms that produce modifications to the nature or scale of people's responses. Examples of confounding airport-related health factors are:

- If people living near an airport tend to be in particular socio-economic or ethnic groupings that frequently have poor diets and/or are grossly obese, then they will tend to have more illnesses than the population generally (British Heart Foundation, 2006).
- If air pollution causes or exacerbates illnesses, people living near airports, especially if aircraft emissions are combined with those from the very busy roads associated with airport activity, will have poorer health than people in general (COMEAP, 2006).

There are hundreds of research papers on noise and health, many which deal with aircraft noise. The quality of the underlying research appears to be very variable:

- There are varying degrees of medical assessment of the conditions examined.
- Some studies are qualitative, although recent research tends to be quantitative.
- Some authors are willing to make quite definitive statements on the basis of statistically 'light' evidence, while others come to no conclusions (other than 'more research is needed').
- Some studies appear in peer-reviewed journals, others in unrefereed reports.
- Some journal editors have a policy of not publishing material critical of published work (other than complete proof that that research is invalid).

Even for studies carried out by professionally experienced researchers, there can be major disagreements about statistical analyses, eg Stafford (2006). Thus, it can be very difficult to come to conclusions about what research is telling us. The authors' conclusions must always be viewed with caution. Several review papers have been published in the last decade, which try to collate and compare the many research findings. They include: Morrell et al (1997); Porter et al (1998); Passchier-Vermeer and Passchier (2000); Miedema (2001); de Kluizenaar *et al* (2001); van Kempen *et al* (2002; 2005); Griefahn (2004); enHealth Council (2004); Babisch (2005; 2006).

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The next major problem, even if the authors' conclusions are robust, is what to do with the results. What level of danger to health is 'significant'? What does this imply for policy about the people exposed? The following attempts to illustrate how these questions can be answered, by integrating recent results on heart attack risks with UK government polices on heath and safety.

Myocardial infarction risks

Babisch (2006) discusses the evidence for the relationship between transportation noise and cardiovascular health, in particular acute myocardial infarctions. An acute myocardial infarction (MI) is a 'heart attack', i.e. where a blood clot blocks a coronary artery, and thus leads to heart muscle being starved of necessary oxygen). His critical review and re-evaluation of the 'best' past studies led to the conclusion that (Babisch, 2005):

'The results of epidemiologic noise studies suggest an increase in cardiovascular risk with increasing noise exposure... Transportation noise from road and air traffic is the predominant sound source in our communities; outdoor sound levels for day–evening–night (L_{den}) > 65–70 dB(A) were found to be associated with Odds Ratios of 1.2–1.8 in exposed subjects compared with unexposed subjects [< 55–60 dB(A)]. Studies use magnitude of effect, dose–response relationship, biological plausibility, and consistency of findings among studies as issues in epidemiologic reasoning.'

[The 'odds ratio' is the relative risk level.]

Babisch's work has led to the German Federal Environmental Agency [Umweltbundesamt – UBA] issuing 'Requirements for the protection against aircraft noise' (Wende and Ortscheid, 2004):

'The assessment periods were chosen analogously to the regulations on other traffic noise sources (rail traffic, road traffic)...avoiding of impairment of health by limiting the exposure to aircraft noise (outside) to equivalent levels below 60 dB(A) by day and 50 dB(A) at night.'

An earlier UBA publication noted that at aircraft noise loads of 60 dB(A) in the daytime and 50 dB(A) at night, there was reason to fear adverse health effects from a point of view. It recommended 'adequate structural soundproofing to be provided' but noted that since adverse effects in outdoor living still remained despite such measures, compensation may become necessary.

A key quantitative source for Babisch's conclusions and these UBA targets is the data in his Figure 14 [page 62], shown here as Figure 1. This suggests that, for road traffic above 60 L_{eq}, risks of MI increase markedly with increased L_{eq}. However, the statistical confidence bands in the Figure are very wide. Is there a real increase from 60 L_{eq} onwards? Are the effects from air traffic the same as for road traffic? How large does an increase have to be for it to be 'significant' in terms of health policy? Should health policy be based on comparatively rare increases in risk? What is appropriate preventative medicine action? What amount/type compensation would be appropriate?

PSZ policy and ALARP

A way of addressing the questions about MI risks and health policy is to study what has been done to resolve an analogous safety problem. This is the problem of public safety zones (PSZ) near airports. There are two compelling reasons why this is a useful analogy. First, the methodology uses principles established over many years by the UK Health and Safety Executive (HSE). Second, the techniques developed have been endorsed by the UK government's Department for Transport (DfT).

Aircraft crashes are rare, but their potential effects to people on the ground near airports cannot be ignored. Studies on the risks to these 'third parties' have led to changes in UK policies on development near to airports. The results have been an important issue in planning inquiries, most especially the Heathrow Terminal 5 Inquiry.

Crashes are now most likely to occur in areas that are close to airport runways, because take-off and landing generally produce the most risks, generally occurring because of operational factors rather than from problems with aircraft design or engine technology. The UK Government established a system of PSZs for the busiest airports more than 40 years ago. PSZs are areas of land at the ends of the runways at the busiest airports. Within PSZs, development is restricted in order to minimise the number of people on the ground at risk of death or injury in the event of an aircraft crash.

The current UK policy on PSZs is set out in DfT (2002). It explains how the PSZ policy was developed through risk contour modelling and by setting limits on the degree of risk that is 'tolerable' for people on the ground near airports. The phrase 'tolerable risk' arises from extensive work by the UK Health and Safety Executive (HSE) on risk decision-making (HSE, 2001). Thus, DfT PSZ policy is built upon long-established HSE risk guidance material.

Figure 2 presents HSE's diagram of the Tolerability of Risk Framework (HSE, 2001 and earlier documents). There is actually only one axis in the diagram: it runs vertically, and represents individual risk, with low values at the bottom and higher values at the top. The narrowing triangle illustrates diminishing individual risk. Individual risk in this context is the risk of death per year to an individual located at a particular place near to the airport.

Two boundary points in Figure 2 divide the range of individual risk for some system of interest into three regions: the intolerable risk threshold and the acceptable risk, the former being greater than the latter. The decision processes are:

- If a system's risk falls into the intolerable category, then action must be taken to redress this. If this is not possible, the system should be halted or not implemented.
- If a system's risk falls into the tolerable category, it must be proven that it is 'as low as reasonably practicable' (ALARP) within that region for the system to be considered acceptable. Thus, showing a system is ALARP means demonstrating that any further risk reduction in the tolerable zone is either impracticable or 'grossly disproportionate' (i.e. it can be shown that the cost of the measure is far in excess of any benefit to be gained).
- If a system's risk falls into the negligible category, no action is required other than monitoring to ensure that the negligible risk is maintained.

'Reasonably practicable" is a difficult phrase. It is essentially the adoption of good practice in health and safety for the activity concerned. Risk reduction is

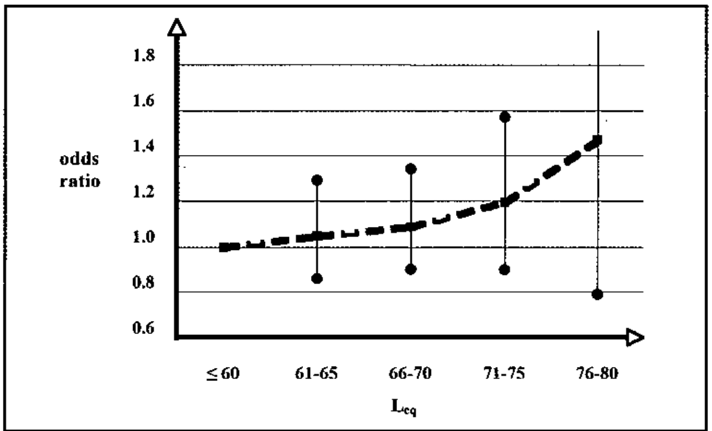

Figure 1: Association between road traffic L_{eq} level and MI incidence, pooled analytic studies

Adopted from Figure 14 of Babisch (2006). The odds ratio is the MI incidence relative to the ≤ 60 L_{eq} incidence. The vertical bars are 95% confidence bands.

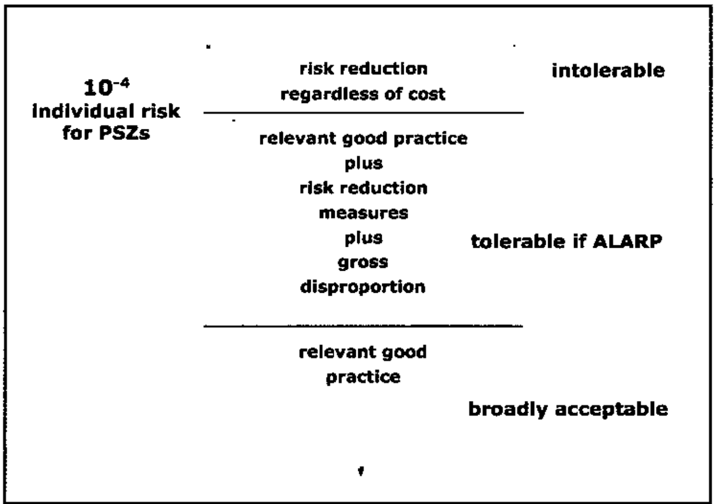

Figure 2: ALARP approach (taken from HSE)

defined to be practicable if and only if it is possible to find cost-beneficial risk reduction measures. The Notes to Figure 2 provides some definitions and more detail.

The methodology used to develop DfT's PSZ policy combined individual risk criteria and cost benefit analysis; termed 'constrained cost-benefit analysis'. This is a complex subject, explained in detail in Evans et al (1997). Summarising very drastically, the main quantitative outputs are a set of individual risk contours and corresponding policy guidance. Risk contours are cautiously-estimated lines of equal risk, analogous to noise exposure contours. The risk modelling produces contours off the runway ends that are wide near the runway ends, becoming much narrower with increasing distance from the runway eventually to form a point, i.e. are roughly triangular).

Three standard contours are used: 10^{-4}, 10^{-5} and 10^{-6}. A person spending all their time on the 10-4 contour line would have a 1 in 10,000 chance of being killed per year because of an aircraft crash. The 10^{-4} value was assessed as being an appropriate upper tolerability limit in Evans et al (1997):

'For the upper tolerable risk level for members of the public, the only widely used value is a risk of death of 10^{-4} per year. This is recommended by the Health and Safety Executive (HSE) for use in other safety critical industries.'

The 10-4 individual risk level was subsequently accepted by DfT as the intolerable risk threshold for PSZ policy. Key DfT (2002) PSZ policy recommendations - which obviously apply equally to new airport developments - include:

- Any existing housing, and other development occupied by third parties for a high proportion of the day, should be removed from within the 10-4 individual risk contours.
- New housing development, and most types of new non-housing development, within the 10^{-5} individual risk contour should not be approved.
- It may also be sensible to restrict development for new, sensitive or high density land uses, such as schools, hospitals, or places of assembly, somewhat beyond the 10^{-5} contour. Such restrictions should be considered on a case by case basis.

ALARP and myocardial infarction fatalities

If ALARP is taken as a sensible principle for assessing risk, and the PSZ 'intolerable risk threshold' analysis is taken as an appropriate methodology for aviation, how should L_{eq} values corresponding to increased risk of fatality from MIs be analysed?

First, increased risk factors have to be converted into mortality rates - the number of deaths occurring in the population under consideration, per year. The starting point is the current mortality rate for MI. Figure 3 shows the most recent - 2004 - statistics for MI deaths in England and Wales, from UK Office of National Statistics (ONS) data. Also from UK ONS data, the population for England and Wales in 2004 was about 53 million. Thus, the

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age group	number	
	men	women
0 - 34	70	17
35 - 44	343	74
45 - 54	1137	242
55 - 64	2787	780
65 - 74	5434	2570
75+	12283	13478
all ages	22054	17161
total	**39215**	

Figure 3: Myocardial infarction mortality in England and Wales, 2004

Adapted from ONS (2006) Table 2.9, pages 92, 93. Code I21.

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mortality rate for 2004 was about 39,215 ÷ 53 million = 7.4 per 10,000. [NB: The rate has been improving significantly over the last decade, eg see Goldacre *et al* (2006).]

Babisch (2006) suggests that MI risks increase progressively above 60 L_{eq} – Figure 1. At the 71-75 L_{eq} datapoint, the increased risk is 19%. If the risk of a fatality from a noise-induced MI were similar that for MIs from all causes, then aircraft noise at 71-75 L_{eq} would increase the MI mortality rate per 10,000 people by ~7.4 x 0.19, which is ~1.4. This means that the aircraft noise-induced MI mortality rate at this L_{eq} level would exceed a 10-4 risk level. The L_{eq} value actually corresponding to a 10^{-4} risk would in fact be at around 70 L_{eq}, based on Babisch's curve-fitting (his Figure 10, with fitted cubic equation [page 53]). This is a slightly cautious calculation, given that the incidence rate estimate includes 'excess fatalities' arising from aircraft noise in its denominator.

But this 10^{-4} risk level is the 'intolerable risk threshold'. In HSE risk assessments, deaths are deaths, whether from aircraft crashes or the cumulative effects of noise on a person's health. Therefore, the policy for 10-4 individual risks should be the same:

- If myocardial infarction risks 'surge' above 60 Leq as calculated by Babisch, then the increased risk at ~70 L_{eq} is at an intolerable risk threshold of 10-4 individual risks. Any existing housing, and other development occupied by third parties for a high proportion of the day, should be removed from within the ~70 L_{eq} contours.

Points for debate

Is the above a reasonable conclusion? Do the facts and logic above support this kind of answer? The assumption has already been made that the risk of a fatality from a noise-induced MI is similar to the fatality risk for MIs from all causes. The following notes debate some of the issues.

Are the statistical uncertainties in the Babisch's results too great? There are certainly wide confidence bands around the trend line in Figure 1. Babisch emphasizes that this exposure-effect curve was not derived for significance testing, but rather to provide a best-fit curve for quantitative risk assessment. The ~70 L_{eq} value is simply taken from Babisch's data – but what should government adopt as 'cautious' parameters? As noted, there are inherent problems in carrying out epidemiological studies. Has Babisch – have the other researchers? – successfully disentangled all the socio-economic and ethic differences? What about air pollution effects (COMEAP, 2006)?

The Babisch results are for road traffic not aviation. True, because that is where the bulk of the research data is available. But Babisch offers reasons why aircraft noise might have increased effects over those from road traffic, eg because 'of the lack of evasive possibilities in the home' and because of aircraft noise effects on sleep. This view has support from research results, for example Figure 2 [page 15] of Babisch (2006), which reviews epidemiological studies of road and air traffic. Note that here is some evidence from studies of annoyance that aircraft noise effects are stronger than those from road traffic noise.

An individual risk 10^{-4} and a mortality rate of 10^{-4} are actually different concepts in population terms. The former refers to 'the risk of death per year to a representative or specified individual as a result of the realisation of specific hazards' (Evans et al, 1997). Mortality rate is 'the number of deaths occurring in the population during the stated period of time, usually a year, by the number of persons at risk of dying during the period'. The definitions are consistent if the population is in both cases representative of the general population. It is surely essential that there is consistency in governmental safety and health decision-making.

MI rates are reducing over time, so calculations for future years should be based on a lower figure. This factor needs to be taken into account, but the noise-induced MI rate may not be reducing, i.e. the Odds Ratio may be increasing over time.

What about health damage arising from non-fatal MIs? The PSZ policy is based on fatalities, rather than trying to include both fatalities and impaired life states post-MI, as represented by 'QALYs' (eg see Rawlins and Culyer (2004). If the latter were to be included through QALYs or a similar scheme then the critical L_{eq} value would presumably need to be set a lower value. [Note that about two-thirds of MIs are not fatal, but produce varying degrees of impairment and the requirement for care.]

Fatal MI rates are reducing because of improvements in medical care, so the rates will be lower in cities, with nearby ambulance services and hospitals, which mean that clot dissolving drugs can be given quickly. This certainly could be a factor. Note, however, that Heathrow currently has no hospitals within its current 'daytime' 63 L_{eq} contour (BAA, 2006 – Community Buildings Noise Insulation Scheme [page 9]).

Why pick on one medical effect? To a degree, MIs serve as a single example of potential health effects. A key point is that it relates to fatalities rather than lower degrees of health impairment. A policy decision on a 'high L_{eq}' value would need to take account of the evidence on all health effects.

Are the numbers of MIs accurately assessed? The numbers are probably underestimates. This is because MIs as counted by Babisch and other researchers are generally restricted to the 'International Statistical Classification of Diseases and Related Health Problems' (ICD-10) codes I21-22 (ONS, 2006). Other forms of Coronary Heart Disease (CHD: ICD-10 codes I23-I25) are not counted statistically as MIs, but in many cases there are similar causal factors. MIs could be viewed a surrogate for all CHD diagnoses, as they are very definite event. Norris (2002) comments on the difficulties of CHD/MI classification.

Could not other means besides removing houses solve the problem? Noise insulation would reduce indoor L_{eq} levels markedly, but it would obviously not produce improvements outside the house, nor when people have their windows open in hot summer weather. Significant reductions in source noise would of course reduce L_{eq} values.

Conclusion

If high levels of aircraft noise exposure dangerously affect people's health, then this issue deserves serious attention. There is evidence in the medical research literature that high levels of aircraft noise exposure increase the risks of myocardial infarction. This information can be combined with the HSE's ALARP principle for assessing risk, and DfT endorsed levels of 'intolerable risk'. The combination would lead to policy guidance that people should not live within ~70 L_{eq} contours. This rests on the belief that the government's health policy criteria should be consistent with its safety policy criteria. This paper has sketched the logic, but is obviously not the 'final word' on the subject.

Acknowledgements

The author would like to thank Bernard Berry and Peter Havelock for information about key research references. Wolfgang Babisch very kindly read an earlier draft, posed some interesting questions, and provided a briefing on his current research and data analyses.

Peter Brooker MIOA is with Cranfield University

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Notes

Risk is classified by the HSE as being in one of three categories: intolerable, tolerable if ALARP, and broadly acceptable ('negligible' in some variants). The boundary lines between the risk categories negligible, tolerable, and intolerable need to be specified; they are not automatically set.

Simplified HSE definitions:

ALARP principle The principle that no risk in the tolerability region can be accepted unless reduced 'As Low As Reasonably Practicable'.

Broadly acceptable risk A risk which is generally acceptable without further reduction.

Individual risk The risk of death per year to a representative or specified individual as a result of the realisation of specific hazards.

Intolerable risk A risk which cannot be accepted and must be reduced.

Tolerability region A region of risk which is neither high enough to be unacceptable nor low enough to be broadly acceptable. Risks in this region must be reduced ALARP.

Pioneers of acoustics:

John Tyler. Who really invented the telephone?

In a previous article in the Pioneers series (vol 30 no 4, July/Aug 2005), Alexander Graham Bell was credited as the inventor of the telephone: if you lived in the USA, Canada and Scotland at this time, this was quite in order. However, if you were a native of Germany, or Italy, or even certain states in the USA, things were nowhere near as clear-cut. An examination of the counter-claims makes interesting reading but dear old Bell survives as the accepted inventor, and the one who made money out of it, although he was given a good run for his money in the US courts… as the story below reveals.

Perhaps this article should be entitled "would-be" pioneers of acoustics, as it is doubtful that there is now any way of proving who really first put the idea into practice.

The battlefield

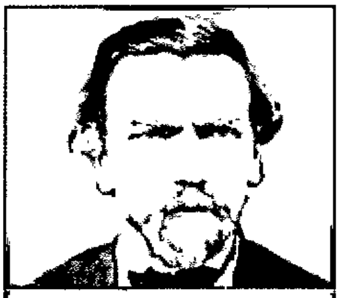
The other contenders for the right to claim the invention of the telephone include the Americans, Elisha Gray, Amos Dolbear and Daniel Drawbaugh; the German, Philip Reis; the Italians, Antonio Meucci and Innocenzo Manzetti; and the Frenchman, Charles Bourseul. In all the Bell Company fought out thirteen lawsuits that were of national interest, and five that were carried to the Supreme Court in Washington. It fought out 587 other lawsuits of various natures. With the exception of two trivial contract suits it never lost a case. Nevertheless the value of shares in the Bell Company went up and down as the lawsuits proceeded.

Biographies of the contenders (in approximately chronological order): the Europeans

Charles Bourseul was born in Brussels on 28 April 1829. A few years after his birth his family moved to France because his father served in the French army as an officer. Little appears to be known about his education but Charles, in contrast to his father, got a job as a civil engineer in a telegraph office. Here he started improving L F Breguet's and S F B Morse's telegraphy system. The successful results encouraged him to experiment with the electrical transmission of the human voice. His construction was similar to the future microphone, but the construction of a receiving part to convert the electrical current back into a human voice failed. His experiments did not give him as much success as he hoped. Nevertheless he published the fundamental idea of the electrical transmitting of sound in 1854 in the magazine *l'Illustration de Paris* and thus it would seem reasonable to place him at the beginning of the road to the telephone. After a long and busy life spent improving the French telegraphy system Bourseul died on 23 November 1912. After

Charles Bourseul

Innocenzo Manzetti was born in Aosta on 17 March 1826. After primary school he went to the Saint Benin boarding school run by the Jesuits, then to Turin, where he obtained a diploma as a land surveyor, then returning to Aosta.



Innocenzo Manzetti

His first job was with the Civil Engineering Corps during which period he became interested in acoustics, mechanics, hydraulics, electricity and astronomy. He first came to the attention of the world in 1849 with his flute-playing automaton. This was built in the stylised shape of a man, life sized, seated on a chair with a flute in his hand. Hidden inside the chair were levers, connecting beams and compressed air tubes, which made the automaton's fingers move on the flute keys according to a programme mechanically recorded on a cylinder, similar to a player piano. The automaton was wound like a clock and could perform twelve different arias. At the beginning of its performance the automaton would arise from the chair and bow its head and roll its eyes.

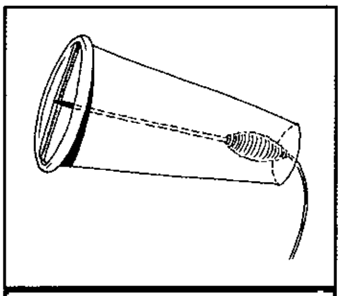
Manzetti's automaton flautist

Manzetti also invented, in 1855, a hydraulic machine to empty water from the wells of the Ollomont mines, which were previously unworkable, and in 1864 he built a steam-powered car (27 years before the one built in Paris by Serpollet). So it may be judged that Manzetti was a competent engineer.

Tancredi Tibaldi, a friend of Manzetti's, recounted in 1896 that the telephone idea came to Manzetti out of a desire to make his automaton talk by pronouncing words spoken by another person at a distance coupled by a wire. According to Manzetti's brother Anania, the idea came from the memory of their childhood games with the chapeau à gibus (a sprung top hat that could be flattened for carrying under the arm) that they used as a loudspeaker to scare their peers by speaking from another room into another hat connected to the first by the usual system of a taut string. Manzetti called his first telephone model, made in 1864, a telegraphe parlant (*speaking telegraph*). It was never patented, presented at conferences or described in newspapers, supposedly because he was timid and retiring and did not care about money. Nevertheless it was spoken of in general terms rather than specific detail by several world newspapers of the time.

The only technical description of Manzetti's invention was given by Dr Pierre Dupont, a friend of the inventor, who was a doctor of medicine and a Major in the Sardinian army. The undated description was found among his papers only after his death, although it was maintained that it was written in 1861.

Dupont's description, translated from the French, is as follows.



Drawing of Manzetti's telephone, said to be derived from Dr Pierre Dupont's notes

"The speaking telegraph consisted of a funnel-shaped cornet in which was placed, transversally, an iron lamina, in the shape of a very thin plate. This plate easily vibrated under the impulsion of the sound waves coming from the bottom of the funnel. In the cornet, there was also a magnetized steel needle, running inside a bobbin, vertically placed with respect to the vibrating lamina and very close to the same.

From the bobbin or spindle started a silk-coated copper wire, the other end of which was connected to a bobbin placed in an apparatus identical to that described above. From this second apparatus started another electric wire, which was connected to join the former. Now, if in the vicinity of the lamina of one of the cornets a sound was emitted, this sound was immediately reproduced by the lamina in the other cornet.

The communication between the laminae of the two cornets took place thanks to the principle that the vibrations of an iron plate in front of a pole of a piece of magnetized iron produce electric currents, the duration [ie frequency] of which is the same as that of the motion of the vibrating lamina.

In a word, the acoustic waves produced by speech, voice, sound into a cornet were transformed in the apparatus into electric waves, and then transformed back into acoustic waves in the other cornet."

Not a particularly clear description, and it is fairly certain that although the device might have been able to transmit tones or clicks, the clear reproduction of speech was probably not within its capabilities. Nevertheless he did think of the concept of speech by wire and so surely deserves to be included in the list of those who initiated the idea.

However, Émile Quétand, writing in le Petit Journal of Paris, wrote:

"Manzetti transmits directly the word by means of the ordinary telegraphic wire, with an apparatus simpler than the one which is now used for dispatches. Now, two merchants will be able to discuss their business instantly from London to Calcutta, announce each other speculations, propose them, conclude them. Many experiments have been made already.They were successful enough to establish the practical possibility of this discovery. Music can already be perfectly transmitted; as for the words, the sonorous ones are heard distinctly."

Later, on, la Feuille d'Aoste reported

"It is rumoured that English[sic] technicians to whom Mr Manzetti illustrated his method for transmitting spoken words on the telegraph wire intend to apply said invention in England on several private telegraph lines." Manzetti later recalled the technicians as being Alexander Graham Bell and family.

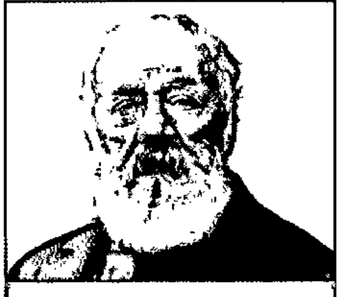
Manzetti died in Aosta on his 51st birthday, poor and largely unrecognised, although a plaque was placed in 1886 on the façade of his house in Aosta by the Association of Mechanical Industry and Related Arts of Turin with the following inscription:

TO
INNOCENZO MANZETTI
Executor in 1864
Of the first telephone apparatus

Innocenzo Manzetti's home and the commemorative plaque, placed there in 1886

Antonio Meucci read the newspaper reports in 1865 of Manzetti's telephone and wrote a letter to the editors of two of the papers claiming his priority in the design of a telephone and quoting his first experiment in Havana in 1849. However, being a gentleman and a true Italian patriot, he wrote

" I do not pretend to deny to Signor Manzetti his invention, but I only wish to make it evident that two thoughts can be found to contain the same discovery and that by uniting the two ideas one can more easily reach a certainty about a thing so important".



Antonio Meucci

Antonio Santi Giuseppe Meucci was born in Florence on 13 April 1808. He was admitted to the *"Accademia di Belle Arti"* on 27 November 1821, and remained in the Academy six years, following the schools of chemistry and of mechanics, the latter encompassing all of the known physics of the time. From 1823 to 1830 he was employed as customs officer at the gates of Florence. Then, living in Florence, he worked as a stage designer and technician in various theatres. In October 1833, he was hired at the renowned Teatro della Pergola, as assistant chief mechanician. In 1834, he set up an acoustic-pipe telephone (still existing today) to allow communication from the stage to the control room.

In 1833-1834, he was involved in the conspiracies for the liberation of Italy, and spent many months in jail with the famous patriot F D Guerrazzi. On 7 August 1834, he married Esther Mochi, a costumer in the Pergola's tailor shop.

In 1835 Antonio Meucci and his wife left Florence to flee the violence of the civil insurrections which raged throughout Italy. Many immigrants who wished for a peaceful life thought they might find some measure of solace in the New Land which lay to the west. Unhappily restricted by law from entering the United States, persons such as Meucci and his family would be turned southward and compelled to dock in Caribbean or South American ports. On

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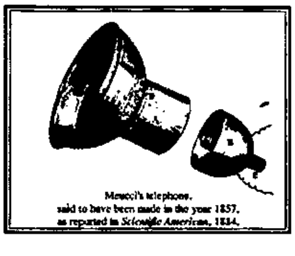
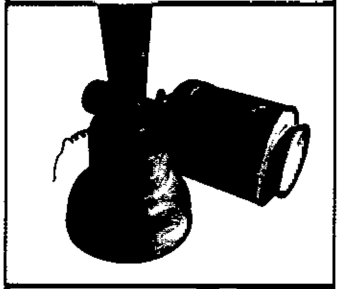
Pioneers of acoustics - *continued from page 37*

7 October 1835, having accepted the job of chief engineer, and his wife Esther the job of chief costumier, in the magnificent Gran Teatro de Tacón of Havana, they embarked in Livorno on the brig Coccodrill with 81 members of the Italian Opera Company. They arrived in Havana on 17 December 1835.

Meucci's posture during his first experiment



Meucci's telephone



A reconstruction in 1932 of Meucci's electromagnetic telephone

A momument to Antonio Meucci, erected in 1923

New arrivals in Cuba, the Meucci family made Havana their home. They found the warm and friendly nation a place for new and wonderful opportunities. In addition to his work with the opera house Sr Meucci pursued numerous experimental lines of research while living in Havana, developing a new method for electroplating metals. In 1844, having obtained a four-year contract from the Governor to galvanise supplies for the army, Meucci set up the first electroplating factory of the Americas. This new art was applied to all sorts of Cuban military equipment, Meucci gaining fame and recognition as a scientific researcher and developer of new technologies. On April 1847 he was given the job of reconstructing the theatre that had been severely damaged by a hurricane. He designed a new ventilation system which would avoid the roof being blown off again. Later he showed his support for the war of independence going on in his home country of Italy by sending money to Garibaldi.

In 1849 he developed an interest in the treatment of physiological conditions (mainly migraines) by electric shock treatment. In the course of his experiments he made the serendipitous discovery which was to launch him on his pursuit of a practical telephone. In the technique he developed for applying the electric shock, the patient was put in one room with a small copper electrode in his mouth and another in his hand. Meucci was in a separate room connected by wire to similar electrodes held in his hands. The figure (from Meucci's description of his experiment) shows the arrangement. When the system was connected to the battery, the patient yelled from the shock and Meucci heard the shout coming from the electrode held in his left hand. In later experiments he stated

> *"I thought I heard this sound more distinctly than natural. I then put this copper of my instrument to my ear, and heard the sound of his voice through the wire. This was my first impression, and the origin of my idea of the transmission of the human voice by electricity".*

After many more experiments Meucci gave his device the name "speaking telegraph". At that time Alexander Graham Bell was a two-year-old boy living in Edinburgh !

In 1850, at the end of the contract with the Cuban theatre, the Meuccis moved to the USA and arrived in New York in May. In early October the family moved to Clifton (Staten Island) and lived in a large house which is now a national monument. While in New York he befriended Garibaldi, who had fled there in 1850.

In 1854 or 1855 Meucci established what was probably the first ever telephone link. While they were living in Clifton his wife Esther became severely disabled by rheumatoid arthritis and could not leave her bedroom. In order to be able to communicate with her from downstairs he wired a cable from her room to the basement where he worked. To call attention a mechanical bell was used, its wires running parallel to the telephone wire. Only one instrument was used at each end that was alternately brought to the ear or the mouth of the user. The speech must have been of poor quality: probably a cry for help could have been recognised but not a request for a pot of Indian tea with bourbon biscuits! But it marked an important stage in the development of a working telephone. Meucci worked for many years on improving the quality of speech transmission and by 1857 had constructed the first electromagnetic telephone which probably would have provided much better speech quality. This instrument used a tempered steel bar, permanently magnetised, and a bobbin wound with a large number of turns. Both of these parts he bought from one Charles Chester, a manufacturer of telegraphic instruments in Center St, New York. The diaphragm of the instrument was made either of a sheet of iron or of a stretched animal membrane to the centre of which was glued a small iron disc. The air gap between the diaphragm and the bottom pole of the magnet could be adjusted by means of a screw.

Having exhausted most of his life's savings in pursuing his work, Meucci was unable to commercialise his invention, though he demonstrated it in 1860 and had a description of it published in New York's Italian language newspaper.

In 1870 Meucci was badly injured in a boiler explosion on a Staten Island ferry. Whilst he was in hospital his wife Esther, distraught and impoverished, sold his telephone models to a second-hand dealer for $6. When Meucci was recovering and discovered what his wife had done he was in despair. As he recovered he wanted to patent his telephone invention but he could not afford to do so, so he settled for a caveat (an announcement of an invention he expected soon to patent), borrowing the $20 required. He then submitted a model of his telephone and technical details to the New York Telegraph Company, but failed to get a meeting with executives. When he asked for his materials to be returned, in 1874, he was told they had been lost. In 1875 Alexander Graham Bell worked in the New York Company. A caveat had to be renewed every year to protect the inventor from competitive patents. Meucci did not have the funds to renew his caveat after 1874 and Alexander Graham Bell, who conducted experiments in the very same laboratory where Meucci's materials had been stored was granted a patent in March of 1876, made lucrative deal with Western Union and was thereafter credited with inventing the telephone. Meucci was devastated by the news of Bell's patent and wrote to his daughter

> *"The telephone that I invented, as you know, has been stolen from me".*

On 13 January 1887, the Government of the United States moved to annul the patent issued to Bell on the grounds of fraud and misrepresentation, a case that the Supreme Court found viable and remanded for trial. Meucci died in October 1889, the Bell patent expired in January 1893, and the case was discontinued without ever reaching the underlying issue of the true inventor of the telephone entitled to the patent. If Meucci had been able to pay the $10 fee to maintain the caveat after 1874, no patent could have been issued to Bell.

Meucci was recently recognised by the US Government, in House Resolution 219, dated 17 June 2002, which expressed the sense of the House of Representatives that the life and achievements of Antonio Meucci should be recognised, and his work in the invention of the telephone should be acknowledged. The Canadian Government retaliated by passing a resolution recognising Canadian immigrant Alexander Graham Bell as the "real inventor of the telephone".

According to a report in the Guardian of 17 June that year,

> *"Italy hailed the redress of a historic injustice yesterday after the US Congress recognised an impoverished Florentine immigrant as the inventor of the telephone rather than Alexander Graham Bell. Historians and Italian-Americans won their battle to persuade Washington to recognise a little known mechanical genius, Antonio Meucci, as a father of modern communications, 113 years after his death. The vote by the House of Representatives prompted joyous claims in Meucci's homeland that finally Bell had been outed as a perfidious Scot who found fortune and fame by stealing another man's work."*

In spite of the above we cannot deny Bell's brilliance. He produced a robust and viable telephone, and he had the force of personality to sell it to a sceptical public. But to do that, he did what all inventors do. He built on the combined wisdom of others - just as Reis had built on the work of Bourseul before him (see below).

Philipp Reis was born on 7 January 1834 in Gelnhausen, Germany, into a Jewish baker's family. In infancy Philipp lost both parents. Grandmother and guardian sent the ten-year boy, whose talent was already obvious to his teacher

continued on page 40

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Pioneers of acoustics - *continued from page 38*

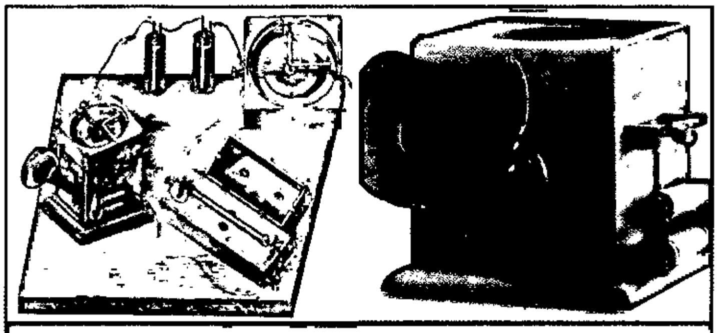
in the elementary school, to the Garniersche private school in Friedrichsdorf (to the north-east of Bad Homburg not far from Frankfurt). There he learned not only mathematics, physics and chemistry, but also English and also - as is natural in the Huguenot establishment of Friedrichsdorf - French. In 1850 the 16-year-old Reis became an elementary school teacher in Friedrichsdorf. Although he was no trained teacher, he knew how to tie up his pupils with interesting experiments. He was a self educated person and he continued his own education taking private lessons in physics, and became a member of the Physical Association of Frankfurt. In 1852 he expressed for the first time his idea of generating sounds by means of electricity.

Philipp Reis (1834-1874)

In 1850, Reis began his work on the telephone ("artificial ear", according to his own definition) by gathering some common materials found around his house. His essential idea came from a paper by the French investigator, Bourseul, mentioned above. In 1854 Bourseul had explained how to transmit speech electrically: he wrote:

> *"Speak against one diaphragm and let each vibration make or break the electric contact. The electric pulsations thereby produced will set the other diaphragm working, and [it then reproduces] the transmitted sound."*

Only one part of Bourseul's idea was shaky. To send sound, the first diaphragm should not make or break contact, but should vary continuously the flow of electricity to the second diaphragm. Reis used Bourseul's term "make or break" but his diaphragm actually drove a thin rod to varying depths in an electric coil. Thus, he did not make or break the current but varied it continuously. In a homemade laboratory in a shed in his garden, and on a very limited budget, Reis assembled components that few people would associate with the construction of a telephone: a violin, a knitting needle, a large cork, a coil of wire, and a sausage. In his first experiments he used a sausage skin stretched across a hollowed-out cork as a membrane for his crude microphone. Using wax, he attached a metal contact to the membrane. This contact was linked to the strings of a violin, which served as a receiver or speaker. Later he would use an electromagnetic receiver.



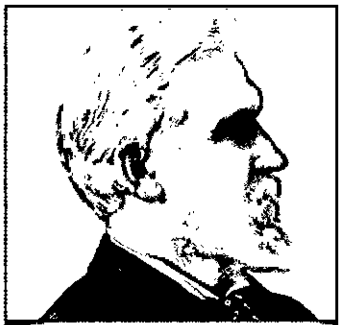
Reis telephone (1861): a scheme (left) and a model (right)

In his short life Philipp Reis accomplished a remarkable feat that brought him neither wealth nor fame. He was sickly and impoverished, with neither the means nor the stamina to capitalise on the device. Because of a rapidly progressing lung 'consumption' Reis could hardly speak from 1872 onwards, and had to give up his work. On 14 January 1874, at the age of only 40, he died of tuberculosis.

European physicists erected a monument to Philip Reis as its inventor. German textbooks accredited Reis with the invention, until the Nazis expunged Reis's Jewish name from German literature. The name has only partially been reinstated.

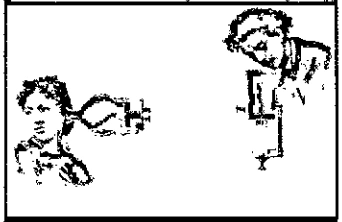
The Americans

Elisha Gray was an American inventor who contested with Alexander Graham Bell the invention of the telephone. He was born in Barnesville, Ohio, on 2 August 1835 and was brought up on a farm. He had to leave school early because of the death of his father, but later completed preparatory school and two years at Oberlin College while supporting himself as a carpenter. At college he became fascinated by electricity, and in 1867 he received a patent for an improved telegraph relay. During the rest of his life he was granted patents on about 70 other inventions, including the telautograph (1888), an electrical device for reproducing writing at a distance.



Elisha Gray, 1878 (Oberlin College Archives)

On 14 February 1876 Gray filed with the US Patent Office a caveat describing apparatus "for transmitting vocal sounds telegraphically". Unknown to Gray, Bell had on the same day applied for an actual patent on an apparatus to accomplish the same end. It was later discovered, however, that the apparatus described in Gray's caveat would have worked, while that in Bell's patent would not have.



Gray's telephone

Contrary to popular myth, Gray's caveat was taken to the US Patent Office a few hours *before* Bell's application. However, the filing fee for Gray's caveat was entered on the cash blotter two hours *after* Bell's filing fee, which led to the myth that Bell had arrived at the Patent Office earlier. Bell was in Boston on 14 February and did not know this was happening until he arrived in Washington on 26 February. Whether Bell's application was filed before or after Gray's caveat no longer mattered, because Gray abandoned his caveat, thus opening the door to Bell being granted US patent 174465 for the telephone on 7 March 1876.

In 1872, Gray founded the Western Electric Manufacturing Company, parent firm of the present Western Electric Company. Two years later he retired to continue independent research and invention and to teach at Oberlin College. He died in Newtonville, Massachusetts on 21 January 1901.

Amos Dolbear invented the first telephone receiver with a permanent magnet in 1865, 11 years before Bell patented his model. Later, Dolbear could not prove his claim, so Bell kept the patent. He lost his case before the US Supreme Court (Dolbear *et al* v American Bell Telephone Company). The 13 June 1881 edition of *Scientific American* reported that had Dolbear been observant of patent office formalities, it was possible that the speaking telephone, by then so widely credited to Mr Bell, would be "garnered among his own laurels". Known to his Tufts University students as 'Dolly', he chaired the Department of Astronomy and Physics from 1874. Dolbear contributed many notable inventions to the scientific world, in addition to the static telephone. These included the electric gyroscope used to demonstrate the Earth's rotation, the opeidoscope, and a new system of incandescent lighting. His research on the static telephone was conducted in his laboratory on the top floor of Ballou Hall, and the first transmissions using the device were made from Ballou to his house on Professors Row. He published several books, articles, and pamphlets, including *Matter, Ether, Motion*, and was recognised for his contributions to science at both the Paris Exposition in 1881 and the Crystal Palace Exposition in 1882.

Amos Dolbear, 1874

Conclusion

From the available sources it is clear that over the last three-quarters of the nineteenth century several worthy scientists and engineers arrived at the idea of voice transmission by wire. With the materials and techniques available to them in their day their success rate was not high. Nevertheless they all contributed to the development of a successful telephone system which was finally brought to fruition by Alexander Bell and Thomas Edison. The legal concert party that went on as the many participants challenged Bell probably benefited only the legal profession, but the outcome was the eventual establishment of a world-wide telephone network.

Parliamentary reports

From Hansard

Commons Written Answers

3 July 2006: Motorways

Chris Huhne: To ask the Secretary of State for Transport how many kilometres of motorway have been resurfaced with quiet noise surface in each year since 1997; and how many kilometres were so resurfaced before they reached the normal life requirement for renewal in each year.

Dr Ladyman: The number of lane kilometres of motorway laid with quieter surfacing in each calendar year since 1997 is set out in the following table.

Calendar year	Lane kilometres of motorway resurfaced
1997	36.4
1998	160.8
1999	280.7
2000	557.5
2001	330.1
2002	430.3
2003	818.5
2004	402.7
2005	362.9
2006 to date	112.8

Source: Information taken from the Highways Agency Pavement Management System (HA-PMS) as at 27 June 2006.

As our priority has been to maintain a safe and serviceable network, no resurfacing works have been undertaken ahead of maintenance requirements.

10 July 2006: Motorway surface noise

Mr Drew: To ask the Secretary of State for Transport by what criteria an area is assessed for its eligibility for motorway surface noise alleviation.

Dr Ladyman: Resurfacing of strategic roads, including motorways, is carried out when maintenance of the existing surface is required on safety grounds or as a result of general wear and tear caused by traffic. When resurfacing is required, quieter surfacing materials are used as a matter of course.

Noise barriers have been installed on existing strategic roads where serious and pressing cases of high levels of traffic noise experienced by nearby residents have been identified and where there has been no early prospect of quieter surfacing materials being laid,. These cases, which were listed on 11 November 1999, were identified using criteria announced by the Minister on 22 March 1999, based on calculated noise levels and road opening dates.

13 July 2006: Hearing aid services

Joan Walley: To ask the Secretary of State for Health if she will make it her policy to collect waiting time data for hearing aid services.

Mr Ivan Lewis: The Department does not collect waiting time data for audiology services. However, since January 2006 we have been collecting waiting time and activity data for 15 diagnostic tests or procedures, including pure tone audiometry. This data has been shared with the National Health Service, for performance management purposes since 2 June 2006. This data will be published on 12 July 2006.

20 July 2006: Road noise

Mr Carmichael: To ask the Secretary of State for Transport how many miles of road were resurfaced to reduce noise in each year since 2000-01; what the location of each resurfacing project was; what the total cost of resurfacing was in each year; and what work is planned in each year up to 2010-11.

Dr Ladyman: The Highways Agency currently resurfaces roads for maintenance reasons only, but has in previous years also resurfaced carriageways for environmental noise reasons, when specific funding was available. The Highways Agency does not separately record these two categories of carriageway resurfacing and it is therefore not possible to confirm the carriageway length resurfaced purely for noise reasons.

Since 2000-01 it has been Highways Agency policy to resurface carriageways with quieter surfacing materials, when maintenance is required. The following table shows the total quieter surfacing delivered in each year (data are only recorded in lane kilometres):

	Lane kilometres of quieter surfacing
2000-01	1,172
2001-02	1,613
2002-03	1,685
2003-04	1,565
2004-05	1,226
2005-06	1,618

The Highways Agency anticipates that it will deliver at least 1,000 lane kms in 2006-07. With respect to future forecasts, the forward maintenance programme is currently being updated, therefore it is not possible to accurately confirm the anticipated delivery for 2007-08. Delivery for years beyond 2007-08 will be subject to confirmation within the comprehensive spending review 2007.

The Highways Agency annually resurfaces a large number of routes, many of very short length; it is therefore not possible to identify every individual location.

Funding for carriageway resurfacing is from the Highways Agency's Renewal of Roads budget, which covers many different maintenance elements including carriageway resurfacing, street lighting, traffic signs and signals, drainage and geotechnical earthworks. Expenditure for carriageway resurfacing alone is not explicitly recorded and it is therefore not possible to identify this separately.

24 July 2006: Helicopter noise pollution

Mr Hands: To ask the Secretary of State for Transport what research he has (a) commissioned and (b) evaluated since 1988 on noise pollution from helicopter use over (i) the United Kingdom and (ii) the Greater London area.

Gillian Merron: The Department has not commissioned any substantial new work on helicopter noise since that carried out for the London Heliport Study in 1992-94 and published in 1995.

Noise hotspots

Mr Lidington: To ask the Secretary of State for Transport when he plans to publish the Highways Agency's report An assessment of noise hotspots along the M40.

Dr Ladyman: The report has just been finalised and copies have been placed in the Libraries of the House. The report is to be published on the Highways Agency's website shortly.

Noise severity index

Mr Lidington: To ask the Secretary of State for Transport if he will alter the formula for calculating the noise severity index to take account of the local environment.

Dr Ladyman: No. The calculation of the index is already carried out in such a way as to ensure resources are targeted at locations where noise levels are greatest and where the greatest number of people would derive benefit from the measures.

25 July 2006: Environmental noise

Mr Lidington: To ask the Secretary of State for Environment, Food and Rural Affairs when he plans to publish the responses to the consultation on proposals for transposition and implementation of Directive 2002/49/EC relating to the assessment and management of environmental noise.

Mr Bradshaw: Copies of the responses will be made publicly available during the summer, through the Defra Information Resource Centre, Lower Ground Floor, Ergon House, 17 Smith Square, London SW1P 3JR.

Noise-related complaints

Sarah Teather: To ask the Secretary of State for Environment, Food and Rural Affairs how many noise abatement notices were served in each London borough in each year since 1997.

Mr Bradshaw: We do not hold the information requested. Data held relating to noise abatement notices are compiled from voluntary returns from local authorities to the Chartered Institute of Environmental Health (CIEH). They are recorded by year, but not location.

The relevant data for 2004-05 for England and Wales are available from the CIEH's website at
http://www.cieh.org/library/Knowledge/Environmental_protection/CIEH_annual_noise_complaint_statistics.pdf.

Lynne Featherstone: To ask the Secretary of State for Environment, Food and Rural Affairs how many noise-related complaints have been lodged in each London borough in each of the last five years; and how many of these resulted in further action.

Mr Bradshaw: We do not hold the information requested. Data held relating to noise-related complaints are compiled from voluntary returns from local authorities to the Chartered Institute of Environmental Health (CIEH). They are recorded by year, but not location.

The relevant data for 2004-05 for England and Wales are available from the CIEH's website at
http://www.cieh.org/library/Knowledge/Environmental_protection/CIEH_annual_noise_complaint_statistics.pdf

NSCA

comments on Environmental Noise (England) Regulations 2006

Background

The Environmental Noise (England) Regulations came into force on 1 October 2006, almost 18 months after consultation on proposals closed. The Regulations aim to enforce the Environmental Noise Directive 2002, which requires all member states to prepare noise maps for agglomerations and all major transportation sources and to use the results to develop noise action plans. The Regulations set out the schedule for noise mapping (the first round of which has to be completed in 2007) and for subsequent noise action planning.

The NSCA welcomes the long-awaited introduction of regulations to enforce requirements for managing environmental noise. However it reiterates some major concerns expressed in a response to the consultation.

1. With the competent authority for mapping confirmed as the Secretary of State, removing ownership of the maps from local authorities, the potential practical application of the maps and associated data on noise exposure in noise management is severely undermined. This represents a lost opportunity to integrate action on noise into local and regional planning, transport and environmental plans and strategies.
2. Aviation continues to be treated as a special case, (Regulation 19) as in other areas of central Government policy. The competent authority for mapping noise and developing action plans for non-designated airports is the airport operator, not an elected local authority. Further, it states that action plans are to cover 'places near the airport'. The NSCA has little confidence that any action plans developed in relation to these noise sources will address the needs of people likely to be affected by aviation and associated noise from airport operations.
3. The NSCA is are concerned that there is no mention of resources for the implementation of noise action plans or for the updating of noise maps and noise action plans.

Specific points on the Regulations

Regulation 7(3) requires the competent authority to review and if necessary revise a noise map whenever a 'major development' occurs and Regulation 17(3) requires the competent authority to review and if necessary revise a noise action plan whenever a 'major development' occurs. There seems to be no definition here of 'major development', and no financial provision for updating maps and action plans.

Regulation 13 requires the competent authority to define 'quiet areas' in agglomerations. It is not clear what is to be defined, especially whether the definition is to be acoustical or geographical.

Regulation 20 requires the competent authority to consult the public about proposals for action plans, but not local authorities or other relevant agencies. The NSCA believes that all bodies or persons with an interest should be consulted.

Regulations 21(1) and 21(2) appear weak and contradictory in that 21(1) states that 'a public authority must treat the action plan as policy' but 21(2) says that a public authority can depart from that policy if it provides the competent authority with written reasons. If any reason would suffice, this would undermine the purpose of the action plans, and, ultimately, the Directive.

Regulation 30 refers to guidance. It would be helpful to have a timescale for its implementation.

In conclusion, with a draft National Noise Strategy for England due to be published for consultation next year, and the Environmental Noise Directive due for revision, it appears there are a number of issues of application and implementation that need to be tackled if the stated aims of the END - that is 'to substantially reduce the number of people affected by noise by 2012' - is to be achieved.

NSCA 3 October 2006

The NSCA can be contacted at 44 Grand Parade Brighton BN2 9QA,
tel. **01273 878770**
http://www.nsca.org.uk

UKAS accreditation and ANC Registration

for organisations carrying out pre-completion testing

UKAS accreditation and ANC Registration for organisations carrying out pre-completion testing still raises questions from consultants and clients.

There is considerable doubt and confusion in the construction industry, not least among building control officers and insurance companies, as to the exact requirements for accreditation or registration of bodies carrying out PCTs in buildings covered by Approved Document E (2003).

The guidance in AD-E is that organisations carrying out pre-completion testing should 'preferably have UKAS accreditation (or a European equivalent) for field measurements'. The 2004 amendment adds that 'The ODPM also regards members of the ANC Registration Scheme as suitably qualified to carry out pre-completion testing'.

When pre-completion testing was introduced in 2003 there were not enough UKAS/ANC test organisations to undertake the work. There are now over 50 UKAS/ANC organisations, and ODPM recommends that UKAS/ANC organisations should be used unless no such organisation is available when required. Builders who employ test organisations should be made aware of this at an early stage.

Although organisations that are not UKAS accredited or ANC registered may work to the same standards as the other organisations, their operation has not been subjected to a check by a third party.

www.planningportal.gov.uk/england/professionals/en/4000000000337.html

Ukas-accredited calibration of filters

AV Calibration

AV Calibration Ltd is now able to offer full UKAS-accredited calibration of octave band and third-octave band filters designed in accordance with either IEC 61260 or IEC 225 and which are fitted to sound level meters. This is a recent addition to its portfolio of UKAS-accredited calibrations, which already covers sound level meters, acoustic calibrators, pistonphones and noise recording equipment.

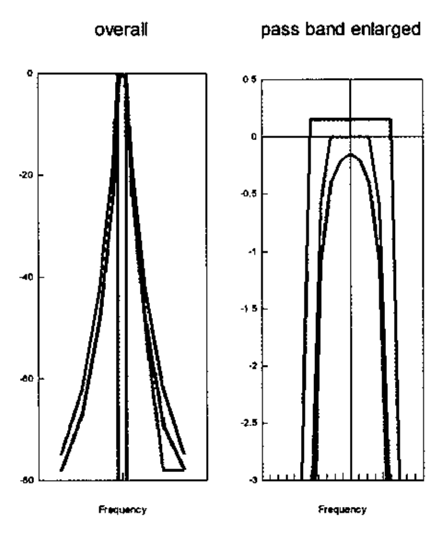
For simplicity a choice of several 'standard' filter calibrations is offered, but these can also be tailored to the customer's requirements. The simplest standard calibration applies to either octave bands or third-octave bands, where a check at each band's centre frequency is carried out and the response of three filters from the set, usually including 1kHz, is measured. For instruments fitted with both octave and third-octave filters, the same checks may be applied to both bandwidths if required.

For customers who are implementing the new tests required by the recent changes in the Building Regulations, a more comprehensive test of third-octave filters is also offered as standard. This carries out checks at the centre frequency of each band, and measures the response of every third octave filter from 100Hz to 5kHz.

Certificates with all measured results plus graphical plots of the responses will be supplied for each calibration. Prices start from £135, and a discount is applied to the cost of testing the filters if the complete sound level meter is calibrated to UKAS standards at the same time.

AV Calibration also offers other types of calibration, traceable to National Standards, for most makes of noise and vibration measuring instruments.

For more information or to book a calibration contact Richard Tyler, tel **01462 638600**, fax **01462 638601** e-mail: **lab@avcalib.co.uk** web site: **www.avcalibration.co.uk**



Typical band-pass filter characteristic

The Art (Deco) of Acoustics

Triple E

Opened in 1928 to considerable acclaim, and receiving a RIBA Award in 1929, the Lawrence Hall is an iconic art deco grade II listed building, with breathtaking architecture and natural light flooding in through four tiers of clerestory windows, domed roof lights and end wall windows.

The building is part of the Royal Horticultural Halls in London, owned by the Royal Horticultural Society (RHS), and it has always been RHS practice to hire out the venue. Although the hall is a popular venue for an increasing number of lavish and prestigious corporate events, as well as a location for film and television productions, including one of the previous set of BBC One television 'ident' videos, its cathedral-like architecture has acoustics to match, and so precludes it from being used for conferences and other events where amplified sound is required.

As part of a £1.2m refurbishment, managing director René Dee originally wanted a blackout system for the hall, but the more he investigated, the more he learned about variable acoustics. Dee says that he went to see an installation by Triple E at LSO St Lukes, in the City of London, and realised that variable acoustic banners could enable Lawrence Hall to be truly multi-functional, capable of hosting the type of events they had been unable to entertain before.

David Edelstein is managing director of Triple E (Equipment Engineered for Entertainment), a company well known for its expertise in variable acoustic banners and curtains. He says that the initial brief was simply to provide blackout blinds, but then they were asked for help with the acoustics as well. An assessment by Arup Acoustics showed a reverberation time in the hall of between 7.5 and 8 seconds, which could be reduced to between two and three seconds by installing the proposed 1540m² of acoustic drapes. The challenge was to design a system that would look as if it had been there for ever: Lawrence Hall was a well-loved building and there was concern about changing its appearance.

Working closely with specialist drape manufacturer J&C Joel, who also supplied technical support and installation crew, Edelstein put together a plan for 56 acoustic roller blinds for the clerestory windows and three acoustic banners for the long vertical windows at the clock end of the hall, all of which would work as blackout blinds too.

The fabric of choice for acoustic drapes and banners, developed specifically by J&C Joel, was wool serge which, constructed as a flat woven fabric, felts during the wet finishing process and so closes the natural air gaps created during the weaving. Wool serge thus has the ideal characteristics for use in acoustic areas, but its aesthetic qualities must also be borne in mind. For the Lawrence Hall, the J & C Joel design and manufacturing team specified the dying and weaving of over 2500m² of acoustic fabric to ensure the hall both looked and sounded right.

Triple E recommended an acoustic roller blind system for the clerestory windows, which range in height from 0.8 to 6 metres. A key element of acoustic banners is an air gap of at least 80mm between two layers of fabric. To achieve this, the acoustic roller blinds are similar to a domestic blind, except that the fabric doubles back on itself, weighted by a travelling roller, to provide that double layer. The double thickness of bonded wool serge used on this project had excellent acoustic values, but also gave a total blackout.

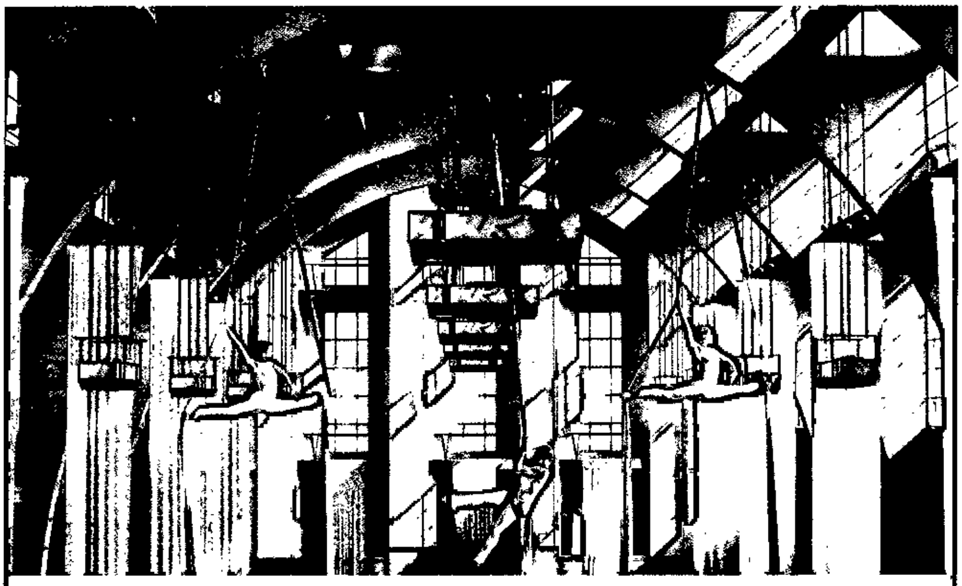
Another vital element to ensuring the fabric hung correctly was the fact that it was cut by hand. According to J&C Joel, although the bonded fabric was inherently stable, it would stretch if cut by machine. The blinds and banners for the Lawrence Hall needed to be absolutely spot-on and hand cutting was the only way to ensure that they were. Fortunately, Joels had the space and facilities necessary.

To maintain the look of the hall, the fabric for both the blinds and the banners was dyed specifically to match the walls, with the guide channels and masking trays for the roller blinds being powder coated to match.

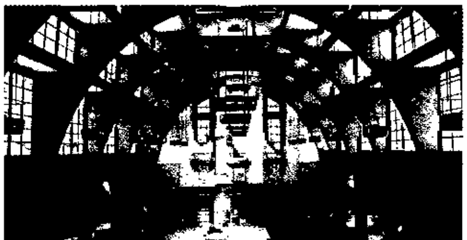
At the clock end of the hall Triple E installed three of its Venetian acoustic banners, the longest being 15m, which are raised and lowered concertina-fashion, necessary over such a long drop. Horizontal aluminium slats were enclosed in each banner at 160mm intervals; a flat stainless steel band, fixed to the bottom tray of each banner, passed through the slats and was pile wound onto drums contained in the wall-mounted frames. There was also provision for the later installation of a further four banners.

Two control panels, were provided, one for the roller blinds which can be deployed either simultaneously or by individual tiers, and the other for the banners. A system was devised for setting top and bottom limit positions from the control panel: Triple E designed and built both panels which had to be very compact. All the cabling for the systems had to be laid outside the building to minimise the effects on the interior look.

The refurbishment of the Lawrence Hall, which included a controllable directional PA system and improved event lighting, provided increased business opportunities, because there are very few venues like it in central London, which are able to seat 1000 people theatre-style.



Still from BBC One ident



The Lawrence Hall before work began to install the blackout and acoustic blinds and banners.

The Lawrence Hall with all clerestory and end wall blackout and acoustic blinds and banners fully deployed.

UKAS accreditation for Hampshire company

Sound Advice Acoustics Ltd

Sound Advice Acoustics Ltd, based in Chandlers Ford, Hampshire has achieved UKAS accreditation for sound insulation testing in according with the requirements within the current Building Regulations Document E (2003) revision 'Resistance to the Passage of Sound'. The co-founder of the company, Mr Mike Scrivener, would like to express his thanks and gratitude to all the staff within Sound Advice Acoustics, and the external auditing company T & S Partnership Ltd, for all their help and support in accomplishing the accreditation.

The quality and technical division of the company is to be headed up by one of the company's directors Mr Brian Scrivener. Although the procedure for achieving UKAS accreditation was both time-consuming and costly, the outcome was well worth the efforts involved. The entire procedure took approximately twelve months to complete and involved the implementation of an entire new computer data logging system designed and installed by Brian Scrivener.

The idea of UKAS accreditation is to generate a fully traceable system both on-site and in the office in accordance with BS EN ISO/IEC 17025:2005 General Requirements for the Competence of Testing and Calibration Laboratories, although 'laboratory' testing will only be conducted on site. The system involved the designation of Quality, Technical, Deputy Quality and Deputy Technical Managers within the company's structure. These managerial positions have specific tasks incorporated within the quality system to ensure that the pre-completion testing aspect of the company operates correctly within the directives created in the quality manual. This results in a smooth operation that is fully traceable, operated under strict external audits and is cost effective to the company's clients.

The new accreditation will add strength and value to the already rapidly expanding company. Sound Advice Acoustics Ltd has already secured several long term contracts for pre-completion testing with some of the largest house builders in the UK. The accreditation involved the close inspection and external validation of the company's test procedures, policy statements, data calculations and the operating quality manual with all subsequent supporting documentation.

With an accreditation number issued by UKAS including the Royal Crest, the company is now involved in the research and development of various separating structures with several of its clients. These detailed investigations are set to give accurate, validated results, and with the knowledge gained can be passed on to future clients with more challenging developments.

Sound Advice Acoustics Ltd was founded in 1991 and is involved in many other fields in the acoustic industry including educational and leisure facilities with regards to building acoustic design. Environmental work, planning applications, noise at work surveys and pre-construction surveys for houses and offices are a few of the other services currently offered.

The private homes division of the company is looking to expand not only in pre-completion testing activities but also other areas such as air quality assessment and building pressure testing. These additional areas of expertise could potentially be UKAS-accredited at a later date.

The management of Sound Advice Acoustics Ltd display their UKAS accreditation certificate.

Averaging in pre-completion tests

The question raised by Ruiari O'Duill in the last edition of Acoustics Bulletin has been answered on many occasions by the ANC registration committee. The question confuses two separate processes: (1) averaging levels measured at different locations in a room and (2) averaging the level differences between rooms. (1) is done on an energy basis, (2) is done arithmetically. This is stated very clearly in Annex B of Approved Document E, Procedures for sound insulation testing. AD-E is part of the Building Regulations, and anyone undertaking pre-completion testing under the Building Regulations should be familiar with the Approved Document.

In preparing the registration scheme, the ANC undertook a thorough review of the standards. We identified the issue of averaging, and the apparent conflict between AD-E and BS EN ISO 140, and discussed this with staff at ODPM, the government department responsible for Building Regulations. ODPM confirmed that arithmetic averaging should be carried out where AD-E directs. Clearly, not all consultants are aware of this or of some other technical issues relating to pre-completion testing, hence the requirement that ANC members undertaking PCTs should undergo a third-party review under the ANC registration scheme, or the UKAS accreditation system.

Adrian James
VICE-CHAIRMAN,
ASSOCIATION OF NOISE CONSULTANTS

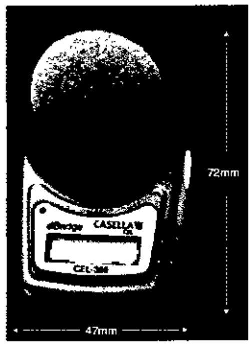
dBadge personal noise dosemeter

Casella

With the new Control of Noise at Work Regulations 2005 in place, the need to monitor individuals noise exposure is of paramount importance. The latest addition to the Casella CEL product family is the CEL-350 dBadge. By using the latest digital technology, the manufacturer claims that the unit achieves new standards of performance in noise dosimetry.

The dBadge has no external cables to get in the way or become damages, unlike traditional dosimeters, and weighs only 68 grams. It measures and logs all workplace noise parameters, and has a 32 hour battery life: the unit can be fully recharged in only 90 minutes. There is an integrated display and visual exposure alarm, and calibration checks are simple and straightforward via an auto-calibration function. The company also provides a comprehensive software package for applications such as the measurement of personal noise exposure and the assessment and monitoring of noise in the workplace.

Contact Casella CEL Ltd at:
Tel: **01234 844100**
e-mail: **info@casellacel.com**
web site: **www.casellacel.com**



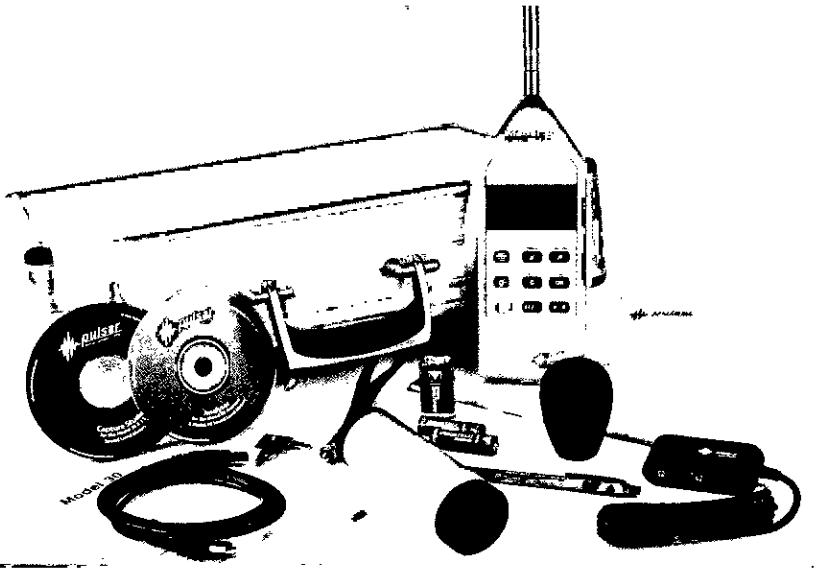
A CEL-350 dBadge

Acoustical instrument rental

Dakat Ltd

Dakat Ltd has announced a new rental service for those interested in hiring noise monitoring equipment for occupational or environmental noise.

An excellent choice of modern instrumentation from Pulsar Instruments gives the user the flexibility to select the ideal tool for their specific application.



A selection Dakat equipment for rental

Each instrument or system is supplied as a full noise measurement kit which includes everything needed to carry out the noise survey.

Easy-to-use software is available as standard allowing the quick presentation of measurements in a professional manner. The company also provides technical support and backup from an experienced team of noise measurement professionals.

Dakat's prices include delivery to the client's premises and collection at the end of the hire period. Thus there are no hidden costs and the number of days booked are the number of full days that the equipment will be on site. It will be delivered the day before the hire period starts and collected the day after it ends.

The selection of equipment that is available for rental is shown on the company's web site at **www.dakat.co.uk**. Web-based orders can also be paid for on-line. Alternatively phone Dakat on **07957 624477** or fax **01252 872256**. The contact e-mail address is **office@dakat.co.uk**

Human vibration analyser

Brüel & Kjær

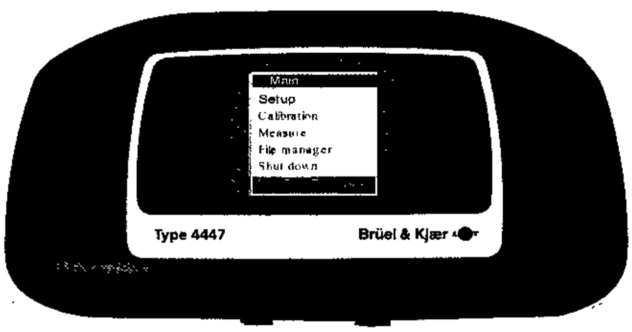
Brüel & Kjær has introduced a portable system for acquisition, measurement and evaluation of human vibration. The Type 4447 Human Vibration Analyser is designed for monitoring exposure of human operators to the harmful influences of vibration of hand-tools, machinery and heavy vehicles.

It is a compact, battery-driven, stand-alone instrument ideal for field work and with a versatile graphics display for control of the instrument and analysis of results. Four buttons control all functions, and all necessary data is displayed for instant assessment of exposure to vibration. A USB interface provides for archiving and post-processing of the data for calculation of vibration doses.

Among the parameters which the Type 4447 simultaneously measures and calculates are triaxial running RMS vibration and peak vibration, weighted or unweighted, crest factor for each axis, frequency-weighted hand-arm vibration and whole-body vibration, the combined vibration on all three axes as a vector sum, MTVV (maximum transient vibration value), MSDV (motion sickness dose value), and VDV (vibration dose value). The Type 4447 is delivered together with a software package for calculation of vibration exposure to check the action values and limit values as stated in European Directive 2002/44/EC.

Brüel & Kjær sought input from many interested parties in the design and development of the instrument. They included consultants working with measurements of, and risk evaluations caused by, exposure to occupational vibration; occupational health departments; manufacturers of building machinery, freight vehicles and other machinery; manufacturers of anti-vibration pads, seats and personal protection equipment; manufacturers of all kinds of hand-tools; and educational and medical institutions.

For further information contact Rebecca McCullough Brüel & Kjær UK Ltd.
Tel: **01438 739000**
Fax: **01438 739099**
e-mail: **ukinfo@bksv.com**
web site: **www.bksv.com**



Type 4447 Human Vibration Analyser

Institute Sponsor Members

Council of the Institute of Acoustics is pleased to acknowledge the valuable support of these organisations

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

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

3-4 November 2006
Electroacoustics Group
Reproduced Sound 22 - Raising the Standard - Oxford

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

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
It's practically a quality measurement!
Are your acoustic measurements fit for purpose? -
National Physical Laboratory

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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