Acoustics BULLETIN

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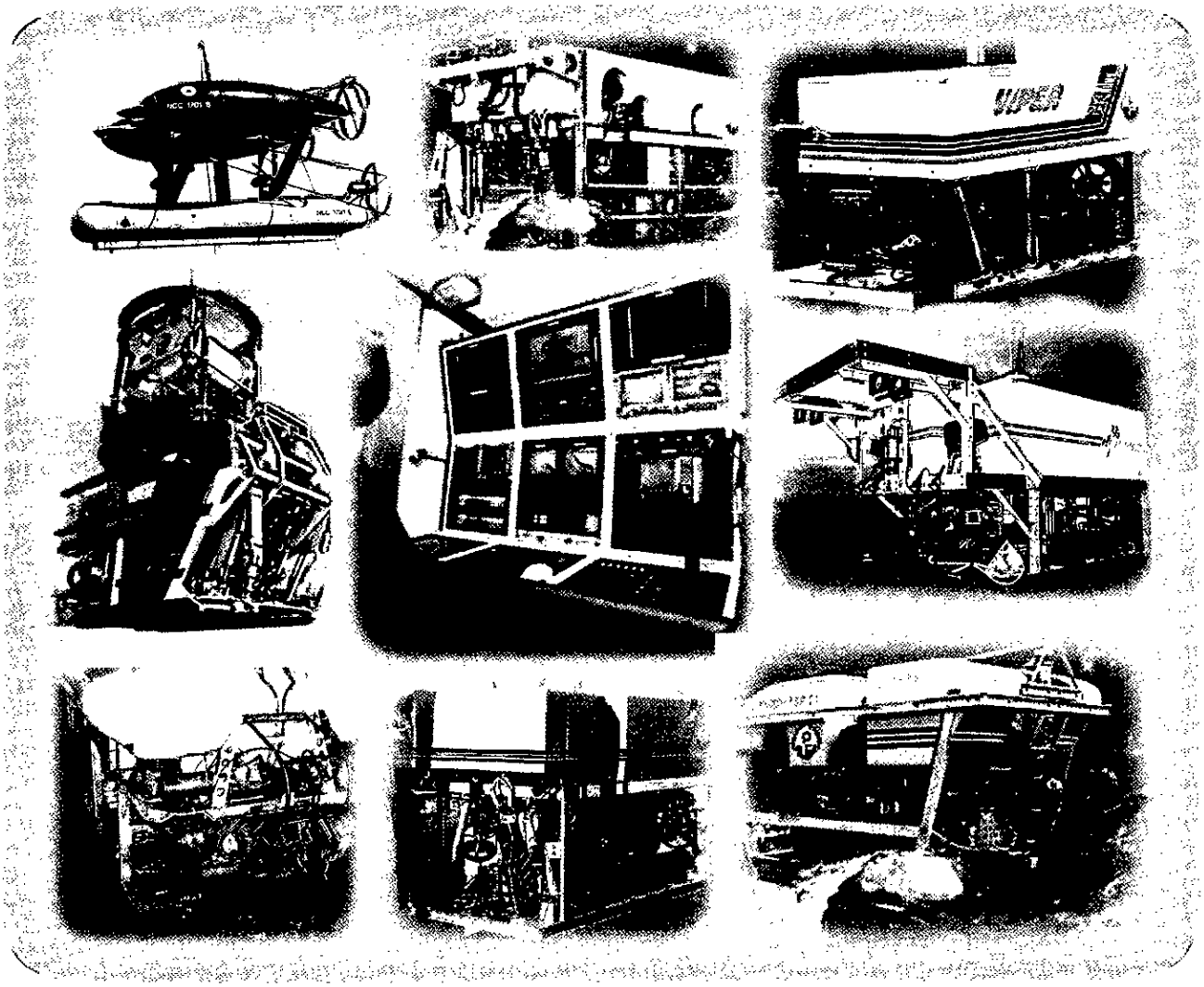

Measuring machinery noise in the ocean

Autumn Conferences 2001
History of hearing protection
BS4142 and noise impact assessment
US perspective on EU directives

Institute of Acoustics

Acoustics BULLETIN

Vol:127No:1Jan/Feb:2002

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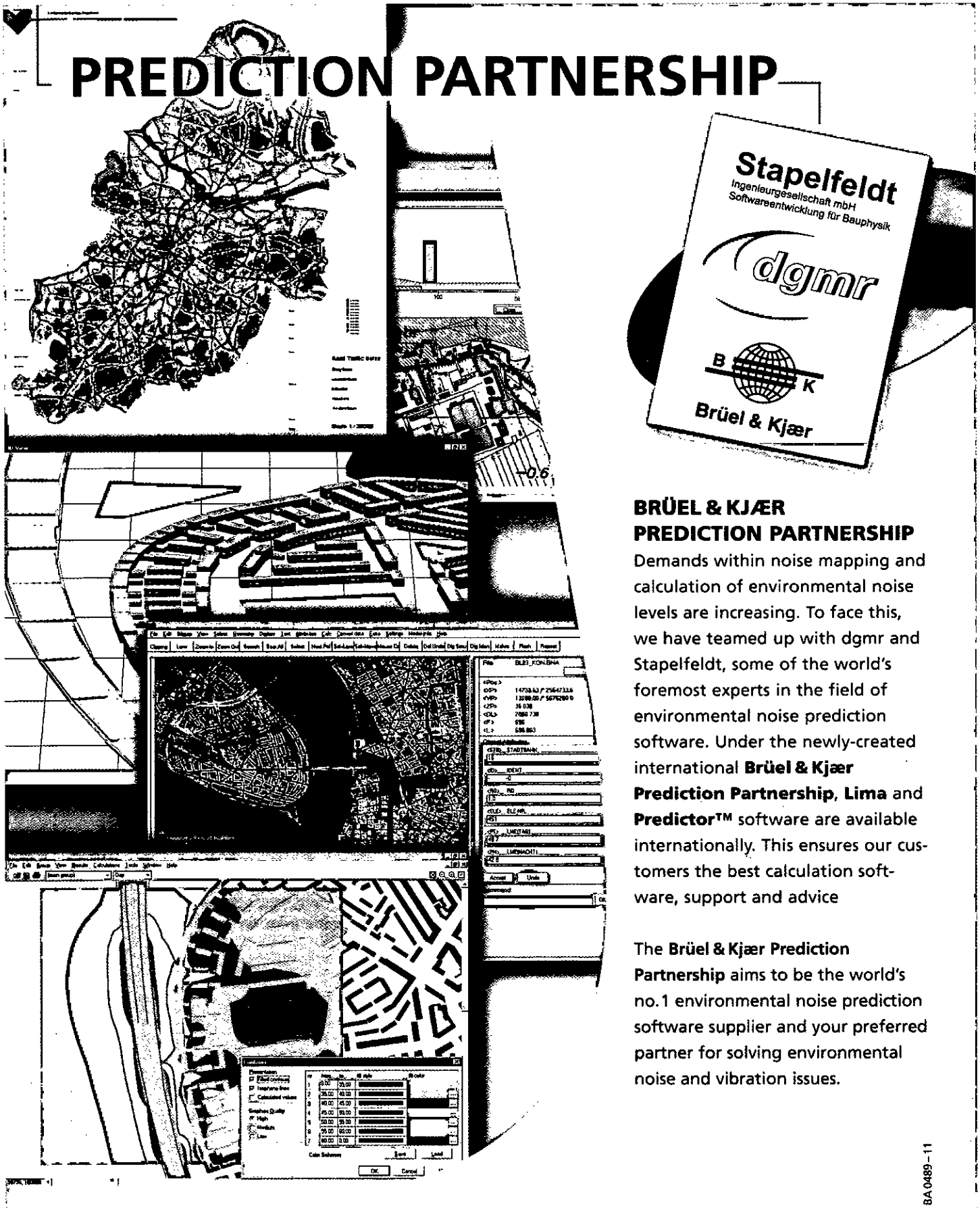
Contents

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.

PREDICTION PARTNERSHIP



BRÜEL & KJÆR PREDICTION PARTNERSHIP
Demands within noise mapping and calculation of environmental noise levels are increasing. To face this, we have teamed up with dgmr and Stapelfeldt, some of the world's foremost experts in the field of environmental noise prediction software. Under the newly-created international **Brüel & Kjær Prediction Partnership**, **Lima** and **Predictor™** software are available internationally. This ensures our customers the best calculation software, support and advice

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Brüel & Kjær

Dear Members

It's not too soon in the new year to talk again about the Spring Conference to be held at the University of Salford on 25 to 27 March 2002. This is being expertly organised by a special committee headed by Yiu Wai Lam. As I write this, just before the Christmas break, the programme is shaping up well with more than 60 papers set to be delivered – covering all aspects of Members' interests. The Spring Conference is particularly important to us because it is hosting the Theme Day on behalf of the Engineering and Physical Sciences Research Council. The Theme Day, created and organised by Keith Attenborough, will showcase research in all areas of acoustics and is designed to assist EPSRC in consolidating their acoustics funding strategy. Coherent support for our area by a major government funding agency is crucial to the long term future of acoustics in the UK, and crucial in enabling us to continue to enhance our heritage in the wider domain of Europe and even further afield.

Do not think that this is all something just for the academics among us. The long term future of consultancy, and small and large industrial concerns alike cannot be divorced from the health of our educational and research base. I urge you very strongly, especially if you are NOT from the academic sector, to give the Spring Conference and EPSRC Theme Day your enthusiastic support. The very competent teams assembled to make the event something to be remembered are working way beyond the call of duty on behalf of all of us. Let us have an impressive record turnout for the event – and you just have time to send in your registration forms!

With best wishes

Mark Tatham

Calling all motor vehicle specialists

(NVH and environmental concerns etc...)

Recently a member was in touch with St Albans suggesting that the Institute sets up another specialist group to meet the needs of people working in this field, in order to provide 'a forum to discuss both current and emerging tools and techniques in the field of automotive NVH'.
In the past such interests have been organised under the umbrella of the **Industrial Noise Group** which, for example, arranged a one-day conference in London in 1993 on *External Vehicle Noise*. However since then there has been little further Institute activity regarding automotive noise.
Although the Industrial Noise Group was successfully reactivated early in 1999, its subsequent activity has not included any motor vehicle noise applications.
The question therefore arises as to whether we should combine motor vehicle work with other industrial noise issues, or establish another more specialist group? Would such a group be more active and successful?
There are obvious dangers of splitting into smaller groupings, particularly in relation to the difficulties of finding volunteer members to organise group events. Such activity - based on the theme of the group - relates to:
❑ disseminating the latest information;
❑ acting as a forum for comment and debate;
❑ originating and organising group meetings and conferences; and
❑ representing the Institute's view on relevant matters.
Members' views on the formation of a new specialist group, or its combination with industrial noise, will be much appreciated. In particular volunteers to join either a new organising committee, or the existing industrial noise group committee, would be especially welcome. Please give this proposal your careful consideration, and leave your name with HQ at St Albans.
Thank you for your help: I look forward to receiving your comments.

David G Bull, *Vice President, Groups and Branches*

IRISH BRANCH REPORT AND AGM

Agreeing criteria for Pubs and Clubs Code of Practice

The guest speaker, **Ken Dibble** CEng FIOA, was welcomed to Belfast by our Chairman **Gerry McCullagh.** There was a good attendance for this AGM and to hear Ken speaking on the subject of the Rationale behind the *Measurement and Criteria Annex* of the *Pubs and Clubs Code of Practice*, for which he said publication was imminent.
Ken mentioned the difficulties in trying to achieve agreed criteria on this subject. In the first instance we were to forget dB(A) and in all cases should capture a frequency analysis of the sound or noise.
He gave examples of the much higher levels obtained at the lower frequencies, notably 63Hz which was indeed generally that of the base energy. Smaller loudspeakers could only produce the second harmonic, ie. 125Hz but in larger premises the fundamental of 63Hz could be reproduced and therefore measured. This was equivalent to approximately 60 phons but the human hearing senses do not 'kick in' until approximately 100 phons. Basically the A-weighting curve chops off all the low frequency sound.
Ken spoke of the way the problem had been overcome by investigating the noise levels using an approach of splitting the spectrum and measuring the exceedance as an A-weighted level and specifically in the (unweighted) 63Hz octave band.
There were to be various categories for the music being played, taking account of whether music occurred more or less than 30 times per year, or more or less than weekly, and finishing times would also be taken into account.
Ken advised us that the measurement of low frequency sound gave several problems, notably that it is readily masked by other low-frequency noises such as lorries or aircraft. We should also be alert for wind noise on the microphone, which particularly affects the low end of the spectrum. He reminded us that low frequencies can be audible in a room with the window shut, but when the window is opened slightly the sound can disappear!

Pictured at the Irish Branch AGM, from left: Robin Mark, Kevin Chambers, Ken Dibble, Gary Duffy & Martin Lester. ***Photo:*** **Sam Bell**

This annex to the Code of Practice was to be ratified the following week and then sent for publication.
[I understand that since this presentation there have been further delays in the ratification of the Code of Practice - Ed.]
At the AGM which followed this enlightening presentation by our prestigious guest, all Officers were re-elected. Gerry McCullagh gave a full account of the past year's activities, and told us of the exciting plans for the future of the Irish Branch.
He congratulated Gail Greer and Payman Agahi on gaining their PhD's in Acoustics.

Sam Bell
committee member
tel: 028 9337 2547
e-mail: sam@noise1.co.uk

NORTH WEST BRANCH REPORTS

From the Wilson Report to the night noise offence - how do they measure up?

On 17 October 2001 **Ian Campbell** of Campbell Associates provided an excellent and enjoyable personal review of the need for noise control and our professional response over the last 35 years. He started putting the date of the Wilson Report into context. It competed in the 1963 newsstands with the Profumo scandal and the Beeching Report on the railways.

Ian went on to look at each of the main headline requirements identified by the Wilson Report and traced these through action, reaction and legislation to the present day.

Our biggest successes have been in controlling transportation-related noise in the road traffic, railway and aviation fields. Unfortunately, improvements in source noise control have been at least partly offset by increases in vehicle numbers.

As a profession we have been less effective in controlling noise from construction and industry, and Ian outlined the history and basis of concern: BS.4142, the threat of 'creeping background' levels, and the various planning controls.

Where we have perhaps found progress most difficult is in the control of noise within buildings, and from entertainment, with relation to neighbour noise. Ian looked forward to some promising future legislation and guidance.

The evening was punctuated with particular insights into a number of areas, not least early efforts to involve the police in vehicle noise control, why sound level meters cost what they do, and the link between calibrators and Russian submarine gyroscopes.

'We have been less effective in controlling noise from construction and industry'

Not all handshakes are golden

Ian Critchley, Peninsular Acoustics and **Chris Nelson**, HSE, gave a fascinating insight into *Hand Arm Vibration,* the subject being dissected from physiological, legislative, measurement, assessment and enforcement perspectives.

Chris started the evening with the effects of hand arm vibration, previous legislation and the research and logic leading to the existing legislation. He went on to cover in some detail the control of daily exposure, employers' actions, and vibration monitoring, and finished with a bibliography of useful publications.

Ian led on from this, looking at the practical aspects of management and assessment in the workplace. He examined particular types of measuring equipment, and demonstrated how measurements can be carried out. I will never see a buffing machine in the same light again.

In going through a very comprehensive case history for a large utility, Ian showed the high variability involved in measurement and suggested how, through appropriate measurement techniques and averaging, a reliable assessment can be made.

Nick Antonio

Vibration from construction works

Some 21 people gathered at Arup Acoustics in Manchester on 29 November 2001 to hear **Dr David Hiller** give a talk on construction vibration. The presentation concentrated on fundamentals of vibration, criteria for assessment, and the measurement and prediction of vibration.

David explained about body waves, compression waves, shear waves and surface waves or Rayleigh waves. The Rayleigh wave is particularly important as about two-thirds of the vibration propagation is in the Rayleigh wave.

He described a graphic example of vibration propagation using the analogy of two ducks on a pond bobbing up and down due to the ripples caused by a brick thrown in the water. Let's hope the RSPCA don't get to hear about it! Although propagation speed is measurable, it is particle velocity (or duck velocity!) that is important as this is what causes effects.

'Two ducks on a pond provided a graphic example of vibration propagation'

He ran through the basics of displacement, velocity and acceleration as well as peak rms, peak particle velocity (ppv) and briefly, very briefly, vibration dose value, vdv. Example traces were shown to illustrate the differences between continuous, intermittent and transient vibration.

We then left the ducks to move on to building damage. He stressed that building damage criteria generally relate to buildings in good condition. We saw the somewhat large range of criteria from the national standards of various countries, and also what appeared to be a large discrepancy between BS.5228 and BS.7385.

Perception levels are very much lower than the levels at which even slight cosmetic damage to buildings may be caused, which explains why we get complaints about vibration but very few cases of building damage due to vibration. Apart from building damage criteria, there are occasions when buildings need to have very low levels of vibration where it could upset sensitive equipment. Hospital operating theatres are one example.

David then moved on to the measurement of vibration, running briefly through what to measure and where to measure, and warning us to be aware of equipment limitations. Transducer mountings are of particular importance when measuring high levels of vibration.

It is vital that the transducer stays firmly in contact with the vibrating surface. This can be achieved by a strategically-placed sand bag (for low levels of vibration), by casting the transducer in plaster-of-paris, or the preferred method of driving a minimum 10mm diameter metal rod into the ground and attaching the transducer to the top.

A helpful suggestion was added: if the rod is tapered, it not only provides a very firm anchorage and goes in more easily, but is also easier to extract after the measurements.

Following a brief historical interlude taking in Reiher and Meister, we looked at examples of vibration from piling, dynamic compaction and other construction activities. David proposed prediction formulae for various activities. Our speaker concluded by saying if anyone wants to know more about his work, they should obtain a copy of the book, *TRL Report 429.*

Paul Freeborn

Examination results

Certificate of Competence in Environmental Noise Measurement

The following were successful in the October 2001 examination

Colchester
Bacon S
Fairweather J F
Hipwood C L
Hopkins D J
Jenkins C
Kaloya M
Lavender M A
MacDonald J
Sandford J
Webb J C

NESCOT
Cufley H S
Ferrari J
Garner B J
Lennon T
Nicholls E
Nock M P
Priddle N

Derby
Brian M A
Shanks G W
Holloway C M
Curtis D
Anstee B J

Bristol
Bowland R L
Budd G D
Darling S J
Gregory M C
Kan Y C S
Lang R N
Moore L
Paulley M D
Paxford J
Warren-McCauley J

Bell College
Croucher S

Ulster
Connery C
Finnegan P M
McCombe N J S

Strathclyde
Crawshaw J
Lightbody M I
Milne A
Murray G
Valenti M

Leeds
Anderson J
Broadbent C
Ehlert M N
Harpham A
Richardson M J

Birmingham
Daily A P D

NV Noise
Wright R M

Certificate Course in the Management of Occupational Exposure to Hand Arm Vibration

The following were successful in the November 2001 examination

Institute of Naval Medicine
O'Neill R I
Currie J

Leeds
Westerby H S
Mulford A
Jones R
Grkwic S

EEF Sheffield Association
Wade J
Martin B G
Mallender D J
Edwards J H
Briggs G E
Booker D
Hope H

The Editor welcomes letters for publication

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Stockport SK42LP
Tel: 0161 479 0919
Fax: 0161 476 0929
e-mail -
ian@acia-acoustics.co.uk

Certificate of Competence in Workplace Noise Assessment

The following were successful in the November 2001 examination

Colchester
Brailey N
Coad S
Commins P J
Gould P W
Hannah A S

Bristol
Collier A M
Nicholson R
Stewart C
Taylor R J

NV Noise & Vibration
Greaves R
Jozefczyk M
Scarisbrick W T
Wagstaff P D

Leeds
Ajmal N K
Buchanan D A
Calvert D M
Hulley M
Jervis A S
Quinn J A
Rodgers E

Loughborough
Anderson A
Babra I
Barugh G
Maxim E
Park D J
Parker J I
Skillicorn P D A
Trask P M
Whitelocks G T

Amber
Broad A S

EEF Sheffield Association
Bramwell L A
Casson R I
Glossop M
Johnson L
Robinson G A
Wadie M
Wallace S

Diploma Prize 2001

President-elect Geoff Kerry presents the 2001 Diploma Prize to Julie May

Julie May, Senior Environmental Health Officer in the housing and environment team at Merton LBC, achieved the highest mark in the recent examination for the Diploma in acoustics and noise control. She received her award from Geoff Kerry, President-Elect of the Institute, during the Autumn Conference Dinner at the Victoria Hotel, Stratford-upon-Avon.

Julie graduated from Kings College London in 1996, with a 2.1 degree in Environmental Health. She then worked at Weymouth and Portland Borough Council for some eighteen months as an Environmental Health Officer in the housing and pollution team, before moving to the London Borough of Merton, again in the housing and pollution team.

She deals with all types of noise complaints received by the department and has responsibility for the day-to-day running of the out-of-hours noise service.

Editor's Notes

Christmas and New Year have come and gone, so I hope yours were good ones: welcome to the first *Bulletin* of 2002. If you have been frantically searching through this issue for the Blue Pages, don't worry, they haven't fallen out of the middle. One result of the ongoing consultation with members about the evolving format of the *Bulletin* was that nobody seemed to mind where the Institute Diary and similar information actually appeared!

The premise for the Blue Pages was that the information therein was as up-to-date as possible, so in days gone by they were printed separately and bound in at the last possible moment. This has not happened for more than a year now, because the entire issue is printed in one run. We have therefore taken the opportunity to revise 'what goes where', so in future you should find the Diary at the back, while other information will be treated as Institute News somewhere near the front.

Members seem to be overwhelmingly in favour of the way the Bulletin looks now, and the criticism I have received has been positive and helpful. Thanks are due to everyone who has returned a questionnaire, or took the trouble to speak to me in person at Stratford-upon-Avon.

Ian F Bennett *BSc CEng MIOA*
Editor

New Institute members

At Council on 6 December 2001 the following were elected to the membership grades shown

FELLOW
Atkins, P R
Chivers, R C

MEMBER
Dandy, M I
Dolan, W J
Douglas, S H
Dunn, M S
Middleton, M S

ASSOCIATE MEMBER
Albon, R M
Butler, S M
Chittock, C J
Clack, D E
Cook, D P
Edwards, J H
Gates, S D
Hargrave, J M
Hargreaves, P D
Hattersley, N P
Kelly, D J
King, S A
Maher, S M
Meister, A
Morgan, A
Murray, K
Paterson, S
Skinner, C J
Spencer, J P
Stephens, W J
Walsh, J L
Walton, M T
Wong, C C C
Woodcock, S L

STUDENT
Agam, T
Chatzigeorgiou, G
Hunter, G J
Perry, S P
Stacey, B
Trevena, A M
Vilatarsana, G

Instruments and Statutory Instruments

The Stratford Victoria Hotel - our conerence venue

Richard Tyler FIOA **and Nigel Cogger** MIOA

report from the Autumn Conference 2001

The 2001 Autumn Conference was held on 14 and 15 November at the Stratford Victoria Hotel in Stratford-upon-Avon for the third consecutive year. Organised jointly by the Environmental Noise Group and the Measurement and Instrumentation Group, under the banner *Measurement and Assessment of Environmental Noise (Instruments and Statutory Instruments)*, it attracted over 120 people to the 22 papers presented.

After a brief introduction from **Richard Tyler,** Chairman of the Measurement and Instrumentation Group and one of the organisers, the Conference started with a presentation from **Martin Joseph** from DEFRA who provided an update on implementation of the EU Directive on the assessment and management of environmental noise.

As part of the Government response, the noise incidence survey is being repeated to determine not only noise levels, but also attitudes to noise throughout the UK. Martin told us that emphasis in the EU is on computation rather than measurement, thus introducing the subject that formed a significant part of the day's discussions.

In answer to a question from Jack Pease, editor of *Noise Management,* on how cost/benefit analysis can be applied to noise issues, Martin pointed out that the study *Synergies and Conflicts* (now published on the DEFRA web site) has shown that people are prepared to pay for an improved noise environment, but that other aspects such as health care and journey times for alternative transport systems can also be assessed.

After hearing the importance which was likely to be attached to noise mapping in the near future, **Edgar Wetzel** from Wölfel Software GmbH presented *Coupling noise mapping software with GIS data.* This showed the potential advantages to be gained using the information available from the Geographical Information System when combined with noise data.

Examples were given of small areas such as a factory site, up to large-scale areas with many different interested parties, and how the ability to use existing data sources could be exploited. Although at present the different formats of the data present some obstacles, the synergy between these information sources should be more fully developed in the future. A question following the presentation pointed out the similarity between noise mapping and air pollution prediction and control.

Declan Waugh then followed with a report on work carried out in Ireland to monitor the soundscapes of relatively untouched and wilderness areas over time. This long term study is investigating a range of landscapes - well illustrated by colour slides - to determine baseline data that will be supported by noise mapping to assist in the development of policies for noise abatement and control in relatively quiet areas and to develop environmental quality objectives for them.

Two questions covered the influence of instrument noise floor and uncertainty on low levels of measured noise - the noise floor of the meters used is approximately 12 to 14 dB(A) and is therefore within 3 to 5 dB of the levels measured at some locations.

After a break for coffee, **Ian Campbell** of Campbell Associates chaired a session mostly connected with noise mapping. **Arne Berndt** from SoundPLAN LLC in Washington USA presented *Improvements in accuracy for the calculation of noise propagation from area sources.* He showed that using the methods described in ISO 9613 errors of up to 6dB could occur with the methods given for turning single area and line sources into point sources. Larger errors were also thought possible with multiple sources.

The method explained by Arne divides the area source into many smaller triangular elements, each of which has a sound centre located. These are then recombined to determine effects on the receiver position. Using this method it was claimed that the effect of unwanted sources can be easily identified and the effects of removing them recalculated with little additional effort.

Wolfgang Probst discussed the integration of GIS data into noise maps, concentrating on the importance of ensuring that the mapping software adequately describes the physical features so that the noise propagation can be accurately modelled. It was

shown that an accurate and efficient noise mapping process can be coupled with software to determine internal noise levels from the outdoor noise, enabling the effects of changes in not only the ambient noise, but also in building design and facade elements to be determined.

The morning concluded with a question and answer session covering all the presentations. This produced some lively and interesting questions, ranging from the effects of temperature inversion and wind-induced noise on noise maps to noise quality in rural areas being as important as the actual sound pressure levels.

Martin Joseph appealed for more information from local authorities and individuals and it was noted that models can only be as good as the data fed into them. **Ralph Weston** (RJD Acoustic Services) wondered if we were actually listening enough - an interesting point after a morning of presentations concentrating to a great extent on theoretical noise modelling.

Following an enjoyable lunch, the afternoon session commenced with **Colin Grimwood** of the Building Research Establishment (BRE) introducing **Douglas Manvell** of Brüel & Kjær in Denmark, who discussed: *Implementation of the Dutch railway noise model for use in noise mapping.* This model is likely to be recommended by the EU for use in the proposed Environmental Noise Directive and was actually started as long ago as 1980. After numerous trials it was revised in 1996 and this is the version currently in use.

A vast database now exists of all train movements for every 100m of track in Holland, and is accessible to many different interested parties. Data has been collected from sound level meters with remote telemetry capabilities, accessed on demand. Despite its existence for many years, there is still no quantification of the uncertainty of the measurements made, or tests to show the correlation between measurement and prediction! For the model to be universally applicable, some degree of standardisation will need to be introduced.

Ken Scannell introduced the strategy used by the New South Wales authorities to control noise, in the context of the recently introduced *Protection of the Environment Operations (Noise Control) Regulation* and the *Protection of the Environment Operations Act.* These are implemented primarily by the Environment Protection Agency, which provides guidance and criteria for a wide range of environmental noise sources from industrial noise to domestic machinery and leisure noise.

Although sleep disturbance and industrial sources operating for limited times of the year are not covered, the policies developed by the EPA do provide detailed guidance and realistic criteria to limit environmental noise - an interesting contrast to the somewhat fragmented and often questionable approaches in the UK.

The chairman then introduced one of his BRE colleagues, **Peter Turner,** discussing *Using sound intensity measurements to diagnose the causes of poor sound insulation.* Taking real case histories, Peter showed that identifying the causes of poor sound insulation between sections of buildings, especially

continued on page 10

Instruments and Statutory Instruments

continued from page 9

where these were unexpected or not responding to standard remedial techniques, can be simplified using a sound intensity meter.

By making fairly rapid scans of all surfaces radiating into the space under investigation, the surfaces making the most significant contributions can be found quickly. A more detailed scan of these surfaces will show which ones are really problematic. An example was given of a floor where only a small section was incorrectly constructed, giving rise to the reported problem.

Problems of traffic noise, significant reflections and reverberation have to be dealt with for this method to really give definitive answers. Yet, in many instances, they are not a problem and the method was shown to be a valuable time and cost saver.

Noise propagation model

After a break for coffee, **John Shelton** of AcSoft introduced the final papers of the day. **Jeroen Borst** discussed the TNO noise propagation model, which has been developed to assist local authorities in fulfilling requirements of the European Directive on environmental noise.

URBIS is a GIS-based package that enables air pollution, odour, safety hazards, annoyance and health effects, as well as noise, to be modelled. The noise model is aimed at both development policies and strategies to deal with environmental noise and at testing their effectiveness.

Changing from predictions and mapping, **Ole Herman Bjor** from Norsonics AS in Norway discussed: *Refinement of SLM design to further reduce measurement uncertainties.* These refinements included the use of just one measurement range covering the whole measurement capability, thus avoiding any range changing errors.

He also discussed the use of a correction for microphone self-noise, which is tailored to the individual microphone fitted to the meter (this may need manufacturer alteration if the microphone were to be replaced at any time). This should allow readings down to approximately 18dB(A) to an accuracy of 0.5dB without the use of special low-noise microphones. Corrections for the change in frequency response when using a windshield can be switched in using digital signal processing techniques, an accuracy improvement not normally fitted to sound level meters.

IOA President-Elect, **Geoff Kerry**, presented the background to the newly published *Good Practice Guide - Uncertainty in Environmental Noise Measurements.* He explained how the information in the guide had been derived and reviewed the measurement studies undertaken to provide examples of uncertainty under controlled conditions.

Good Practice Guide launched

Following the **Environmental Noise Group's** AGM, a sherry reception hosted by University of Salford was held in the exhibitors' area to launch *Good Practice Guide.* The excellent Conference Dinner was followed by a speech from Geoff Kerry, deputising for the President. Having just launched the University of Salford's *Good Practice Guide* to the determination of uncertainty in acoustics measurements, he apologised for turning the first day of the Conference into the 'Geoff Kerry Road Show'.

First he presented the *2001 Diploma Prize* to **Julie May**, who works for the London Borough of Merton and studied at NESCOT.

Geoff then thanked the conference organisers, starting with the back-room staff at HQ, and mentioning the high-profile guilty parties. As always, the hotel manager and his staff had done a thoroughly professional job in hosting the conference. He also acknowledged the support of the exhibitors, which included ANV Measurement Systems, Casella CEL, GRAS, ProsCon, Campbell Associates, Brüel & Kjær and the Association of Noise Consultants, as well as the IOA and the University of Salford.

Geoff confessed he could no longer claim to prefer the former Windermere venue to Stratford-on-Avon, except for a minor disappointment. He had taken, he admitted, a certain malicious delight in reminding people at the end of the Windermere event that he had only an hour's drive to get home, when some of the more extreme southern-based colleagues faced a journey of eight or nine hours! Nevertheless, he recognised the ideal location of Stratford for the annual 'big event', and looked forward to welcoming members to the 2002 Spring Conference, which will be held in Manchester (Salford, for the pedantic).

On that subject Geoff praised the foresight of

Debate continued during the Conference dinner

The reception hosted by the University of Salford was particularly well attended

Good Practice Guide launched at Stratford

Early Wednesday evening Salford University held a reception to launch its Good Practice Guide on the sources and magnitude of uncertainty arising in the practical measurement of environmental noise. It was particularly appropriate that this took place in the exhibition room housing displays from all the prominent acoustic instrumentation manufacturers.

Advances in technology have helped to reduce instrumentation measurement errors and uncertainties, especially sound level meter function and calibration. However, the use of a sound level meter and its operation, especially out of doors, can give rise to additional uncertainties that can influence interpretation of the results obtained.

Indeed the whole 'measurement chain' must be regarded as a source of uncertainty in the value finally recorded. Identifying all sources and magnitudes of the uncertainties provides a means of quantifying the total uncertainty in any environmental noise measurement, and can reveal ways of minimising them, thus improving accuracy of the final result.

The University of Salford guide, which was prepared with the financial support of the National Measurement System Programme for Acoustical Metrology, Department of Trade and Industry, aims to present the whole topic of 'uncertainties' as simply as possible, in order that users can take up the ideas and use the information either to define the magnitudes of final measurement uncertainty, or identify the probable sources of uncertainty. A simple and straightforward approach allows the user to decide what is required and how much can be done, based on the information available.

The NPL's Measurement Good Practice Guide no.11 was adopted as the basis for handling uncertainties, mainly because it had proved successful in circumstances where there was a reasonable degree of control of the measurement parameters. However, there is no reason why it cannot be applied to the measurement of environmental noise where there is little control over some extraneous factors.

Content of the Salford 'Good Practice Guide' is based on assessments, comparison exercises, and case studies carried out or obtained and analysed in terms of uncertainties arising from relevant environmental effects, measurement practice and instrumentation uncertainties. A key element is to provide the necessary procedural material in an easily digestible form for all practitioners.

The approach taken is to break each environmental noise measurement exercise into three stages, which can be described as the source, the transmission path and the receiver, and to consider the processes and associated uncertainties in each stage. An 'uncertainty budget' is then drawn up for each stage, and used to evaluate the final combined uncertainty.

In a real environmental noise measurement situation it can be extremely difficult to provide a reliable estimate of uncertainty, because it is unique to the particular circumstances of the application. However, by using information and guidance obtained from relevant sources and references, and from carrying out practical studies, it should be possible to evaluate the source of most uncertainties in a measurement, and make an estimate of the magnitude. A list of useful references is included, so that the user can take the analysis further if deemed necessary.

Geoff Kerry launches the 'Good Practice Guide'

Standards on environmental noise measurement will, in future, require an assessment of the measurement uncertainty to be made. This guide offers an appropriate means of determining such uncertainties.

The guide emphasises adoption of good practice to reduce uncertainties in measurement results. Identifying sources and magnitudes of uncertainty are essential to identify where measurement practice can best be improved. A knowledge of the magnitude of the uncertainty in a measurement is particularly useful when comparing measurements with guidelines or with another measurement result.

All delegates who attended the reception were presented with a copy of the guidance. It is hoped that the Good Practice Guide will prove its worth to all who undertake acoustics measurements in the field, by helping us to quantify the accuracy of - or more properly, the uncertainty inherent in - our acoustic measurements.

the Commonwealth Games organisers in taking the opportunity to hold the Games after the Institute of Acoustics had been in town. He pointed out that a great deal of new infrastructure would already be in place in Manchester in readiness for the IOA's visit (including the Metrolink extension) so it made sense to take advantage of this and hold a second international event there in the same year.

CPD --- a lifetime commitment

He then introduced **Ralph Weston**, who would point out the importance of Continuing Professional Development in all aspects of life. He used as an example Ralph's experience of driving in New York City, when fresh from the airport their hire car was stopped by an officer of the law. Apparently Ralph learned on that occasion exactly how not to behave in such a situation, but was saved by his nationality. The NYPD does not expect the British to know how to distinguish between different sorts of red traffic light, which is a relief to us all.

Ralph Weston's speech was directed at encouraging us all to embrace CPD. He was wearing one of two hats - both of which were demonstrated. CPD was important to all, both young and not so young, students and supervisors, and owners of consultancies and businesses. It was about networking, about who you know as well as what you know. It is an extension to a CV, but more than this.

To use an analogy from a Christian source, what was needed was a bit of acoustic spirituality. The first step was to look at yourself, where you are today, and what skills you have.

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He mentioned a letter of recommendation he had once seen, which said that the candidate was a jolly good chap but he could not control his project budget. Ralph had spent his coming to Stratford today.

The IOA code of practice says that members must upgrade their professional knowledge and skills. CPD is a way of recording and recognising this: members must also be aware of technological advance and standards. On that subject, he had a need for a remote monitoring device that is robust enough to leave outside, but cheap enough not to worry about the insurance - which wasn't available anyway.

The next step was an action plan determining what you want to do next in the short, medium and long term. This might be ... your next job, a career break, an ability to command £450/hour like the recent Railtrack accountant, or an ambition to become the next President of the IOA (apparently we should ask Geoff how to do this). For himself, he wanted to know how to get honorary membership so that he didn't have to pay his subs any more.

To make his point, Ralph Weston dons two hats - including one that apparently enables him to read sideways

The third aspect of CPD was learning the skills and keeping up with developments. This was where the IOA came in, by providing the conferences, meetings, workshops and training for members to develop the skills they need. Examples of Ralph's skills included a talent for dancing, discovered when he had won a special competition at an Autumn Conference. He also learned recently how to resolder wires - even in this age of integrated circuitry, someone had to solder the bits together.

We had learned from the press the previous week that the ancient Britons used acoustics in their design for Stonehenge. During the second world war we tried to use acoustic focusing to provide early warning of approaching German aircraft: the relative speed of sound and aircraft meant we could theoretically get an extra three minutes' warning. Now NASA has recorded acoustic signals from the sun, in order to model the solar flare emissions. All in all, there was plenty to learn out there.

Ralph concluded by saying that if any member wanted to know more, and especially if he or she wanted to go for Chartered Engineer status, they should contact HQ or visit the web site now!

As usual, discussions in the vicinity of the hotel bar followed, well into the early hours.

Implementing IPPC in the UK

Thursday dawned frosty and foggy. **Stephen Turner** chaired the 9am start session which opened with **Lesley Ormerod** from the Environment Agency introducing UK implementation of the EU Directive 96/91 on Integrated Pollution Prevention and Control (IPPC) and the recently published draft guidance on noise emissions.

Lesley explained the structure within the EA that will deal with noise and summarised the approach adopted in the draft Horizontal Guidance Note H3, on which the EA's implementation is based. The overall policy is based on protection of the environment as a whole, rather than one aspect (such as noise or vibration) being dealt with in isolation from the other environmental implications of an industrial process.

Paul Bassett continued the theme of industrial noise control in his presentation of case studies involving the assessment and control of tonal noise. This paper provided a practical link to the second presentation by **Ole Herman Bjor** of Norsonics, who spoke on *Quantification of tonal penalties in environmental noise assessments.*

He described an algorithm that attempts to measure the intrusiveness of tonal components in environmental noise measurements and which can be built into many microprocessor-based sound measuring instruments that include frequency analysis. Instead of the operator having to make an arbitrary decision as to whether the perceived noise is tonal or not, the instrument will make a decision based on narrow-band frequency analysis and define the tonal penalty in the range 0 to 6 dB in 1dB steps. (In BS.4142, for example, the only step given is 5 dB.) The method is being considered for inclusion in ISO 1996-2, and is similar to an existing DIN 45681 standard, but as with so many new standards, it is not exactly the same!

Nigel Cogger broadened the spectrum in a review of planning guidance which highlighted the problems that can occur when the implications of noise from new noise generating or affecting noise sensitive development are assessed using only a rigid interpretation of BS.4142.

The emphasis on relative criteria rather than absolute limits is inconsistent with the PPG24 guidance on transportation sources, the recommendations of BS.8233, and the WHO Guidelines for Community Noise. A more flexible planning strategy was proposed, which adopted a similar approach for planning to the IPPC document H3 and the consultation paper on Minerals Planning Guidance Note MPG11.

The question session focused primarily on the problems of tonal noise and included an interesting comment by **Mike Breslin** of ANV on the automatic detection of tones: the system described by Ole Herman Bjor did not consider the additive effect of a series of harmonics that can produce a higher perceived level. He was also concerned that instruments can give a false sense of security when levels are close to the noise floor.

J McCullough felt that third-octave analysis was adequate to detect tonal components and wondered

why it was necessary to determine tonal effects within an instrument when tones are generally easily perceived. Ole Herman Bjor emphasised that the aim of the algorithm in an instrument was to provide an objective correction, rather than the somewhat coarse penalties used at present.

SLM standard explained

After a break for coffee, **Geoff Kerry** appeared again, this time as Chairman of the next session of papers, and introduced **Richard Tyler** of AVI Ltd and Chairman of the IOA's Measurement and Instrumentation Group.

Does the new SLM standard IEC 61672 make any difference to measurements? was the question posed. Firstly, he gave a resumé of the ten years of development of the new standard and a discussion of the principal changes from the existing standards IEC 60651 and IEC 60804. He then moved on to the effects on measurements of an improved directional response of the whole meter, different tolerances for the effects of temperature, humidity and EMC, and the specification of previously undefined parameters.

As with many aspects of noise measurement, the answers lie as much with the user as with the equipment, but a question from the floor wondered if existing meters would be rendered obsolete overnight. This would not be the case unless a meter to the new standard were specified for the job in hand.

Per Rasmussen from GRAS in Denmark then proceeded to enlighten delegates on *Periodic verification of measurement microphones.* Often overlooked because the testing is not particularly easy, the frequency response and sensitivity of a measurement microphone can be reliably measured using a combination of a pistonphone and an electrostatic actuator.

Not all measurement microphones can be tested with an actuator, but increasingly this is not true. The relative speed of this type of testing was recommended as the best low-cost test to show that the microphone is undamaged and giving a frequency response suited for precision measurement making.

In the question and answer session that followed, more information on the differences the new SLM standard will produce were discussed, and it was confirmed that very few Class 2 sound level meters are fitted with microphones that can be calibrated by the actuator method just described, so that low-cost microphones could not be verified cheaply.

Vibration measurement

After lunch, **Martin Armstrong** from Brüel & Kjær UK chaired a session on vibration measurement. **Rupert Thornely-Taylor** introduced the new ANC guide on the measurement and assessment of groundborne noise and vibration. Without giving too much away, Rupert managed to achieve what many thought impossible - a lucid explanation of how that 'arcane' document BS.6472 should be used. We look forward to publication of the Guidelines!

A question from the floor

Following the interpretation of BS.6472 given by Rupert, **Tim Wilton** from Vibrock Ltd stepped up to ask *BS.6472: Fact or Fiction?* stating that the two major criticisms levelled at the standard were that it is too complex and it does not reflect human response to vibration!

He then went on to discuss the special case of blasting and how the special appendix for this topic in the revision of the standard currently under discussion came into being. He concluded by suggesting that the adverse effects of blasting can be offset as much by good public relations as by any noise and vibration reduction methods.

The final session of the conference was chaired by **Tim Clark** of Bristol City Council and commenced with **Robert Beaman** from RAF Halton describing *Development and assessment of a measurement methodology for determination of helicopter directivity.* With the increasing use of helicopters in day-to-day events, modelling of a helicopter would be helpful in predicting its impact on various environments.

Helicopter noise is very speed-dependent and tonal, so accurate predictions must take these factors as well as the helicopter's position into consideration. A measuring system with accurate time correlation had been devised to provide the basic data for a model: this was described and

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examples of the data gathered shown. The correlation between the measured results and the modelling was shown to be good and some of the detail of the noise contours underneath the helicopter produced interesting results.

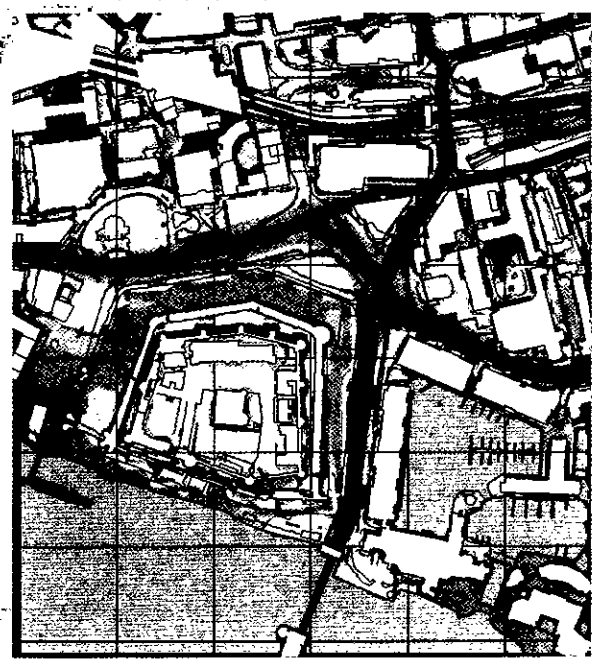
Richard Collman returned to the theme of measurement practice with his paper *Measuring and assessing the sound you intend, not everything else.* Richard emphasised the importance of examining the detailed time history of noise levels, rather than relying on the long term averaging of statistical data used as the basis for much of the guidance, standards and legislation. The principle of monitoring short term data that can then be used not only for a detailed analysis, but also to derive the long term parameters, was illustrated by case studies.

Ken Dibble provided speech reinforcement throughout----

Curtis Lakin provided a link from the *Measurement of Environmental Noise to the Reproduced Sound 17* conference that followed, with a paper describing the strategy used by Mendip District Council to control noise from the Glastonbury Festival, which has now been running for about 30 years. Curtis emphasised the importance of early planning with the organisers and discussed the monitoring equipment and criteria now used to control noise not only from the 12 stages, but also the market traders and other stands which operate all night.

Tim Clarke closed a very successful conference, thanking the contributors, administrators and all participants, and **Ken Dibble** for providing the sound reinforcement system.

Richard Tyler FIOA, *is Chairman, Measurement and Instrumentation Group*
Nigel Cogger MIOA, *is a member of the Environmental Noise Group.*



REPRODUCED SOUND 17

Measuring, Modelling or Muddling?

Introduction by

Robin Cross FIOA,

Chairman, organising committee

This is my second year as Chairman of the Electro-Acoustics Group's Reproduced Sound conference programme committee. This year's working title was *Measuring Modelling or Muddling?* The conference theme was centred around a technical examination of the commercially available software packages for specifying, designing and auralising sound system components from studios to stadia and microphones to loudspeakers.

The original modelling package 'shoot out' took place at an earlier Reproduced Sound conference and generated great interest, together with the highest ever attendance. With the abundance of processing power available today the committee took the view that it was time to review the state of the art - coupled with a discussion forum to highlight the different approaches.

The committee was united in stressing that the papers would not be sales pitches and that the delegates would not be seduced by the user interface, but by a hard look at the assumptions and short cuts embedded in the software model. All of these desires were met.

Peter Barnett Memorial Award

After the untimely death of committee member Peter Barnett last year, Peter Mapp and I discussed the possibility of a prestigious annual award to be presented to an individual to recognise Peter Barnett's work in speech intelligibility, electroacoustics and education. The Institute endorsed this suggestion.

Prior to introducing the first Peter Barnett Memorial Lecture, Peter Mapp explained to delegates the background to the award. The recipient of an award is likely to have distinguished themselves in one of three areas. These are:

- *Research into the practical aspects of speech intelligibility or electroacoustics;*
- *Achievements in the field of education, not necessarily as a university lecturer but also in the training of people in industry etc; and*
- *A world renowned expert in speech intelligibility or electroacoustics who would be invited to give a Peter Barnett Memorial Lecture and receive the award.*

The name of each recipient would be engraved on the base of the award.

Peter's company, AMS Acoustics, has financed the creation of a shield, produced in solid silver and mounted on a square wooden base. In fact it is not really a shield but a model of a binaural dummy head which Peter used a lot in his work and, it was felt, was appropriate and would have pleased Peter. This 'trophy' is to be awarded to a person chosen by a select committee. However, high standards will be aimed for and it is possible that it will not be awarded in every year.

We were delighted that **Herman Steeneken,** the father of STI, accepted our invitation to give a talk to the Conference on the subject. We were not disappointed! The rigour of the research which underpins the STI technique became at once apparent and impressive.

If I took nothing else away from Herman's talk, it was that the technique was never intended to be used to quantify Public Address and Sound Reinforcement systems! After his paper Dr Hermann Steeneken was presented with the new

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The President Mark Tatham presents the Peter Barnett Memorial Award to Dr Herman Steeneken. Although room reflections make it appear like a bottle of rum, it is actually made of highly polished silver!

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award by the President of the Institute, Professor Mark Tatham.

After the talk and presentation and prior to dinner, AMS hosted a reception, at the start of which the delegates toasted the spirit of Peter Barnett.

Evening presentation

Saturday night saw the return of **John Watkinson** to give a talk on loudspeaker design entitled *Loudspeakers for humans*. Carefully avoiding any possibility of being uncontroversial, John had brought his 'toys' along to show us. Naturally these were sophisticated examples and demonstrations of loudspeaker design (see photograph).

Put together the core ideas that at very low frequencies volume velocity is what matters, that at the loudspeaker crossover frequency the two transducers must have the same volume velocity capability, that accurate resolution in the time domain is more important than a flat frequency response and that a loudspeaker is just an information delivery channel, and you have the ingredients for the design of a rather special pair of loudspeakers.

The demonstration was most impressive and had delegates walking round the loudspeakers, listening intently and putting on their own favourite tracks. A pair of what John called 'AFC' loudspeakers were demonstrated next. It transpired that 'AFC' stood for 'Active Flip Chart' and was in fact a pair of NXT distributed mode loudspeakers harnessed to a Watkinson sub-bass design and disguised by the hotel's flipchart frontispiece. The DMLs - despite their relatively low cost - gave a good account of themselves.

John Watkinson displaying one of his new speaker designs

Keynote Lecture

Making computer speech intelligible

IOA President Mark Tatham gave the invited keynote lecture on his work on text-to-speech systems. Present advances in the research focus on concentrating less on making the speech sound natural and much more on giving the speech stream all of the attributes which the human 'receiver' needs to repair and reconstruct the 'plan' as formed in the mind of the 'sender'. So if the 'percept' accurately matches the 'plan' then the function has been completely fulfilled.

By redefining the input and output ports of the information channel, the speech can be tuned to overcome the expected limitations of the channel. The limitations, of course, are the electro-acoustic and acoustic environment which form part of that channel. This idea neatly connects the requirements of improved intelligibility with the practical limitations of delivery systems. In my estimation, future 'intelligibility' meters will contain a realistic perceptual model of the auditory system coupled with the 'plan'. A thought-provoking lecture indeed.

Electroacoustics Group AGM

On the evening of the first day the Electroacoustics Group held its AGM. This was carried out most efficiently by Chairman **Ken Dibble** and resulted in the current committee members being re-elected. Ken then announced that the Meetings Committee had suggested that, in view of the expense of RS conferences and the relatively small financial return achieved, the conferences should be biennial.

There was considerable opposition to this proposal from the floor and various suggestions for increasing revenue were suggested. The most pertinent comment was that increasing the attendance numbers by only 10 delegates would put the finances well into the black. This could be done by wider promotion in other professional areas. Subsequent to the AGM, the President expressed his support for continuation of the RS conferences annually.

All of the sessions, Loudspeakers, Speech Intelligibility, Room Modelling, Measurement (including **Stephen Jones'** discussion panel) and **Peter Mapp's** evening workshop on Voice Alarms were of very high quality and gave the delegates plenty of food for thought.

Thanks go to Duran Audio for the loan of a pair of Intellivox DSP array loudspeakers which coped admirably with the acoustic properties of the difficult low ceiling in the conference room. I would like to thank the sound and IT crew, **Ken Dibble, Robin Dibble** and **Stephen Chiles.**

I would also like to thank the members of the organising committee who have again performed an admirable task and have wrought the conference from the initial concept all the way to a successful event. They are **Steve Jones, Peter Mapp, Julian Wright, Sam Wise, Bob Walker, Ken Dibble, Allen Mornington-West, Peter Philipson, James Angus, Martin Roberts,** and **Mark Bailey.**

Thanks are due to the exhibitors who mounted high quality displays. This year they were: **Brüel & Kjær; AcSoft; ISVR, University of Southampton; Telex Shuttlesound** and **University of Salford.**

Finally, I invite you, the reader - if you've never been to a Reproduced Sound Conference - to consider coming along to the next one. You won't be disappointed!

REPRODUCED SOUND 17

Technical sessions

John W Tyler FIOA

As usual, my thanks are offered to the session chairmen who provided notes to aid the compilation of this report. Also as usual the reports on each paper are necessarily brief. Any reader needing more information should contact HQ, St Albans to order a copy of the Proceedings (or the CD-ROM) or a photocopy of any particular paper.

Loudspeakers

Chairman: **Julian Wright** (Exeter Advanced Technologies)

❑ **Application of the finite element method to model the nonlinear voice coil motion produced by a loudspeaker magnet assembly.** *(Mark Dodd,* Celestion & KEF Audio (UK))

The first paper at this year's conference was given by Mark Dodd, who discussed modelling of nonlinear voice coil motion using the Finite Element method. Mark illustrated the influence of eddy currents with some effective animations and showed promising predictions of harmonic distortion.

❑ **Nonlinear distortion in professional sound systems: from voice coil to listener.** *(Alexander Voishvillo,* Cerwin Vega Inc, USA)

Alexander Voishvillo presented a summary of his substantial and continuing work on multitone stimuli for measurements, air propagation distortion and the use of nonlinear parameters as input into nonlinear differential equations for predicting loudspeaker distortion.

❑ **Acoustic optimisation using finite and boundary elements.** *(Patrick Macey,* PACSYS Ltd)

Patrick discussed optimisation of acoustic Finite Element models, illustrated with a simple but effective optimisation of a loudspeaker horn profile. Optimisation is undoubtedly of major interest in furthering the use of FEA in acoustics.

❑ **Increasing the acoustic compliance of loudspeaker cabinets.** *(Mark Dodd,* Celestion & KEF Audio (UK))

Then Mark Dodd, speaking in place of Julian Wright, explained the use of activated carbon to increase the acoustic compliance of loudspeaker cabinets. This ubiquitous adsorbent material provides smaller boxes or bigger bass!

❑ **The Yamaha NS10M: Twenty years a reference monitor. Why?** (*Philip Newell,* Reflexion Arts, *Keith R Holland,* ISVR & *Julius P Newell,* Independent Audio Consultant)

Finally, to round off an excellent session, Phil Newell tried to uncover reasons for the success of the Yamaha NS10 as a studio monitor, with the implication that a flat anechoic frequency response is definitely not the key to success in this area! Arguably a performance more sympathetic to placement near or on a mixing console produces a more desirable result.

Speech intelligibility

Chairman: **Peter Mapp** (Peter Mapp Associates)

❑ **Improving the intelligibility of aircraft PA systems.** *(Peter Mapp,* Peter Mapp Associates)

Peter talked about a survey, carried out on a range of commercial jet aircraft whilst in normal flight, of perceived intelligibility and operational signal-to-noise ratio of the aircraft on-board PA systems. He found a wide variation in values; typical passenger cabin background noise levels of 80 to 85 dBA (100 to 105 dBC) were recorded, whilst many of the PA systems were found to operate with either zero or negative S/N ratio.

Extensive testing of a cabin mock up showed that high frequency dispersion is a major factor contributing to perceived intelligibility. Also the use of Distributed Mode Loudspeaker technology was found to bring about significant improvements in clarity and intelligibility but the use of RASTI as an accurate intelligibility descriptor was questionable.

❑ **Development of an accurate, handheld, simple to use meter for the prediction of speech intelligibility.** *(Herman J M Steeneken* and *Jan Verhave,* TNO Human Factors, The Netherlands, *Steve McManus,* Gold Line Corporation and *Ken Jacob, Bose* Professional Systems)

On behalf of the four authors Ken described the development of a handheld meter for the accurate measurement of intelligibility. The various codes and standards now require sound systems for emergency purposes to meet or exceed a minimum level of speech intelligibility. Measuring compliance with standards normally requires complex instrumentation and expert technicians. The handheld meter described in this paper was developed to make measurements of speech intelligibility easy to do for both experts and non-experts alike.

❑ **Extracting STI from arbitrary running speech.** (*Trevor Cox* and *F Li,* Salford University)

The authors have developed a neural network method that estimates STI from received running speech and have validated it via simulations. The accuracy is comparable with that achieved by measurements with standard artificial test signals when limited to a one-net-one extract approach or a closed set of speech examples.

Room modelling

Chairman: **Stephen Jones**, (Symons Group)

❑ **Acoustic modelling - approximations to the real world.** (*Bob Walker,* BBC R&D)

Bob's paper provided an overview of acoustic modelling methods applied to enclosed spaces. He included discussion of conceptualisation, physical scale modelling, ray tracing, image based methods and finite element representations.

Room Modelling discussion panel in session

❑ **Computer modelling with CATT-Acoustic: theory and practice of diffuse reflection and array modelling.** *(Adrian James* and *Amber Naqvi,* Adrian James Acoustics Bengt-Inge Dalenback, CATT)

James described the room acoustics prediction and auralisation software CATT-Acoustic. The paper focused on the handling of frequency dependent diffuse reflection and loudspeaker array modelling.

❑ **Analysis of DDS-controlled loudspeaker arrays by 'near field acoustic holography'** (*Evert Start* and *G W J van Beuningen,* Duran Audio)

Evert explained that the introduction of Digital Directivity Synthesis (DDS) for loudspeaker arrays has allowed the synthesis of optimised, complex-shaped radiation patterns to become possible. Using special simulation software the array response can be predicted in the far field as well the near field. He described the analysis and verification of DDS-controlled sound fields by measurements.

❑ **Loudspeaker array prediction.** *(Roger Schwenka,* Meyer Sound Laboratories)

Roger's paper dealt with problems of designing an array of loudspeakers which requires high resolution complex polar data to model accurately the frequency response and direct field caused by the interaction of loudspeakers in the array. He described the acoustic prediction program MAPP Online whose function is to design loudspeaker arrays.

❑ **Merging EASE for sound reinforcement systems and CEASAR for room acoustics.** (*O Schmitz* and *M Vorlander,* Institut fur Technische Akustik, Germany, *S Feistel* and *W Ahnert,* ADA Acoustic Design, Germany)

Wolf Ahnert gave a demonstration of the broadening of computer programs for electroacoustics into room acoustics and on into lighting sightlines etc using the same graphical model.

❑ **Room acoustics modelling using digital waveguide mesh structures.** (*Damien Murphy* and *David Howard,* University of York)

Damien examined how digital waveguide mesh models provide an alternative to geometric methods for modelling the acoustics of a room. He showed that this was a promising technique, demonstrating the characteristics of natural wave motion, accurate detection of modal frequencies and appropriate reverberation characteristics. In addition he explained the benefits of the model with surround sound.

❑ **SYSNOISE and RAYNOISE: modelling sources, interior and exterior sound.** (*Colin McCulloch,* Dynamic Structures and Systems)

Colin gave a comprehensive overview of the two products. The features of SYSNOISE (finite element and boundary element acoustics and vibro-acoustics) and RAYNOISE (beam tracing for interior and exterior sound) were described together with some application examples.

❑ **ODEON - a design tool for auditorium acoustics, noise control and loudspeaker systems.** (*Claus Lynge Christensen,* Technical University of Denmark)

Claus gave a good description of the program and demonstrated that it had a wide application, not only to auditorium acoustics but also to rooms such as churches, interior noise control and sound distribution systems in public places. He gave a number of interesting demonstrations of various applications.

❑ **Applications of PAFEC Vibroacoustics to the audio industry.** (*Patrick Macey,* SER UK)

Patrick traced the history of PACSYS Ltd, the program PAFEC (Program for Automatic Finite Element Calculations) and PAFEC Vibroacoustics. He described examples of the application of the latter to the acoustic analysis of a small room and the radiation from a loudspeaker.

❑ **In ray tracing we trust? A user's view of ray tracing based room modelling.** *(Don Oeters* and *B Cox,* Arup Acoustics)

Don described experiences of using ray tracing based acoustic computer modelling programs such as CATT and ODEON, in the design of rooms. The accuracy and variability of the predicted values and their reliability for use as a design tool was discussed.

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This session was followed by a panel discussion with the day's speakers arrayed at the front. The fact that the discussion went on for nearly two hours was a measure of the success of the Room Modelling session.

Measurement

Chairman: **Sam Wise** (Arup Acoustics)

❑ **Some requirements for an ideal speaker controller for directionally controlled arrays.** *(Sam Wise,* Arup Acoustics)

The morning opened with Sam Wise's paper Human Interfaces for Loudspeaker Controllers, which was slightly different from that published in the Proceedings. Jumping off from papers on the subject given earlier in the conference, and especially taking note of the evening discussion session on Voice Alarms, Sam started by giving delegates a quick look at Electro-Voice's RACE software. This clearly shows the lobing effects created when two loudspeakers covering the same frequency range are placed close to each other along with the resulting frequency response.

Loudspeaker(s) and listener can be moved with respect to each other using a mouse, giving quick insight into loudspeaker interactions. Since RACE can directly control the DX38 loudspeaker controller, the effects of filtering and delays can also be shown on the graphical display - and then installed.

After this short demonstration the theme was transliterated to the idea that the architect was also a loudspeaker controller and might even be human. Various graphical methods of convincing them about the importance of acoustics effects were demonstrated.

❑ **Standards for acoustics measurements - who, why and where now?** (*Adrian James* and *Amber Naqvi,* Adrian James Acoustics)

Adrian James presented a session on Standards for Acoustic Measurement. The paper considered the wide variety of types of measurement required within acoustic standards and whether these are appropriate today. A survey was taken of a sub-set of international consultancies and research centres and ISO 3382 was in particular found to be wanting and was regularly disregarded. Suggestions were made about what direction changes might be made along with the recommendation that the standard is revised when it becomes due for review in 2002.

❑ **Sound power - the forgotten loudspeaker parameter.** (*Peter Mapp,* Peter Mapp Associates)

The next paper by Peter Mapp on sound power demonstrated the fact that with most loudspeakers the sound pressure spectrum (frequency response) and sound power spectrum were substantially different. It is sound power that drives the reverberant response of a room, leading to a poor experience for the majority of listeners who were seated off-axis where the direct sound was also not flat.

This mismatch leads to diminished speech intelligibility and reduced musical enjoyment. The more similar spectra from distributed mode loudspeakers and other constant directivity devices may be one reason why they perform unexpectedly well in some installations.

❑ **Tailoring the total radiation pattern of a group of loudspeakers.** (*Glenn Leembruggen,* Arup Acoustics)

Glenn Leembruggen from Arup's Sydney office then followed with a similar topic. By predicting the response of combinations of conventional loudspeakers, suitable electronic and mechanical adjustments can be made that will induce them to behave in a more helpful manner, producing a desired coverage pattern with a largely constant directivity over a wide frequency range.

The result - a direct sound pressure spectrum that remains essentially constant over the audience area and falls off in an orderly manner outside it - again produces a sound power spectrum matching the direct sound spectrum and accordingly much improved intelligibility.

❑ **Far-field radiation from a source in a flat rigid baffle of finite size.** *(Joerg Panzer,* NXT New Transducers Ltd)

Joerg Panzer of NXT gave a highly mathematical paper considering the far field radiation from a source in a flat rigid baffle of finite size. A diffraction model using wave-number convolution was used to estimate the far field radiation of some simple structures. The results compare well with FEM models of the same behaviour. The method enables fast calculations and eases the design of distributed mode loudspeakers in particular.

James Angus illustrates the finer points of dither in the super audio CD format

The Mask of Mono

In the days of old California,
In the days of rule by Spain,
We knew many figures of legend,
Of those many; just one will remain.

Some call me Don Diego;
I come like a wraith from the gloom;
You will see just the flash of my rapier,
Hear a sound from one side of the room.

I am the man they call Mono;
I bring hope to the poorer, the weaker;
Fear not, for Mono is coming,
But only out of one speaker.

I leave a large letter M
Engraved on some prominent panel;
Vengeance will be mine
But only in the left channel.

I have grace; I have charm; when I speak
I have rhyme, I have cadence and metre;
I am civilised man at his peak
But I'm short of one woofer and tweeter.

Can't you trace that mysterious humming?
Does the future seem blacker or bleaker?
Fear not for Mono is coming,
But only out of one speaker.

Mono; a man you can trust;
For the tyrant, there's nowhere to hide;
I'm on the side of the just
And what's more, I'm just on one side.

I was made on the loom of the night
With justice my warp and my weft;
I will ride for whatever is right;
That's me over there on the left.

The sound of some drums can be numbing;
And melodeons could be a mite meeker;
Fear not, for Mono is coming,
But only out of one speaker.

Here I stand, your friendly avenger,
The man with one channel switched off;
Everyone knows when I'm here
Except maybe Vincent Van Gogh.

I carve a large letter M
And into the night I am gone; oh,
I always do it upside down;
The fools! They're all looking for Wono!

From the herd of the horseman of hunger
I will ride with a large chicken tikka;
Fear not for Mono is coming,
But only out of one speaker.

I wear the mask of an outlaw
That none may look on my face,
But you know at the first sign of treble
I'll come riding out from my bass.

I will ride out for Juan and Juanita;
There is nothing that Mono can't fix;
Is there no guitar in the monita?
Is the banjo too high in the mix?

I'm the saviour of man and of woming;
Be joyful and cry out 'Eureka!'
Fear not, for Mono is coming,
But only out of one speaker.

(With thanks to and the permission of Les Barker)

❑ **Detection of speech in the presence of delayed same signal reinforcement.** (*Krissada Vivatvakin* and *Ian Flindell*, ISVR, University of Southampton)

ISVR fielded a paper by Kris Vivatvakin on the detection of speech in the presence of delayed same signal reinforcement. Does a delayed signal mask the direct signal? What is the effect? A subjective test was devised to investigate forward, simultaneous and backward masking.

❑ **The views of recording studio control room users.** (*Bruno Fazenda* and *W J Davies*, University of Salford)

Bruno Fazenda from Salford University sought the views of recording studio control room users on their preferences on a number of topics. Trends and agreement was good among interviewees. Mostly they were looking for confidence in what they were hearing. The main problems arise at low frequencies due to the modal character of small rooms.

❑ **Achieving effective dither in the super audio CD format.** (*James Angus*, Salford University)

Last but not least, James Angus used a balloon and a folding bicycle as entertaining ways to explain the effect of dithering on digital audio signals. Dithering is used to move the noise and distortion products arising in conversion systems into parts of the spectrum where they are less audible. It had been stated that the delta modulation system embodied in the Super Audio CD format (SACD) could not be properly dithered. If James' bicycle is an indicator, it certainly can be!

Thus ended another successful Reproduced Sound Conference, the main features of which were the excellence of the papers and the friendly relaxed atmosphere of the whole proceedings. This was evident in the good humour displayed during the energetic discussions after each paper and during the conference dinner.

The highlight of the latter (apart of course from the President's address!) was an 'audio' poem by Les Barker that was acquired and read by Robin Cross. It resulted in gales of laughter from the delegates who joined in the obvious punch line. It may have been the occasion that made it seem so funny but we are giving readers a chance to judge for themselves by reproducing it here.

Finally, may I echo the Conference Chairman's closing remark in his introduction; if you have never been to an RS and your interests lie in this direction,

the history and development of

HEARING PROTECTION DEVICES

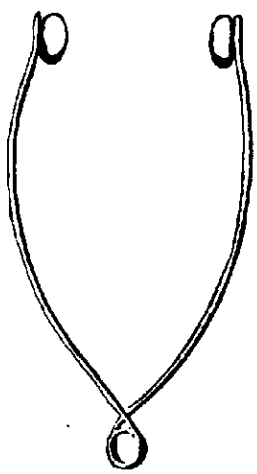
W Ian Acton FIOA

Evolution provided mankind with fingers which, perhaps fortuitously, fitted into his ears. Fingers in the ears remained, and perhaps still remain, the traditional form of hearing protection against the noise of battle. Modern tests show they are reasonably effective; except that is for the unfortunate person who needed his fingers to light the tinder or pull the trigger.

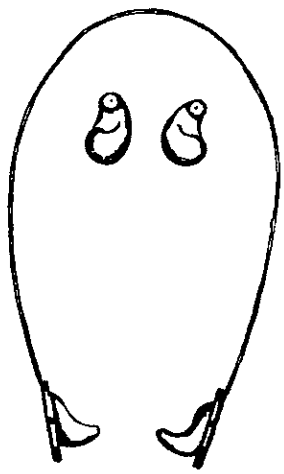
Odysseus in Greek mythology overcame this problem by ordering his crew to plug their ears with beeswax to prevent them hearing the Sirens' voices as they rowed past. Since then, perhaps several hundred different forms of hearing protection have been proposed. A relatively few historical developments have been selected and reviewed in the present paper. The figures have been reproduced from the original sources without alteration.

Canal Caps

The first hearing protection device appears to be a form of canal cap described by Fearon in a British Patent in 1864. This consisted of metal discs about the size of a farthing (a small obsolete English coin now worth about one-sixth of a cent) which could be padded, and were pressed against the tragus by a wishbone-shaped spring passing under the chin



Canal caps
Fearon, 1864
Figure 1

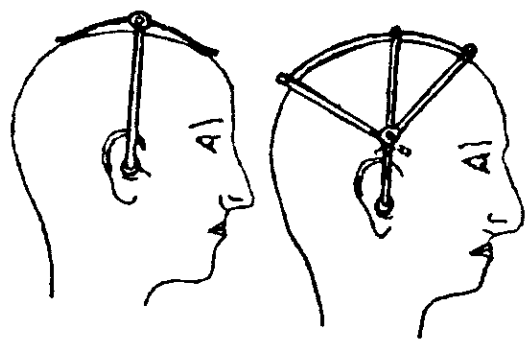


Canal caps
Rein, 1865
Figure 2

(Figure 1). Commended to railway travellers who may be subjected to unpleasant or distressing sounds, they could be camouflaged with flesh-coloured paint, hidden behind beards, or for ladies, by bonnet ribbons.

Whereas Fearon only promised to soften or deaden the sound, only a month later Rein (1864) claimed to be able to entirely exclude sound. Clearly this was before the advent of consumer protection legislation. His apparatus was essentially similar, except that the caps were moulded to fit into the entrance to the meatus as well as resting on the tragus *(Figure 2)*. Again, the device was commended to railway travellers and others who found continuous crashing or other unpleasant noise distressing.

Vaughan (1895) substituted a simple or compound spring passing over the head in the position occupied by a modern head band *(Figure 3)*. The pads were said to close the ear, but further details were not given.



Canal caps
Vaughan, 1895
Figure 3

In a variation introduced by Carroll (1937) the head band was replaced by a wire frame encircling each ear.

Attention was focused on other types of ear protection until 1961 when Devlin patented canal caps having an adjustable head band. This looked remarkably like the 'Glorig Sound Sentry' which appears a year or two later, although it is not known whether it was a direct antecedent.

Ear Plugs

The first manufactured ear plugs can be attributed to Dr. Cousins, a surgeon from Southsea, England. He described his invention to a meeting of the British Medical Association in 1883 thus: a 'conical vulcanite plug, shaped like a rifle-bullet, closed by a thick disc of the same material'. Dr. Cousins recognised the need for the plug to make a seal with the ear canal.

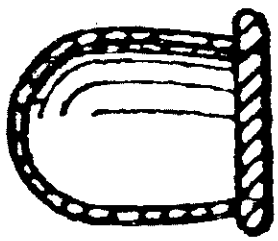
As the report continued: 'The plug must not be merely introduced into the ear, but firmly pressed and screwed round the meatus. It was made also fixed in spring-supports, which passed behind the head, the cushion being supported on a little stem, and the pressure regulated by a screw'.

Dr. Cousins' patients undoubtedly included personnel from the nearby Royal Navy dockyard, as he recommended it to 'persons working in loud noise, such as artisans in factories, soldiers and sailors during the discharge of cannon, and all who were painfully affected by noise'.

In 1884, Dr. Cousins patented a seemingly less uncomfortable version of his plug made of india-rubber *(Figure 4)*. He claimed reduction of sound to the extent of two thirds. A hearing aid consisting of a collapsible reflector concealed in a walking stick, also

patented by Dr. Cousins a little while afterwards, may have been an admission of the failure of his plug!

Also in 1884, Plessner of Germany patented a spherical ear plug to fit into the ear canal, and he



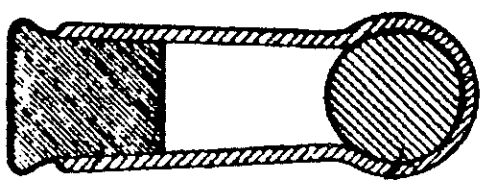
Earplug
Cousins, 1884
Figure 4

Earplug for watch chain
Plessner, 1884
Figure 5

recognised for the first time the need for different sizes. The plug was fitted with a shank and tab for insertion and removal *(Figure 5)*. The whole was made of metal; the author suggested gold so that it could be hung on a chain of an old fashioned pocket watch.

Numerous variations on the ear plug theme were described in the following years: they included a glass bulb (Wacks, 1888); india-rubber sphere attached to a string (Bartels, 1895); a sphere which could be screwed into the ear against a plate retained in the concha (Atkinson, 1915); a cone of rustless metal (Santi, 1928); and moulded rubber (Hershman, 1934, MacLellan and MacLellan, 1935).

An idea patented by Knudsen in 1939 is worthy of mention. Two inertia masses separated by an airspace provided an impedance mismatch *(Figure 6)*. The outer inertia mass was a dense material such as metal, whereas the inner material could be sponge rubber or beeswax. The air (or gas) space could



Earplug with impedance mismatch
Knudsen, 1939
Figure 6

be lightly packed with fibrous absorbent material. Improvement to the seal into the ear canal might have proved more beneficial than increasing the transmission loss of the plug.

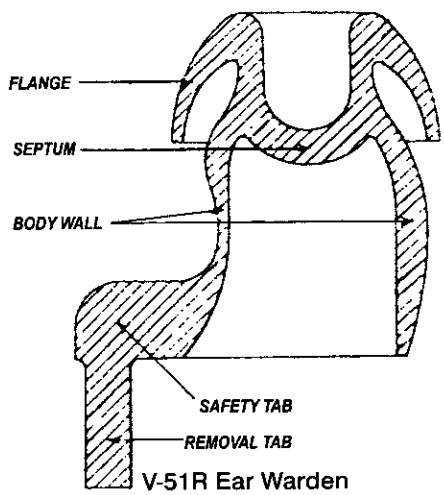
The Second World War spurred research into the development of ear plugs. A resilient rubber ear plug patented by Cantor (1943) looked remarkably like the SMR plugs issued to the armed forces. This consisted of a thin outer rubber shell filled with

Resilient Earplug
Cantor, 1943
Figure 7

resilient porous material which was supposed to conform to the shape of the ear canal *(Figure 7)*. The purpose of the flange was not stated, although it would, in practice, have prevented too deep insertion.

Systematic evaluation of various designs of ear defender were undertaken on behalf of the US National Defense Research Committee, and the preliminary results of the first fifty devices tested were reported by Watson and Knudsen (1944). The well known V-51R, also known as the 'Ear Warden', happened to be the fifty first *(Figure 8)*. This was originally made in three sizes, but was found to provide a satisfactory fit for only 83% of adult males. The range was extended by the introduction of the extra large and extra small sizes in 1956 (Blackstock and von Gierke, 1956).

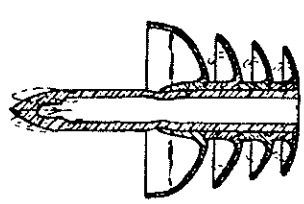
The Commonwealth Acoustic Laboratories carried out their own investigations, and by 1962 had evolved a design looking like the V-51R but with two flanges instead of one (Piesse, 1962). Commercial versions were sold with a small tube of surgical jelly to aid insertion and provide a better seal. Vrillaud (1960)



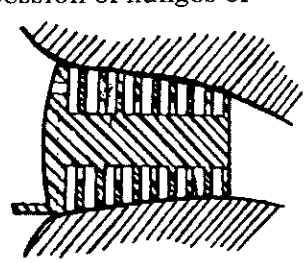
V-51R Ear Warden
Cantor 1943
Figure 8

patented an ear plug having small indentations to retain the lubricant during insertion into the ear canal.

A major drawback of the V-51R and similar designs was the need to have someone of at least paramedical status to ensure fitting of the correct size. There have been numerous attempts to produce a universally fitting ear plug having a succession of flanges of



Multi-flange Earplug
Henderson, 1955
Figure 9



Multi-flange Earplug
Santi, 1961
Figure 10

increasing size on the central stem. One of the first due to Henderson (1956) had four flanges *(Figure 9)*, and the ultimate was the millipede-looking design by Santi (1961) *(Figure 10)*.

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the history and development of

HEARING PROTECTION DEVICES

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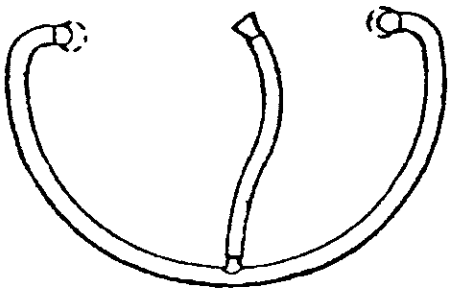
Personally moulded ear plugs

Personally moulded ear plugs to fit into the concha and the entrance to the ear canal were proposed by Nieriker in 1913. Neither the method of production nor a suitable material were described. Tegner (1942) placed emphasis on the plugging of the ear canal, with the concha-fitting part merely being utilised to hold the plug in the canal. He also suggested connecting the pair of plugs together with a cord.

A cold-curing silicone rubber material which could be used to mould the plug in situ in the ear was suggested in 1958 (Midland Silicones Ltd., 1958). Developments since this time have related mainly to the materials and methods of moulding.

Conformable and disposable ear plugs

The first conformable ear plug dates from 1885. Grundler of Germany patented a stethoscope-like device tipped by rubber bulbs. These could be inflated by a mouthpiece after insertion into the ears *(Figure 11)*. They must have represented a very considerable advance in both comfort and degree of protection over contemporary devices, but, like the others, were never produced commercially.



Inflatable Earplugs
Grundler, 1885
Figure 11

Most conformable ear plugs fall into the disposable or semi-disposable category and this applied to the plastic composition which Kuppers (1907) suggested 'for forming sound-dampers for the ears'. This was 'prepared from bees-wax and Venice turpentine', and could be coloured to imitate the skin. A proprietary brand of modelling clay known as 'Plasticine' mixed with cotton wool was suggested as 'ear stoppings for preventing gun deafness' (Harbutt, 1914).

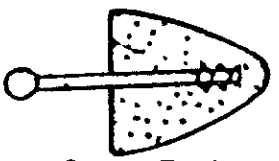
There are numerous references to ear plugs fashioned from cotton wool and various types of oil, wax or grease. The commercial availability of preformed plugs of cotton wool and soft wax known as 'Quies' was confirmed in a letter to *The Times of London* newspaper in 1934 (Levack, 1934).

Davis and Luxon, also in 1934, devised a cotton wool ear plug having a conical wax base. The whole looked like an ice cream cone *(Figure 12)*. The instructions for manufacture directed that the wads of cotton wool should be inserted into molten wax in a mould, but did not indicate how to prevent the cotton wool acting like a wick and soaking up the wax.

Halle (1935) fitted a loop of thread for use in withdrawing waxed cotton wool ear plugs from the ear canals. Liversedge (1947) devised an instrument mounted on a head band for inserting cotton wool fed from a reel 'into the ears under screw pressure'.

A precursor of the present day conformable plastic foam ear plugs was described by Hultgren (1953). These plugs were conical and made from a 'perforate spongy material' of softened copolymer. As they were formed by a casting process there was an imperforate skin. A hard stem was provided to act as a grip *(Figure 13)*. The modern history of this type of plus is well known.

Pre-formed cotton wool Earplugs
Davis and Luxton, 1934
Figure 12

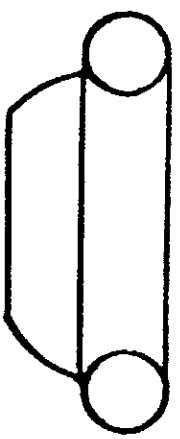


Spongy Earplug
Hultgren, 1953
Figure 13

Disposable glass down ear plugs were in use in Sweden at least as early as 1953 (Heijbel, 1961). Again, the modern history of this type of plug is well known.

Ear muffs

The first ear muff was described as long ago as 1918, and it happened to have a fluid seal *(Figure 14)*. It was intended for fitting to the ear piece of telephones or speaking-tubes to exclude interfering noise. Its possible use as a hearing protector was not recognised by the inventor (Brown, 1918).



Fluid-seal ear muff
Brown, 1918
Figure 14

Other devices were devised 'for protecting the ear from noises which inhibit sleep, such as the noise occasioned by irregular action of the heart' (Winn, 1925), and 'for covering the ears during hair treatment to reduce the effect of noise, heat, etc.' (Denton and Halewood, 1932).

Hearing loss among the pilots of military aircraft was recognised during the 1930's, and the leather flying helmets then in use were provided with flaps to cover the ears (Dickson et al, 1939, Dickson and Ewing, 1941). Various means of improving the performance of the flaps were suggested, including sewing ladies' powder puffs inside them.

The development of the jet engine during the Second World War brought exposure to levels of continuous noise not previously experienced. The early engines were tested in the open without noise-attenuating enclosures or remote control panels. Symptoms such as dizziness and giddiness were caused by direct stimulation of the vestibular organs by the intense noise (Dickson and Watson, 1949, Dickson and Chadwick, 1951). Whereas noise-induced hearing loss had been considered an inconvenience, these symptoms prevented work on an important defence project. The development of an effective ear muff became a matter of some urgency.

The result was the design patented by Cobbe and Henery (1945) and described in contemporary

continued on page 26

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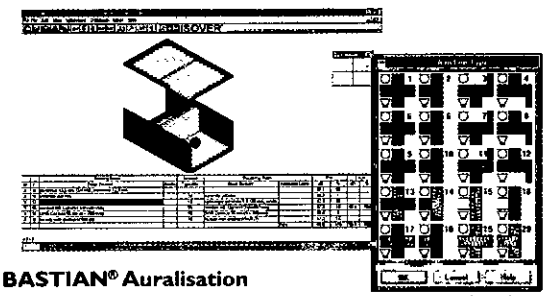

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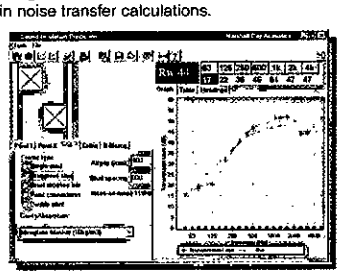

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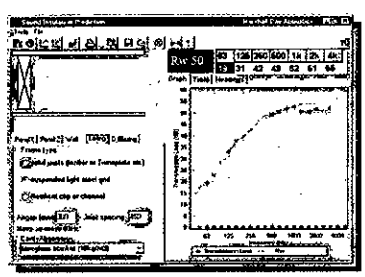

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the history and development of

HEARING PROTECTION DEVICES

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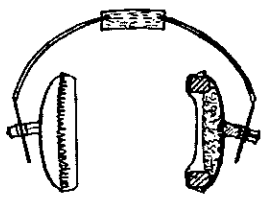
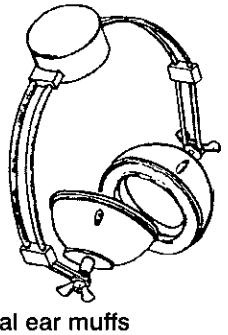
aircraft journals (Anon, 1945 and 1946). It bore some resemblance to a modern muff, but the inventors were handicapped by the lack of a suitable cushion. They used rings cut from sheets of relatively stiff foam rubber, and a high head band pressure was required to make this conform with the shape of the head and effect a seal *(Figure 15)*. A contemporary Air Ministry test report (Dickson et al, 1954) said 'the headband spring is so strong that one's head feels as if gripped in a vice'.

Various refinements followed, but the problem of head band force was not solved until the



Ear muff
Cobbe and Henry, 1918
Figure 15



Fluid-seal ear muffs
National Research Council Canada, 1954
Figure 16

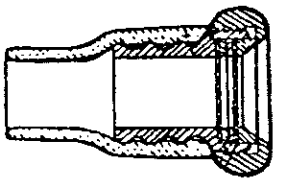
development of the fluid seal by Shaw and Thiessen (1954) working for the National Research Council of Canada. Their cushions differed from the earlier simple design of Brown (1918) in a number of respects, but perhaps most important they were only partially filled with fluid. This enabled an effective seal to be made against the side of the head. These muffs were produced commercially as soon as patent rights were granted in 1958 *(Figure 16)*.

Fluid-seals have the major drawback that they become totally ineffective if they are punctured and the fluid leaks away. This is almost inevitable in some work places, for example where there are sparks from grinding or welding. This problem was overcome by substituting a foam material (having air in the pores) for the liquid. It has not been possible to determine when this refinement was proposed, but commercial production started in the early to mid 1960's.

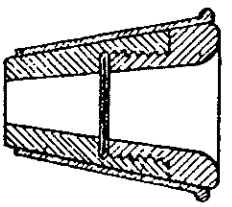
Amplitude non-linear devices

Inventors have sought to devise hearing protectors with non-linear amplitude properties with nearly as much zeal as the alchemists sought to change base metal into gold.

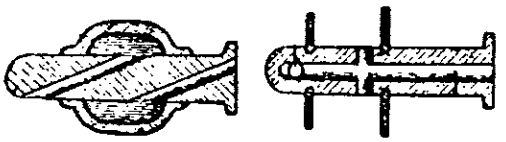
Mallock (1905) patented a tubular ear plug incorporating a membrane of goldbeaters 1 skin having stop plates of wire-gauze on either side. Adjusting the spacing was supposed to permit the diaphragm sufficient movement to 'allow the transmission of ordinary vibrations but damp excessive variations of pressure', *(Figure 17)*. An



Earplug with diaphragm
Mallock, 1905
Figure 17



Earplug with diaphragm
Plobner, 1909
Figure 18

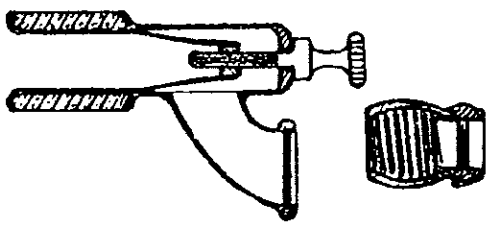


'Non linear' earplug
Elliott, 1911
Figure 19

almost identical device was described by Plobner in Germany in 1909 *(Figure 18)*.

An ear plug described by Elliott (1912) had a tortuous passage via a cavity between the inner ear canal and the outside atmosphere *(Figure 19)*. It was claimed this was 'for protecting the ears from excessive pressure due to concussion'. It more likely acted as a low-pass filter.

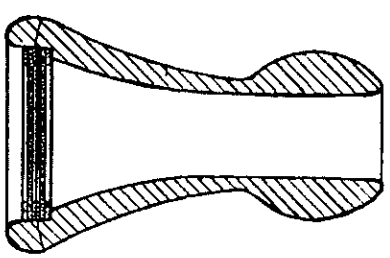
Mallock (1913) described a rather fearsome development of his earlier device in which a rubber sleeve could be expanded to fill the ear canal under screw pressure, rather like an expanding drain plug. The so-called non-linear diaphragm was located at



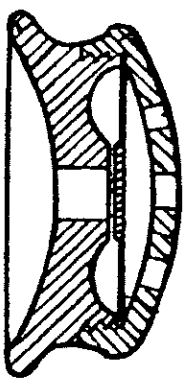
Earplug with diaphragm and expanding insert
Mallock, 1911
Figure 20

the end of a branch tube *(Figure 20)*. This must have produced the ultimate seal into the ear canal, and at the same time the ultimate level of discomfort.

The ear plug incorporating a diaphragm was refined into the design shown in *Figure 21* by Mallock (1914). Protection against 'acoustic shocks' was claimed. As far as known, it was the first hearing



Earplug with diaphraghm
Mallock, 1914
Figure 21



Earpiece with diaphragm
Tod, 1914
Figure 22

protector to be produced commercially and was sold under the name Mallock-Armstrong. It was supplied to the armed forces in the First World War and remained on sale until comparatively recently. Seven sizes were available.

A variation on the diaphragm idea was incorporated into a supra-aural ear piece by Tod (1914). The diaphragm carried a pad which was supposed to close a hole 'when the diaphragm is moved by violent vibrations' *(Figure 22)*. The device was claimed to prevent gun deafness by 'allowing slight sounds to pass, but cutting off the violent vibrations due to gun firing'.

Bone and ivory were purported to have non-linear sound conducting properties according to Pinkus and Lake (1916). They designed an ear plug of these materials with the claim that 'protection is afforded to the ear against abnormally loud noises, without impairing sensitiveness to sounds of low intensity, as in conversation'. No justification was provided for their claims. If, indeed, bone were to have these properties, the malleus, incus and stapes should provide in-built protection.

Ruedi and Furrer (1946) described ear muffs having 'little holes' which, it was said, acted as a 'resonator'. They were tested by subjecting unspecified animals wearing the muffs to explosions which 'killed the animals .... without injuring their ear drums'. Johnston (1953) put the muffs to a more practical test using human subjects working in a drop forge. The muffs failed to prevent industrial deafness, and Johnston suggested that the performance might be improved if the holes were filled.

In the well known Lee-Sonic 'Ear Valv' ear plug produced in the early 1950's, a diaphragm within a perforated capsule was held in a central position by two coiled hair-springs. The diaphragm was claimed to move under the influence of high sound levels thereby blocking the innermost hole.

All designs for mechanical types of non-linear hearing protectors suffer from the drawback that there is simply not enough energy in noise to overcome the inertia of the moving parts and to deform the spring components. Thiessen (1961) calculated that the Lee-Sonic ear plug could not possibly begin to operate below 175 dB at frequencies of 500Hz to 1 kHz.

The small orifices and tortuous passages in these devices may attenuate high level impulse noise such as gunfire by causing the linear pressure flow to become turbulent. This property was deliberately exploited by Forrest and Coles (1970) in the design for the 'Gunfender', which was simply a V-51R ear plug incorporating a finely perforated metal shim. Tests on cadaver ears showed that it provided useful attenuation to the noise of rifles.

The only way of providing non-linear properties at lower levels of noise must involve either manual deployment at times of need or electronic circuitry. An ear muff incorporating a manually switched telephonic device was described as long ago as 1914 for protecting the ears of gunners (Kalse and Kalse, 1912, *Figure 23)*. A manually operated valve for closing a passage through the cups of ear muffs was patented in 1957 (National Research Development Corporation, 1957).

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the history and development of

HEARING PROTECTION DEVICES

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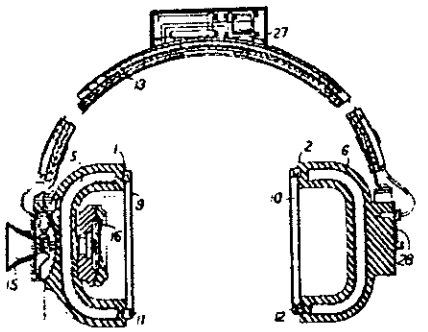
Electronic switching was provided, in effect, by a peak limiting amplifier incorporated into ear muffs designed by the Explosives Research and



Communication headset with switch Kalse, 1912

Figure 23

Development Establishment in the United Kingdom (Robins, 1969). Modern developments include the use of amplifiers having nonlinear properties over a wide amplitude range.

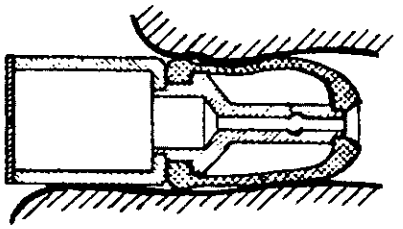
Frequency non-linear devices

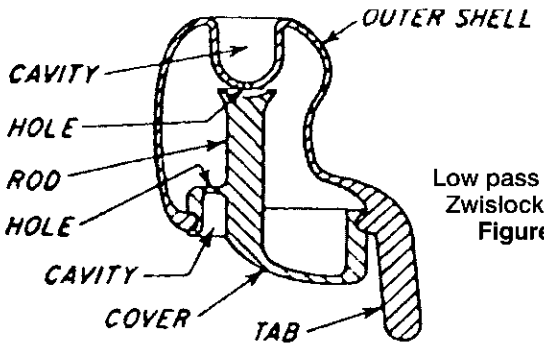
All ear protectors have the property of attenuating higher frequency more than lower frequency sound. Deficiencies in design or manufacture may permit more transmission of low frequency sound than was either intended or desirable.

An ear plug specially designed as a low-pass acoustic filter was described by Zwislocki in 1948 *(Figure 24)*. This was refined into the type known as the Selectone ear plugs in 1952 *(Figure 25)*.

Low pass earplug Zwislocki, 1948

Figure 24





Low pass earplug Zwislocki, 1952

Figure 25

Conclusion

There is nothing new in this world; not even hearing protection.

Acknowledgement

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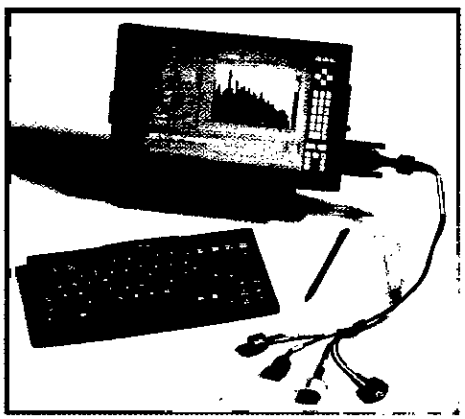

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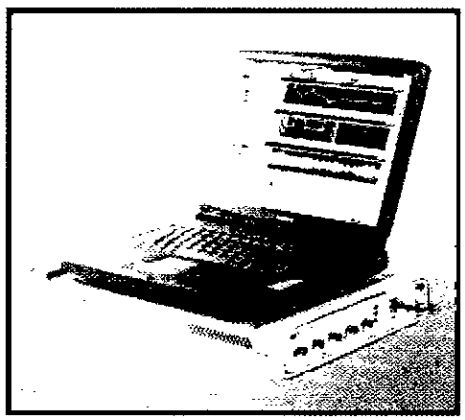

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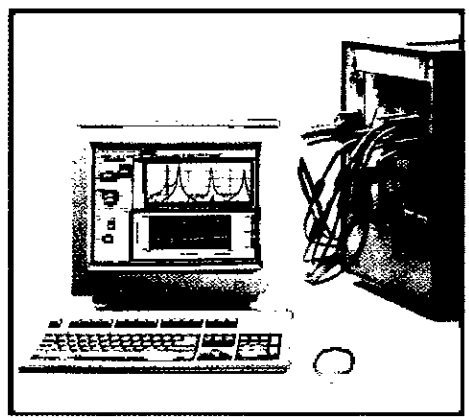

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A framework for noise impact assessment

and the role of BS4142

R J Bowdler FIOA

Recent workshops on *BS.4142* have tried to assess in what ways members feel the standard should be changed - if at all - and have even posed the question of abandoning it altogether. We all know that the standard has its faults and many of us have been frustrated that past revisions have not addressed many of our concerns. Yet the fact is that this remains the only standard or guidance providing a structured way of assessing noise impact by reference to a pre-existing background noise level.

Discussions about the standard's future have been hampered by a lack of agreement as to when and how it should be used. Without first establishing this, we cannot make an informed decision on its future. One of the main areas for its potential use is in noise assessments for planning purposes. I want to look at this and try to form a framework in which the standard, or something like it, might fit.

This paper is confined to the question of amenity of individuals and their property, as is considered in the planning process. It is not concerned with the question of nuisance under the *Environmental Protection Act*. Nuisance may require different methods of assessment - or it may not.

BS.4142 represents one of the two fundamental methods of assessing the impact on noise on housing and other noise sensitive uses. It uses the relative method, which compares the level of intruding noise with the level of the prevailing background noise. The alternative is the absolute method which sets a maximum level of noise at housing, based on the levels of noise which result in sleep disturbance, or levels of noise which a proportion of people consider to be unacceptable. The absolute method is exemplified in the noise exposure categories (NECs) for new housing set out in *PPG24* (England and Wales) and *PAN56* (Scotland).

'Discussions about the Standard's future have been hampered about lack of agreement as to it's use'

Primary principle

In my opinion the primary principle should be this: the level of noise to which new housing will be exposed should be based on absolute levels which take account of such factors as sleep disturbance or annoyance. New housing should be built to a reasonable absolute standard of noise pollution in the same way that, for example, an absolute standard of ventilation is required by regulations.

Where there is already housing in an area, residents may have chosen the level of acoustic amenity which they enjoy. They may have chosen the place for other reasons, were forced into it for reasons over which they had no control. Whatever the case, they have become accustomed to that level of acoustic amenity and they have a right not to have it degraded significantly. The level of any new noise source must therefore be related to the existing noise levels.

New housing

PPG24 in England and Wales, and *PAN56* in Scotland, set out the standards for new housing on sites affected by road, rail or aircraft traffic noise. Categories are established which demonstrate whether the noise climate at the site is suitable for new housing or not, or that it could be suitable provided adequate mitigating measures were taken. The guidelines deal only with transportation noise. Neither document refers to new housing in an area of industrial noise.

The World Health Organisation standard for sleep restoration is 30dB measured as L_{Aeq}. Some documents, including *PPG24* and *PAN56*, quote the WHO figure as 35dB. This is derived from an older (1980) WHO report. I have reservations about the later (1995) version. The level of 30dB appears to have been derived, at least in part, from studies of 19 insomniac cases. Most of the other data were obtained from laboratory tests.

In any case, it is admitted in the report that 80% to 90% of cases of sleep disturbance occur from events internally within the house. I am therefore inclined to adopt an internal level of 35dB, implying an acceptable external night-time level of about 45dB. This is the same as that adopted in *PPG24* and *PAN 56* as the boundary between Category A and Category B.

British Standard 8233 proposes suitable noise levels in bedrooms of 30 to 40 dB(A) and in living rooms 40 to 45 dB(A). Taken as L_{Aeq} the bedroom average of 35dB is consistent with the previous paragraph. The higher level of living room noise of 45dB, broadly equivalent to 55dB externally, is consistent with the daytime boundary between Category A and Category B given in *PAN56*.

This all suggests that for transportation noise, the boundary between category A and category B in *PPG24* or *PAN56* is reasonable.

PPG24 and *PAN56* are not specific about new housing developments in an existing industrial environment. Because people are usually less familiar with industrial noise and have a different perception of it, the permissible levels should be less than those for transportation noise. In the case of industrial noise, I would suggest that night-time or daytime levels, measured as 8 hour L_{Aeq} or 16 hour L_{Aeq} respectively, should be 5dB lower than those for transportation noise.

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Noise impact assessment and BS4142

continued from page 31

In other words, a 5dB weighting could be added to an industrial noise source and this weighted or corrected level compared with the section of the NEC table for mixed sources in *PPG24* or *PAN56*. Thus, for a proposed housing site subject to continuous industrial noise without high maximum levels to fall into category A of *PPG24* or *PAN56* it would have a daytime level below 50dB and a night-time level below 40dB, both measured as L_{Aeq}.

Many local authorities in Scotland, including Edinburgh, require that noise from industrial premises at night is less than *NR25* inside new housing with windows open. This again is approximately equivalent to a 40dB external night time level as derived in the previous paragraph.

Although the principle of categories as set out in *PPG24* and *PAN56* appear to be well founded, there may be reasons why the absolute levels ought to vary with circumstances. Consultants and local authorities

'There may be reasons why the absolute levels ought to vary with circumstances'

should be able to agree the absolute levels in accordance with the circumstances of the application and the nature of the site.

New noise source

I have already stated my opinion that the relative method should be used for the introduction of a new noise source and I see no reason why *BS.4142* should not form the basis. The principle of using L_{A90} for background noise and L_{Aeq} for intruding noise seems perfectly reasonable.

Using the L_{A90} index is reasonable because people are usually most affected by an intruding noise during the quietest periods. L_{Aeq} has the advantage that it is a generally accepted measure for intruding noise, although the effect of the variation of noise, in particular high maximum values, needs to be brought in. I will deal with this later. *BS.4142* also seems reasonable in its use of one hour values during the day and five minute values at night.

One difficulty with *BS.4142* is that, although L_{A90} should be used, it does not state over what period it should be measured. Nearly every local authority we deal with considers that the night-time L_{A90} should be measured during the quietest part of the night. The method we normally adopt is to measure L_{A90} in 15 minute periods over the night-time period, and take the background level as the average less one standard deviation. As it happens, in most cases a very similar final result is obtained by measuring only for three or four hours during the quietest part of the night, because although the average level is lower, the standard deviation is smaller.

The level of industrial noise measured as L_{Aeq} should be compared with the background level measured as L_{A90} to obtain an assessment of the impact. As a general guide, industrial noise levels of +5dB should be acceptable, but alternative differences should be agreed between the consultant and the local authority as circumstances demand.

The assessment of new transportation noise poses particular problems. Perhaps this is more so in Scotland than elsewhere. The development of much-needed employment sometimes puts road traffic - and often lorries at night - through areas where

'The assessment of new transport noise poses particular problems'

previously there was none. In the section on new housing above, I suggested that transportation noise should be permitted at a level 5dB higher (as L_{Aeq}) than industrial noise. I suggest that this could be an appropriate guideline for the introduction of new transportation noise. The new noise can be compared with the existing background noise with a guideline excess of +10dB rather than the +5dB for industrial noise. Again variations with individual circumstances could be permitted.

All these suggestions refer to completely new transportation or industrial noise in an area previously unaffected. Where a development is proposed which may increase existing transport or industrial noise then there is good reason to consider taking this into account. It may be that comparison should be made between the new and existing L_{Aeq}.

Maximum noise levels

My proposals so far have dealt only with L_{Aeq}. It is generally agreed that some account should be taken of the variability of a noise.

In note (vi) to the table of Noise Exposure Categories in *PAN56*, a night-time limit for L_{Amax} is set out. This states that sites where individual noise events regularly exceed 82dB L_{Amax} (slow time weighting) more than twice in any hour ... should be treated as being in NEC C. Reference to the table at the boundary between category B and category C shows that this sets an upper limit for L_{Amax} which is 25dB above the L_{Aeq} (23dB in the case of rail noise).

Note 1 of *PPG24* says more or less the same thing. It would seem reasonable to adopt this as a more general requirement for transportation noise. That is to say, for example, that road traffic levels measured as $L_{Amax}(S)$ of 70dB to 82dB should place a site in category B, even if the L_{Aeq} value places it in category A.

The 1995 WHO report, in addition to the L_{Aeq} standard, suggests a value of L_{Amax} of 45dB internally: this is 15dB higher than the L_{Aeq}.

Because people are usually less familiar with industrial noise and have a different perception of it, as I mentioned above, I consider that the night time $L_{Amax}(S)$ level for industrial noise could be 15dB more than the appropriate L_{Aeq} rather than 25dB. This addition of 15dB is consistent with the WHO report. This L_{Amax} measure could be used to replace the subjective method of correction for impulsive noise in *BS4142*.

The establishment of a realistic value for L_{Amax} is not easy as the quantity tends to vary from measurement to measurement. We have generally measured L_{Amax} over five minute or 15 minute periods and used as the value for assessment the average value plus one standard deviation.

Summary

In summary, the following standards should be used for the assessment of the effect of transportation or industrial noise on housing.

For new housing - noise from transportation: As set out in *PPG24* or *PAN56*, but whichever is the higher of $\{L_{Aeq}\}$ and $\{L_{Amax}(S) - 25dB\}$ should be taken as the site noise level. Category boundaries should be varied as appropriate by agreement with the local authority.

For new housing - noise from industrial sources: The site noise level should be calculated as the higher of $\{L_{Aeq} + 5dB\}$ and $\{L_{Amax}(S) - 10dB\}$. This should be compared with the mixed sources table in *PPG24* or *PAN56*. Category boundaries should be varied as appropriate by agreement with the local authority.

For new transportation developments: The transportation noise should be taken as the higher of $\{L_{Aeq}\}$ and $\{L_{Amax}(S) - 25dB\}$. This level should not be more than 10dB greater than the background noise level (or other agreed figure) measured as L_{A90}.

For new industrial developments: The industrial noise should be taken as the higher of $\{L_{Aeq}\}$ and $\{L_{Amax}(S) - 15dB\}$. The industrial noise level should not exceed the background level by more than 5dB or such other margin as may be agreed with the local authority.

Background noise should be measured as L_{A90} during the night or the day as appropriate, in 15 minute periods. The background noise should be taken as the average less one standard deviation.

Maximum noise should be measured as $L_{Amax}(S)$ in 15 minute periods. The maximum noise should be taken as the average plus one standard deviation.

The future for BS.4142

I see a role for *BS.4142* or its successor specifically in determining the impact of new industrial and transportation noise, but not in determining the suitability of sites for sensitive development, nor for determining expansion of existing transportation or industrial development. The main role of the new standard should be to specify clearly how L_{Aeq}, L_{Amax}, and L_{A90} are to be measured and presented. The final assessment of the impact based on this framework should be the responsibility of the consultant and the local authority, who should clearly explain the local circumstances which lead to their conclusions.

Dick Bowdler FIOA *is with New Acoustics, Duntocher, Clydebank.*

Measuring machinery noise in the ocean

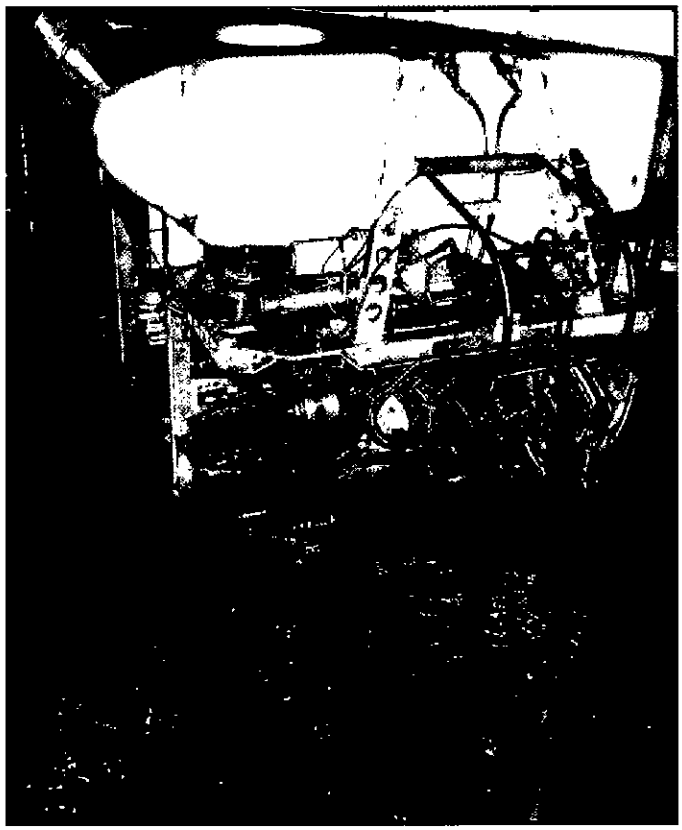
R A Hazelwood MIOA

Sound waves in the ocean are used as a substitute for light and radio waves whose transmission is largely blocked. GPS navigation, so useful for surface shipping, is not available. Thus, the navigation of submarines, both manned and robotic, makes extensive use of sonar techniques.

The technology of remotely operated vehicles (ROVs) has been growing rapidly, driven in large part by the exploration of the sea bed for the recovery of oil, gas and other minerals. Accurate subsea surveying is necessary as a precursor to many installations.

Such surveys are now routine in water depths well over 1km and the best results require the temporary deployment of acoustic beacons at known fixed positions on the seabed. Ranges to such beacons can then be found by measuring the two way time of flight of short 'pings'. This technique, described as long baseline (LBL), is particularly suited to accurate surveys in deep water, because the triangulation analysis can be used to minimise the uncertainties due to variation in the sound speed.

However, operational ranges are often limited by the ambient noise at the receiver. It is thus important to measure the self noise of ROVs, and to find ways to minimise its effects. Noise from other sources, including ship propellers and thrusters, are also important, but ROVs are compact independent devices for which the noise can be more readily characterised. Funding has been awarded to the National Physical Laboratory (NPL) to study the options for such measurements. This is described by Dr Steve Robinson in the programme summary given on the opposite page.



Picture shows the 'Hammerhead' deep sea ROV, built and operated by SubSea International Inc, being lowered into the waters of the enclosed moon pool of Tidewater's ROV support vessel 'Nautical Tide'. The ROV is rated to 5000m water depth, with two 75 horsepower hydraulic pumps used to power the thrusters and tools. The hydrophone multiplexer is in the white housing, temporarily strapped to the ROV, with multiple hydrophone cables (blue) tie-wrapped in place prior to deployment to 180m water depth.

As supplier of the industry standard 'Compatt' seabed transponders, Sonardyne offers a noise measurement service to clients who recognise the importance of noise in the planning of their operations. Professional surveying companies who have the responsibility of supplying critical data to oil companies are keen to avoid unforeseen constraints on the use of expensive ship time. Although relatively deep water (>100m depth) is required for reliable noise measurements which minimise the errors due to reflections from the sea surface and sea bed, such measurements are still cost effective for critical applications, especially those in very deep water (>3000m).

A recent example of this work (May 2001) was undertaken off the Portuguese coast near Lisbon, at the request of John E Chance and Associates. A set of hydrophones (Sonardyne type 7947 HYDRAphone system) was attached to the ROV to measure the noise at various points over its surface, with different degrees of shielding from the machinery noise.

Dr Dick Hazelwood is with Sonardyne International Ltd

Study of rapid methods for assessing radiated noise from underwater vehicles

S P Robinson MIOA

Increasing concern has been expressed in recent years regarding the potential harm to marine life caused by exposure to man-made noise in the ocean. What is sometimes not so well appreciated is that the self-noise of underwater platforms such as ROVs (underwater robotic vehicles) can be a limiting factor in the performance of acoustic systems that are mounted on them.

This is particularly acute for sub-sea acoustic positioning systems where the range becomes limited by the noise. A potentially crippling limitation, given that the current trend in hydrocarbon production is towards working in deeper and deeper water as the offshore industry begins to harvest oil and gas fields well off the edge of the continental shelf.

Many millions of dollars-worth of oil is recovered from the deep ocean (>1km), and this depends on ROVs for surveying, building and servicing the plant. Sometimes, expensive on-site visits are required to service equipment that appears not to be working to specification, when in fact the problem is the noise of the vehicle and not system performance.

For an assessment to be made, agreed methods of measuring noise must be in place. Noise ranges can be used to measure the noise radiation pattern but these are controlled by the military and are exorbitantly expensive. More rapid methods of assessing noise are possible by use of methods analogous to those used in air acoustics. For example, measurements are possible in the sort of reverberant test tank often possessed by manufacturers. Alternatively, measurements may be possible using 'portable' ranges.

NPL has a project (number 3.2.06.1) in the current National Measurement System Acoustical Metrology Programme to examine potential methods for rapid assessment of underwater radiated noise. It is intended that the project will be co-funded, involving a UK SME, acoustic system manufacturers, an ROV manufacturer, and other interested parties.

It is intended that potential methods will be reviewed and where feasible, measurements made on representative examples of underwater platforms. A successful project will provide first steps towards:

- ❑ Pulling together interested parties and provide a focus for industrial pre-competitive effort in this area;
- ❑ Providing an evaluation of a number of potential approaches to measuring noise;
- ❑ Enabling NPL to provide input to international standards bodies with the aim of developing specification standards for noise measurement;
- ❑ Beginning to provide a framework through which the noise radiated from underwater vehicles can be specified (ultimately perhaps in an analogous way to the method of specifying the noise radiated by domestic refrigerators).

Dr Steve Robinson is with National Physical Laboratory Centre for Mechanical and Acoustic Metrology, Teddington, Middlesex.

EU noise directives challenge USA industry

Richard H Lyon

The European Union's Directives with regard to product noise were due to come into effect in January 2002. After that date, some manufacturers must publish the sound power levels of their products, and some of these will have to meet preset noise limits. In the latter case, companies wishing to sell products in Europe will have to be tested for their noise output, and if found not to meet the restrictions, these products cannot be sold.

In general, the equipment involved is for commercial use and includes common types of construction machinery. One category that falls within the Directives' scope is lawnmowers and trimmers. The size ranges of these include both commercial and domestic consumer equipment. There is a serious question about whether such machines can comply with the Directives and still do their job. Those US companies marketing them are likely to have great difficulty in selling products that are both effective and compliant. In January 2006 the limits on permissible radiated sound power are to be reduced further.

What the directives require

The Directives place a limit on the amount of sound power that can be emitted by the product in question. The sound power is A-weighted and is to be measured using a prescribed protocol, essentially a free-field hemispherical sound pressure procedure. Certain organisations, certified by the EU, are authorised to either do the measurements or to observe measurements made in the manufacturer's facility.

Table 1: Component noise source ranking (hypothetical example)

A-weighted sound power levels (L_w dB re 1pW)

Blade noise: tones and broadband aerodynamic noise			105
Engine noise			102
Deck radiation	top surface	99	
	underneath	96	
	total		101
Exhaust noise			92
Summed total:			108

The stated limits for the sound power for the equipment in question are presented in *Table 3* for both January 2002 and January 2006. Generally, larger and more powerful pieces of equipment are allowed to make more noise, even though it is often the case that it is more difficult to install sound attenuation devices on smaller units. Interestingly, leaf blowers do not have to meet a noise limit: they fall into the category that requires only noise labelling.

Since it is known that there will be a variation in the sound power radiated by products made on the same production line, the Directives provide a procedure that takes this into account (our experience is that the standard deviation is of the order of 1.5dB).

If the manufacturer measures the average sound level by a sampling procedure, the average must fall at least 3dB below the stated limit. Or, the manufacturer may do 100% testing and all units must be below the limits in *Table 3*. It is likely that the latter procedure will end up being a 'measure and tweak' process for valuable products or a 'measure and allocate' process for less valuable items.

It is interesting that a 'free field' method of measurement is specified. It is not clear why a reverberant room method is unacceptable. One can speculate that the concern for periodic components in the sound was thought to be a problem, but the free field method has its own problems of accuracy, and even greater problems of convenience and cost.

An example of product compliance: lawnmowers

Most of the major players in the commercial lawnmower market sell their products internationally. Those who are US-based have a strong international position and will expect to sell

their equipment in Europe and Asia. They need to be concerned that the EU Directives may well be a harbinger of similar restrictions on product sound, not only in Europe, but also in other major and developing markets.

Referring to *Table 3*, we see that the permissible sound levels for mowers depend on the width of the cutting track. There is a very large variation in this track for commercial mowers as used by golf greenkeepers, landscapers, and parks managers.

A typical rotary mower of the type used by the latter two groups has a cutting width of about 2 metres and falls in the $L \leq 105$dB (this example is reproduced from the manufacturer's catalogue, and is unrelated to the data example to follow). Mowers in this class therefore are limited to, and average, permissible sound power level of 102dB.

A hypothetical example of sound power data for a mower as used by landscapers is shown in *Table 1*. Although hypothetical, we believe the example to be reasonable. The major 'sources' of radiated sound are the engine (intake, exhaust, and structural), the mowing deck (from which sound is radiated both upward and downward) and the aerodynamic radiation by the moving blade and fixed surfaces. We see that the aerodynamic noise dominates, but the other two sources make a significant contribution to the overall noise.

A balanced design would lead to making all three sources equal contributors to the overall sound. If the limit is 102dB, then each source should produce 97dB. This will require a reduction in the sound for each source as shown in *Table 2*. This table also shows the reduction needed if 100% sampling is used, and the limit is 105dB. The reductions in sound radiated by the engine and the deck structure, although significant, are readily achievable by conventional noise reduction methods.

The source requiring the greatest attenuation

Table 2: Balanced noise reduction (hypothetical example)

Balanced design with 3 important noise sources, to meet a requirement of 102dB	
Blade noise = engine noise = deck vibration radiation = 97dB	
Significant reductions for all 3 sources are required	
Blade noise	8dB reduction
Engine noise	5dB reduction
Deck vibration radiation	4dB reduction
With no allowance for unit-to-unit variability: balanced level at 100dB	
Blade noise	5dB reduction
Engine noise	2dB reduction
Deck vibration radiation	1dB reduction

is aerodynamic radiation, for which we need a reduction of nearly 9dB. Since the sound power radiated by aerodynamic forces varies with the sixth power of velocity, the obvious solution is to slow down the blades. With a V^6 dependence, each 1dB reduction requires a 4% reduction in speed. A 9dB reduction will require a 30% reduction in speed. With the blades moving this slowly, the mower will not cut grass!

The solution: science or lawyers?

The situation posed by the EU Directives is somewhat reminiscent of the product noise efforts of the USA Environmental Protection Agency in the 1970's, which could be summarised as 'we have the technology, let's get on with the job'. My opinion is that US manufacturers of mowing equipment do not

Table 3: Limits on A-weighted sound power levels for specified equipment

type of equipment	Parameter	Permissible sound power level dB	
		stage I, as from 03.01.02	stage II, as from 03.01.06
Compaction machines (vibrating rollers, vibrating plates, vibratory hammers)	$P \leq 88$ $8 < P \leq 70$ $P > 70$		
Tracked dozers, tracked loaders, tracked excavator-loaders	$P \leq 55$ $P > 55$		
Wheeled dozers, wheeled loaders, dumpers, graders, loader-type landfill compactors, combustion engine driven counterbalanced lift trucks, mobile cranes, compaction machines (non-vibrating rollers), paver finishers, hydraulic power packs	$P \leq 55$ $P > 55$		
Excavators, builders' hoists, construction winches, motor hoes	$P \leq 15$ $P > 15$		
Hand-held concrete breakers and picks	$m \leq 15$ $15 < m \leq 30$ $m > 30$		
Tower cranes			
Welding and power generators	$P_e \leq 2$ $2 < P_e \leq 10$ $P_e > 10$		
Compressors	$P \leq 15$ $P > 15$		
Lawnmowers, lawn trimmers / lawn edge trimmers	$L \leq 50$ $50 < L \leq 70$ $70 < L \leq 120$ $L > 120$		

The parameters determining the noise limits are:
Net installed power P kW
Electric power P_e kW (generators)
Mass m kg (concrete breakers)
Cutting width L cm (lawnmowers)

have the technical knowledge, the facilities, or the personnel to reduce aerodynamic noise by 9dB while maintaining cutting performance.

The task requires basic research and development of a type that the national laboratories and research organisations normally carry out. In Europe there are several examples of such laboratories that directly support industry, such as CETIM in France and the Frauenhofer Institutes in Germany.

In the 1970's, the response of US industry to EPA initiatives was to turn to the lawyers and away from their engineers. They may well adopt such an approach to the EU (issues regarding restraint of trade particularly spring to mind). Their success in such an approach may be very different in this situation. European manufacturers, with the backing of national laboratories and universities accustomed to providing research and development for industry, may be in much better shape to meet the noise limits that the EU Directives require. US industry is likely to have a more difficult time.

No research supported by the NSF or other government agencies has helped American industry to meet the January 2002 deadline. Support of such research may help in meeting the January 2006 deadline. But it is time for supporting agencies to realise that the solutions to 'mundane' problems, like the sounds of lawnmowers and other products, involve issues of design and understanding that are every bit as challenging as the latest concerns in information and nano-technology. It is time for us to get on with the job precisely because we do not have the technology.

THINGS YOU NEED TO KNOW

What *does* a wind farm do?

It generates wind.

An increased amount of wind is usually noticeable within sight of the farm, because generated wind cannot yet be stored efficiently.

Are they noisy?

Not particularly, but considerable discussion has arisen recently as to whether the noise of the wind, or merely the generating machinery, should be limited by planning conditions.

Who runs the Wind Farms?

They are run by the regional Wind Company; for instance in the east of England they are owned and run by Anglian Wind.

What happened before there were Wind Farms?

A small amount of wind has always occurred naturally. In the age of sail, sailors would attempt to generate it by 'whistling for a wind'. However only a small amount could be generated using this method and it was both unreliable and inefficient. In more recent times, local communities built windmills to provide local wind. These could produce only limited quantities and still had no storage facilities.

What percentage of wind occurs naturally?

There is a great deal of controversy over the amount of naturally-occurring wind. A figure of between 25% and 40% has been suggested; however in Cornwall, WeatherGen plc claims that the wind Cornish Wind regards as natural is actually run-off from wind it has sold to other regions, meaning that Cornish Wind should pay for it. This is still in dispute.

Should I buy my own wind?

In England and Wales your local council (weather department) buys wind on your behalf, paid for out of Council Tax. If you need extra wind for a specific purpose it can be bought direct from a wind company. In Scotland the legislative powers have been devolved to the Scottish Assembly, which has yet to debate the issue.

Who can I buy my wind from?

It depends on the area in which you live. In Wales, for example, wind can be bought from Gwynt Cymru (Welsh Wind), or from a global company such as WeatherGen. You receive the same air, and only the name on the top of the bill is different.

(Acknowledgements are due to an anonymous author who inspired this article - Ed)

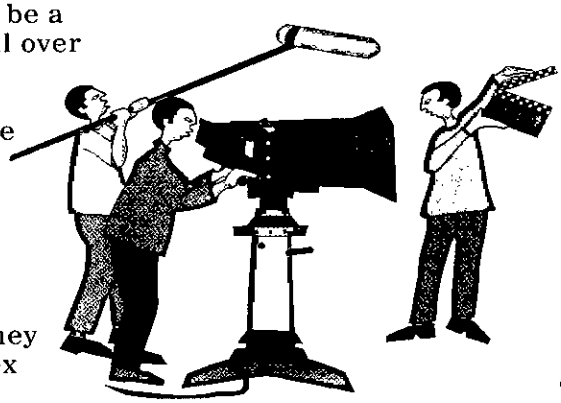
MAKING A VIDEO APPEARANCE

How *was* it for you?

James Caplin

I've just made a video about noise - *Better Noise Assessments* - with three people who are well-known in the world of acoustics: Keith Broughton, Principal Specialist Inspector (Noise & Vibration) for the Health and Safety Executive; David Bull, an experienced noise consultant who is also the Chief Examiner of the Institute of Acoustics' own Certificate of Competence in Workplace Noise Assessment; and Paul Rubens, Managing Director of Casella CEL. I wondered, on behalf of Acoustics Bulletin, how they found making a video?

Paul Rubens first. "It was interesting, a reasonably harmless experience, no big hiccups. Some bits I thought would take loads of time were quick, things I thought would be quick took months." He explained that, in common with most people who have not made a video before, he thought the actual filming would be a lengthy process. In fact, it was all over in less than a week.



The part that took - which always takes - a long time was the scriptwriting. This is something with which professional video-makers are all too familiar: the to-ing and fro-ing of the script eats up time. The more people involved; the more they know about their subject; the busier they are; the longer and more complex the process becomes.

So Keith Broughton might see a version, and suggest changes, which would then have to be checked with David Bull, who might be away, but who on his return would agree to some, disagree with others, and suggest some of his own. Back the script would have to go to Keith, who, inevitably, was now away.

As for appearing in the video, Keith Broughton seemed relatively unfazed. When we talked about why, he revealed something unexpected from perhaps 45 years ago. "It goes back to my speech and drama training. Mother put me through hell. She thought my local accent was no good." (He comes from Nottingham). "It has paid off. I gained in self-confidence, and can stand up in front of an audience and give a presentation." He even remembers his teacher's name: Miss Allbreck. We can vouch for her training: Keith is good on camera, relaxed and amusing.

David Bull, who also appeared on camera, had no Miss Allbreck in his past and found appearing on camera more difficult. "It was a little bit stressful, wondering what I was in for, not having done it before, I was a bit on edge - not excessively, just enough to get the adrenaline going."

Now the video is made, what do they think of the final result? Keith Broughton is pleased, describing it as "concise and to the point." On a personal level too, it seems to have hit the mark. "We don't have facilities for viewing videos at work easily, far easier to take it home. So my wife and son saw it. He's a very critical teenager - they were quite impressed. I don't think he'd ever seen Dad in that light."

Paul Rubens had surprisingly low expectations - surprising considering that this was the man partly funding the initiative. "It was better than I thought it was going to be - I thought it would be educational and dull - but I watched it for 15 minutes and quite enjoyed it, time flew past."

David Bull, too, had low expectations and was also pleasantly surprised. "The final product was better than I anticipated. I do see plenty of videos from commercial organisations, and to be honest, I don't think them useful. I watched it through two or three times, and the more I watched it, the more it made sense and the more worthwhile I thought it was."

We also wondered whether David and Keith thought that others who have not made a video should get involved in doing one if asked. David was unequivocal: "Do it, definitely. The feedback from watching yourself on film would have helped me as a teacher or lecturer - it would be a valuable exercise for any young teachers."

Keith Broughton's take on this question was different. As a senior figure in the HSE, he was most concerned that he not be used in the video to promote a particular company. So when asked if others should consider appearing in a video, he gave an HSE answer: "As long as the ground rules are set, it's OK."

Which brings me to one unique thing about the production. In spite of part sponsoring the product, Paul Rubens kept urging us to reduce the exposure of Casella in the video. Usually people who sponsor a programme push the other way. So we would add something in the script mentioning Casella and he'd try to get us to take it out. We argued that, as a sponsor, audiences expect (and tolerate) a certain amount of marketing. The fact that both Keith and Paul are comfortable that the video does not sell Casella suggests that we've got the balance about right.

The final word then, should go to our sponsor. Paul Rubens again: "The most enjoyable thing in the project was watching it at the end. It is a good product of which we can be proud."

Extracts are provided by Rupert Taylor FIOA

FROM HANSARD

Written answers

23 October 2001

Night flights

Mr Todd: To ask the Secretary of State for Transport, Local Government and the Regions what assessment he has made of the adequacy of controls on night noise at UK airports.
Mr Jamieson: Controls on aircraft noise at night may be imposed voluntarily by the airport operator, in consultation with those affected. They may be subject of informal agreement, for example, with the relevant airport consultative committee, or of enforceable obligations under section 106 of the Town and Country Planning Act 1990 or they may be the subject of planning conditions. At airports designated for the purposes of section 78 of the Civil Aviation Act 1982, controls may be set under that power: at present, only Heathrow, Gatwick and Stansted are so designated.
In the consultation paper, 'Control of noise from civil aircraft', published last year, we also proposed that the Secretary of State be given a new power to require a noise amelioration scheme to be made and agreed with an appropriate local authority to address particular local issues. Responses to that consultation are being analysed and I hope to announce the outcome shortly.

24 October 2001

Late-night licences

Annabelle Ewing: To ask the Secretary of State for Culture, Media and Sport if she will make a statement on her response to the recent judgment on late-night flights into Heathrow; what impact this decision has had on her Department's policy on bar licence hours; and what her policy is on late-night noise disturbance in city centres.
Dr Howells [holding answer 22 October 2001]: The Government is carefully studying the judgment of the European Court of Human Rights in the case of Hatton and others v the United Kingdom, and its possible implications for a range of issues including our policy on alcohol licensing hours. If appropriate, it will be carefully taken into account before a Bill to reform the alcohol and public entertainment licensing laws is presented in Parliament.
Permitted licensing hours for licensed premises in England and Wales are set out in the Licensing Act 1964. Our current policy on the reform of these laws provides that opening hours would be attached as a condition of individual premises licences. It also provides that local residents will have the right to object to the grant of a licence, or to apply for the hours of opening to be restricted, or to seek a review of an existing licence on grounds of public nuisance, including noise disturbance. Where the local authority denies such an objection, the objector would be entitled to appeal to the magistrates courts.
In addition, on 1 December this year, we shall be bringing into force section 17 of the Criminal Justice and Police Act 2001 which provides new powers in England and Wales for the police to close instantly for up to 24 hours licensed premises which are causing disturbance to the general public as a result of excessive noise emitted from the premises.
Annabelle Ewing: To ask the Secretary of State for Culture, Media and Sport if she will place in the Library the guidelines issued by her Department regarding noise abatement best practice in relation to conditions set by councils on late-night licence applications; and if she will make a statement.
Dr Howells [holding answer 22 October 2001]: Guidance on conditions which might be attached to public entertainment or late-night refreshment house or night cafe licences in England and Wales concerning noise abatement has not been issued by the Department or by the Home Office when it was responsible for this policy area.
In the case of public entertainment licences, local authorities have a broad discretion to impose such conditions, terms and restrictions as they see fit.
In the case of late-night refreshment houses and night cafes, conditions may be imposed to prevent unreasonable disturbance to local residents, and 'closing orders' may be imposed to the same end. Some local authorities have sought agreements with parts of the licensed trade on standardised conditions which might be adopted in connection with public entertainment licences.
From time to time local authorities publish advice on associated matters in conjunction with the Health and Safety Executive. The majority of local authorities in making licensing decisions generally adopt similar standards to those which they adopt in enforcing the provisions of the Environmental Protection Act 1990 and the Noise Act 1996.
Alcohol licensing in England and Wales is the responsibility of licensing justices and not the local authority, and they have a broad discretion to refuse various extensions beyond normal permitted licensing hours to prevent unreasonable disturbance to people living in the neighbourhood.

8 November 2001

Physical Agents Directive

Mr Bercow: To ask the Secretary of State for Transport, Local Government and the Regions what assessment he has made of (a) the impact on British businesses of the proposed physical agents directive and (b) its cost to British business.
Dr Whitehead: Regulatory Impact Assessments of the common position on both proposed physical agents directives on vibration and noise have been prepared by the Health and Safety Executive. The RIA on the vibration directive has already been submitted to the European Scrutiny Committee and is available in the House of Commons Library; I will shortly submit the RIA on the noise directive and place it in the Library.

12 November 2001

Noise mitigation

Mr Goodman: To ask the Secretary of State for Transport, Local Government and the Regions when he will publish the timetable for the implementation of the ring-fenced budget for noise mitigation measures.
Mr Jamieson: The Government's policy of reducing the effects of traffic noise is being implemented through two programmes. The Government's *Transport 2010:* The 10 Year Plan gives a commitment to surface at least 60% of the trunk roads, including all the concrete trunk roads, with quieter materials by 31 March 2011. We have a policy of using quieter surfaces as a matter of course whenever a road needs to be resurfaced and I recently announced the criteria to be used for prioritising the concrete trunk roads to be resurfaced with quieter materials.
The second programme, with an annual £5 million ring-fenced budget, is to provide noise mitigation measures in the most serious and pressing cases where practical and cost-effective measures can be provided.

Book Reviews

Signal Processing for Active Control

S J Elliott

ISBN 0-12-227085-6 Academic Press 2001
price £59.95
(511 pages, over 400 references, majority in the 1990's, but a few in 2000)

As a component of the *Academic Press Series* on **Signal Processing and its Applications,** this book gathers together those aspects of signal processing which have been applied to active control of unwanted disturbances through using the outputs of controlled secondary sources to interfere with the primary disturbances. The widest applications have been for noise and vibration control, which form the major part of the book.
It is the eighth book on active noise or vibration control to have been acquired by the reviewer since the first one appeared in 1992, indicating active control's development in maturity. It is also the third book to have been authored by Steve Elliott, either singly or jointly.
The first question in the reviewer's mind was 'Is this just going to be a rehash of Steve's earlier books?' The answer is a quite definite no! There are a large number of additional topics plus further developments of those covered in the 1992 edition of *Active Control of Sound* (Nelson and Elliott).
For example, this new book has Chapter 2 with over 50 pages on *'Optimal and Adaptive Digital Filters'*, compared with Chapter 4 of the 1992 book which has less than 20 pages on digital filters.
The second question in the reviewer's mind was 'Will it all be heavy signal processing theory?' Again, this is not so. Of course, it is largely a theoretical book, but applications are described and elaborated.
Dr Geoff Leventhall FIOA

Occupational exposure to noise: evaluation, prevention and control

An international meeting of experts in the field of acoustics was organised by the **Office of Occupational Health, World Health Organisation,** Geneva from 25-27 September 1995.
The objective was to produce a document on the occupational aspects of noise including its effects on humans, particularly hearing loss, its measurement and exposure assessment, and its prevention and control.
The meeting was attended by 19 specialists from 16 countries, many of whom contributed new materials for the proposed document. Several other specialists in this field collaborated by correspondence. The document was recently published by the Federal Institute for **Occupational Safety and Health, Germany** on behalf of the World Health Organisation.

The editors, *Berenice Goelzer, WHO; Colin H Hansen, Australia; and Gustav A Sehrndt, Germany,* have met the objectives of the meeting. These were to produce a book with CD-ROM for occupational hygienists and other occupational health and safety personnel as an introduction to the subject, for use as a handbook, reference, and textbook. It provides an overview of the evaluation, prevention and control of exposure to noise at the workplace, with a view to preventing noise-induced hearing loss. It starts with the fundamentals of acoustics, including the quantities to be measured and their relation to the psychology of hearing. Further details are given in the following chapters on the physiology and pathophysiology of the ear and hearing. The discussion of the occupational causes of hearing loss and the impossibility of recovery from severe damage to the inner ear leads to the important issue of exposure criteria. Since there is agreement that noise reduction at source is the first choice for preventing hearing loss, basic information on noise sources is given in the next chapter.
The next two chapters deal with the evaluation of exposure to noise, covering strategy for noise surveys and details on the required instruments, including their use and calibration.
In spite of all efforts to reduce noise at the workplace, it is necessary to monitor the individual's hearing by repeated audiometry: this is covered in an extensive chapter which also deals with the training of audiometric testing personnel and the preparation of the workers to be tested.
Legal provisions in many countries require hazard prevention by control programmes. Principles and measures for engineering noise control, as well as hearing conservation programmes and their management, are presented, always considering control of noise at the source as the basis of any preventive strategy. However, the importance of personal measures should not be overlooked and this is covered in a chapter which includes an introduction to the different hearing protectors as well as worker education and training. Sources of information and a list of relevant case studies are given in the last chapter, emphasising the importance of standards for noise control at the design stage.
The book including CD-ROM is available from the Wirtschaftsverlag NW, Verlag für neue Wissenschaft GmbH, Bürgermeister-Smidt-Str. 74-76, DE-27568 Bremerhaven, Germany or info@nw-verlag.de, price € 27.60 plus postage.

ECUA 2002

Tutorial course for young acousticians from European countries

The 6th European conference on *Underwater Acoustics* will be held in Gdansk, Poland, from 24 to 27 June 2002. On the first day a tutorial course for young European acousticians will be organised under the auspices of the European Commission. The main topic will be *'Underwater acoustic and remote sensing technologies for exploration and sustainable exploitation of marine ecosystems'.*
The course is intended to provide a new relevant platform for the exchange of information and experience among young European participants, supporting their mobility and the growth of scientific and technical qualifications. It will also serve as a vehicle for the dissemination of research and development in the field of underwater acoustics and remote sensing technologies in environmental applications within the EU and candidate member states, particularly in the Baltic Sea region (eg Poland).
The lectures will be delivered by outstanding European and American scientists on the following topics:

- ❑ **Sea surface reverberation, modelling and experiments:** *Prof Thomas Neighbors,* Science Applications International Corp, USA
- ❑ **Scattering of acoustic waves in the Baltic Sea:** *Prof Zygmunt Klusek,* Institute of Oceanology, Polish Academy of Science, Poland
- ❑ **Acoustic tomography in the sea:** *Prof Michael Taroudakis*, FORTH IACM, Heraklion, Greece
- ❑ **Numerical techniques for broadband signal simulation in ocean acoustics:** *Prof Finn B Jensen,* SACLANT, La Spezia, Italy
- ❑ **Application of GIS for the monitoring, exploitation and sustainable environmental management of marine ecosystems:** *Prof Leo van Biesen,* Vrije Universiteit Brussels, Belgium
- ❑ **Acoustic underwater communications:** *Prof Adam Zielinski,* University of Victoria, Canada

Further information from the ECUA 2002 web site www.ecua2002.gda.pl or from Dr Zbigniew Lubniewski, Technical University of Gdansk, Department of Remote Monitoring Systems, Nanutowicza 11.12, 80-952 Gdansk, Poland.

Developers of 3D sound win UK's biggest engineering prize

The Royal Academy of Engineering honours the UK's most distinguished engineers and aims to take advantage of the enormous wealth of engineering knowledge and experience its 1000 Fellows possess. It exists to pursue, encourage and maintain excellence in the whole field of engineering to promote the advancement of the science, art and practice of engineering for the benefit of the public.

Five engineers, who developed and applied three-dimensional audio technology to computer games with dramatic effect, have won the UK's biggest engineering prize - the £50,000 Royal *Academy of Engineering MacRobert Award*. Their audible innovation is now set to revolutionise the way we hear sound on mobile phones and palmtops.

Dr Alastair Sibbald, David Monteith, Richard Clemow, Peter Clare and **Adam Philp** of Sensaura Ltd in Hayes, west London, received the solid gold MacRobert Award medal and prize from HRH the Duke of Edinburgh on 14 November 2001. A special display of the technology they developed opened on the same day at London's Science Museum.

Sensaura's engineers have duplicated the directional sensation that humans get listening to a live event. For example, when an aircraft passes over you know instinctively where to look for it. "Our primitive ancestors needed their directional hearing to stay alive," says managing director David Monteith. "We take it for granted that we can hear in three dimensions but it is a challenge to recreate that effect through ordinary stereo speakers".

The 3D Positional Audio system was originally developed to enhance classical music recordings, invoking the all-enveloping experience of music in the concert hall. The company soon realised that computers were a much bigger market and licensed it as software that now runs on over 50 million PCs worldwide.

'We take it for granted that we hear in three dimensions'

It provides immersive 'surround' sound for game-players and music listeners through conventional stereo speakers from their PC.

3D Positional Audio is particularly in demand for PC games. The system is now being applied to game consoles themselves, with Sensaura technology being incorporated in the Microsoft Xbox video game system, to be launched in the UK early 2002.

This three-dimensional effect should make next-generation mobile phones more user-friendly. The technology enables callers taking conference calls to 'hear' different callers speaking from different positions around them, all via the same handset. The caller's voice can also be made to sound as though it is coming from a metre or so in front of the listener, instead of the current, unnatural 'in-the-ear' voice. This is possible because we can hear in three dimensions, although we only have two ears. The company's principal scientist, Dr Alastair Sibbald, says that the secret lies in the way our head and ears are built, acting like a complex, directionally-dependent acoustic antenna. Incoming sound waves are diffracted around the head before they reach the eardrum so the brain receives a slightly different signal from each ear. There is also a time delay between the signals reaching each ear, and our brains combine all this information to tell us where to look for the sound.

Sound recordings made using an artificial head produce a 3D effect that incorporates these natural audio cues. The company has developed ways to synthesise these acoustic effects by creating its own pair of perfectly matched 'digital ears' to obtain the necessary data. Listeners can even programme the sound output to their own ear shape to get bespoke surround-sound.

The company provides sophisticated 3D audio technology for the interactive entertainment industry. Following its origin as a research project at Thorn EMI Central Research Laboratories (CRL) in 1991, Sensaura has evolved to become a leading worldwide supplier of 3D audio. The company licenses its technology to the major audio chip manufacturers, who supply in excess of 60% of the PC audio market.

Further information from Jane Sutton, Royal Academy of Engineering, tel: 020 7227 0536 e-mail: suttonj@raeng.co.uk or Rebecca Woolley, Sensaura Ltd tel: 020 8848 6766 e-mail: rwoolley@sensaura.com

Retired Chartered Engineer?

The Retired Chartered Engineers Association (Sussex), which provides talks, visits and social events, celebrates its 50th anniversary this year.

Over this half century it has been successful in enabling retired Chartered Engineers from a diverse range of disciplines to continue to follow their technical interests, balancing this with a social programme where members and their partners can meet in an informal and friendly atmosphere.

The association also provides a much-needed source of friendship at a time when many retired individuals find it difficult to adjust. Based in Worthing, the Association has over 100 members across Sussex and new members are welcomed. It may not necessarily occur to a retired Chartered Engineer to seek out an organisation that is specifically aimed at him or her.

Although readers of *Acoustics Bulletin* are predominately in work, there will those who are about to retire, or are considering retirement. If you are interested, contact the Membership Secretary: Colin Pilling CEng MIChemE MIGasE MIMgt, 84 Marine Crescent, Goring by Sea, West Sussex BN12 4JH, tel 01903 522 356 fax 01903 603 594.

MEPs and EU ministers disagree about noise limits

MEPs are embroiled in a political battle with EU ministers over whether or not noise limits should be imposed on particular forms of transport across Europe.

The environment committee of the European Parliament is resisting an attempt by the council of ministers to weaken a planned noise directive. Amendments from MEPs would set specific and binding EU noise limits for road vehicles, railway tracks and trains, and aircraft. The committee is to ask the parliament to reinstate the amendments. Ministers say it is too early to impose noise limits, and that a standard system must first be established to measure and map out noise pollution: only then should national noise abatement plans be drafted.

The Dutch Green MEP Alexander de Roo said that environmental noise is an immense problem affecting one-third of EU inhabitants. Entrenchment on both sides is such that the disagreement between MEPs and ministers may have to be resolved by a conciliation committee.

Corrie prepares for noisy neighbours

Four contractors have been told to keep quiet in their bids to build an office and flats scheme next door to the home of TV soap *Coronation Street*. Interserve, Gleeson, Mowlem and Amec are pricing the £13 million development for Crosby Homes.

The proximity of the site to Granada Studios had led to fears that noise and vibration from construction work could disrupt shooting, but Crosby has agreed to reduce the impact of the work and will put up a privacy screen of tall trees between the studio and the nine-storey development in Manchester.

A Crosby spokesman said that they had combined physical measures such as screening and silencing of plant with a system of regular meetings with Granada to resolve any unforeseen problems. Although most of *Coronation Street* is filmed indoors, there can be problems with outdoor scenes. Granada has had similar issues before with other building work and the company is pleased with the opportunity to work with Crosby to resolve any noise issues before work starts in early 2002.

Microstar Laboratories
Filters enhance data acquisition

Real-time, high-speed data acquisition and control is made possible on a PC using products from **Microstar Laboratories UK Ltd.** The company manufactures a range of *Data Acquisition Processor* (DAP) boards and systems for PC-based data acquisition. The boards have an on-board independent processor, enabling them to work independently from the host PC free from the delays that are caused by the Windows operating system.

Products are available in ISA/PCI format and are compatible with most industry standard software packages. Typical industry applications are monitoring, test systems, vibration, sound and rotating machinery and process control.

The company has just announced an IIR filter module, an onboard digital implementation of the five classic filter types: Bessel, Butterworth, Chebyshev, Inverse Chebyshev and Elliptic.

The new module, DAPL IFM (IIR filter module), is an optional additional command module complementing the existing FIR filters built into DAPL 2000, the 32-bit multitasking real-time operating system that runs on every data acquisition board. DAPL 2000 is normally controlled through Windows (NT, 2000, ME, 98, 95) or Linux, either locally or over a network.

DAPL 2000 makes it easy to configure a DAP board for high performance data acquisition applications under Windows or Linux. The onboard operating system supports over 100 easy-to-use commands optimised for data acquisition and control. The new DAPL IFM command module enables a simple means of specifying onboard IIR filters, running in real time and continuously filtering the sampled data stream. A single command named after the filter type specifies the filter in just one line, for example:

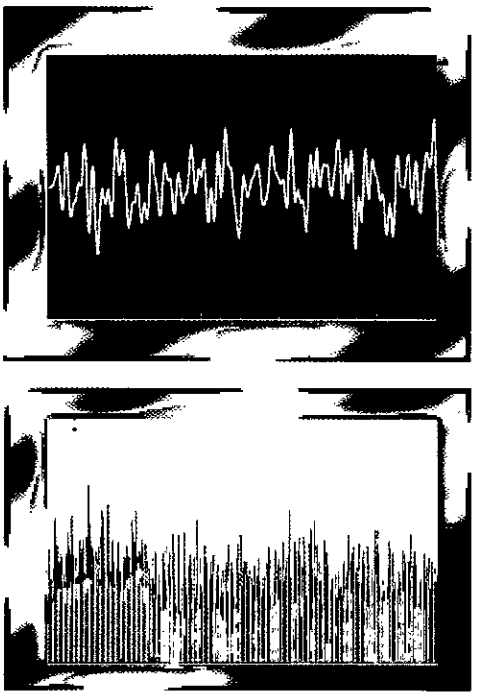
```
CHEBYSHEV(IPIPEO, 8, 0.20, 0.1, $BINOUT)
```

The above command operates on the data stream from channel 0 (input pipe 0), applying an eighth-order Chebyshev filter with a cut-off at 20% of the Nyquist frequency, allowing a 0.1dB passband ripple. It streams the filtered data to the PC through the system binary output pipe, $BINOUT.

The other commands, BUTTERWORTH, BESSEL, CHEBYINV, ELLIPTIC, for the four other filter types, have the same simple user interface (source, order, cutoff, ripple level, destination). Any data pipe may act as source or destination.

A single DAP board, with external rack-mounted expansion hardware, can handle up to 512 analogue inputs. With the new DAPL IFM (IIR Filter Module), DAP 2000 can now filter the data on any channels using any mix of all five filter types. Each filter operates independently, and different parameters can be set for each.

For further information: Barry Towner, tel: 01367 870184 fax: 01367 871001
mstarlabs@btinternet.com
www.mstarlabs.com



Upper picture shows the output from the CHEBYSHEV filter command in the text superimposed on the input waveform. Lower picture shows the FFT of the CHEBYSHEV filter superimposed on the FFT of the input waveform, showing the high frequency attenuation.

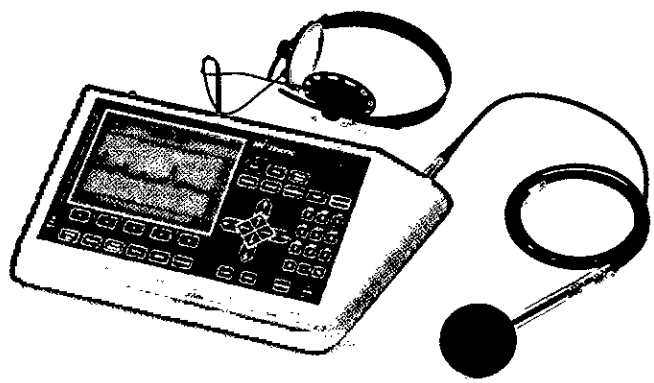
Norsonic

New Nor-118 Pocket Analyser

A new sound level analyser from **Norsonic** combines a 120dB dynamic range with real-time octave and third octave band filters as well as A- and C- and Z-weighting networks. Following the tradition of modular expansion, the *Nor-118* can be fitted with an electronic level recorder feature allowing time profile recording with 100ms resolution. Measurements can be made with all three time constants (F, S and I) employed simultaneously and sound power measurements can be made in octaves or third octaves.
The modular expansion principles allow new functionality to be added when needed, not necessarily at the time of purchase. Norsonic never uses technology that requires physical modules to be inserted every time a particular function is needed. Once installed and activated all functions remain in the instrument.

Building Acoustics using the Nor-121
While the Norsonic *Nor-121* is an advanced analyser originally designed for environmental noise analysis its capabilities, however, are no longer limited to those applications. New modules developed for the instrument enable customers to make measurements in the field of building acoustics.
In the building acoustics mode, the Nor-121 offers dual channel operation, a built-in noise generator, built-in sound insulation calculation, and a reverberation time module. It provides a self-contained solution to the problems of sound insulation and room acoustics.

For more information: John Campbell, Campbell Associates, tel: 01279 718898 fax: 01279 718963



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Brüel & Kjær

16-channel conditioning amplifiers

Setting up multi-channel testing systems in cars, aircraft, trains and satellites is often time-consuming and tedious. **Brüel & Kjær's** new range of 16-channel *DeltaTron* conditioning amplifiers can substantially reduce set-up times and increase measurement reliability.
The type 2694 family has been developed for multi-channel applications such as modal analysis, operational deflection shapes and microphone array measurements, where between 16 and 512 channels are typically used.
Four versions of type 2694 are available, all controlled with Windows-based software via an RS232 interface to a PC. Set-ups can be defined off-line then uploaded into the amplifiers within seconds. It can be used as a stand-alone unit or in multiple configurations. The 2694 can read serial numbers, type numbers and sensitivities for all relevant transducers types through the RS232 interface. The transparent protocol option allows the entire contents of the IEEE 1451.4 Transducer Electronic Data Sheet (TEDS) to be read if required.
The conditioning amplifiers are designed with extremely low noise and have a dynamic range of over 120dB. Because multi-channel measurements are often conducted in difficult or hostile environments, where vibration, temperature variation, and high humidity can affect the reliability of instruments, the 2694 has been designed to perform reliably in such conditions.
For more information: Lene Gerstrøm, tel: 01438 739000 fax: 01438 739099 e-mail: info@bkgb.co.uk web: bksv.com

Brüel & Kjær is a Key Sponsor of the Institute

Bridgeplex

New UK distributor

Acoustic product and material specialist **Bridgeplex Ltd,** trading under its **Soundcheck** trademark, has been appointed official distributor in the UK and Ireland for Swedish-based Auson AB.
The company offers a new anti-vibration noise control product specifically engineered to reduce vibration in sheet metal or plastic panels, drumming effects, and impact noise between metal and hard substances such as concrete or glass.
Noxudol 3100 is a waterborne viscous elastic sound damping paste based on polymer. Although preferably applied by spraying, it can be easily painted on by brush or roller. It has very good adhesive qualities and is water-resistant with excellent abrasion resistance when hardened.
The base material contains anti-corrosives, giving some protection against condensation. Even with its low weight per unit area (approximately half that of traditional bitumen-based barrier mats) it has a high damping factor.
Noxudol 3100 has been used successfully on metal and plastic panels with thicknesses varying between 0.5 and 5.0mm, such as ventilation ducts, machinery covers, earthmoving equipment, driving cabs and car bodies. It fulfils the technical fire requirements of the Swedish vehicle standards for car bodies.
The product is supplied in 1 litre, 5 litre and 20 litre cans and 208 litre drums. A 600ml standard aerosol pack is also available for small and intricate applications.
For more information tel: 0208 8789 4063 fax: 0208 8785 4191 e-mail: soundcheck@btinternet.com

Bridgeplex Limited (Soundcheck(tm)) is a sponsor member of the Institute

Brüel & Kjær

Investigating domestic noise complaints

The Chartered Institute of Environmental Health's *Annual Report 2000,* reveals that UK local authorities recorded 115,860 domestic noise complaints between April 1999 and March 2000, a rise of almost 44% since 1990. Most of these complaints require time-consuming investigations, frequently in unsociable hours, and to meet the needs of local authorities, **Brüel & Kjær** has launched the new *Matron-II* system.

Housed in a discreet standard briefcase, this greatly reduces the workload of environmental officers by doing most of the time-consuming work. It can monitor noise for days on end, providing valuable evidence to help investigating officers take appropriate action.

Matron-II is suitable for investigating all types of domestic noise complaints including loud music, barking dogs, DIY, verbal abuse and harassment and other anti-social behaviour. The system is designed to be in line with the 'best value' concept for total cost of ownership and is simple to use enabling the equipment to be operated by complainants in-situ.

The equipment is installed in the complainant's property with the officer calibrating the sound level meter, setting the unit to 'record' and locking the case to prevent any interference with the calibrated instruments. The microphone is positioned at the point of the alleged nuisance and the tape can then be operated by the complainant via simple remote control.

Appropriate for mediation or prosecution cases, Matron-II recordings are admissible in court and provide valuable evidence for investigating officers in pursuing noise complaints. The fact that the system can be operated by the complainant enables officers to avoid many of the difficulties associated with noise complaints, particularly those taking place during unsociable hours. Matron-II, therefore, offers local authorities an effective weapon in their battle against domestic noise complaints.

There are two Matron-II systems. One consists of a Class 1 sound level meter, type 2238, a Class 1 calibrator, type 4231, a Sony TCD-D8 digital audio tape (DAT) recorder, simple remote control for recordings, tripod, microphone extension cables and power supply plus cables. The second is similar but without the logging sound level meter.

In most cases the microphone will be located indoors but it may be positioned externally using a longer extension cable and a weatherproofed outdoor microphone kit. Accessories include Windows(r) based software for the graphical presentation of recorded results, and a loudspeaker with integrated amplifier for playing back recorded tapes.

Brüel & Kjær also provides optional calibration and service support to ensure the Matron-II systems continue to operate within specifications.

For more information: Lene Gerstrøm,
tel: 01438 739000 fax: 01438 739099
e-mail: info@bkgb.co.uk www.bksv.com

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New product manager

Casella CEL has appointed *David Billington* as Product Manager for its range of noise and vibration instruments. He joined Casella three years ago as an area business manager covering the West Midlands, South West and South Wales.

In his new role, David will assess the long-term requirements of the global marketplace, support the existing noise and vibration product range, and provide specialist help to sales representatives and distributors.

Previously, David spent ten years working with the flow measurements department of the Milk Marketing Board in Telford. His qualifications include an OND in Radio and Telecommunications, and he attended the IOA Diploma course at Liverpool University.

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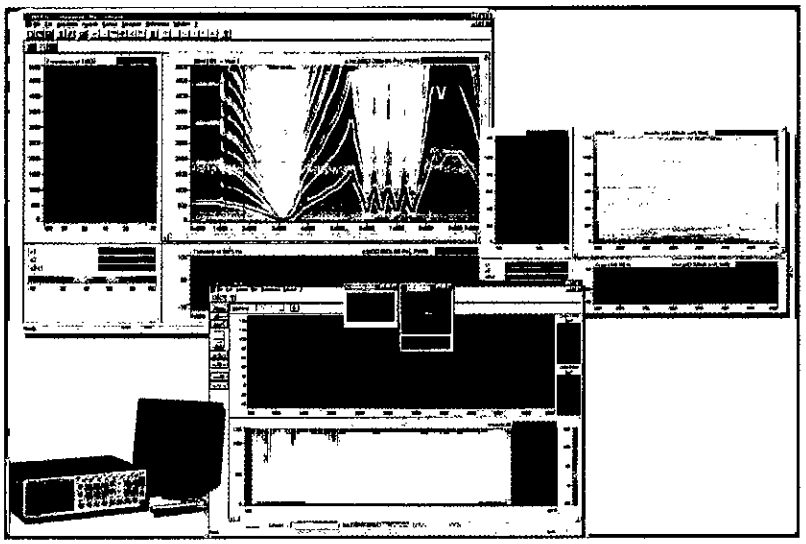


This extensive 32-bit software suite from 01dB, converts a PC into a highly versatile frequency analyser

Acsoft

New acquisition and analysis system

An extensive 32-bit software suite from 01dB, converting a PC into a versatile frequency analyser, is now available in the UK from **AcSoft Ltd.** The *dBFA32* core package offers FFT, whole octave and third-octave analyses and can be adapted to almost any application in real-time sound and vibration analysis by adding software modules.

Together with real-time analysis, the software suite provides order analysis, digital audio recording, sound power and sound intensity measurement (to ISO9614), psychoacoustics calculations, and further off-line analysis operations. A sine, pink noise, and white noise generator is included.

AcSoft claims that even non-specialists will find the system user-friendly regardless of the options selected. It was developed in the Microsoft Windows environment for ease of use and compatibility with word processors and spreadsheets for simple report generation, as well as being able to use other data analysis tools such as DDE and Matlab.

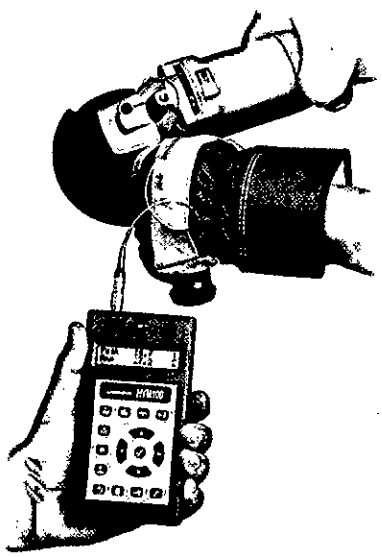
The new dBFA32 suite, together with the 01dB Harmonie or Symphonie system, the new Melodie multi-channel acquisition front end, or the Jazz DAT interface, is claimed to be ideal for mobile applications such as in the automotive and aerospace industries.

For more information: John Shelton, tel: 01296 682686 fax: 01296 682860

Proscon

Human vibration meter upgraded

Following initial success of the *Larson Davis HVM100 Triaxial Vibration Meter*, **ProsCon Environmental** has released the latest upgrade for this instrument.



Having already offered Real Time Triaxial measurements for hand/arm and whole body vibration, the new upgrade makes the unit even easier to use, with a 'boot-up' to hand arm setup, and new exposure time calculation.

Key to the instrument's success has been its operational simplicity. Once the original setup is created for hand/arm measurements, the operator simply attaches the accelerometer and begins measuring.

All three axes are measured simultaneously and readings of RMS, Min, Max and PEAK are gathered for X, Y, & Z axes as well as a sum of all three. The HVM100 now carries out an exposure time calculation based on current requirements, stores 100 files automatically and can be downloaded to a printer or computer with the supplied cable.

Having researched its instrument needs, BAE Systems has favoured the HVM100 for sites at Barrow in Furness, Walton, Brough, and Prestwick for use in the shipbuilding industries.

For information tel: 01489 891853 fax: 01489 895488 email: info@proscom.co.uk

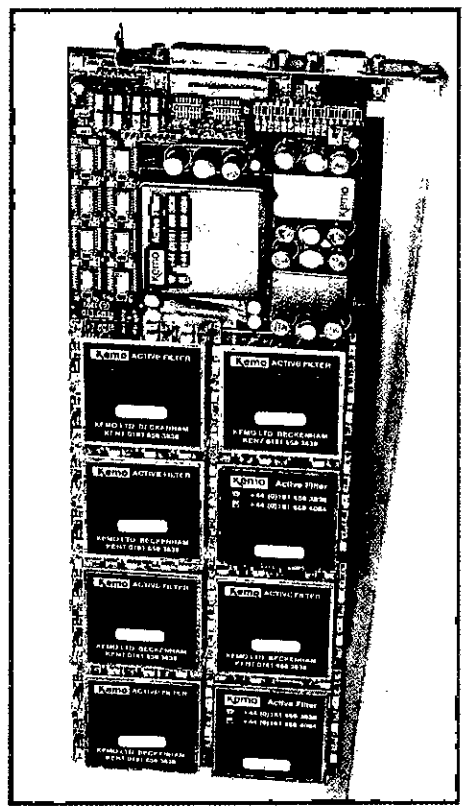
Kemo

Eight-channel filtering

The **Kemo** *CardMaster 8* is an 8-channel filter carrier card designed to fit in a PC card slot. It is suitable for local filtering and amplification in condition monitoring or data acquisition systems, where it can act as a configurable front end. It can also be used in OEM applications as a noise filter within equipment:

Each channel is configurable with single-ended or differential input, AC/DC coupling, pre-filter input gain up to +60dB, and selectable ICP current for accelerometer applications. All parameters can be set individually for each channel.

The CardMaster 8 is designed for use with Kemo's 1200 series of resistor-set filters, or the 1600 series of programmable filters. These are available from stock with a wide range of filter responses to meet a range of applications. With the 1200 series modules, three selectable frequencies can be set by on-board jumpers. With the 1600 series, 255 frequencies can be set by on-board switches.



The Kemo CardMaster 8 filter carrier card

The input will accept AC or DC signals over the range [IFB1](10V. ICP accelerometer signals from 1 to 10 mA at 24C are set by an on-card resistor for each channel. Input gain from 0 to +60 dB is user-selectable via resistors on each channel, and DC offset and gain are adjustable by 10-turn potentiometers.

For more information tel: 020 8658 3838 fax: 020 8658 4084 www.kemo.com

Institute Diary 2002

29 Jan
One-day Workshop
BS EN12354, Building Acoustics Group, London

4 Feb
Research Co-ordination, Professional Devlopment, *St Albans*

7 Feb
Diploma Tutors & Examiners, Education, *St Albans*

12 Feb
Groups and Branches Meeting, *St Albans*

14 Feb
Publications Committee, *St Albans*

19 Feb
Meetings Committee, *St Albans*

21 Feb
Membership Committee, *St Albans*

26 Feb
Engineering Division Committee, *St Albans*

28 Feb
One-day Meeting
Noise Mapping - which way now?, *Measurement & Instrumentation Group, London*

7 Mar
Executive, *St Albans*

21 Mar
Medals & Awards, Council, *St Albans*

25-27 Mar
Spring Conference: Past, Present and Future Acoustics, *Salford*

11 Apr
One-day Meeting
Noise Control in Practice, Industrial Noise Group, *Birmingham*

12 Apr
CMOHAV Examination, *Accredited Centres*

9 May
CMOHAV Advisory Committee, *St Albans*

13 May
Research Co-ordination, Professional Development, *St Albans*

17 May
CCWPNA Examination, *Accredited Centres*

22 May
One-day Meeting
Weather or not to measure, Measurement & Instrumentation Group, *Leicester*

21 May
Meetings Committee, *St Albans*

23 May
Diploma Tutors & Examiners, Education, *St Albans*

30 May
Publications Committee, *St Albans*

31 May
CCENM Examination, *Accredited Centre*

6 Jun
Membership Committee, *St Albans*

11 Jun
Engineering Division Committee, *St Albans*

13-14 Jun
Diploma Examinations, *Accredited Centres*

18 Jun
CCWPNA Advisory Committee, *St Albans*

20 Jun
Executive, *St Albans*

2 Jul
CCENM Advisory Committee, *St Albans*

4 Jul
Medals & Awards, Council, *St Albans*

19-21 Jul
Auditorium Acoustics: historical and contemporary design and performance, *Building Acoustics Group, London*

23 Jul
Diploma Examiners Meeting, *St Albans*

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