

ACOUSTICS

BULLETIN



in this issue... Autumn Conference 2007 report

plus... Noise reduction of hand-held vacuum cleaners
by geometric optimisation of components

An inevitable consequence: the story of industrial deafness - part 2

Using vibration analysis to detect early failure of bearings

Creeping Background - an urban myth?

DIRECT FROM THE UK MANUFACTURER

Noise Insulation & Sound Deadening Solutions

Rely on over **20 years** of **experience & expertise** when it comes to

REVA[®]C

Acoustic Roof Membranes

Dense and flexible polymeric noise insulation barrier product used within acoustic roof constructions.

- Single ply membranes from 2.5 kg/m² - 15kg/m² (1.0mm - 6.0mm thickness)
- Available in a range of sheet and roll dimensions
- Clean and non-hazardous
- Easy to cut
- Low tack
- Free from bitumen, lead, unrefined aromatic oils

DEDPAN[®]

Anti-Drumming Materials for Metal Cladding Systems

High performance resonant damping treatment for roof and wall elements.

- Reduces vibration induced noise & structural flanking problems at source
- Self-adhesive and available in roll and sheet forms
- Tested to ISO CD/140 18 (Draft Standard)
- As referenced in DfES produced BB93 "Acoustic Design for Schools"
- Minimal weight increase
- Clean and non-hazardous
- Also available, Spray & Trowel applied Damping Compounds



Wardle Storeys (Blackburn) Ltd.

Durbar Mill, Hereford Road Blackburn BB1 3JU

Tel: 01254 583825 Fax: 01254 681708

Email: sales.blackburn@wardlestoreys.com

For further information please telephone **01254 583825** or visit **www.wsbl.co.uk**

EXPERTS IN NOISE INSULATION & SOUND DEADENING

Noise and Vibration measurement systems

Svante manufactures the most advanced, reliable, value for money sound and vibration analysers. With features including 1/1 and 1/3 octave real-time analysis, FFT analysis, RT60 measurements for building acoustics, signal recording to USB memory stick and free lifetime firmware updates – can you afford to ignore Svante? Available only from AcSoft, contact us today for more details.



SVANTEK

AcSoft

AcSoft Limited, 8B Wingbury Courtyard, Leighton Road, Wingrave, Aylesbury HP22 4LW
Telephone: 01296 682686 Fax: 01296 682860 Email: sales@acsoft.co.uk www.acsoft.co.uk

Contacts

Editor:

I F Bennett CEng MIOA

Associate Editor:

J W Tyler FIOA

Contributions, letters and information on new products to:

Ian Bennett, Editor, 39 Garners Lane,
Stockport, SK3 8SD
tel: 0161 487 2225
fax: 0871 994 1778
e-mail: ian@acia-acoustics.co.uk

Advertising:

Enquiries to Dennis Baylis MIOA,
Peypouquet, 32320 Montesquiou, France
tel/fax: 00 33 (0)5 62 70 99 25
e-mail: dbioa@hotmail.com

Published and produced by:

The Institute of Acoustics,
77A St Peter's Street, St Albans,
Hertfordshire, AL1 3BN
tel: 01727 848195
fax: 01727 850553
e-mail: ioa@ioa.org.uk
web site: www.ioa.org.uk

Designed and printed by:

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

Views expressed in Acoustics Bulletin are not necessarily the official view of the Institute, nor do individual contributions reflect the opinions of the Editor. While every care has been taken in the preparation of this journal, the publishers cannot be held responsible for the accuracy of the information herein, or any consequence arising from them. Multiple copying of the contents or parts thereof without permission is in breach of copyright. Permission is usually given upon written application to the Institute to copy illustrations or short extracts from the text or individual contributions, provided that the sources (and where appropriate the copyright) are acknowledged.

All rights reserved: ISSN 0308-437X

Annual subscription (6 issues) £126.00

Single copy £20.00

© 2007 The Institute of Acoustics

ACOUSTICS

BULLETIN

Vol 32 No 6 November/December 2007

Contents

Institute Affairs

6

Citations

New Members

Meeting Reports

Young Persons' Award for Innovation in Acoustical Engineering

Autumn Conference 2007 report

Technical Contributions

19

Practical industrial noise control: Responding to the new challenges placed on industry by the 2005 Noise at Work Regulations

Noise reduction of hand-held vacuum cleaners by geometric optimisation of components

An Inevitable Consequence: The Story of Industrial Deafness - Part 2

Using Vibration Analysis to Detect Early Failure of Bearings

Creeping Background - an urban myth?

Work experience at AIRO

News & Project Update

42

Policy & Practice

45

Parliamentary Reports - From Hansard

People News

46

Product News

48

Committee meetings 2007-08

50

List of sponsors

50

Conferences & meetings diary 2007-08

50

List of advertisers

50

Front cover photograph: Any effective transportation noise mitigation policy needs to include source noise reductions. Things were much quieter 50 years ago!

The Institute of Acoustics is the UK's professional body for those working in acoustics, noise and vibration. It was formed in 1974 from the amalgamation of the Acoustics Group of the Institute of Physics and the British Acoustical Society.

The Institute of Acoustics is a nominated body of the Engineering Council, offering registration at Chartered and Incorporated Engineer levels.

The Institute has over 2800 members working in a diverse range of research, educational, governmental and industrial organisations. This multidisciplinary culture provides a productive environment for cross-fertilisation of ideas and initiatives. The range of interests of members within the world of acoustics is equally wide, embracing such aspects as aerodynamics, architectural acoustics, building acoustics, electroacoustics, engineering dynamics, noise and vibration, hearing, speech, physical acoustics, underwater acoustics, together with a variety of environmental aspects. The Institute is a Registered Charity no. 267026.



Institute of
Acoustics

Under Wraps

In 2004, Brüel & Kjær introduced the award-winning Hand-held Analyzer Type 2250 – an unprecedented success reflected by the thousands used by sound and vibration professionals around the world.

Four years on, it's time to push the boundaries even further.

On December 1st 2007, Brüel & Kjær will reveal its latest innovation for hand-held sound and vibration measurement.

We think it's a milestone instrument – we look forward to hearing your opinion online!

Follow our countdown to release on www.bksv.com



HEADQUARTERS: DK-2850 Nærum · Denmark · Telephone: +4545800500
Fax: +4545801405 · www.bksv.com · info@bksv.com

Australia (+61)29889-8888 · Austria (+43)18657400 · Brazil (+55)115188-8166
Canada (+1)514695-8225 · China (+86)1068029906 · Czech Republic (+420)267021100
Finland (+358)9-755950 · France (+33)169907100 · Germany(+49)42117870
Hong Kong (+852)25487486 · Hungary (+36)12158305 · Ireland (+353)18037600
Italy (+39)025768061 · Japan (+81)337798671 · Republic of Korea (+82)234730605
Netherlands (+31)318 55 9290 · Norway (+47)66771155 · Poland (+48)228167556
Portugal (+351)214711453 · Singapore (+65)3774512 · Slovak Republic (+421)254430701
Spain (+34)916590820 · Sweden (+46)84498600 · Switzerland (+41)18807035
Taiwan (+886)227139303 · United Kingdom (+44)1438739000 · USA (+1)8003322040

Local representatives and service organisations worldwide

Release date *December 1st 2007*

Brüel & Kjær

Institute Council

Honorary Officers

President

C E English CEng FIOA
The English Cogger LLP

President Elect

J F Hinton OBE FIOA
Birmingham City Council

Immediate Past President

Dr A J Jones FIOA
AIRO Ltd

Hon Secretary

Prof V F Humphrey FIOA
ISVR, University of Southampton

Hon Treasurer

A W M Somerville MIOA
City of Edinburgh Council

Vice Presidents

Prof B M Shield
London South Bank University

Dr B McKell CEng MIOA
Hamilton & McGregor

S W Turner FIOA
Casella Bureau Veritas

Ordinary Members

Prof K V Horoshenkov
University of Bradford

Prof J Kang CEng FIOA
University of Sheffield

Dr M R Lester
Lester Acoustics

P J Rogers
Cole Jarman Associates

Prof P D Thorne
Proudman Oceanographic Laboratory

Miss L J Webb
Arup Acoustics

Dr B J Williams
University of Wales

Chief Executive

K M Macan-Lind

Dear Members

Our autumn conference season is now well underway and I have attended the conferences organised by the underwater acoustics group and the noise and vibration engineering group. The dissemination of knowledge is an important part of the Institute's work and these conferences play a vital part in that work. The conferences covered widely different subjects and reminded me just how diverse are the interests of our members. I am delighted to see that every year our membership increases and this allows us to provide support for those working in the more obscure areas of acoustics.

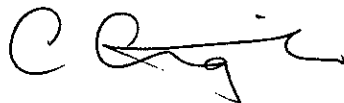
The underwater conference tackled the complex subject of detection and classification of underwater targets and drew a truly international field of delegates and speakers. It was therefore appropriate that I was able to present the 2007 A B Wood Medal to an American researcher, Dr Preston Wilson.

The autumn conference on Advances in Noise and Vibration Engineering addressed the diagnostic techniques and also engineering solutions. Again I was pleased to see many overseas counties represented in the delegate list. The dinner provided the opportunity to present several awards. Prof Peter Wheeler received an Honorary Fellowship and Dr Mike Fillery an Award for Services to the Institute in recognition for his work developing our education services. The prize for the best results in the IOA Diploma went to Jacqui Patel and Ed Clarke, chairman of the ANC, presented prizes for the best papers at IOA conferences to Geun-Tae Yim (2006) and Dr Anthony Chilton (2007). The evening concluded with the IOA Young Persons' Award for Innovation in Acoustical Engineering which was again sponsored by IAC. Trevor Baylis OBE made the presentations to the winner, Dr Constantin Coussios, and to the runners-up, Dr Frederic Cegla and Lara Harris. Trevor then entertained us with a passionate celebration of invention and British inventors, delivered in his own idiosyncratic style.

The education programme is the other main way in which the Institute facilitates knowledge transfer for our members. We are deeply indebted to Peter Wheeler who, after many years, is retiring from the post of education manager, for the outstanding contribution he has made in developing the service. I am delighted that Prof Keith Attenborough has agreed to take over as manager and thereby ensure that we continue to maintain and develop this aspect of our work at the highest possible level.

The successful development of the Institute depends greatly on the time given freely by so many people serving on its various committees. At the last Council meeting we decided to honour four past presidents for their significant contributions and, in addition to Peter Wheeler, we are awarding Honorary Fellowships to Prof Roland Dobbs, Mike Ankers and Bernard Berry.

Finally, with 2007 drawing to an end, may I wish you all a very happy Christmas and a prosperous and peaceful new year.



Colin English

PRESIDENT



Citation

for Dr Mike Fillery: Award for Services to the institute

Mike studied at Surrey University where he gained a BSc in metallurgy and materials and was awarded his PhD for work on the microstructure of carbon fibres.

In 1980 he became a senior lecturer in physics at the University of Derby, where he later taught the Institute's Diploma course. Initially this was limited to the hearing and hearing protection module, but eventually he became course leader, delivering most of the lectures. In 1987 he organised a short course for the CEBG on noise control and the workplace noise assessment course taught at the University.

While at Derby he also helped to initiate a taught MSc in applied acoustics in which the IOA Diploma studies counted for a third of the course. He was also responsible for the development of the successful MSc programme in environmental management which contained a significant acoustics input.

From the late 1980s he also undertook consultancy work, which provided many useful examples for his teaching material, and he left the University in 2002 to become a full-time consultant, first with Symonds Group and then Scott Wilson. He has a passion for fast cars, changing them often – recent cars include Jaguar, Saab convertible, Z3, Porsche, another Jaguar and now back to Saab – and it is rumoured that the M1 section between Derby and St Albans was his favourite race track! It is perhaps no coincidence that much of his consultancy work has been involved with the noise of motor sport (especially at Donington Park circuit).

Citation

for Professor Peter Wheeler: Honorary Fellowship

Peter Wheeler started his career as a graduate engineer at the BBC after reading physics at Imperial College. He gained an MSc in applied acoustics from Chelsea College and joined the ISVR consultancy group in 1973, and in 1981, with a further grant from the Wolfson Foundation, helped establish a second consultancy unit concentrating on electroacoustics and audio communications. During his time at ISVR, he led the development of the ANR noise cancelling ear defender headset: although primarily designed for use in Tornado, technical difficulties with the aircraft's avionics system prevented it being brought into service with the RAF, but it was adopted by the army for use in all fighting vehicles and is currently used in the main battle-tanks of both the UK and US armies. He was subsequently awarded his PhD for related research in the field of electroacoustics.

In 1986 he joined Racal Acoustics Ltd as marketing director, where he was responsible for identifying and developing new product areas in this specialist avionics and communications field.

In 1990 Peter Wheeler was appointed professor of applied acoustics at the University of Salford and was responsible for broadening the academic base and the introduction of new courses including the popular audio technology degree. He oversaw the merger of Salford College into the University and was appointed pro-vice-chancellor in 1995.

Throughout his career, Peter has always served the IOA, initially as secretary of the southern branch in the 1970s. He became a member of membership committee and the engineering division at its inception and was then elected to Council, before serving as president from 1992 to 1994.

Peter initially trained as an electrical engineer and is a Fellow of the IET. As a chartered engineer working in electroacoustics he has always



(l-r) Kevin Macan-Lind (chief executive), Colin English (president), Mike Fillery, after receiving his award for services to the Institute

Mike was a member of the Institute's education committee from 1992 and became chairman in 1999. During his time as chairman, Mike presided over several important changes, including a significant expansion of the Diploma distance learning programme and the introduction of the coursework element for the specialist modules. He served frequently on the teams re-accrediting Diploma centres.

He stepped down as chair of education committee in 2005 when he joined the small band of semi-retired exiled acousticians in the south of France. He has also served on several other education-related committees as well as being midlands branch secretary for many years.

Mike has played a major role in developing the educational work of the Institute and we are delighted to award him with the award for services to the Institute.



Peter Wheeler receives his Honorary Fellowship from the President

been interested in innovation and technology transfer and has encouraged many young acousticians to further their careers via the Institute and the engineering division. After retiring from Salford he joined the IOA staff as manager of the engineering division, and has guided many members along the path to becoming chartered, helping the Institute considerably by enhancing its reputation with the other engineering institutions. Not content with this role, he took on the task of education manager and set about developing the distance learning stream, improving quality and laying the foundation for the future development of the IOA Diploma.

For these reasons the Institute of Acoustics is very proud to award Peter Wheeler an Honorary Fellowship.

Citation

for Professor Michael Howe: Rayleigh Medal 2007

Prof Michael Howe is one of the world's foremost theoreticians in aeroacoustics. His work is characterised by a profound insight into the most significant aspects of physical problems, and an outstanding gift for casting these problems in mathematical form and for finding appropriate solutions. He also displays an ability to explain his work so that it may be readily assimilated by the reader. Michael has an understanding of the approximations that may reasonably be made in order to achieve analytical solutions, and is able to incorporate the experimental results of other workers into his own research, with a corresponding enrichment of the end product.

Michael Howe's published contributions to acoustics are very numerous and span a wide range of topics, but are mainly in aeroacoustics, involving the interaction of sound with, or its generation by, fluid flows and rigid or flexible structures. The impact of his research, over almost four decades, in the fields of wave propagation in general, and acoustics in particular, has been enormous.

He has made significant contributions in the areas of:

- The generation and attenuation of sound in free and bounded flows
- The generation and absorption of noise by trailing-edge flows
- The effects of fluid flow on the impedance of wall cavities
- The propagation of sound in inhomogeneous media and fluid flows, including acoustic scattering by turbulence
- Long-range sound propagation over irregular surfaces
- Noise generation and absorption by turbulent boundary layers
- The acoustic and fluid/structure interactions of elastic structures
- Linear and nonlinear feedback phenomena, including flow-driven aperture and cavity resonances
- Pressure wave generation by the interaction of high-speed trains and tunnels.

Since 1997, he has published extensively on a wide range of aspects of this last topic. His work is of fundamental importance in the understanding of the physics of the problem and his contributions have led to great advances in predictive models, necessary for the design of tunnel geometry to minimise the effects of pressure wave generation.

Since obtaining his BSc in mathematics and a PhD from Imperial College, London, Michael has held positions at the University of Cambridge and the University of Southampton, and has worked at Bolt Beranek and Newman in Cambridge, Massachusetts. He is currently professor of theoretical mechanics at Boston University.

Michael has published more than 150 refereed journal articles and is the author of books including the recently published text 'Acoustics of fluid-structure interactions'. His name is familiar to workers in acoustics and he has earned the lasting respect of the aeroacoustics community at large, having made an enormous contribution to the quantitative understanding of the physics of the interaction of fluids, structures and sound in a wide range of topics, from Helmholtz resonators to high-speed trains.

For these reasons the Institute of Acoustics is very proud to award the 2007 Rayleigh Medal to Prof Michael Howe.



Call for presentations

Autumn Conference 14 and 15 October 2008

The Measurement & Instrumentation Group is planning the Autumn Conference 2008 covering aspects of current and emerging methods and techniques for sound and vibration measurement **in practice**, and has proposed that part of the Conference is devoted to practical presentations in the use of modern instrumentation for specific measurement tasks. This idea has been endorsed by Council.

The presentations are to be given by manufacturers, or their accredited representatives, with specific reference to the products they supply and for which some recent innovation or new application is relevant. The presentation must be designed to educate the audience in making the measurement correctly using the equipment being presented, and must include a detailed background to the task the equipment is measuring. Please note this is not intended to be a sales-based presentation, nor is it the opportunity purely to demonstrate the merits of a particular product over that of its competitors.

Practical demonstrations of the measurement are encouraged, either during the presentation, which is preferable, or during break periods in the conference. Target length of presentation is 30 minutes, but longer may be allowed if specifically requested and if the need can be demonstrated.

Applications are invited from any manufacturer or its accredited agent now. The application should take the form of an abstract of no more than 250 words outlining the education to be provided, the measurement being debated and why this adds to the current array of measurements currently available. The equipment to be used should be listed, along with a statement as to whether the presentation will include a demonstration during the presentation. Details of any presentation aids (eg cameras, projectors etc) which may be required for the demonstration must be included.

Formal applications must be received by 6 December 2007. The Measurement & Instrumentation Committee will decide which applications are successful during December and all successful applicants will be notified no later than January 2008. The committee's decision is final. If accepted, the agreement to make a presentation will be considered binding.

Please make submissions to Richard Tyler, Chairman, Measurement & Instrumentation Group, by e-mail to richard@avi.f2s.com, by post to AVI Ltd, 13c Old Bridge Way, Shefford SG17 5HQ or by fax to (+44) 01462 638601.

Young Persons' Award for Innovation in Acoustical Engineering

Sponsored by IAC Ltd - Presented by Trevor Baylis OBE, 17 October 2007

Winner

Dr Contantin-C Coussios Institute of Biomedical Engineering,
Department of Engineering Science.

Snap, sizzle and pop: how sound and bubbles can cure cancer

High amplitude ultrasound waves, generated by a device outside the body, can be focussed deep within tissue and used to heat up a region about the size of a grain of rice, killing all cells within it. This therapy, known as High-Intensity Focussed Ultrasound, shows great potential as a means of treating cancer tumours without surgery, but is currently hindered by the relatively long treatment times and the difficulty in monitoring treatment in real time. The excitation of tiny gas bubbles at the ultrasound focus, a phenomenon known as acoustic cavitation, has been shown to greatly enhance the local rate of heating, whilst the acoustic 'signature' of these bubbles could provide a way of monitoring treatment in real time. Dr Coussios was presented with the Institute of Acoustics Young Person's Award for Innovation in Acoustical Engineering for the development of novel techniques for sensing and controlling acoustic cavitation during cancer therapy by High-Intensity Focussed Ultrasound, and for identifying means of correlating the degree of cavitation activity with the temperature and level of cellular damage within the ultrasound focal region.



Constantin-C Coussios, with Trevor Baylis OBE, displays the IAC-sponsored Young Persons' Award for Innovation in Acoustical Engineering, together with his portable cavitation tubes

First runner-up

Dr Frederic Cegla Fluid Dynamics and Acoustics Group, Institute of Sound and Vibration Research

Ultrasonic thickness monitoring up to 600°C in harsh environments

The project describes the development of a robust ultrasonic 'acoustic cable' for the non-destructive measurement of wall thicknesses in harsh environments (such as high temperatures or radioactive environments) that would usually destroy the ultrasonic transducer. Ultrasonic signals can be transmitted from the sensitive transducer along the acoustic cable to the measurement zone allowing the transducer to be placed in a suitable environment while monitoring components in harsh conditions over long periods. Standard ultrasonic testing equipment can be used to send, receive and record signals. The technology has been patented and is currently being developed for commercialisation.



Frederic Cegla receives his runner-up prize from Trevor Baylis OBE

Second runner up

Lara Harris ISVR, University of Southampton

Use of the modulation transfer function to predict listener ratings of loudspeaker musical reproduction quality at low frequencies

The project was carried out as part of an MSc degree at the Institute of Sound and Vibration Research. The primary aim was to obtain subjective data to establish whether a method using modulation transfer functions (typically used to evaluate speech intelligibility) might be a more useful indicator of bass reproduction quality in loudspeakers than those which are commonly employed in the audio industry. Stringent listening tests were conducted to assess a range of loudspeakers which were in fact simulations of several different models. These were created using digital signal processing to modify the response of a single loudspeaker: though somewhat unusual, several of the key problems inherent to most tests of this kind could be avoided by taking this approach. It was found that there was some correlation between the listeners' and measured quality scores, particularly so for one very experienced listener, providing clear evidence that this is a subject which merits further investigation.



Lara Harris (second runner-up) with Brian Quarendon (IAC)

New members

The following new members were approved by Council on 27 September 2007

Members (MIOA)

Aygun, A
Baxter, R H
Blakeman, D R
Buchan, D P
Campbell, A M
Carey, P J
Casey, J
Chambers, A O
Dixon, I P
Emsley, C A
Femenia, J
Ferguson, N S
Hayes, A
Hladky, S J
Ho, C K Y
Johnston, I E
Knowles, A E
Mabey, A P
McGrath, P A
Novo, P
O'Duill, R C
Palmer, D A
Papanagiotou, K
Postema, M A B
Priddle, N
Prokofeva, E
Pyatt, P J
Sheridan, S M
Short, A C

Stedman, N
Tjellesen, L L
Woolley, R J

Associate members (AMIOA)

Akhurst, P J M
Anderson, J
Awbery, S
Balkota, N
Barker, J L
Bird, S M
Boyd, J M
Braiden, J J
Cawley, D
Chapman, D
Clare, D
Clark, P
Cobain, S J
Colder, R
Coulthard, A
Creedy, O
Davies, G
Davis, M L
Dellatorre, L
Dodd, A J
Dolbear, G J
Drakeley, R
Durup, N D
Dwight, S P
Ehlert, M N

Elias, A I
Elsey, K B
Filippi, F
Fisk, J H C
FitzGerald, D
Flanagan, N
Fletcher, A T
Fryer, A D
Galloway, M I
Garcia, I M
Gibson, A C
Green, W A
Green, A M
Hales, M
Hall, R B
Hargreaves, J A
Harper, A M
Hart, J P
Hastings, T B
Hatch, A
Henry, N E
Hirst, S E
Hogg, J W
Horner, B D
Hutchinson, K
Hutton, D N
Jackson, S T
Jindu, Z P
Kalra, R
Kelly, P A

Lane, H F
Legon, M R
Lucas, B D
Mackay, J D
MacPhee, I C
Magbado, P A
Marshall, S
McElroy, K R
Mendis, J J M
Michon, A
Morgan, A W
Murgia, S
Olver, T R
Pantazopoulou, P
Pell, K R
Rankin, R A
Reeve, S R
Reynolds, J M
Rose, G
Rossiter, P R
Runcie, P M
Salter, G R
Sanderson, P J
Sloan, M H
Spence, A C
Swift, G
Tan, J
Taylor, S J
Templeman, B J
Townsend, M D

Walsh, P J J
Watt, L
Watts, C F D
Websdell, P C
White, A S
Wiggins, I M
Williams, R D
Wright, C M
Affiliates
Payne, M J
Ryder, D C

Technician members

Caddy, J N
Campbell, A S
Curle, P A
Hammond, J
Joselyn, R
Kimber, R
Oxborough, E

Student members

Clayton, D S
Jiang, J
Kalianidis, I
Moss, P G

Sponsor members

Chambers & Newman
(Manchester) Ltd
Scott Wilson

Meeting Report

Nicola Stedman. London Branch

Back in September 2006 Amber Naqvi of Sonic Element gave an evening presentation to the London Branch on Studio Acoustics, specifically discussing his recent research on critical listening room design and a novel sound field simulation technique (Acoustics Bulletin vol.31 no.6 November/December 2006). During his presentation Amber explained how wave-field synthesis (WFS) improves current 3D sound simulation techniques, using the visualisation laboratory (VisLab) facility at the University of Surrey as a case study.

Following significant interest in Amber's presentation, the London branch organised a half-day visit on 21 March 2007 to the Centre for Communication Systems Research at the University of Surrey, for a tour of the I-Lab multimedia facilities.

Dr Stephane Villette, Mr Maxime Bourget, Dr Huseyin Hacıhabiboglu and Dr Banu Gunel gave a tour of the audio research facilities, with demonstrations of current audio related research. The tour included

- a demonstration of the VisLab, which consists of a 7.5 by 2.5 metre semi-cylindrical active-stereo rear-projected visualisation screen, a

340-loudspeaker IOSONO WFS 3D audio system, and a virtual reality system allowing rendering of virtual environments in 3D video and 3D audio;

- a visit to the I-Lab, a research facility with the aim of developing innovative ways of using multimedia and communication technologies;
- a visit to the studio facility, with demonstrations of current research including: extending the audible boundaries of a room with loudspeaker arrays; sound source localisation with different microphone array geometries; virtual visual objects responding to sounds; binaural audio for mobile devices; wave propagation and source directivity synthesis with digital waveguide mesh; and filter interpolation for sound synthesis.

Further information about the CCSR/VisLab/I-Lab facilities can be found at <http://www.ee.surrey.ac.uk/CCSR/facilities/ilab/vi.html> or by emailing Dr Stephane Villette at S.Villette@surrey.ac.uk

The London branch committee would like to extend its thanks to Amber Naqvi, Dr Stephane Villette, Mr Maxime Bourget, Dr Huseyin Hacıhabiboglu and Dr Banu Gunel.

European Acoustics Association

Kevin Macan-Lind. 18th General Assembly, Madrid

The eighteenth General Assembly meeting was held on Saturday 8 September within the magnificent facilities of the Palacio Municipal De Congresos, in Madrid, the venue having been used to host the nineteenth International Congress on Acoustics in the preceding week (2-7 September 2007).

Thirty-two representatives from the EAA member societies were present, including Professor Bridget Shield HonFIOA, IOA vice-president (international), and Kevin Macan-Lind, IOA chief executive. Some of the highlights of the meeting are reported below.

New board: The following board was elected:

president	Luigi Maffei (Italy)	former general secretary
vice-president	Michael Vorländer (Germany)	former president
vice-president	Peter Svensson (Norway)	
general secretary	Kristian Jambrosic (Croatia)	
treasurer	Salvador Santiago (Spain)	continuing

Acoustics '08, Paris: This conference, to be held in Paris from 29 June to 4 July 2008, is being organised jointly by the ASA, EAA and SFA (French Acoustical Society). It will include the 155th ASA meeting, the fifth Forum Acusticum, the ninth French Congress on Acoustics, the seventh Euronoise conference and the ninth European Conference on Underwater Acoustics. The preliminary call for papers has been issued

and there will be excellent facilities for exhibiting organisations.

Journals: The EAA sends a link to the contents of Acta Acustica/Acustica to all its member societies. A reciprocal arrangement is now in place with the Acoustical Society of Japan and with JASA.

Regional conference: It was proposed by the board that a smaller EAA 'Regional Conference' might be held in the years when there is no Euronoise or Forum Acusticum. The year 2010 would be the first when this may happen, and it was suggested that the conference might be held between two member societies.

EAA Medal: A new award is to be launched shortly to honour acousticians who have made a large contribution to the promotion of acoustics in Europe. The medal will be awarded at each Forum Acusticum starting in Paris in July 2008.

Euronoise 2009: The IOA was officially informed in January 2007 that the proposal to host Euronoise 2009 in the city of Edinburgh had been evaluated and accepted by the EAA Board, who duly ratified this decision at the General Assembly meeting in Madrid. Work on the event has already started, with the dates 26 to 28 October 2009 being chosen to allow a reasonable gap after the 2009 Internoise conference in Ottawa. Bernard Berry is to be the general chairman. A Euronoise 2009 logo has been designed and will start to appear on publicity material leading up to the event. Those wishing to register an interest in attending should visit www.euronoise2009.org.uk.

On the Saturday evening attendees at the General Assembly, with their partners and family members, retired to the convivial surroundings of the Restaurant Mayte Comodore on the Plaza de la Republica Argentina in central Madrid. The excellent food and wine contributed to the important business of networking.



General Assembly of the EAA

Meeting Report

David Watts. Central Branch

The July meeting of the Central Branch was a presentation by Richard Collman entitled *Creeping Background – an urban myth?* Richard explained how consultants face a wide range of different noise level limits from 10 dB below the background noise level to 5 dB or more above the background noise level and he related some of the reasons for the limits, given by those setting them.

The audience heard that when the effects of a 5 dB tonal penalty are included, a 20 dB wide range of potential noise limits arises, which raises the question – is this reasonable, or has someone got something wrong? Richard pointed out the implications of such widely varying limits on the extent and cost of noise control measures that might be required.

The presentation then examined two frequently used justifications for a 10 dB below background limit – that such a limit is a positive indication that complaints are unlikely and in order to prevent creeping background. Tracing the origins of the “complaints are unlikely” reason, Richard observed that this arises from BS 4142, a standard dating back to 1967, a time when it was much more common to find heavy industry in close proximity to dwellings compared with the present day. The creeping background concept was explained, then challenged, by reference to examples illustrating

situations of multiple noise sources affecting multiple noise sensitive locations, with different sources affecting different places in urban areas.

Slides of noise level time histories demonstrated the complex nature of noise in an urban environment and how the 90th percentile descriptor may have the same value for very different noise environments. The applicability of a 5 dB penalty was discussed against the background noise level context, highlighting that for source noise levels below the background noise level, the background noise environment is likely to dominate, so, it may not be appropriate to add the penalty.

Issues of enforceability were raised in view of the difficulties of testing a limit set below the background noise level, given that the background noise would then control the noise level measured by a sound level meter. Richard indicated that in a densely packed urban location it is often impossible to prove a breach of a 10 dB below background condition, making such conditions invalid.

The discussion amongst those at the meeting indicated that the issues highlighted by Richard's interesting and informative presentation were widely shared.

The topic is investigated further in Richard's article 'Creeping background: an urban myth?' in this issue of Acoustics Bulletin.

Keith Attenborough FIOA

to succeed Peter Wheeler as Education Manager

In November, following early retirement from the University of Hull where he was Head of Engineering and then Research Professor, Keith Attenborough is to succeed Peter Wheeler as Education Manager. Keith has been Chief Examiner for the IOA Diploma for many years and was a member of the IOA Education Committee before that. He is founding Chair of the IOA Research Coordination Committee.

As well as seeing through the important Diploma restructuring initiated during Peter Wheeler's tenure as Education Manager, Keith would like to oversee further development of the Distance Learning material and greater 'missionary' involvement of the IOA with educational material at all levels.

Keith graduated in Physics from University College London before obtaining a PhD in the Civil Engineering Department at the University of Leeds. From 1970 for 28 years he worked in the Open University (Milton Keynes UK) being promoted to a personal Chair in Acoustics in 1992. In 1996 he received the Institute of Acoustics Rayleigh medal for distinguished contributions to acoustics. Chair of the ANSI Working Group on Ground Impedance. He is an elected Fellow of the Acoustical Society of America and of the UK Institute of Acoustics. He is a member of the ASA and EAA Technical Committees on Noise. He is Editor-in-Chief of *Applied Acoustics*, an Associate Editor of the *Journal of the Acoustical Society of America* and on the Editorial Board of *Acta Acustica* united with *Acustica*. He has published over 240 papers in refereed journals and conference proceedings. His research has included pioneering studies of acoustic-to-seismic coupling and blast noise reduction using granular materials. He has jointly authored the text 'Predicting

Outdoor Sound' published by Taylor and Francis at the end of 2006.

During his 'retirement' as well as working Part Time for the IOA, Keith plans to continue research including laboratory simulations of blast noise propagation, development of an acoustic rain gauge and investigations into sonic crystal noise barriers. In addition to various musical activities and to avoid being a 'golf widower' he plans also to take up golf.



Autumn Conference 2007

Ian Bennett. Conference report

The Noise and Vibration Engineering Group of the IOA took its turn to organise this year's Autumn Conference, held in the now-traditional and opulent surroundings of the Paramount Oxford Hotel, Wolvercote. Eighteen technical papers, an invited paper and the 2007 Rayleigh Medal lecture were attended by 71 delegates from all corners of the globe including Tokyo and Seattle. The theme of the conference was 'Advances in noise and vibration engineering', dealing with problems from health and safety at work to low-noise design. Understanding the source of noise and vibration problems being critical to the identification of effective solutions, the conference covered the broad area of problem solving in noise and vibration engineering from diagnosis to the engineering result. New measurement methods and innovative solutions to practical noise and vibration problem were covered.

Technical sessions: Day 1

The conference was opened by Malcolm Smith, chairman of the Noise and Vibration Engineering group, who commented on the diversity of papers that were to be presented over the coming two days, and the diversity of interests of NVEG members.

The first presentation was an invited paper by Professor Barry Gibbs (University of Liverpool), on the prediction and measurement of structure-borne sound power in buildings. Barry explained that vibrating machines were often combined sources of airborne and structure-borne sound, and although it was reasonably straightforward to measure airborne sound sources and then to predict the resultant sound pressures at a distance, either in the open or within spaces, it was less straightforward to measure the structure-borne power and then predict the resultant sound pressures. The paper demonstrated and reviewed the methods for estimating the sound power from the source and receiver mobilities at the contact points, and then suggested a two-stage method of characterising the source. The first step was to measure the velocity of the source mounted on a 'reception plate'. Secondly, the average of the contact mobilities was estimated and used as the basis of the power calculation, although it was accepted that this might not be readily available.

Monitoring adherence to movement of military vehicles in sensitive former war-zones is a problem that was addressed by Prof Victor Krylov (Loughborough University). The demand for autonomous systems capable of reliably detecting and identifying heavy military vehicles, such as tanks and armed personnel carriers, has become one of the most important issues in the delicate post-war political climate in many theatres. The quarter-car model presented was based on the dynamics of the wheel and body mass of the vehicle rolling over a rough surface coupled to a Rayleigh wave model of ground propagation, proved to be accurate enough to distinguish between different types of vehicles in many cases.

Greg Dimitriadis (Liege University) described a study of wing flutter, a key feature of which was to design a new pressure sensor to meet specific requirements in the experiments. The pressure and frequency range of the experiments necessitated the development of novel pressure transducers, which had to be capable of operating at low (or zero) frequency and pressure values very close to atmospheric pressure. They also had to be as small and light as possible. Besides providing some interesting video images of aerofoils fluttering either symmetrically or asymmetrically, the measurements also moved forward the understanding of the non-linear effects involved in flutter.

The final talk of the morning session was given by Andreas Rousounelos, (Loughborough University) who had derived (by hand) an impressive formula for the radiation efficiency of a plate stiffened by a clamped beam. Beam stiffening is a common technique for the reduction of acoustical radiation from plates, which works by modifying the structural properties of the plate. It has been used in many applications for sound and vibration control but its effects on sound radiation have not been studied theoretically. It follows that the use of beam stiffening may lead to undesirable acoustical results.

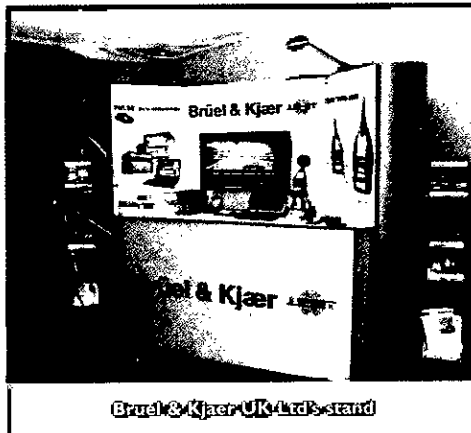
Wednesday afternoon's session was chaired by Stephen Walsh (Loughborough University) and continued the theme of the first day: 'Advances in diagnostic techniques'. The session opened with a paper presented by Ole-Herman Bjor (Norsonic) entitled 'Proposed revisions to the BS EN IEC 61260 standard for fractional octave filters for sound and vibration applications' co-authored by Ian Campbell (Campbell Associates). The presenter described the proposed changes to the standard which if adopted will enable calibration laboratories to issue certificates of conformity rather than a simple statement of performance as at present: the proposed revision to the standard will introduce the concept of legal metrology as currently used in sound level meters and acoustic calibrators. He included an interesting diversion into the differences between the names of frequency bands and their actual centre frequencies, depending on the base to which the system was arranged. This was followed by a paper entitled 'Numerical investigation of structure-borne interior noise in flexible rectangular boxes'



Ole-Herman Bjor takes a question from the floor



LMS was a welcome newcomer to the exhibition

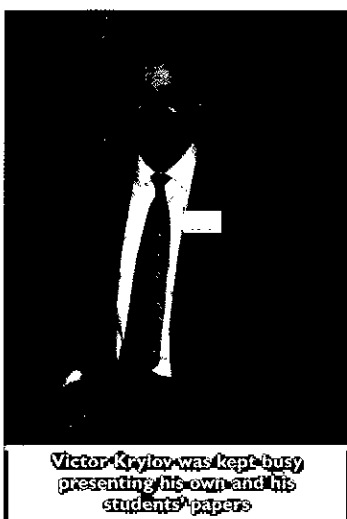


Brüel & Kjær UK Ltd's stand



AcSoft demonstrated their latest wares

co-authored by Vassil Georgiev and Victor Krylov (both Loughborough University). Flexible rectangular box-like structures represented one of the geometrically idealised structures commonly found in engineering. In this presentation numerical results were presented for the uncoupled mode shapes and resonant frequencies as well as for the coupled structural-acoustic frequency response functions for the interior acoustic pressure. Coloured visualisations of the mode shapes for resonances in both the enclosed airspace and the plates bounding the space were very helpful for the audience.



Victor Krylov was kept busy presenting his own and his students' papers

Jane Horner (Loughborough University) presented the next paper on behalf of her graduate student Yikun Hu (Loughborough University) on 'A practical method to measure the higher order modes in circular ducts'. In this presentation a simplified technique to resolve the different modal contributions was proposed which was based upon a combination of approximate duct calculations and a reduced number of measurement locations.

A thirty-minute break for coffee again allowed time for the delegates to visit the exhibition stands. The first paper after the break was entitled 'Damping of flexural vibrations in tapered rods of power-law profile: experimental studies' and was presented by Victor Krylov on behalf of co-author Victor Kralovic (Loughborough University). The sharp tips of such rods represented the so-called one-dimensional black holes for flexural waves. However, since real manufactured rods were characterised by imperfections the application of absorbing material was paramount. Measurement results for rods with different types of absorbing strips were presented and showed that the resonant vibrations in all the tapered rods were reduced substantially in comparison with the case of the non-tapered rod.

The next paper was presented by Hannes Bonhoff (Technical University of Berlin) and co-authored by Bjorn Petersson (Technical University of Berlin) and was entitled 'The distribution of force orders on structure-borne sound source interfaces for the concept of interface mobilities'. This paper continued the theme of the morning's keynote paper on structure-borne sound, in particular the employment of the concept of interface mobilities for source-receiver systems with multi-point or continuous interfaces. However, for a practical application of this approach cross-order terms are neglected. This paper presented a study on the admissibility of neglecting the force orders in such cross-order terms.

Keith Peat (Loughborough University) gave the closing presentation of the session entitled 'End corrections due to perforated pipes'. This paper gave details of the experimental determination of the end correction for pipes that are connected to perforated tubes. Such assemblies were typically found in the triple-pass silencers commonly used to control exhaust noise on road vehicles.

Evening entertainment and presentations

The evening's proceedings began with the AGM of the Noise and Vibration Engineering group, at which it was confirmed that the present committee members were to continue in their positions, the committee not yet being due for re-election. A number of issues were then discussed, under the chairmanship of Malcolm Smith, with sighs of relief elicited from several NVEG members when it became clear that the search for new blood on the committee was to be focused on the younger members! In all seriousness, however, suggestions for meeting

ANC

THE ASSOCIATION OF
NOISE CONSULTANTS

The ANC is the only recognised association for your profession

Benefits of ANC membership include:

- Your organisation will be listed on the ANC website by services offered and location
- Your organisation will appear in the Directory of Members which is circulated to local authorities and client groups
- Your organisation may apply for membership of the Registration Scheme to offer Sound Insulation Testing
- The ANC guideline documents and Calibration Kit are available to Members at a discount
- Your views will be represented on BSI Committees - your voice will count
- Your organisation will have the opportunity to influence future ANC guideline documents
- ANC members are consulted on impending and draft legislation, standards, guidelines and Codes of Practice before they come into force
- The bi-monthly ANC meetings provide an opportunity to discuss areas of interest with like minded colleagues or just bounce ideas around
- Before each meeting there are regular technical presentations on the hot subjects of the day

Membership of the Association is open to all consultancy practices able to demonstrate, that the necessary professional and technical competence is available, that a satisfactory standard of continuity of service and staff is maintained and that there is no significant financial interest in acoustical products. Members are required to carry a minimum level of professional indemnity insurance, and to abide by the Association's Code of Ethics.

www.association-of-noise-consultants.co.uk

continued on page 14

Autumn Conference 2007 - continued from page 13

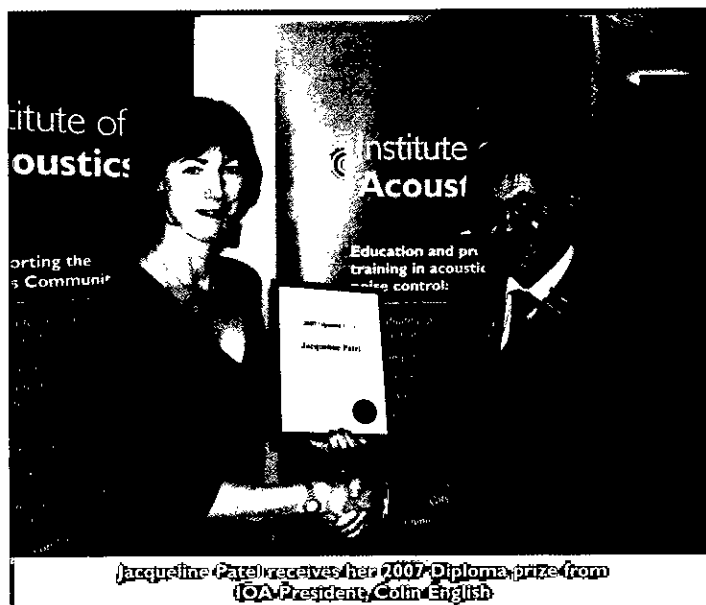
topics and offers of help on the committee are always welcome. Malcolm can be reached at mgs@isvr.soton.ac.uk.

There was just time to freshen up and change before the drinks reception in the exhibition hall, in the now-customary semi-permanent marquee, where the rumble of traffic noise from the A44 prevented any embarrassing silences. This reception gave an opportunity to inspect the latest offerings from the major manufacturers of acoustical measuring instruments, and the products available to control noise in buildings. Exhibitors included Brüel and Kjær, ANV Measurement Systems, AcSoft, PC Environmental, CMS Acoustic Solutions, Campbell Associates, LMS and Acoustici. The comment was made that with three of the exhibitors showing arrays of microphones for sound source location, the tent looked more like a bicycle repair workshop than seemed quite right!



Drinks reception: (l to r) Michael Howe, Keith Peat, Victor Kraylov

The conference dinner was served in the rapidly-transformed lecture room (thus avoiding the acoustical difficulties in the mezzanine restaurant suffered at a previous conference). It was followed by presentations by Colin English, President of the IOA, of an Honorary Fellowship of the Institute to Peter Wheeler, and an award for services to the Institute to Mike Fillery. The citations for each award are published elsewhere in this issue of Acoustics Bulletin. The prize for the best IOA Diploma student went to Jacqueline Patel.

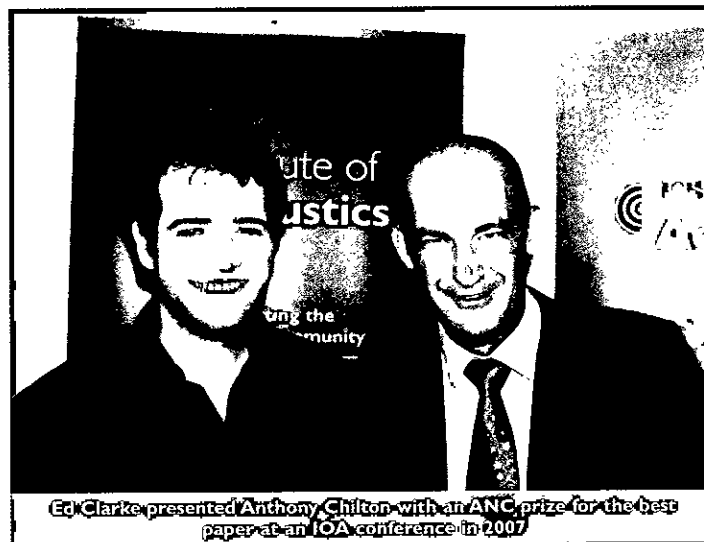


Jacqueline Patel receives her 2007 Diploma prize from IOA President, Colin English



Ed Clarke presented an ANC prize for the best paper at an IOA conference in 2006 to Geun-Tae Yim

Ed Clarke, chairman of the Association of Noise Consultants, then presented prizes for the best papers at IOA conferences in the last two years to Geun-Tae Yim (2006) and Anthony Chilton (2007). Finally, thanks to the generosity of IAC Ltd, the winner and two runners-up in the biannual Young Persons' award for innovation in acoustics were introduced by Brian Quarendon, chairman of IAC, who handed over to the guest speaker, Trevor Baylis, to present the prizes. The first prize of £500 and a trip for two people to Barcelona, together with the handsome silver trophy, went to Dr Constantin-C Coussios for his work on high-intensity focussed ultrasound. The first runner-up was Dr Frederic Cegla, and the second runner-up Lara Harris. Their work is described in more detail on page 8 of this issue.



Ed Clarke presented Anthony Chilton with an ANC prize for the best paper at an IOA conference in 2007

Trevor then treated us to an entertaining and forthright speech in his inimitable style, on inventions and inventors, pointing out that intellectual property was a vital asset to the nation in this post-industrial age, and uttering a cri de coeur on behalf of all young innovators that the theft of intellectual property – theft of ideas – should be regarded as seriously as theft of material goods.

Technical sessions: Day 2

The theme for the second day of the conference was 'Towards engineering solutions' and in the morning session seven diverse papers were presented under the chairmanship of David Lewis.

The opening paper by Naval Agarwal from the Boeing Company USA presented an overview of noise sources and the diagnostic techniques used in aircraft for source identification. These included the use of

blocking panels, sound intensity measurements and measurement of surface acceleration. The application of these techniques was illustrated via a number of case studies with solutions involving application of damping treatments, replacing fan units and the use of Helmholtz resonators.

Ken Brown (ISVR Consulting, Southampton) reviewed the various ISO methods for determining the sound power of machinery (ISO.374x series) and described how the ISO.3747 reference source approach was adapted to enable the sound power of a distributed impulsive source to be determined. The approach adopted was to calibrate the measurement environment to determine a sound pressure to sound power correction for the space. By computing the cumulative distribution of the derived sound power the relative importance of the impulsive events could then be determined.



Trevor Baylis and Dr Constantin Coussios

Two interesting case studies relating to 'whistling gratings' were presented in the third paper by Craig Scott (Bureau Veritas) and Eleanor Girdziusz (Faber Maunsell). They described the possible theoretical causes (structural resonance, cavity resonance and vortex shedding) and the in-situ and wind tunnel tests that were conducted to confirm the actual cause and possible solutions. In both cases disrupting the air flow was found to be an effective approach in avoiding the generation of a tonal noise.



Part of Dr Coussios' support team

The final paper before the coffee break illustrated the use of microphone arrays and their application to aero-acoustic and industrial noise problems. It was presented by Malcolm Smith (ISVR Consulting). Malcolm presented examples of noise maps of airframe noise



Colin English flanked by Brian Quarrendon and Geoff Crowhurst, both of IAC

measured during flyover and the application to landing gear mock-up in a wind tunnel. He illustrated the use of arrays on machine sources, and the approach used to integrate noise maps over an area as a function of frequency to determine sub-system sound power. The problems in using microphone arrays in industrial halls where there was significant scattered sound were also illustrated.

The order of papers following the break was changed to allow time to resolve some technical issues with PowerPoint presentations and incompatible laptops, so Mike Fillery (Scott Wilson) opened with his paper comparing the manual and automatic capture of noise from motor racing events with special reference to Donington Park circuit. A noise standard for 'quiet days' at a racetrack was introduced some years ago, in which a static close-proximity exhaust noise level test was carried out, with a maximum noise limit of 100dB(A). However, this proved difficult to implement in practice, some motorcycles producing proportionally much more noise out on the track than the static test would suggest, and some sports cars being unable to pass the static test despite being completely road legal. After much consideration, a drive-by test similar to that used for type-approval regulation of vehicle noise was adopted, but the full ISO R362 was too lengthy and complicated. The LAmex (fast response) was eventually decided upon, and would be measured manually or automatically as a race vehicle drove past a certain point on the circuit. The key point illustrated was the interpretation of data which had been automatically captured, and then relating it back to the event under investigation. To sort the wanted from the unwanted sound, either a manned observation or an audible recording was needed. Simple filtering could be used to rescue data from the time history, but this depended on knowing what the answer was going to be. Mike concluded that automatic monitoring at a receptor site would always be open to mistakes with current methods.

Simon Stephenson (Bureau Veritas) gave an interesting paper and an audio demonstration of a low-frequency environmental noise problem relating to combustion driven oscillations in a waste incinerator. He reviewed how the problem was diagnosed, by undertaking noise measurements around the incinerator during equipment trials, to identify the root cause of the tonal noise. Tests were then conducted to identify settings where the system could be operated without exciting system resonances. He also went on to describe possible remedial measures that could be applied should the waste gas stream and operating conditions need to be modified in the future.

The final paper in the re-jigged morning session was presented by Stefan Weyna (Szczecin University of Technology, Poland). He described and illustrated methods which allowed the complex acoustic energy flow in real-life sound fields to be visualised. Animated three-dimensional graphical representations of complex flows were derived from large numbers of field measurements using a sound intensity

continued on page 16

Autumn Conference 2007 - continued from page 15

probe, and these clearly showed how reality was often far more complex than the theory might predict!



Trevor Baylis meets Dr. Coussios' family and research team

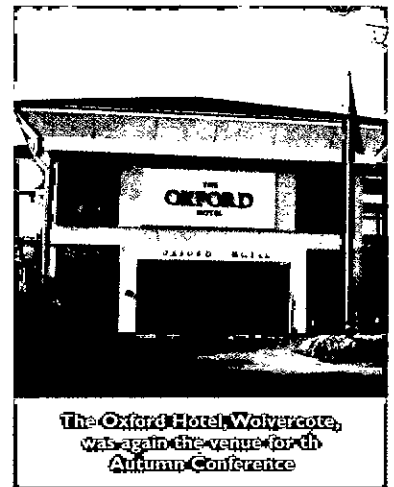
The afternoon session, chaired by Mike Hewett, started with the president reading the Rayleigh Medal citation for Michael Howe of Boston University. After being presented with the Rayleigh Medal 2007 Michael presented a fascinating paper on the acoustics of fluid structure interactions. The paper showed how Kirchoff vectors can be applied to the theoretical analysis of noise generation in a variety of fluid structure interaction scenarios. Michael focused on the benefits of the technique to the analysis of speech generation mechanisms and transient compression waves caused by high-speed trains in tunnels. The latter example was illustrated by a dramatic recording of the noise produced by train entering a tunnel in Japan, which emerged as an explosive noise at the far end of the tunnel. Michael went on to explain how the Kirchoff vector technique could be used to predict the effectiveness of different designs of tunnel entry hoods, installed to reduce the onset of these waves. He was able to show how the results of the predictions matched very closely with the findings of scale model tests and was able to give an indication of how tunnel entry hood design may develop in the future.

The last two papers of the day both dealt with the subjective aspects of noise and vibration. Marco Biot of the University of Trieste presented a paper on the issues surrounding comfort on cruise ships and Peter Wilson of the Industrial Noise and Vibration Centre presented a paper on techniques for product testing based on subjective impression. Marco's paper gave an interesting insight into the differences between 'offered comfort' and 'real comfort'. He explained that although noise and vibration were clearly major factors in producing the perception of comfort among cruise ship passengers they were related to other influences in extremely complex ways. He presented the results of surveys of passengers which made it clear that noise character factors such as intermittency, tonal content, high-frequency and low-frequency content, and sources that cannot be localised were much more important than absolute level when it came to passengers' perception of comfort. The passengers most likely to consider that the comfort had been adversely affected by noise were those in the cabins with the lowest background noise levels: in these, the intermittent sources such as entertainment noise were more clearly audible. This research enabled the shipbuilder Fincantieri to prioritise its design processes more effectively.

Peter kept those people who stayed till the very end entertained with a well-illustrated paper which described how objective testing procedures could be derived from analysis of noise samples from products which were deemed to be subjectively 'good' and 'bad'. Once derived, these procedures could be applied to production line product

testing facilities. He explained how the techniques were based on multiple analyses of a recorded sample using a range of time and frequency domain processes. The exact combination of processes used for each product was determined by more detailed analysis of the 'good' and 'bad' reference samples. He included examples such as sound quality of the seat-beat warning buzzer on a Mini, and the incipient failure of a peristaltic pump. The techniques used to undertake the objective tests often involved vibration measurements as proxies for acoustical indicators, in order to avoid problems with high ambient noise levels in a manufacturing environment. The end result of the approach was a cost-effective system that could be used reliably in industry. The Mini system, for one, was reckoned to have paid for itself inside a week by allowing the manufacturer to deal rapidly with warranty claims.

Peter Wilson thus brought to a close a fascinating and successful (if slightly under-attended) Autumn Conference. See you at the next one!



The Oxford Hotel, Wolvercote, was again the venue for the Autumn Conference



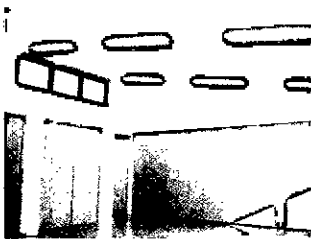
Kevin and Linda Macan-Lind meet US visitors Mr and Mrs Naval Agarwal



The IAC presentation party (l-to-r) Brian Quarrendon, Dr Frederic Cegla, Colin English, Geoff Crowhurst, Lara Harris, Trevor Baylis OBE, Kevin Macan-Lind, Dr Constantinos Coussios

ECHOSORBA ACOUSTIC CEILING PANELS

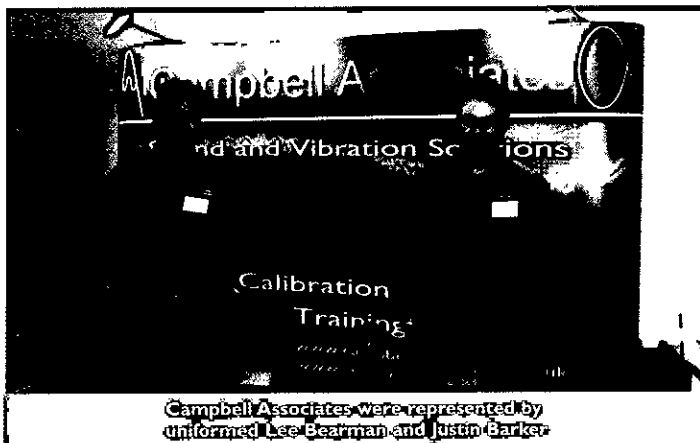
Echosorba stick-on acoustic panels are extremely lightweight and provide very high sound absorption performance. They are designed to meet the requirements of BB93 of the Building Regulations in Schools and public buildings as well as in stairwells, hallways, corridors for flats and other open spaces where noise reverberation is a problem.



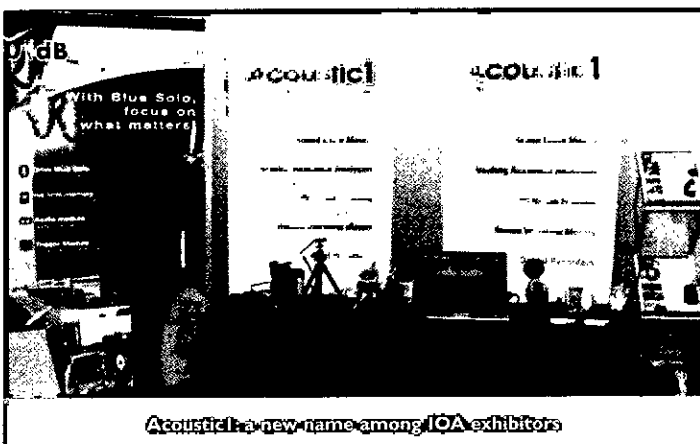
- **Echosorba** acoustic panels are simply glued to the ceilings and high level walls.
- Quick and simple installation
- **Echosorba** acoustic panels are minimal thickness, only 30mm thick, therefore does not lose headroom height.
- No need to remove and refit electrical fittings as acoustic panel can be cut around services.
- Pre-decorated so no other finishing is required
- Class 'O' fire rated
- Very lightweight, only 3 kg/m² in weight
- Noise Reduction Coefficient (N.R.C) 0.85 when fixed direct to a backing.



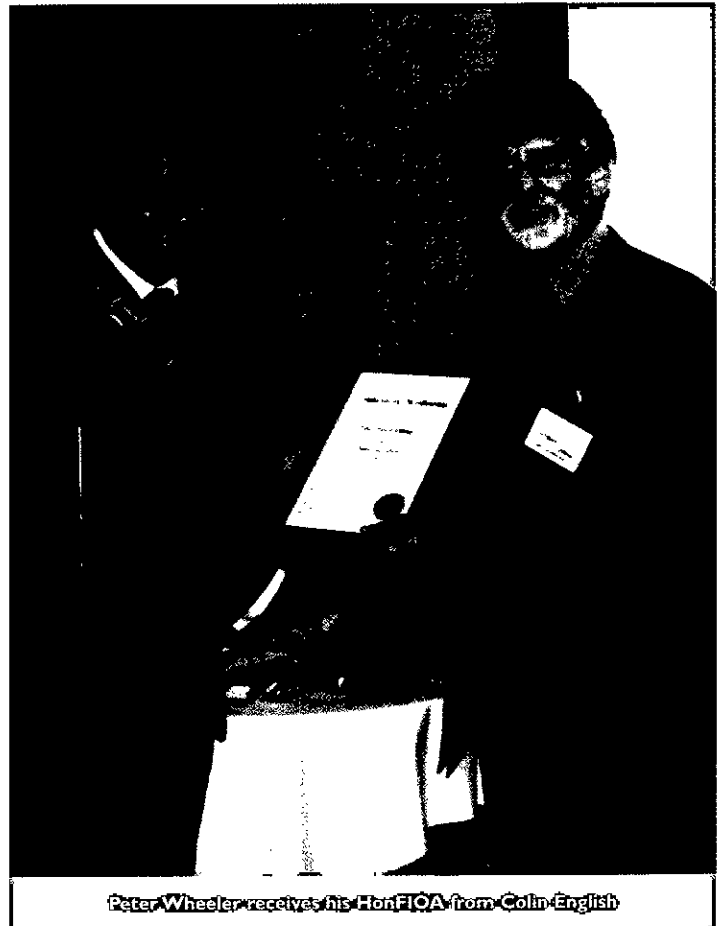
www.soundsorba.com



Campbell Associates were represented by uniformed Lee Bearman and Justin Barker



Acoustical: a new name among IOA exhibitors



Peter Wheeler receives his HonFIOA from Colin English

Meeting report

Judy Edrich. Village life at PLASA 07

With the noise of PLASA 07 still ringing in our ears, we would like to thank the Institute of Sound and Communications Engineers (ISCE) for once again generously inviting the IOA to have a presence at the PLASA 07 exhibition from 10 to 13 September.

This year, owing to a very fortunate mix-up, we ended up with a small stand of our own. The ISCE seems to have expanded rapidly and now has an impressive array of exhibition materials, including a brand new pop-up display. Luckily, however, there was a spare stand so we did not have to encroach on ISCE space and the IOA was able to camp there for the duration of the exhibition. It did mean that we were not exactly next to ISCE, but judging from the numbers of visitors to the ISCE stand and to the IOA stand there would not have been very much time for chatting anyway!

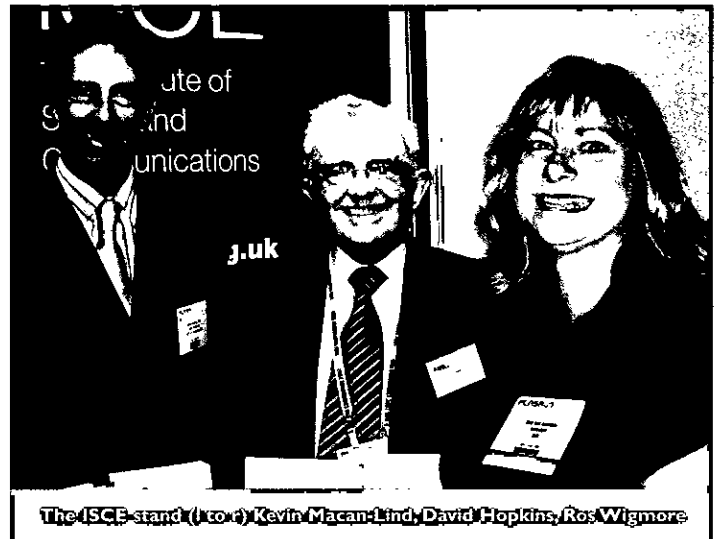
The ISCE village was a new venture this year and it worked very well. From the IOA's point of view PLASA was very successful. Both Kevin Macan-Lind, Chief Executive, and Nezi Yusuf, our new Membership and Publications Officer, helped out on the stand and their assistance was very welcome in helping to field the enquiries during busy times. Visitors were mostly interested in our

Reproduced Sound 23 conference, and the expertly designed A5 flyers (thanks again to Duran Audio) seemed literally to 'fly' off the stand. However, there was also a healthy interest in our training courses and membership. Several people stopped and simply asked what the Institute does – a confirmation, if ever it was needed, that it was good to have a presence there. As always, Judy went round visiting and talking to manufacturers promoting the Reproduced Sound conference, which this year will be held at the Sage in Gateshead. There was a very encouraging interest and even one or two early registrations! Equally encouraging was the amount of interest shown by the trade magazines.

We will be welcoming the ISCE as an exhibitor at our Reproduced Sound 23 conference and hope to continue what has become a very close cooperation between the two institutes. Special thanks are offered to Ros Wigmore, ISCE Secretariat, and David Hopkins OBE AMIOA, President of ISCE, for their valuable help and support.



IOA Chief Executive Kevin Macan-Lind encourages ISCE President David Hopkins OBE AMIOA to attend RS23



The ISCE stand (l to r) Kevin Macan-Lind, David Hopkins, Ros Wigmore



The IOA's friendly little corner at PLASA 07. ISCE Secretariat Ros Wigmore meets Nezi Yusuf, Membership and Publications Officer



The ISCE village

Practical industrial noise control:

Martin Rayns. Responding to the new challenges placed on industry by the 2005 Noise at Work Regulations

This article discusses the practical implications of the 2005 Noise at Work Regulations and offers some guidance on how a practical approach can be implemented in industry, now that the 'new' regulations have been effect for more than a year.

Current legislation

It is estimated that over one million people in the UK are still exposed to excessive noise levels at work and are at risk of suffering hearing damage. Despite advancing knowledge, some 170,000 people suffer deafness, tinnitus or other ear conditions as a result of exposure to excessive noise at work. It was to combat this problem that stiff new requirements were introduced in April 2006 under the Control of Noise at Work Regulations 2005, because noise induced hearing loss is irreversible but is entirely preventable.

The new regulations not only brought a 5dB reduction in upper and lower action levels and the imposition of a new upper exposure limit, but also introduced a fundamental change in the focus of noise at work legislation, which is equally important.

Whilst the focus of earlier legislation was on the assessment of noise, the quantification of exposure levels and the consequent need for hearing protection, the new regulations move towards an agenda of proactive control and management of noise issues. The new legislation concentrates on controlling noise at source and the implementation and monitoring of a noise control action plan over a given period of time.

The key elements of the new legislation are:

- A reduction of 5dB in the exposure levels at which action has to be taken, from 90dB(A) and 85dB(A) in the previous regulations to 85dB(A) and 80dB(A) from 6 April 2006, with a maximum exposure limit of 87dB(A);
- Risk assessments, which must include noise control programmes and actions;
- The implementation of good practice in noise control and risk management procedures, such as reducing noise exposure and providing employees with hearing protection, information and training;
- Control of noise at source by technical or organisational means, rather than a reliance on personal protective equipment (PPE) wherever it is reasonably practicable to do so;
- The use of PPE should only be considered as a last line of defence, and it should only be used when all other forms of noise control have been exhausted;
- Continual health surveillance of all employees exposed to noise levels above the lower action level, which means undertaking audiometric hearing tests on all employees exposed to levels above the upper action level and the maximum limit value.

Experience in recent years has illustrated that employers across most industry sectors take a largely responsible attitude to noise measurement, with noise assessments being undertaken at the required frequency. However, what is apparent is that historically, noise assessments have been lacking in practical options and proposals to assist the employer, with either short-term cost-effective solutions, or



Figure 01

Martin Rayns, Noise Consultancy Manager Wakefield Acoustics

more importantly a cohesive longer-term noise action programme, taking into account all the factors that are vital in responsibly addressing noise in the workplace.

Typical noise assessments have accurately fulfilled all the requirements of previous legislation, providing the employer with a very clear evaluation of on-site noise problems. These problems, however, frequently left him scratching his head and searching for the right solutions. Under the new regulations employers and businesses are now looking increasingly to the few experienced industrial noise control engineering companies capable of accurately diagnosing noise problems, and providing both practical and cost-effective solutions to what are often complex noise engineering issues.

What does all this mean in practice? And what does the employer do next, having completed his noise at work assessment and established his employees' daily noise exposure levels?

Practical identification of noise source

The key to the practical and cost-effective treatment of noise problems is to begin with a very accurate diagnosis of the noise source. It is not unusual to be called to a site where the customer believes a particular

continued on page 20

The professionals' choice for independent, IOA qualified, technical guidance and consultancy



**Custom
Audio
Designs**

Sound insulation & acoustic materials for Part E & Robust Details
www.customaudio.co.uk - 01730 269572

New high performance Jocavi® acoustic range & 3D modelling service

Practical industrial noise control: - continued from page 19

piece of machinery to be the problem noise source, and in some instances a solution has already been prescribed. Not only can this prove to be a wrong decision, but it can also be a costly one!

In accurately treating noise sources it is imperative to identify and then treat the dominant noise source: 'Understand your noise problem'. This is best achieved by taking a range of sound level readings, including a frequency analysis, and by turning off machinery to attempt to identify and isolate dominant noise sources. Whilst this is always desirable, it is in practice not always possible. It is at this point that knowledge of the industry and the consultant's experience come into play.

Still at a practical level, it can be possible to take advantage of an identical piece of machinery within the plant and compare the noise levels it emits. On many occasions a machine can be noisier in one area than another. This can be caused by a lack of adjustment - on a knife separator, for instance - or simply by worn out bearings.

A recent request for an acoustic enclosure for a compressor was solved by simply repositioning the motor shroud. At some point this had been leant on, so that the impeller, running at 1500rev/min, was actually rubbing on it. An identical machine was running beside the first unit at a much lower noise level, and the difference had been overlooked. As a result of observation, and with a little lateral thinking, the noise problem was solved at no cost! Whilst it may sound unusual, many similar examples can be cited by experienced noise control engineers everywhere.

In organisations where the noise source is easily identifiable, the process can very often be done in-house, with the assistance of a maintenance engineer and at very low cost. Organisations that are affected with high noise levels from a multitude of plant and machinery are much more likely to require a full noise audit with more the involvement of much more specialist noise control expertise. An effective noise audit undertaken as part of an overall noise action plan

will identify the benefits in terms of the noise control options available and the potential costs involved. It will help prioritise the actions required relative to the number of employees that may benefit from the actions taken, and help quantify the costs involved. It will serve as a record in cases where the final decision turns out to be that there is no practical noise control solution.

Practical solutions

Having identified the dominant noise sources it then becomes possible to look closely at the root cause or causes and endeavour to establish solutions and options. In tackling industrial noise sources there is a wide variety of solutions which, with a clear diagnosis of the actual noise source, should form part of an overall noise reduction programme. These are often referred to as the 'hierarchy of noise control' and involve such areas as elimination, workplace design and organisation, engineering noise controls, and isolation. These are discussed in turn below.

Elimination

Noise problems can sometimes be solved by:

- Seeking to eliminate the actual noise source, by removing the actual process or machine that is causing the noise, replacing the machine with a less noisy piece of equipment, or by seeking to redesign the work or work pattern;
- In new plants a low-noise purchasing policy can be implemented, so that noise levels are fully taken into account when procuring plant and equipment: this can help produce more informed decisions.

It is worthy of note that great care must be taken in the interpretation of manufacturers' noise data, and the circumstances in which noise emission figures are given. Engineers involved in purchasing new

continued on page 22

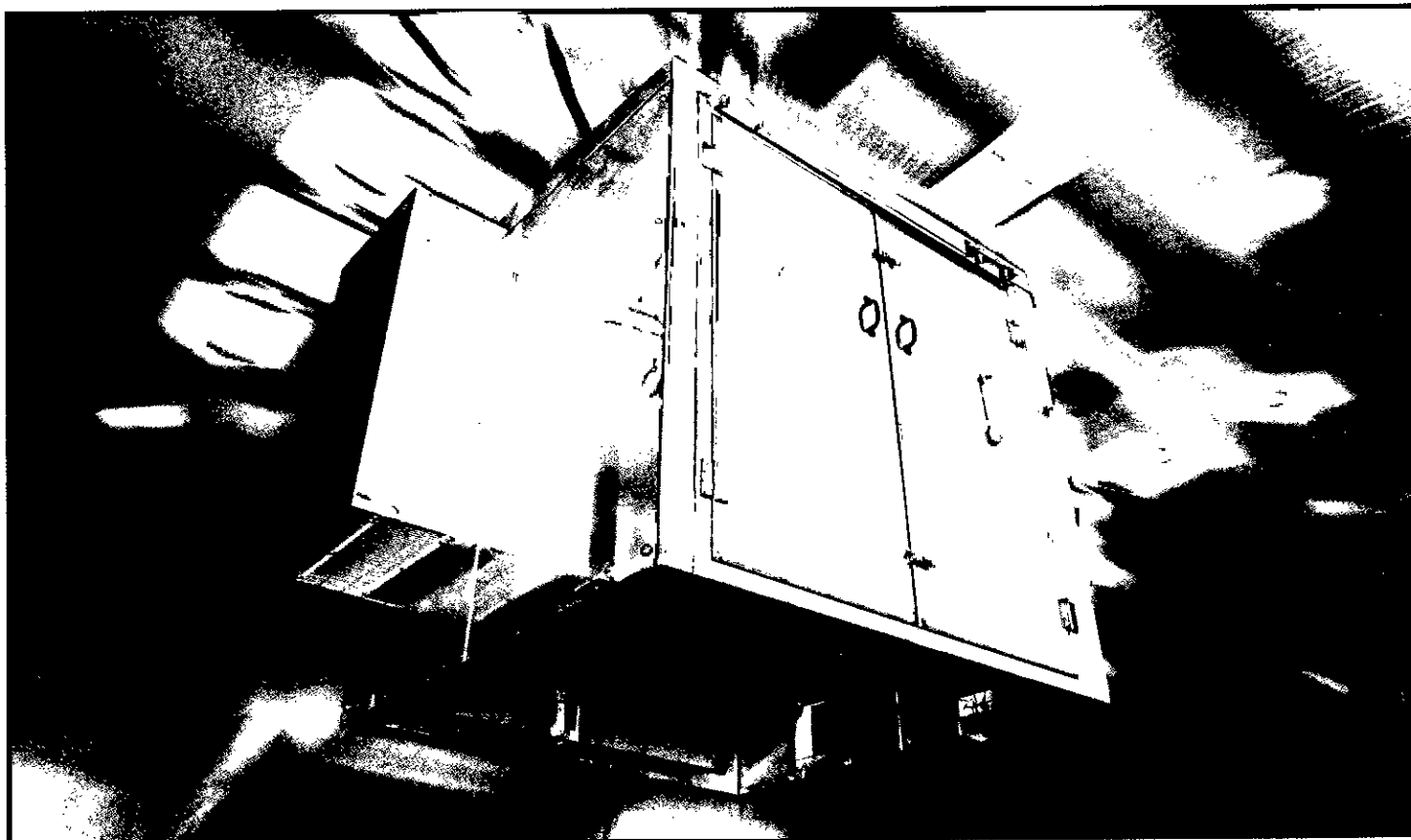


Figure 02

A drop-over acoustic enclosure with attenuators for ventilation air

SoundPLAN

Powerful software to predict, assess and map noise from transportation, industry and more

With SoundPLAN, you can develop and test noise-reduction strategies. Then use the many graphic tools, including 3-D Graphics and Animations, to generate professional presentation material.

SoundPLAN is ideal for documenting projects for ISO 9000 compliance.

— and you can trace and repeat jobs using:

- △ Detailed calculation and execution protocols
- △ In-depth results documentation
- △ Control features to verify input geometry and source data
- △ A logbook to record calculations parameters



...the powerful tool for sound management.

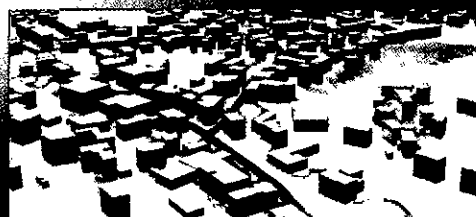
(Available in 9 languages)

www.soundplan.com

David Winterbottom
Technical Development & Investigation Ltd
Unit 1, Deans Hall Business Park, Oak Road,
Little Maplestead, Halstead, Essex
CO9 2RT UK

01787 478328

tdi.ltd@btconnect.com



Practical industrial noise control: - continued from page 20

equipment need to ensure that the data provided truly reflect the acoustical environment in which the new machine will be installed.

Workplace design and organisation

- Reviewing process flows and layouts
- Reviewing work patterns
- Relocating workers into less noisy areas

Engineering controls

A review is made of each noisy process, seeking to identify the root cause, along the following lines.

- A small reduction in pressure will show an immediate reduction in noise levels at no cost
- Silencers on exhaust vents and reduced-noise nozzles can be fitted, again at a low cost
- Isolate vibrating machines by fitting anti-vibration mounts and flexible joints on rigid pipe work, thereby reducing potential structure borne noise problems
- Fit damping material to reduce vibration on feed chutes and conveyors
- Reduce air pressure on vibratory tables and conveyor vibrators, or switch them off when the product is not moving along the conveyor: this will also produce an immediate reduction in noise levels, very often with cost savings
- Remove or reduce drop heights and metal-on-metal impacts
- Review component and material feeds and speeds of equipment
- Review maintenance regimes and ensure regular maintenance of equipment, as this can be a key contributor to noise levels in the factory, and is thus a relatively quick and cost-effective way of reducing noise levels
- Carefully consider modifications to existing machine guards with a view to improving acoustical performance
- When designing new machine guards, consider noise along with all other health and safety considerations.

Isolation

- Consider the installation of enclosures, screens and baffles around noisy equipment
- Fit inlet and outlet silencers to fans, blowers, steam vents and exhaust stacks.
- Provide sound-resistant booths to isolate workers from noise sources.

The provision of quiet havens can often prove to be the most cost-effective solution, and where sophisticated control equipment is used in running a production process, a booth can provide an improved working environment for both operator and machine.

As a direct result of the change in legislation many manufacturing companies previously not affected by noise regulations now find that they have factory noise levels that fall just above the upper action level or the daily exposure level. It is these companies that are most likely to benefit from a consultation.

Reductions in noise levels of between 5dB and 10dB (nominally) can often be achieved by a thorough examination and careful consideration of the topics outlined above. This can often result in a deregulation of work areas that would, under the new legislation, become hearing protection zones, where the wearing of hearing protection by all employees would be mandatory.

Inevitably, situations will arise (despite taking in-house action to reduce noise levels) where considerable reductions in noise levels are required, or where the employees have to be isolated from the noise sources. Typically in these cases the reductions required could be in excess of 20dB, or even considerably higher. It is highly unlikely that a company will have the necessary skills to cater for these levels of attenuation, and it will need to call upon a professional industrial noise

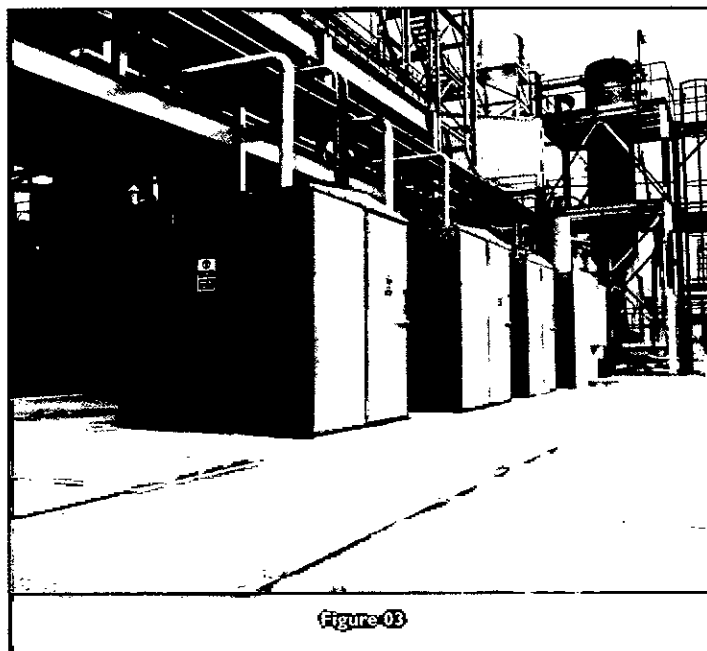


Figure 03

A group of free-standing acoustic hoods on a process plant

control engineering company.

The use of acoustic enclosures, sound havens, barriers and doors are some of the methods designed to isolate the receiving personnel from the noise sources. Any or all of these approaches could provide the optimum solution. Despite the problems that can be encountered as far as access, maintenance and cooling airflow are concerned, acoustical enclosures can be designed to cope with most if not all of the difficulties, provided that there is a thorough consultation with production management, maintenance staff, and (most importantly) with the machine operators. Furthermore, enclosures can be linked into many manufacturing processes with automatic access for conveyor systems, pallet shuttles and the like. The provision of safety switches on access points can also very often improve the safety features protecting the employee on a particular process, besides providing the intended benefit of reduced noise levels. Windows can be included which use modern shatterproof materials, and stainless steel structures and panels make them enclosure a perfectly acceptable option for most food and pharmaceutical industry applications.

Wall constructions, ventilation louvres and attenuators can be carefully sized using specialist acoustical design software to produce the optimum construction, ensuring that adequate cooling is maintained within the enclosure, whilst keeping the package at its most cost-effective.

Practical results

A recent project involving the supply of two acoustic enclosures designed to achieve 74dB(A) at a distance of 1m from any enclosure surface, and housing equipment previously producing noise levels in excess of 100dB(A) was recently supplied and installed on site. Having incorporated the customer's particular requirements with respect to daily equipment adjustment and long-term maintenance, which involved the complete removal of the roof from the enclosure, the finished product, when independently checked following installation, was found to achieve 72dB(A) at 1m. This in turn resulted in a highly delighted and satisfied customer, with change left in his pocket!

Martin Rayns MIOA is Noise Consultancy Manager with Wakefield Acoustics, Cleckheaton, tel **01274 872277**, www.wakefieldacoustics.co.uk

Noise reduction of hand-held vacuum cleaners...

H Ashrafi and M J Mahjoob. ...by geometric optimisation of components

High noise levels of vacuum cleaners are partly associated with the design of the air passages of different components. An experimental investigation was conducted to study the effect of component geometry on the noise emissions. A typical charge-type vacuum cleaner was selected for noise treatment. Each path was optimised geometrically to modify the air flow and reduce the overall noise level. This was achieved by considering the different sources generating aerodynamic noise in the vacuum cleaner. The redesigned parts were prototyped and tested in different conditions and the variation of vacuum power and noise level investigated.

Introduction

The competitive market of home appliances and tighter noise regulations have forced manufacturers to design quiet machines. Small vacuum cleaners have always been a source of unwanted noise and the subject of many customer complaints.

The noise generated in small charge-type vacuum cleaners is mainly of aerodynamic origin. The sound level is affected by many factors, and this makes theoretical studies very complicated, therefore to reduce the level, the noise sources must be identified and the related sound producing phenomena investigated. Changes of air stream then should be made in order to eliminate the mechanism activating a particular sound source. The fan itself is a major source of noise, in addition to the noise produced by airflow through the inlet. Careful consideration of turbomachinery noise is needed to design quieter fans for vacuum cleaners. Common sources of aerodynamic noise and the possibility that they occur in the selected vacuum cleaner are discussed next.

Aerodynamic noise

Ideal models of acoustic sources are classified in three types [1,2]:

Monopole: Sound is generally caused by unstable bulk flow and is usually observed in exhaust mufflers. The sound intensity of a monopole source is proportional to the fourth power of flow velocity.

Dipole: Sound is caused by the interaction of unstable flow on solid surfaces. This turbulent flow on the surface produces periodic forces causing the solid surface to oscillate and propagate sound. The sound intensity of a dipole is proportional to the sixth power of flow velocity.

Quadrupole: The interaction of two incident flow streams produces internal stresses and creates a sound source which is modelled as quadrupole. The sound intensity is proportional to the eighth power of flow velocity.

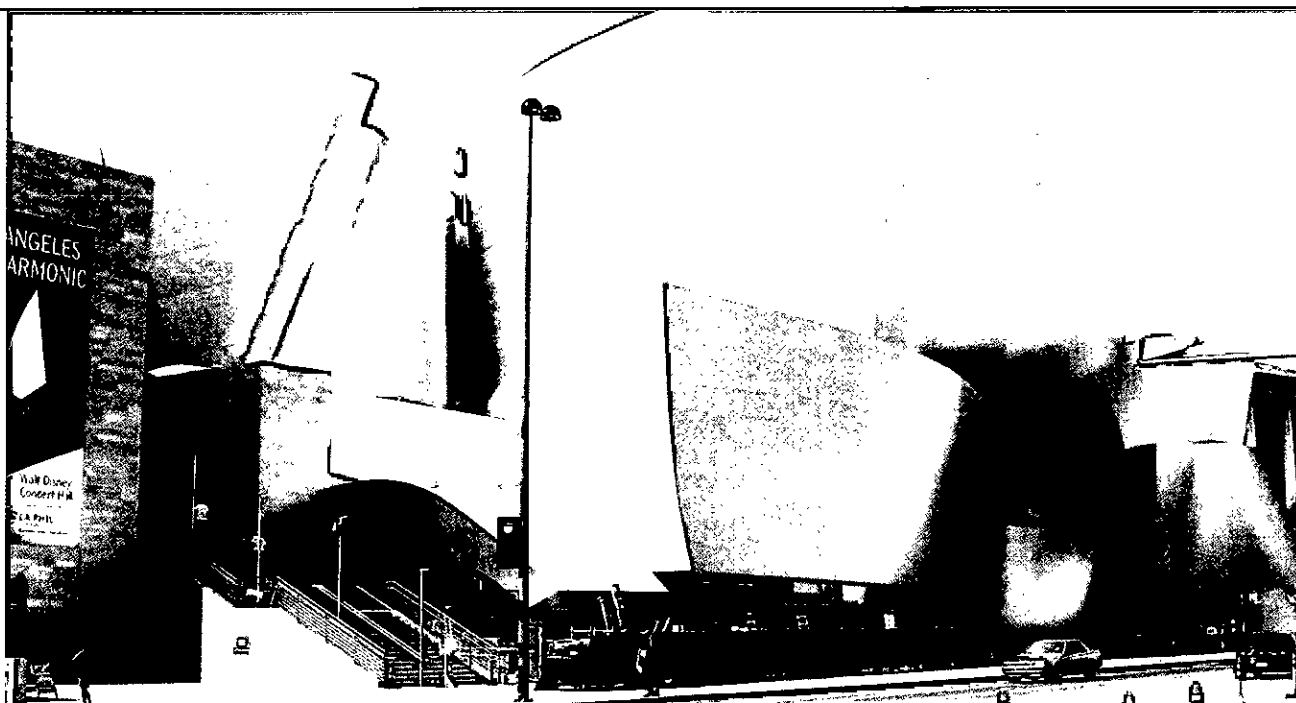
Noise physical models

Leakage noise appears when air leaks arise because of a pressure difference between two media, for instance the noise produced by leaking air out of a small hole or crack in a gas pipeline. This can be both monopole and dipole.

Cavity noise occurs when there is no flow, so standing waves appear in the medium. This type of sound is broad band, and lower frequencies tend to predominate.

Rush noise is generated by the oscillatory forces of turbulent flow over a solid surface. If flow separation occurs, the vortices become larger and periodic forces develop which can be ten times greater than the forces between boundary layer and the surface.

continued on page 24



ANDRE Structural Vibration Isolation Bearings

Trelleborg Bakker designs and manufactures elastomeric bearings under the trade name ANDRE to support and isolate buildings.

- Load range: 50 kN to > 3000 kN
- Natural frequency: > 4 Hz
- Design life: > 100 years

Picture: The Walt Disney Concert Hall in Los Angeles

Trelleborg Bakker B.V.
The Netherlands
Phone: +31(0)180 495555
UK contact: Ashley Haines
UK phone: +44(0)116 267 0300
ashley.haines@trelleborg.com
www.trelleborg.com/bakker

TRELLEBORG
ENGINEERED SYSTEMS

Noise reduction of hand-held vacuum cleaners... - continued from page 23

Source identification in air stream

Front body

The air inlet of the handheld vacuum cleaner is shown in Figure 1. The inlet flow shape is very important: as illustrated here, the abrupt change at the intake opening makes the airflow turbulent, causing excessive noise at this point.

Air passes through a dust filter after the inlet and front body. However, before this filter is encountered, the air must be dried and any resulting liquid kept back in the transparent front body. To this end, the filter part is designed so that the air stream is dehumidified by passing underneath the filter before passing through it (Figure 2). Here too, two sources of noise emerge. First, the air impinges on the filter bed at a right angle. Second, there is a 90-degree change of direction after entry into the filter vent. As well as the noise associated with the air incidence, the filter bed generates sound as cavity noise. This flow type also causes an extra pressure drop, which reduces the vacuum performance drastically. The flow in the filter housing through the holes leads also to produce leakage-type noise along with the related pressure drop.

4.2 Main body

The main body consists of two distinct sections: the air inlet and the air outlet. As shown in Figure 3 the air entering the body inlet is not directed properly, but is pulled suddenly into the body, leading to streamline disturbance and eventually to aerodynamic noise generation. Figure 4 demonstrates the exhaust trap through which the air passes after leaving the fan and just before it is discharged into ambient air. This part produces a noticeable increase in noise due to:

- Sudden incidence of the air onto the interior surface of the trap
- Leakage noise produced as high velocity airflow passes through the slots of the trap
- Rush noise as a result of the high pressure air being exhausted without a significant reduction in velocity.

As well as the problem of noise generation, this form of exhaust trap causes high pressure drop which reduces the useful pressure of the cleaner. Moreover, owing to the additional air resistance the fan is working a considerable way off its design point, meaning that it operates in a low efficiency region. Turbomachinery noise produced by the fan is discussed below.

Geometric optimisation of vacuum cleaner parts

Based on the concepts explained above, a new design was developed to remove as many noise source mechanisms as possible by geometric modifications. This was achieved on different components as follows.

Front body

In order to avoid streamline disturbances the inlet profile of the front body was changed to provide laminar flow, by gradually directing the air into the appliance. This profile eliminates the previous sudden breaks of streamlines (Figure 5).

Filter body

The geometric form of the filter body was changed fundamentally. The air flow slides smoothly along the lower surface of the filter instead of impacting onto a rigid surface, and continues to the trap as smoothly as possible. The cavity at the bottom part of the filter was eliminated. The air passage into the filter trap was modified by increasing the trap area was increased and integrating its surface with that of the filter body, in order to minimise turbulence (Figure 6).

Main body

The air inlet to the main body was changed to a converging nozzle in which flow streamlines can continue without any interruption, sudden break, or impact on the front of the main body (Figure 7).

The outlet trap was also fundamentally changed. As the air leaves the fan it enters an exhaust duct, the width of which increases steadily to provide a laminar flow exit whilst reducing the exit velocity. Besides redesigning the exhaust duct the outlet taper was extended to eliminate leakage noise and reduce the air resistance. This also gave an increase in the 'vacuum' performance of the appliance (Figure 8).

Air exhaust directly to the atmosphere should be avoided in order to reduce

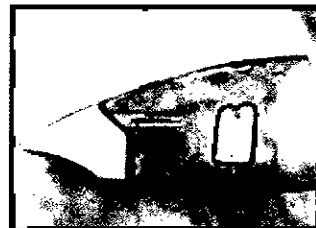


Figure-01

Old front body

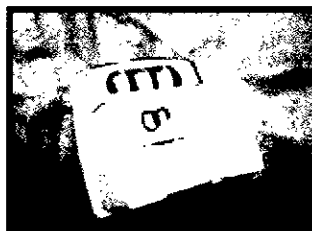


Figure-02

Old filter housing

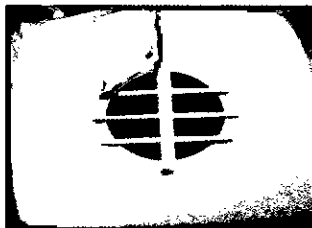


Figure-03

Main body inlet



Figure-04

Main body outlet

turbulence-generated noise. A diagonal exhaust duct was designed, giving two advantages. First, the turbulence noise was reduced as a result of the reduced air velocity reduction and more laminar flow. Second, the fan was not exposed directly to ambient air, so its rotational noise could not be propagated from the appliance. The relationship between noise level reduction and the angle of the diagonal exhaust duct is shown below (Figure 9).

The greater the angle of the duct, the more noise reduction is achieved;

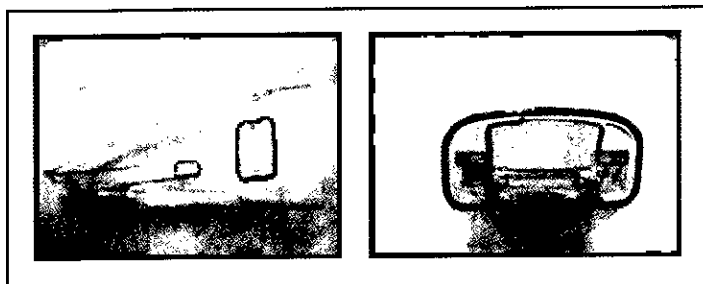


Figure-05

Modified front body



Figure-06

Modified filter housing

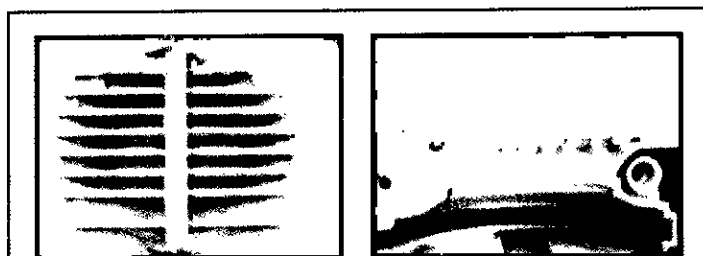


Figure-07

Modified body inlet

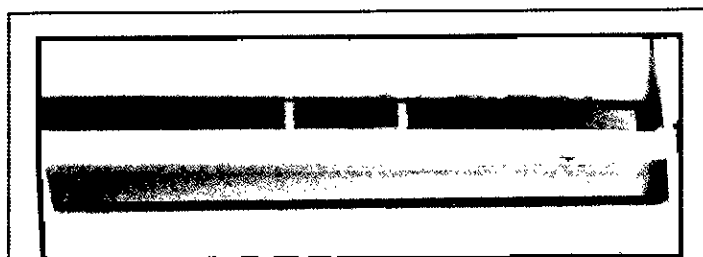


Figure-08

Modified body outlet

however, the diagonal duct causes a pressure drop in the passage which leads to reduction in vacuum performance. In order to strike a balance between these two targets a 45° duct angle was chosen.

Fan

Turbomachinery noise has been the subject of considerable investigation over the past few decades and various solutions have been discovered. Generally,

centrifugal fan noise includes both broad-band and pure tone noise. The broad-band noise is generated as a result of turbulence, while the tonal noise is produced at the fan blade passing frequency:

$$f = n \omega \quad (1)$$

where n is the number of blades and ω the rotational speed of the fan.

The sound power level L_w of centrifugal fans can be estimated from the equation

$$L_w = 10 \log \omega^5 R_2^6 b_2 - 36 \quad (2)$$

where R_2 is the outlet radius of the fan, and b_2 the blade height at the outlet.

The ASHRAE Handbook gives another practical equation for estimating the sound power level of a backward-curved centrifugal fan:

$$L_w = K_w + 10 \log Q + 20 \log P + BFI + C_N \quad (3)$$

where Q is the volume flow rate, P is the fan pressure difference, $BFI = 3$ and K_w is found from Table 1.

63	125	250	500	1000	2000	4000	8000	Hz
35	35	34	32	31	26	18	10	dB

Table-01

Values of K_w

C_N is a result of the fan's deviation from its maximum efficiency, which leads to noise emission, as shown in Table 2.

efficiency	CN
90%	0
75%	5.2
40%	12.2

Table-02

Values of K_w

Since the reduction in fan rotational speed or external radius will lead to a vacuum drop for the appliance, these parameters cannot be changed. However, other modifications can be applied to reduce the fan noise level. As shown by equation (3), the fan noise level is related to the pressure difference produced by it. Changes in the blade angle at the outlet of the fan can reduce the extra exhaust pressure which leads to noise generation. Furthermore, a decrease in air resistance within the airflow passage helps the fan to operate nearer its design point, in order to reduce parameter C_N .

Further experimental investigations showed that other parameters are also involved. The most important are the blade profile and the inlet and outlet profiles.

These following additional modifications were made to achieve the maximum reduction in fan noise.

- A directing edge was provided at the inlet of the fan
- A curved surface was introduced to the centre of the fan, to direct the flow to the entrance of the blades
- The entry form of the blades was changed from two-dimensional to a three-dimensional profile: in other words, there are chamfers in two directions so that the airflow passes over the blades gradually and smoothly (Figures 10 and 11).
- The blade tips at the outlet were also chamfered to reduce the air interaction with blades.

continued on page 26

Noise reduction of hand-held vacuum cleaners... - continued from page 25

Experimental results

Noise level test

The noise level was measured in free field with a 2260 B&K sound level meter ('Investigator' sound analyser). In order to investigate the effect of each section the noise level of each part was recorded separately, and tested in the assembly. For components such as front body or filter housing, an air-jet was provided through a tube or duct and the noise was recorded.

Vacuum pressure test

Vacuum pressure was tested via three different methods:

1. Test vacuum chamber, in which orifices simulated various working conditions for the vacuum cleaner and the head vs flow curve was obtained;
2. Air tunnel, in which the flow rate was measured by anemometer and the desired head applied at the inlet of the vacuum cleaner;
3. Pipeline, in which the flow rate was calculated using the Bernoulli equation and a pressure gauge.

The test results are shown in Table 3. Since the purpose of the work was to investigate the noise reduction, the vacuum pressure test results are merely summarised.

component optimised	sound level reduced by	vacuum pressure increase
front body	2dB	6%
filter body	1dB	15%
main body (inlet)	3dB	7%
main body (outlet)	5dB	12%
fan	9dB	18%
complete appliance	12dB	58%

Table 03

Discussion and conclusion

High noise levels of vacuum cleaners are mainly attributed to the turbulent flow within the appliance's air passages and components. Experiments investigated the effects of component geometry on the noise emissions. A noisy hand-held vacuum cleaner was selected for diagnosis and treatment. Each component was optimised geometrically to modify the air flow and reduce the overall noise level. Different sources generating aerodynamic noise in the vacuum cleaner were examined. Redesigned prototype components were constructed and tested in different conditions, and the variations in vacuum cleaner power and noise level were recorded. The machine performance and the vacuum power were also improved over the course of the noise reduction treatment.

Based on the modifications made, geometrical parameters play the main role in the aerodynamic noise generation within the airflow devices. Further investigations and CFD simulations are now required to complete the results and arrive at quantitative design procedures.

Acknowledgements

This article is closely based on a paper presented by the authors at ISMA 2006, the International Conference on Modal Analysis — Noise and Vibration Engineering, held at the Katholieke Universiteit Leuven, Belgium, and reproduced with the permission of the University as publishers. Acoustics Bulletin is grateful for permission to use the paper in this way.

The authors would like to thank the Pars Khazar industrial group and Nur Toushe Company for their support and preparation of the samples, and the University of Tehran for providing the test facilities.

H Ashrafi and **M J Mahjoob** are with the Noise, Vibration and Acoustics (NVA) Research Centre School of Mechanical Engineering, University of Tehran, Iran. Email: mmahjoob@ut.ac.ir and hanu.ashrafi@gmail.com

Channel angle influence

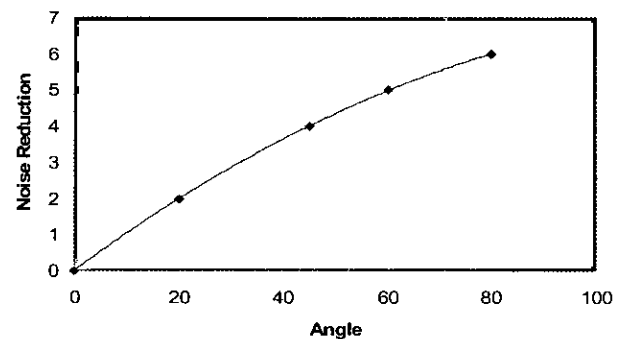


Figure 09

Noise level reduction vs. angle



Figure 10

Old fan

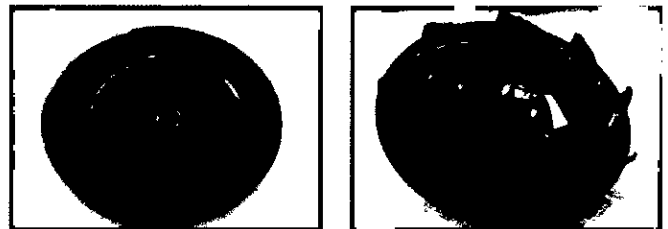


Figure 11

Modified fan

References

- [1] *Aerodynamics of road vehicles* Edited by Wolf-Heinrich Hucho 1998 (available from the Society of Automotive Engineers)
- [2] *Handbook of Acoustical Measurements and Noise Control* Edited by Cyril M Harris, Third Edition 1997
- [3] Neise, W *Noise reduction in centrifugal fans*. JSV 1976-45(3) pp375-400
- [4] *Good practices on ventilation system noise control* Environmental Protection Department Noise Management Policy Group 1999. (www.epd.gov.hk/epd/english/environment/tnhk/noiselguide_ref/files/vent-sys.pdf)
- [5] Uoskainen, Seppo. *Turbulences as sound sources* Espoo 2003, VTT publications 513. VTT Technical Research Centre of Finland, Vuorimiehentie
- [6] Dowling, A P and Hynes, T P *Sound generated by turbulences* European Journal of Mechanics 23(2004) pp491-500
- [7] Howe, M S *Influence of separation on sound generated by vortex-step interaction* Journal of Fluids and Structures, Vol. 11 no.8, November 1997 pp857-872

An Inevitable Consequence: The Story of Industrial Deafness - Part 2

Dick Bowdler concludes his history of occupational deafness in the UK

Time and Motion

As we saw in Part 1, by the end of the 1940s all the parts of the jigsaw were available to enable employers to protect their workers' hearing. Knowledge of how to reduce that risk, by using baffles, enclosures or sound absorbent materials, or by the provision of ear protection, was readily available to anyone who made the effort. Besides materials to reduce sound levels, ear protectors were available. Research was being carried out in several countries, notably in Scandinavia and the United States. In January 1953 Colin Johnston wrote an article in the *British Journal of Industrial Medicine* in which he concluded that 100 to 112 phon represented the borderline for damage to hearing. These levels are approximately equivalent to the range 86 to 98 dB(A) in modern terms.

Just as in the 1930s it was nuisance that drove progress in industrial deafness, so in the 1950s it was the desire for more efficiency that drove it. This was the period when 'Time and Motion Study' and similar techniques were used to determine how we could all work more efficiently. The 1959 film 'I'm all right Jack' satirised this together with other issues of the time.

Attitudes, rather than knowledge, were still holding back progress. In the early 1950s the British Railways Board carried out research into workplace noise, both in the interests of efficiency and because of the deafness suffered by so many of its employees. Its failure to follow up the initial work was to rebound on them thirty years later in the court case of *Kellett v British Rail Engineering*, about which we shall learn more later on. The evidence brought out in the case tells us something about the attitudes that still prevailed.

In the latter part of 1951, tests of 'V51R' ear plugs were carried out by a Divisional Medical Officer amongst employees in two boiler shops belonging to the railway. The doctor believed that boilermaker's deafness could to a great extent be reduced or prevented by supplying the workforce with ear protectors. These tests were reported to the Chief Medical Officer at British Railways with the recommendation that the protectors should be issued regionally. A reply in early 1952 stated that there would be no objection to ear defenders being purchased and re-sold to staff, though the Railway Executive was opposed to the free issue of protectors.

Further correspondence between the Divisional Medical Officer and the Railway Executive took place during 1952, with the doctor recommending the provision of ear protection for certain employees. In the particular case of one employee, he had '...no doubt that continued exposure to the excessive noise ... will in time cause permanent damage to his hearing'. This was turned down by the Executive on the grounds that they would receive similar requests from other employees, all of which would be difficult to refuse.

Meanwhile, in 1952, similar tests of V51R ear plugs were also carried out at British Rail's Doncaster works. These tests resulted in a request for management to supply ear defenders for members of staff. This request was refused on the grounds of cost. The Doncaster Works Committee tried to persuade management to change its mind, apparently without success. In early 1953 a similar trial of V51R plugs was carried out at the Crewe works. The results were highly satisfactory and the staff representative on the Works Committee asked that they be made standard issue. The outcome is not known, but it seems likely that no ear protection was ever provided — certainly not on a consistent basis.

At the end of 1955 British Railways' Research Department approached Professor Burns of Charing Cross Hospital with the object of his investigating the loss of hearing of employees who worked in noisy environments. Professor Burns said that above a certain sound level threshold there was a hazard of progressive deafness. However Dr



Figure 01

V51R earplugs came in a variety of sizes and colours

Newnam of British Railways expressed his concern that such a survey might precipitate common law claims. It seems that this consideration put an immediate stop to any further work, and Dr Burns' survey never took place — though he did carry out further investigations into noise and efficiency.

In a sense one cannot blame British Railways, because that employer's attitude only reflected the prevailing view at the time. Nevertheless the time had come when employers had to take some responsibility for the damage they were causing to the hearing of their employees.

Quantification

In the *Transactions of the Association of Industrial Medical Officers* in 1955 Brian O'Brien wrote: 'Today a greater concern for the welfare of the industrial worker's health has focussed a good deal of attention on the effects of prolonged exposure to noise of a degree harmful to the sense of hearing. Efforts are being made to protect the ears both by reducing the actual volume of noise to which they are exposed and by augmenting the natural defences of the human ear'. He further stated that 'recognition of such occupational deafness by Courts of law and insurance companies has been forced by an increasing number of successful claims for damages'. I have been unable to find any record of any of these early claims.

There were now more professional people specialising in acoustics and noise. There were physicists in the Building Research Laboratory, later to become the BRE. Physicists also worked on noise at the National Physical Laboratory and there were architects and engineers who had obtained experience of acoustics in the design of radio and television studios in the BBC.

There were articles on how to reduce noise at work throughout the 1950s — albeit again for much of the time they were concerned more with efficiency than deafness [20]. In 1957 Cyril Harris published his book *Handbook of Noise Control*. This, together with books by another American, Leo Beranek, was to become a major work of reference for the next decades. There were articles in which the causes of deafness were discussed and performance figures for ear plugs and earmuffs were shown [21], [22], [23], [24].

In 1960, Burns and Littler broke through the final main difficulty, that of quantifying a 'safe' level of noise. They suggested a specification for hearing preservation in Chapter 17 of the book published by

continued on page 28

An Inevitable Consequence - continued from page 27

Butterworth *Modern Trends in Occupational Health*. This specification was described in frequency bands.

In mid 1963 two Government publications were to mark what was, in hindsight at least, a turning point, even if the documents were not widely read at the time.

Noise - Final Report (usually known as the Wilson Report) was published in July 1963. Dealing (quite comprehensively) with all aspects of noise it discussed noise induced deafness and set down criteria for the safeguard of hearing [25]. It suggested two alternative noise limits, both in terms of frequency spectra. The first limits were the figures from Burns and Littler which were in the octave bands used in Britain and the USA at the time (since superseded by the ISO definitions). The second set of limits was based on a proposal by Aram Glorig (an American) that NR85 was a suitable curve. It is of interest to compare the two. In the table below, the Burns and Littler noise levels have been converted from the old octave bands to the current centre frequencies.

	63	125	250	500	1k	2k	4k	8k	Hz
Burns and Littler	98	94	89	85	84	80	80	80	dB
Glorig	103	96	91	87	85	83	81	79	dB

Table 01

Noise and the Worker was published in 1963 by the Ministry of Labour. Although not referred to as a Code of Practice it was in essence just that, and has been treated as such by the Courts. It discussed ways of assessing whether an employer had a noise problem and how to conduct a noise conservation programme. It showed how to measure noise and reduce it and identified the danger levels of noise [26]. Under the heading *The danger levels of noise* the publication stated that:

Before the effects of loud noise can be judged, therefore, it is not only necessary to measure the noise but to assess the amount of exposure to it during a normal working day or working life.

It is generally agreed, however, that if workers are exposed for eight hours a day, five days a week, to a continuous steady noise of 85dB or more in any octave band, in the speech range of frequency (500 to 4,000 cycles per second) it is desirable to introduce a programme of noise reduction or hearing conservation. (This is a level of noise in which normal speech cannot easily be heard; at a distance of a few feet communication can be achieved only by shouting.)

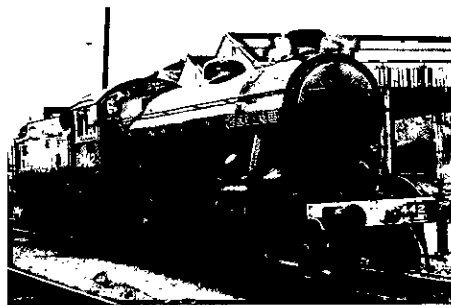
It set out Burns and Littler's figures as levels above which noise should be 'avoided'. The publication went on to give examples of how noise levels had been successfully reduced at source in factory environments and how reductions in noise could be accomplished.

In 1970, following considerable research, Burns and Robinson at the National Physical Laboratory published *Hearing and Noise in Industry* [27] and the following year Robinson published *Estimating the risk of hearing loss due to exposure to continuous noise* [28]. This introduced the concept of noise dose and effectively of L_{eq} - though commercial sound level meters capable of measuring L_{eq} directly did not become available until the mid 1970s. Furthermore, they introduced the use of A-weighted sound level as the measure of exposure. L_{eq} and A-weighting have remained the preferred measures ever since.

As a result of Burns' and Robinson's work the third edition of *Noise and the Worker* was published in 1971 and gave the following table indicating *Levels of noise which indicate a serious hazard to hearing*. (Table 02)

In connection with the danger levels of noise the publication says, in referring to the above table: 'It is ... possible to give guidance which will help to protect most people against serious hearing loss'. Moreover, 'Damage risk criteria should be regarded as maximum permissible levels and not as desirable levels. If possible the noise should be reduced to levels lower than the danger levels set out in [the table]'. In 1975 the new ISO 1999 standard used the same concept (Noise Immission Level) to estimate

continued on page 30

**Figure 02**

British Railways conducted investigations into noise in locomotive workshops in the 1950s

DE

Code of Practice for reducing the exposure of employed persons to Noise

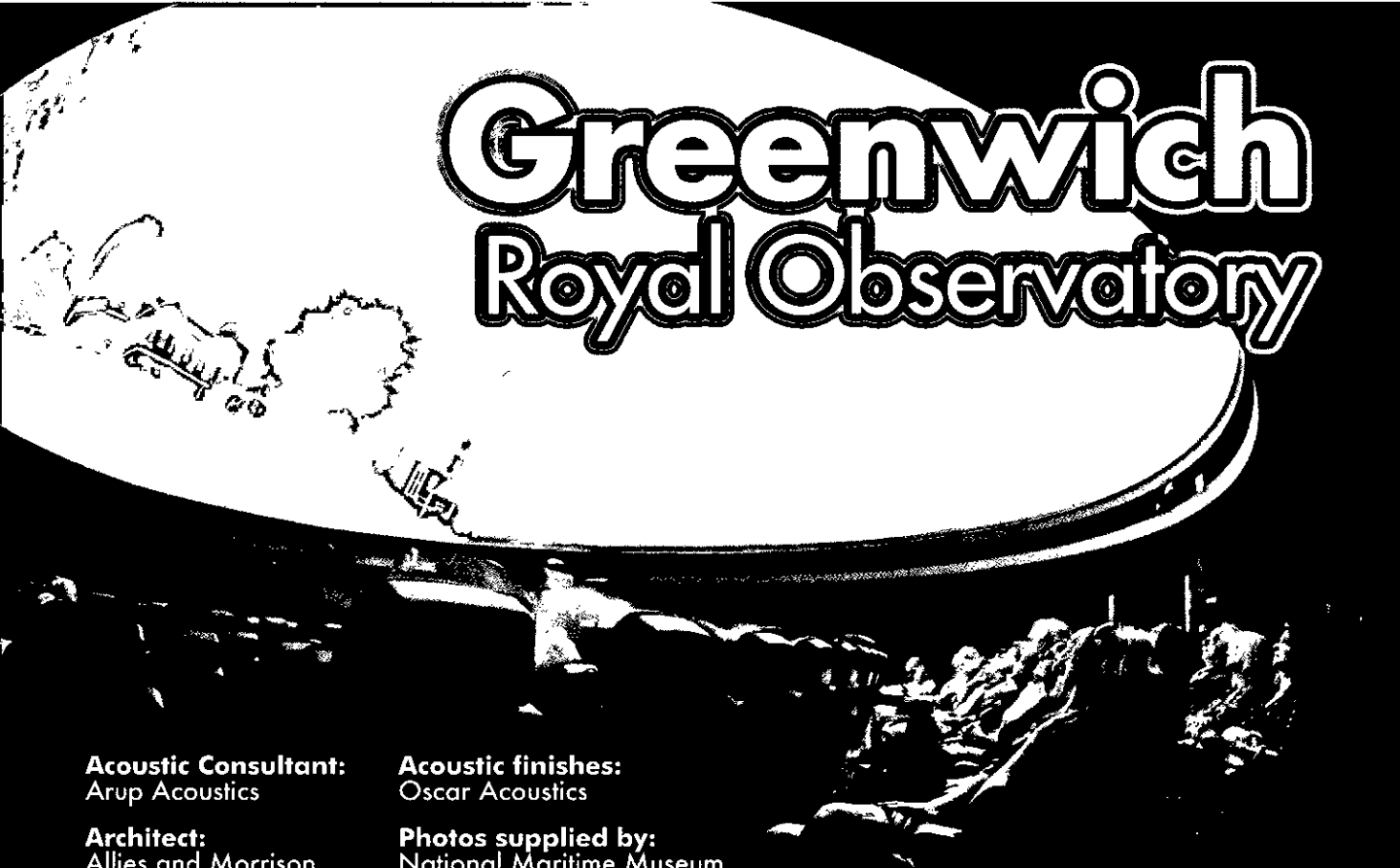
HER MAJESTY'S STATIONERY OFFICE 1972 52p NET

Figure 03

The famous 'yellow code' was introduced in 1972

Exposure duration hours per day	Maximum sound level dB(A)
8	90
4	93
2	96
1	99
½	102
¼	105

Table 02



Greenwich Royal Observatory

Acoustic Consultant:
Arup Acoustics

Acoustic finishes:
Oscar Acoustics

Architect:
Allies and Morrison

Photos supplied by:
National Maritime Museum

SonaSpray & Sonacoustic, the chosen acoustic finishes for the Greenwich Royal Observatory

SonaSpray K-13 Black was specified for application to the inner face of the concrete planetarium at 50mm thick. Its excellent absorption, through colour, one coat application, plus it had already been proven at the National Space Centre's planetarium in Leicester, made it the ideal product.

Sonacoustic was specified for the barrel vaults in the refurbishment of the 1890's South Building, now a learning centre and gift shops. Sonacoustic PL achieves the required acoustic environment whilst appearing as normal plaster.

Solutions for every acoustic problem...

- Excellent acoustic performance
- Full range of seamless acoustic decorative finishes
- Class 0 to BS476 Part 6 fire rated
- Application to most substrate configuration
- Large colour choice
- Manufactured from recycled materials

Other available products...

- SoundBlox - Acoustic building blocks
- SonaCel - Floating sound barrier systems
- SonaTherm - Acoustic thermal control
- SonaPanels - Attractive, innovative acoustic panels

Tel: 01474 873122
www.oscar-acoustics.co.uk

OSCAR
ACOUSTICS

An Inevitable Consequence - continued from page 28

the likelihood of hearing damage.

In 1972 the *Code of Practice for reducing the exposure of employed persons to Noise* was published, which again set down a level of 90dB(A) whilst emphasising that this did not guarantee protection of the most susceptible workers. This continued in effect without amendment until 31 December 1989. The Code

'...sets out recommended limits to noise exposure. It should be noted that, on account of the large inherent variations of susceptibility between individuals, these limitations are not in themselves guaranteed to remove all risk of noise-induced hearing loss.

The limits set out in this section should be regarded as maximum acceptable levels and not as desirable levels. Where it is reasonably practicable to do so it is desirable for the sound to be reduced to lower levels'.

The Courts

Notwithstanding the warnings about 90dB(A) not being the desirable maximum level the figure became stuck in the minds of both employers and the Courts as being a 'limit'. Lord Cameron of Lochbroom, in finding for the defenders (defendant) in the case of *McLeod v Wiggins Teape (Stationery) Ltd* in 1990, said he was not satisfied that the pursuer (claimant or plaintiff) *'... was subject to levels of noise beyond the maximum acceptable limit of 90dB(A), let alone for material periods of time such that the defenders had been under a duty to take reasonable care to protect her from risk of permanent damage to her hearing'.*

In 1983 at Newcastle-upon-Tyne Crown Court Mr Justice Mustill heard a case brought by shipyard workers - *Thompson and others v Smiths Shiprepairers and others*. It is significant because it effectively set the date - as was intended when bringing the group of actions - beyond which an employer would have become negligent: this was 1963. Broadly the judge's reasoning leading to that date was the publication of the two government documents (the *Wilson Report* and *Noise and the Worker*), the fact that ear protection had by then become available, and the fact that the noise could be measured. His decision has been largely accepted by claimants and defendants ever since [29].

One exception to the 1963 date is of particular interest, because it explains the whole principle behind the liability for negligence and why, as was suggested at the beginning of this article, it took 80 years to get proper protection for people's hearing at work. In May 1984 James Kellett brought an action against British Rail Engineering Ltd for damage to his hearing. The main facts - the plaintiff had been exposed to noise in his employment and had damaged his hearing - were agreed by both sides, so Mr Justice Popplewell was asked only to rule on a number of specific issues. Amongst these were the question of whether the defendant was negligent at any time since 1946, and if so, from what date?

The plaintiff and the defendant agreed that the principles to be adopted in determining negligence were those set out in an earlier case of *Stokes v Guest Keen and Nettlefolds* in 1968 (*Weekly Law reports* 1776 at page 1783). It is worth repeating that judgment verbatim:

'The overall test is still the conduct of the reasonable and prudent employer taking positive thought for the safety of his workers in the light of what he knows or ought to know. Where there is a recognised and general practice which has been followed for a substantial period in similar circumstances without mishap he is entitled to follow it unless in the light of common sense or newer knowledge it is clearly bad. But where there is a developing knowledge he must keep reasonably abreast of it and not be too slow to apply it and where there is in fact greater than average knowledge of the risks he may be thereby obliged to take more than average or standard precautions, he must weigh up the risk in terms of the likelihood of injury occurring and the potential consequences if it does and he must balance against this the probable ineffectiveness of the precautions that can be taken to meet it and the expense and inconvenience they involve. If he is found to have fallen below the standard to be properly expected of a reasonable and prudent employer in these respects he is negligent.'

Having examined the facts regarding BREL's actual knowledge of the situation as set out above, Mr Justice Popplewell concluded that from

1955 at the latest British Rail Engineering Ltd had been negligent in its lack of concern and action to protect the plaintiff.

Statute

The European Council Directive (86/188/EEC) of 12 May 1986 on the protection of workers from the risks related to exposure to noise at work started the road to legislation. This led to the *Noise at Work Regulations 1989* which came into force on 1 January 1990. In summary these stated that there was a general obligation on employers - irrespective of whether an employee's noise exposure exceeded the levels laid down in the regulations or not - to reduce the risk of damage to their hearing to the lowest level reasonably practicable. There was also an obligation to carry out a noise assessment in any areas where levels may exceed an $L_{EP,d}$ of 85dB.

Where noise levels were at an $L_{EP,d}$ of 90dB or more there was an obligation to reduce as far as was reasonably practicable - without resorting to the use of ear protection - the exposure to noise. In addition there was an obligation to provide suitable ear protectors and take all practicable steps to ensure they were worn, and generally to provide information, instruction and training to employees.

Where noise levels were less than 90dB $L_{EP,d}$ but were still 85dB or more, there was an obligation to provide suitable ear protection at the employee's request and to provide information, instruction and training to employees.

The *Noise at Work Regulations 1989* are now replaced by the *Control of Noise at Work Regulations 2005* which came into force for most employers last year.

The position for employees is now very much better than it was one hundred years ago but we should not think that everything has now been done. Thousands of people still have their hearing damaged at work either through their own thoughtlessness or ignorance, or worse, through their employer's negligence. Although negligence can be compensated in the civil courts that is of little consequence set against with the effect of hearing loss. Deafness is still a severely under-rated disability and it is not yet time to sit back and say that we have done all we can.

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

References

- [20] *Business*, April 1956
- [21] *Business*, September 1956
- [22] *Times Review of Industry*, 1958
- [23] *Personnel Management*, vol.41, no.350 December 1959
- [24] *Noise in Factories*, Department of Scientific and Industrial Research, 1960
- [25] *Noise - Final Report*, HMSO, 1963
- [26] *Noise and the Worker*, Ministry of Labour, 1963
- [27] Burns W and Robinson D W. *Hearing and Noise in Industry* HMSO 1970
- [28] *Occupational Hearing Loss 1971* (edited by D W Robinson) Academic Press
- [29] *Thompsons v Smiths Ship Repairers: Decision of Mr Justice Mustill 1984* *Weekly Law Reports* p522.

Using Vibration Analysis to Detect Early Failure of Bearings

S J Lacey.

Vibration produced by rolling bearings can be complex and can result from geometrical imperfections during the manufacturing process, defects on the rolling surfaces or geometrical errors in associated components. Noise and vibration is becoming more critical in all types of equipment since it is often perceived to be synonymous with quality and often used for predictive maintenance.

Rolling contact bearings are used in almost every type of rotating machinery, whose reliable operation very much depends on the type of bearing selected and the precision of associated components such as shafts, housings, spacers and nuts.

Bearing engineers generally use fatigue as the normal failure mode, on the assumption that the bearings are properly installed, operated and maintained. Today, because of improvements in manufacturing technology and materials, bearing fatigue life (which is related to sub-surface stresses) is not the limiting factor, and accounts for less than 3% of failures in service.

Unfortunately, many bearings fail prematurely in service because of contamination, poor lubrication, misalignment, temperature extremes, poor fitting, unbalance and misalignment. All these factors lead to an increase in bearing vibration and so condition monitoring has been used for many years to detect degrading bearings before they catastrophically fail, resulting in associated downtime costs or significant damage to other parts of the machine.

Rolling element bearings are often used in noise-sensitive applications, such as household appliances and electric motors, which often use small to medium size bearings. Bearing vibration is therefore becoming increasingly important from both an environmental consideration and because it is synonymous with quality.

It is now generally accepted that quiet running is synonymous with the form and finish of the rolling contact surfaces. As a result, bearing manufacturers have developed vibration tests as an effective method for measuring quality. A common approach is to mount the bearing on a quiet running spindle and measure the radial velocity at a point on the bearing's outer ring in three frequency bands, 50 to 300 Hz, 300 to 1,800 Hz, and 1.8 to 10 kHz. The bearing must meet rms velocity limits in all three frequency bands.

In the process industries, vibration monitoring is now a well-accepted part of many planned maintenance regimes and relies on the well-known characteristic vibration signatures which rolling bearings exhibit as the rolling surfaces degrade. However, in most situations, bearing vibration cannot be measured directly and so the bearing vibration signature is modified by the machine structure. This situation is further complicated by vibration from other equipment on the machine such as electric motors, gears, belts, hydraulics, structural resonance, and so on. This often makes the interpretation of vibration data difficult other than by a trained specialist and can in some situations lead to a misdiagnosis, resulting in unnecessary machine downtime and costs.

Sources of Vibration

Rolling contact bearings represent a complex vibration system whose components (rolling elements, inner raceway, outer raceway and cage) interact to generate complex vibration signatures.

Although rolling bearings are manufactured using high precision machine tools and strict quality controls, they inevitably will have degrees of imperfection and generate vibration as the surfaces interact, through a combination of rolling and sliding.

Although the amplitudes of surface imperfections are now in the order of nanometers, significant vibrations can still be produced in the entire audible frequency range (20Hz to 20kHz). The level of the vibration will

depend upon many factors including the energy of the impact, the point at which the vibration is measured and the construction of the bearing.

Variable compliance

Under radial and misaligning loads, bearing vibration is an inherent feature of rolling bearings, even if the bearing is geometrically perfect and is not therefore indicative of poor quality. This type of vibration is often referred to as 'variable compliance' and occurs because the external load is supported by a discrete number of rolling elements whose position with respect to the line of action of the load continually changes with time.

Variable compliance vibration is heavily dependant on the number of rolling elements supporting the externally applied load; the greater the number of loaded rolling elements, the less the vibration. For radially loaded or misaligned bearings 'running clearance' determines the extent of the load region, and hence, in general, variable compliance increases with clearance.

Geometrical imperfections

Because of the very nature of the manufacturing processes used to produce bearing components, geometrical imperfections will always be present to varying degrees depending on the accuracy class of the bearing. For axially loaded ball bearings operating under moderate

continued on page 32

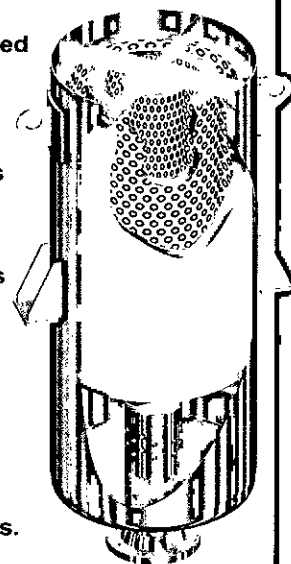
FLO-DYNE



Industrial Silencers & Pulsation Dampeners designed and manufactured for:

- Atmospheric Vents
- Vent Valves
- Control Valves
- Pressure Reducing Stations
- Blow Down Duties
- Rotary Blowers & Compressors
- Reciprocating Compressors
- Exhausters & Blowers
- Liquid & Hydraulic Pumps

We also specialise in the design, manufacture and installation of Surge control equipment for potable and waste water pumping stations. ISO9001 Registered.



Flo-Dyne Place, Asheridge Business Centre
Asheridge Road, Chesham, HP5 2PT

Tel: +44 (0) 1494 770088 Fax: +44 (0) 1494 770099

Email: sales@flo-dyne.net

Web: www.flo-dyne.net

Using Vibration Analysis ... - continued from page 31

speeds, the form and surface finish of the critical rolling surfaces are generally the most significant source of noise and vibration. Controlling component 'waviness' and surface finish during the manufacturing process is therefore critical, since it may not only have a significant effect on vibration but also may affect bearing life.

It is convenient to consider geometrical imperfections in terms of wavelength compared with the width of the rolling element-raceway contacts. Surface features of wavelength of the order of the contact width or less are termed roughness, whereas longer wavelength features are termed waviness.

Surface roughness

Surface roughness is a significant source of vibration when its level is

high compared with the lubricant film thickness generated between the rolling element-raceway contacts.

Under this condition, surface asperities can break through the lubricant film and interact with the opposing surface, resulting in metal-to-metal contact. The resulting vibration consists of a random sequence of small impulses, which excite all the natural modes of the bearing and supporting structure.

Waviness

For longer wavelength surface features, peak curvatures are low compared with those of the Hertzian contacts, and rolling motion is continuous with the rolling elements following the surface contours. The relationship between surface geometry and vibration level is complex and is dependent upon the bearing and contact geometry, as well as conditions of load and speed. Waviness can produce vibration

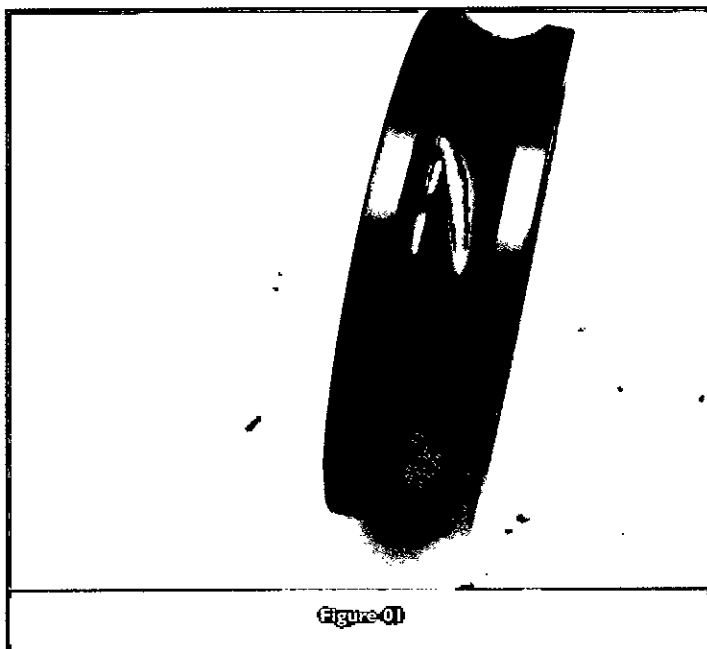


Figure 01

Geometrical imperfections can cause excessive noise in bearings

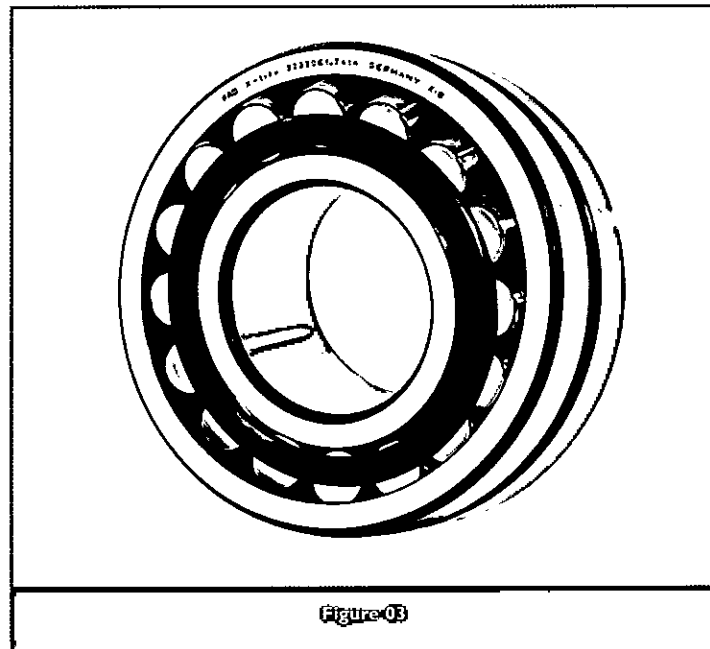


Figure 03

Typical rolling element bearing



Figure 02

Markings resulting from inadequate lubrication where surface roughness is present

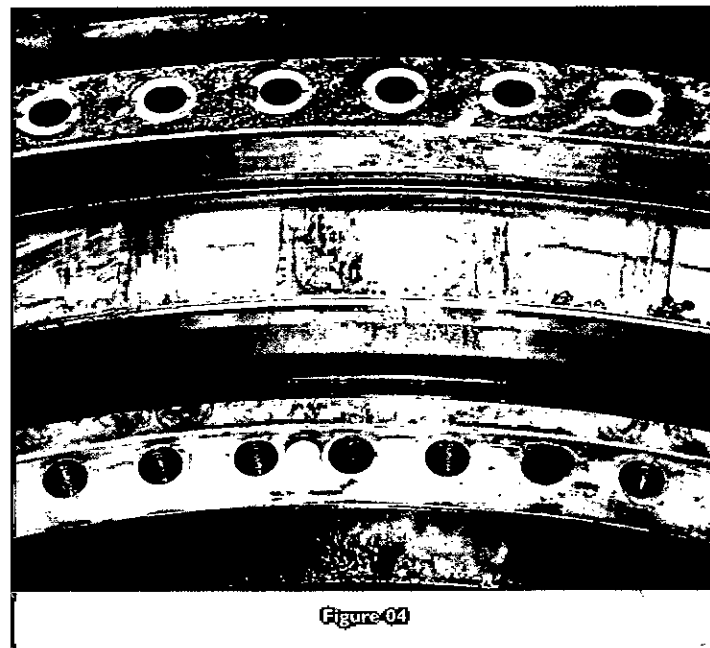


Figure 04

A discrete fault on the outer raceway can generate a series of high-energy pulses

at frequencies up to around 300 times rotational speed but it is usually predominant at frequencies below 60 times rotational speed.

For typical bearing surfaces, poor correlation of parallel surface heights profiles only exists at shorter wavelengths. Even with modern precision machining technology, waviness cannot be eliminated completely and an element of waviness will always exist albeit at relatively low levels.

As well as the bearing itself, the quality of the associated components can also affect bearing vibration and any geometrical errors on the outside diameter of the shaft or bore of the housing can be reflected on the bearing raceways with the associated increase in vibration. Therefore, careful attention is required to the form and precision of all associated bearing components.

Discrete defects

Whereas surface roughness and waviness result directly from the bearing component manufacturing processes, the term 'discrete defects' refers to damage of the rolling surfaces due to assembly, contamination, operation, mounting, or poor maintenance. These defects can be extremely small and difficult to detect and yet can have a significant impact on vibration-critical equipment or can result in reduced bearing life. This type of defect can take a variety of forms, including indentations, scratches along and across the rolling surfaces, pits, debris, and particles in the lubricant.

Bearing Characteristic Frequencies

Although the fundamental frequencies generated by rolling bearings are related to relatively simple formulae, they cover a wide frequency range and can interact to give very complex signals. This is often further complicated by the presence of other sources of mechanical, structural or electromechanical vibration on the equipment.

The bearing equations assume that there is no sliding and that the rolling elements roll over the raceway surfaces. However, in practice, this is rarely the case and owing to a number of factors the rolling elements undergo a combination of rolling and sliding. As a consequence, the actual characteristic defect frequencies may differ slightly from those predicted, but this is very dependent on the type of bearing, operating conditions and fits.

Since most vibration frequencies are proportional to speed, it is important when comparing vibration signatures that data is obtained at identical speeds. Speed changes will cause shifts in the frequency spectrum causing inaccuracies in both the amplitude and frequency measurement. Often in variable speed equipment, spectral orders may be used where all the frequencies are normalised relative to the fundamental rotational speed. This is called 'order normalisation' where the fundamental frequency of rotation is called the first order.

Analysis of bearing vibration signals is usually complex and the frequencies generated will add and subtract and are almost always present in bearing vibration spectra. This is particularly true where multiple defects are present.

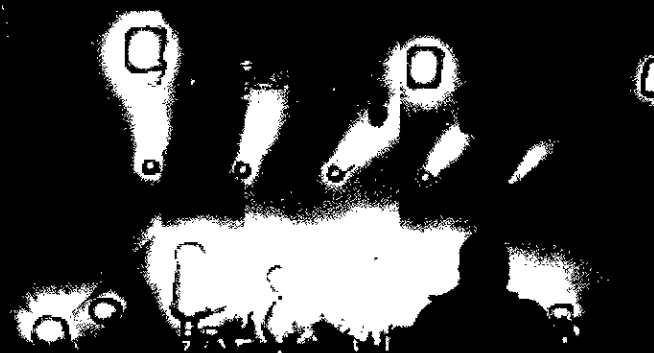
However, depending upon the dynamic range of the equipment, background noise levels and other sources of vibration bearing frequencies can be difficult to detect in the early stages of a defect. But, over the years, a number of diagnostic algorithms have been developed to detect bearing faults by measuring the vibration signatures on the bearing housing. Usually, these methods take advantage of both the characteristic frequencies and the 'ringing frequencies' (ie natural frequencies) of the bearing.

Raceway defect

A discrete defect on the inner raceway will generate a series of high energy pulses at a rate equal to the ball pass frequency relative to the inner raceway. Because the inner ring is rotating, the defect will enter

the sound of music

for some it's entertainment, for others it's a nuisance.



Cirrus has a range of Sound Level Meters, Noise Dosemeters and Noise Monitors ideal for the measurement and control of noise from entertainment venues, pubs and clubs, all covered by our industry-leading 12 year warranty.



Contact us for more information



www.cirrusresearch.co.uk

Sound Level Meters | Personal Noise Dosemeters
Environmental Noise Analysers | Permanent Noise Monitors
T: 01723 891655 | F: 01723 891742 | Email: sales@cirrusresearch.co.uk

continued on page 34

Using Vibration Analysis ... - continued from page 33

and leave the load zone causing a variation in the rolling element-raceway contact force, hence deflections. While it is in the load zone the amplitudes of the pulses will be highest, but they reduce as the defect leaves the load zone resulting in a signal which is amplitude-modulated at inner ring rotational frequency.

A discrete fault on the outer raceway will generate a series of high energy pulses at a rate equal to the ball pass frequency relative to the outer ring. Because the outer ring is stationary the amplitude of the pulse will theoretically remain the same, and so will appear as a single discrete peak within the frequency domain.

Rolling element defect

Defects on the rolling elements can generate a frequency at twice ball spin frequency and harmonics, and at the fundamental train frequency. Twice the rolling element spin frequency can be generated when the defect strikes both raceways, but sometimes the frequency may not be as high as this, because the ball is not always in the load zone when the defect strikes and energy is lost as the signal passes through other structural interfaces as it strikes the inner raceway. Furthermore, when a defect on a ball is orientated in the axial direction it will not always contact the inner and outer raceway and thus the defect may be difficult to detect.

Cage defect

The bearing cage tends to rotate at typically 0.4 times inner ring speed, has a low mass and therefore, unless there is a defect from the manufacturing process, is generally not visible.

Unlike raceway defects, cage failures do not usually excite specific ringing frequencies and this limits the effectiveness of the envelope spectrum. In the case of cage failure, the signature is likely to have random bursts of vibration as the balls slide and the cage starts to wear or deform and a wide band of frequencies is likely to occur.

Other sources of vibration

Contamination is a very common source of bearing deterioration and premature failure and is due to the ingress of foreign particles, either as a result of poor handling or during operation.

By its very nature, the magnitude of the vibration caused by contamination will vary and in the early stages it may be difficult to detect, but this depends very much on the type and nature of the contaminants. Contamination can cause wear and damage to the rolling contact surfaces and generate vibration across a broad frequency range. In the early stages the crest factor of the time signal will increase, but it is unlikely that this will be detected in the presence of other sources of vibration.

Vibration Measurement

Vibration measurement can be generally characterised as falling into one of three categories: detection, diagnosis and prognosis.

Detection generally uses the most basic form of vibration measurement, where the overall vibration level is measured on a broadband basis in a range, for example, 10Hz to 1kHz or 10Hz to 10kHz. In machines where there is little vibration other than from the bearings, the spikiness of the vibration signal indicated by the crest factor (peak/rms) may imply incipient defects, whereas the high energy level given by the rms level may indicate severe defects.

Generally, other than to the experienced operator, this type of measurement gives limited information but can be useful when used for trending, where an increasing vibration level is an indicator of a deteriorating machine condition. Trend analysis involves plotting the vibration level as a function of time and using this to predict when the machine must be taken out of service for repair. Another way of using

the measurement is to compare the levels with published vibration criteria for different types of equipment.

Although broadband vibration measurements may provide a good starting point for fault detection the technique has limited diagnostic capability: although a fault may be identified there may be no reliable indication of where the fault is, such as bearing deterioration, bearing damage, unbalance, misalignment, and so on. Where an improved diagnostic capability is required, frequency analysis is normally used, which usually gives a much earlier indication of the development of a fault and also the source of the fault.

Having detected and diagnosed a fault, the prognosis (ie the estimated remaining useful life and the possible failure mode of the machine or equipment) is much more difficult and often relies on the continued monitoring of the fault to determine a suitable time when the equipment can be taken out of service. Alternatively, experience with similar problems can be relied on.

Overall vibration level

This is the simplest way of measuring vibration and usually consists of measuring the rms vibration of the bearing housing or some other point on the machine with the transducer located as close as possible to the bearing.

The technique involves measuring the vibration over a wide frequency range eg 10Hz to 1kHz or 10Hz to 10kHz. The measurements can be trended over time and compared with known levels of vibration, or pre-alarm and alarm levels can be set to indicate changes in the machine condition.

Alternatively, measurements can be compared with general standards. Although this method represents a quick and low cost method of vibration monitoring, it is less sensitive to incipient defects: it only detects defects in an advanced condition and has a limited diagnostic capability. It is also easily influenced by other sources of vibration such as unbalance, misalignment, looseness, and electromagnetic vibration.

Frequency spectrum

Frequency analysis plays an important part in the detection and diagnosis of machine faults. In the time domain the individual contributions of unbalance, gears, etc to the overall machine vibration are difficult to identify. In the frequency domain they become much easier to see and can therefore more easily be related to individual sources of vibration. A fault developing in a bearing will show up as increasing vibration at a characteristic frequency making detection possible at a much earlier stage than with overall vibration.

Envelope spectrum

When a bearing starts to deteriorate the resulting time signal often exhibits characteristic features, which can be used to detect a fault. Bearing condition can rapidly progress from a very small defect to complete failure in a relatively short period of time, so early detection requires sensitivity to very small changes in the vibration signature.

The vibration signal from the early stage of a defective bearing may be masked by machine noise making it difficult to detect the fault by spectrum analysis alone. The main advantage of envelope analysis is its ability to extract the periodic impacts and the modulated random noise from a deteriorating rolling bearing. This is even possible when the signal from the rolling bearing is relatively low in energy and 'buried' within other vibration from the machine.

Dr S J Lacey is engineering manager of Schaeffler (UK) Ltd, Sutton Coldfield

Creeping Background

Richard Collman. An urban myth?

Different Local Authorities (and other specifiers such as acoustic consultants) set widely varying limits for noise. Where a limit is set relative to the background noise level (BNL) in dB(A) it may vary between 10dB below the BNL to 5dB above. This variation does not depend upon any objective criteria but simply on who sets the limit. Surely this cannot be right?

If this is not bizarre enough there is another factor that can increase the variation by a further 5dB. In many cases a 5dB 'rating penalty' is applied if the noise contains acoustically distinguishing characteristics such as tonality or impulsiveness (on the basis of BS.4142:1997). This is primarily a subjective assessment which means that for borderline cases some individuals will apply a penalty and others will not.

The limit for noise from a source that has slight acoustically distinguishing characteristics may vary from 15dB below the BNL (based on 10dB below less a further 5dB rating penalty) to 5dB above the BNL (if no rating penalty is felt to be appropriate). As Chart 1 shows, what is specified as a 'suitable' noise level may therefore vary by up to 20dB(A) for the same noise source.

It is appropriate to set a 'suitable' noise level for a source at a specific location that takes account of the proximity of other noise-sensitive locations and the acoustic sensitivity of the surrounding area. However, the 20dB variation above is location-dependent, based upon who sets the limit, taking no account of proximity or sensitivity. If different sides of a street were to fall within different Local Authorities who adopted

policies at either end of the range above, it is conceivable that the permissible noise level from a piece of equipment may vary by 20dB(A) depending solely on which side of the street it happens to be located. For large items of equipment this could cost tens of thousands of pounds, or even prevent the installation of the equipment owing to the difficulty of achieving the 'suitable' noise level.

Why specify 10dB below background?

Usually one (or both) of the following reasons are given for setting a limit 10dB below BNL:

- BS.4142:1997 states this indicates that 'complaints are unlikely';
- In order to prevent 'creeping background'.

It is worth looking into both of these more closely.

BS.4142:1997 'Method for rating industrial noise affecting mixed residential and industrial areas' states that if the rating level (source noise level with a 5dB rating penalty, if appropriate) is at least 10dB below the BNL, this is a 'positive indication that complaints are unlikely'. It also states that if the rating level exceeds the BNL by 5dB this is of 'marginal significance' and that if the difference is 10dB 'complaints are likely'.

continued on page 36

Product Development Technologist

Salary up to £35k + bonus + benefits • North West

Our client has more than 100 production plants in over 30 countries worldwide. With an annual turnover in excess of 3 billion Euros, it is one of the largest independent European building materials groups and the market leader in the UK. Short, direct decision making paths, courage to tackle new ideas and commitment to long term investment in the business make them one of the UK's most exciting companies to work for.

The Technologist will be part of a development group responsible for the technical development of the company's manufacturing sites across the UK and Europe. The Product Development Technologist will design and develop building systems to provide insulation based solutions - acoustic and/or thermal, developing both new applications for the current product range and new products for existing and alternative markets. You will arrange full scale plant trials, evaluate results and ensure that products achieve certification and approval for use in the country and market in which they are intended for launch. Your work will therefore require a reasonable amount of UK and European travel.

To be successful in this position, you should have a degree or equivalent experience in physics, material science or building science and have held a previous role in product development or within a physical testing laboratory. A proven record of project managing the introduction of new products is essential and an ability to speak French or other European languages would be of help in the role.

You should possess excellent communication skills, be comfortable working with a high degree of autonomy and be able to demonstrate a degree of creativity in your work to date. You will work well with others and be comfortable communicating with more senior colleagues. Practical building/DIY skills would be useful, as the role may involve design and operation of test rigs to evaluate building systems.

Remuneration is highly competitive and career prospects excellent within this international group.

Please reply in confidence sending your CV and current salary details, preferably by e-mail and quoting reference PMM210 in the subject field to: phil.mcmahon@ellisonsage.co.uk or alternatively by post to: Phil McMahon, EllisonSage Search & Selection, The Gables, Station Road, Haxby, York, YO32 3LU. Tel: 01904 768008.


EllisonSage
search & selection

Creeping Background - continued from page 35

At first glance this may appear to provide firm support for 10dB below BNL, however, things are not quite so clear-cut. The 20dB(A) variation identified earlier arises from different interpretations of BS.4142 because, applying the same standard, an alternative perspective is that a noise source which exceeds the BNL by 5dB ('marginal significance') is suitable. Although there is a connection between the likelihood of complaints and the level by which a noise source exceeds the BNL there are other, often more significant, factors to consider.

If a noise source is perceived to be unavoidable and possibly beneficial, it is less likely that complaints will be made for the same level of noise than for a source which is perceived to be unnecessary, is easily prevented, or has other adverse consequences. One example may be that someone relaxing in their garden may be able to hear their neighbour playing music in their garden. It is more likely that they will ask their neighbour to 'turn it down' if they strongly dislike the music than if they have similar musical preferences. The likelihood of a complaint depends on the musical preference of the potential complainant not solely on the (absolute, or relative to background) loudness of the music in their garden. The likelihood of complaint will also tend to vary depending upon the frequency of the occurrence and on the relationship between the neighbours.

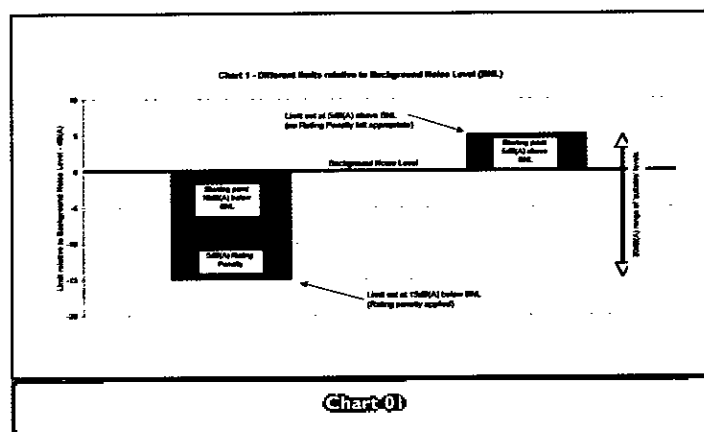
The BS.4142 methodology originated in the 1960s when there were far more sources of 'industrial' noise, particularly located relatively close to dwellings. Simplistically, it considers the intrusiveness or otherwise of noise from a factory at the (nearby) houses during lulls in the residual noise level when residents would ordinarily expect the ambient noise level to fall. In the 1960s there were also fewer sources of mechanical noise within dwellings. As the title makes clear it is intended for the assessment of 'industrial' noise affecting mixed residential and industrial areas. It is not intended for other applications. It also specifically considers the noise level outdoors and excludes consideration of indoor noise levels, which are more likely to be relevant during the night when the main concern will usually be to protect residents against sleep disturbance.

It is fairly clear that a metal turret punch press is a source of 'industrial noise'. However, is a small ventilation fan also an 'industrial' noise source? Houses generally have boilers, pumps, refrigeration compressors and other motors (washing machines etc) operating intermittently throughout the day and night. They (or their neighbours) may also have air-conditioning units or ventilation fans, particularly during the summer, when people are more likely to be sleeping with open bedroom windows.

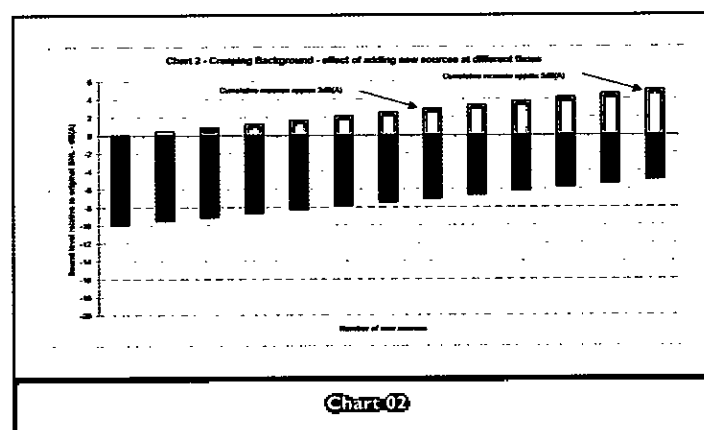
When does a domestic noise source become industrial? Is it simply a question of scale or is it more to do with the character of the noise? If it is a question of scale, then the distance separating the noise source and noise sensitive locations, and any other factors affecting the propagation path, must also be considered because this may affect the level of noise at the noise-sensitive locations to a greater extent than the size of the equipment.

It is not appropriate to simply apply the BS.4142 assessment methodology to the noise from any item of equipment regardless of its characteristics. This means that applying a blanket '10dB below BNL' criterion to the noise from mechanical equipment because BS.4142 states that complaints are unlikely is unreasonable and often likely to result in an unnecessarily low noise level being specified.

'**Creeping background**' is the phenomenon by which the ambient noise level at a location is gradually increased by a significant amount,



What is considered a 'suitable' noise level may vary by up to 20dB



Seven 'new' noise sources each producing a level 10dB below background are needed to produce a cumulative level the same as the pre-existing background

due to the addition of multiple noise sources over time, each of which only slightly raises the then existing ambient noise level. The aim of specifying a limit of 10dB below the background noise level is to ensure that any new noise source has negligible effect on the existing BNL. It is clear that if ten new noise sources were installed simultaneously, each producing a level 10dB below the BNL, the cumulative level of noise from these would be the same as the pre-existing BNL. If the noise sources are installed over a period of time, each will raise the BNL against which each subsequent noise source would be compared. Chart 2 shows that in this case it would require seven new noise sources, each of which produces a level that is 10dB below the BNL at the time that source is introduced, for the cumulative level of noise from these to be the same as the pre-existing BNL.

As with BS.4142, at first glance this effect appears to provide firm support for 10dB below the BNL but again, other factors must also be considered. In most cases, the level of noise from a new source will tend to be controlled by one of the nearest noise-sensitive locations. This means that noise sources at different premises are likely to be controlled by different noise-sensitive locations. Sketch 1 shows a plan of different noise-producing and noise-sensitive locations, in relatively close proximity to each other as would be typical of urban locations. This shows that only two or three noise sources are typically controlled by the same noise-sensitive location, and that different noise sources at the same premises may even be controlled by different noise-sensitive locations. The noise level at other locations will generally be lower owing to the increased distance and different acoustical screening to the other locations. This means that in order for several different noise sources to produce the maximum permissible

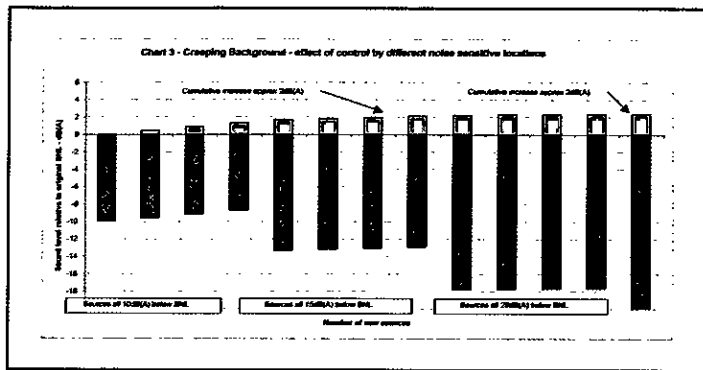


Chart 03

The noise level at any one location will be affected by the closest noise sources, but the effect of noise sources closer to other noise-sensitive locations will be negligible

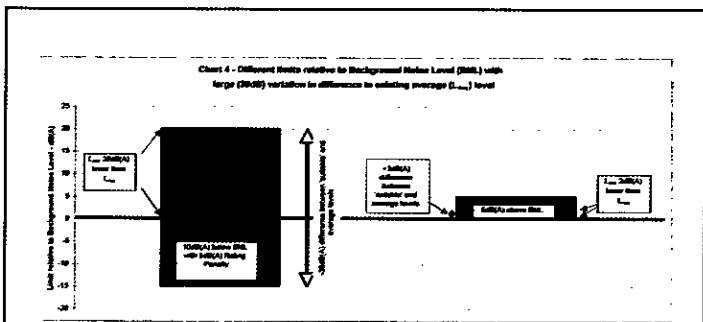


Chart 04

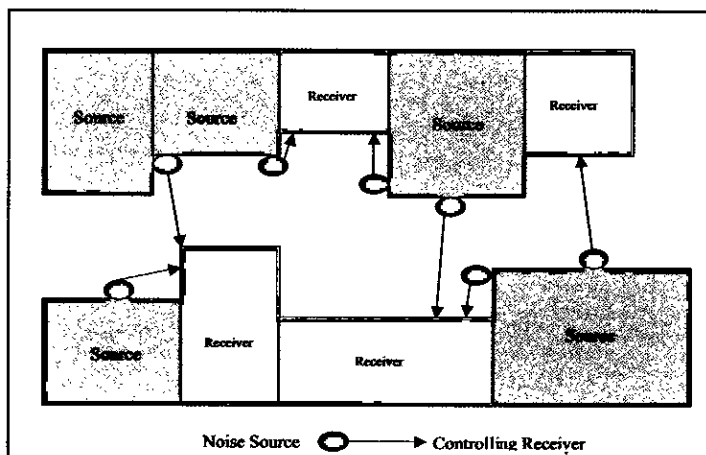
A criterion of 10dB below BNL with a 5dB rating penalty against an L_{Aeq} that is 20dB above the BNL. In this case the 'suitable' level is 35dB below the L_{Aeq} .

level at the same noise-sensitive location, ie for them to be controlled by this location, it needs to be one of the closest locations to all of these different noise sources.

Chart 3 shows that the result is that the noise level at any one location will be affected by the closest noise sources, but the effect of noise sources that are closer to other noise-sensitive locations will be negligible. In this case the first four noise sources are controlled by the location being considered. The next four noise sources are further away, so that the resultant noise level at this location is 5dB lower than at the controlling location. Similarly the next four source levels are 10dB lower. Particularly in urban locations, where noise sources and noise sensitive locations are relatively densely packed, creeping background would seem to be of limited significance.

Background or average noise level?

There is no fixed relationship between the BNL (L_{A90}) and the average (L_{Aeq}) level at any location. The L_{A90} is specifically intended to exclude most (90%) of the residual noise level, indicating the level prevailing for the quietest 10% of the time. For a location with a relatively steady



Sketch 01

Plan of different noise-producing and noise-sensitive locations in relatively close proximity to each other

ambient noise level the L_{A90} and L_{Aeq} will be similar. At a location beside a reasonably busy road the L_{A90} will exclude the noise of vehicles passing the listener, whereas the L_{Aeq} will mainly reflect the noise from these vehicles, largely ignoring the effect of the quieter periods. In this case it is quite possible that the two parameters will differ by more than 20dB.

The point of this is that any comparison between the (average) noise level from a new source and the existing BNL will totally ignore the difference between the average noise levels of the new source and existing situation. Where the existing L_{A90} and L_{Aeq} are similar, a level that is 10dB below the BNL will be only slightly more than 10dB below the existing L_{Aeq} . Where the existing L_{A90} is more than 20dB below the existing L_{Aeq} , a target noise level of 10dB below the BNL will be more than 30dB lower than the existing L_{Aeq} .

Chart 4 shows a criterion of 10dB below BNL with a 5dB rating penalty against an L_{Aeq} that is 20dB above the BNL. In this case the 'suitable' level is 35dB below the L_{Aeq} . The second case shows a criterion of 5dB above the BNL, with no rating penalty and the L_{Aeq} only 2dB above the BNL. In this case the 'suitable' level is 3dB above the L_{Aeq} . This means that in these two cases there is a variation of 38dB in the difference between the 'suitable' level and existing L_{Aeq} . Is this reasonable?

When is a rating penalty appropriate?

Graphs 1 and 2 show two very different acoustical environments, both with the same BNL, but with L_{Aeq} values differing by 14dB. They also show the noise from a condensing unit, producing an average level of 40dB(A) whilst operating, equating to a rating level of 30dB(A) (or 35dB(A) if a 5dB rating penalty were applied) based on 30 seconds of operation during a five-minute period. The lower condensing unit noise

continued on page 38

notified body : laboratory : site : building acoustics : dedicated pre-completion testing team



Fire Acoustics Structures

0115 945 1564
www.btconline.co.uk
btc.testing@bpb.com



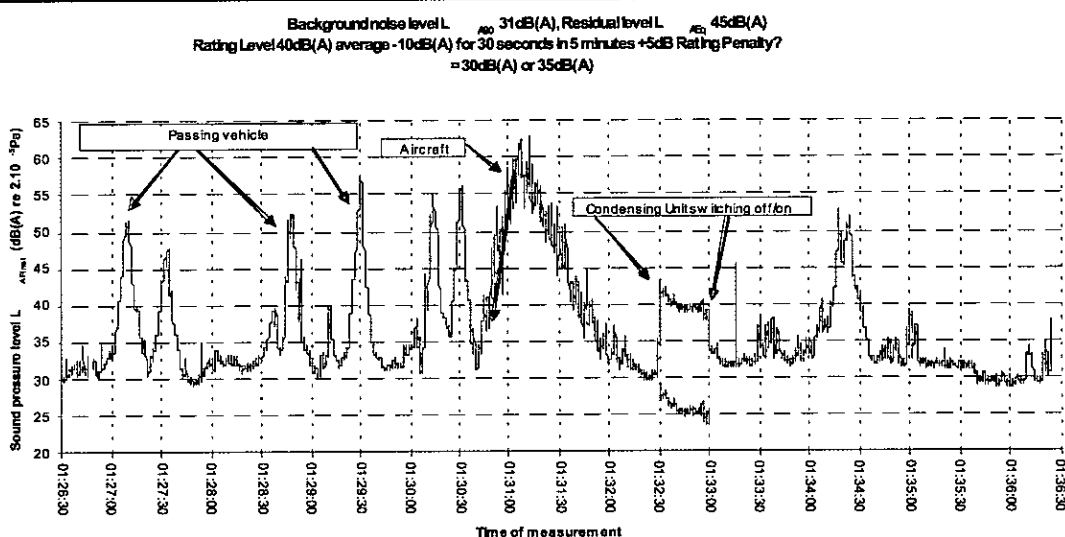
Creeping Background - continued from page 37

profile shows the level if it is attenuated to 10dB below the BNL (with a 5dB rating penalty). In both of these cases the difference between the source and background noise levels is the same, yet the intrusiveness (or otherwise) of noise from the condensing unit varies significantly.

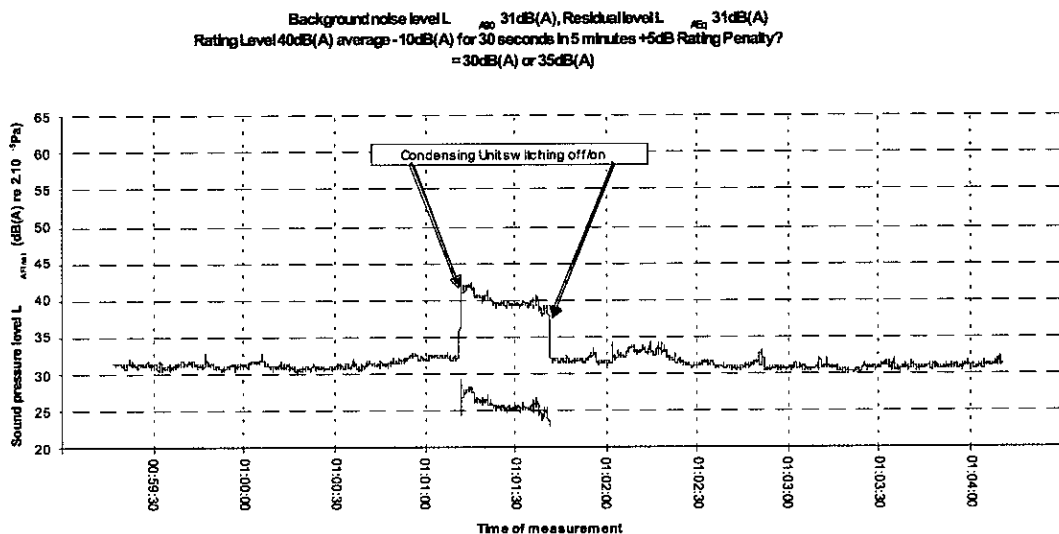
Is it appropriate to apply a rating penalty to a noise source that is 10dB below the BNL at the nearest noise sensitive location? Noise from the source may have acoustically distinguishing characteristics when it is at a level at which it can readily be heard. However, if the noise level from the source is masked by the residual noise, it is likely that any acoustically distinguishing characteristics will be similarly masked so that it is not then appropriate to apply a rating penalty.

For example, a condenser may have eight or ten fans that are switched

on and off in pairs to suit the thermal load on the equipment. When the first pair of fans is switched on or off, the change in level may be noticeable when close to the unit. However, at the noise-sensitive location the effect will be less noticeable because of the reduced noise level of the two fans with the increased distance. When the second pair of fans is switched on or off the difference is less noticeable because of the noise from the first pair of fans, and so on for the remaining pairs of fans. This means that although the overall noise level with all fans running may indicate that the plant switching on or off will be noticeable, the fact that the maximum noise level is reached in stages will overcome the potential intrusiveness of fans switching suddenly. As BS4142 makes clear, the decision whether to apply a rating penalty or not should be based on the characteristics of the noise at the appropriate noise sensitive locations, not close to the noise source itself.

**Graph 01**

Existing ambient sound level at rear of Store

**Graph 02**

Existing ambient sound level at rear of Store

What happens if equipment is relocated or replaced?

If equipment is to be replaced it is common practice to require an acoustical assessment of the noise from the new plant. This provides an opportunity to install quieter equipment if the original equipment is found to produce an unsuitably high level of noise — so far, so good.

If plant is to be relocated it may also be appropriate to undertake an acoustical assessment to check the suitability of the level of noise from the plant at the new location. If relocating the plant will result in an unsuitable level of noise at the new location, this can be addressed as part of the plant relocation.

Similarly, if the plant currently produces an unsuitable level of noise and is being relocated close to the current position, this can provide an opportunity to ensure that the relocated plant then achieves a suitable noise level.

However, what if the existing noise level produced by the plant is similar to the existing BNL, approximately 15dB below the existing residual (average) noise level and complies with other guidance suggesting suitable levels of noise from the plant? Is it then appropriate to require the noise level from the plant to be reduced by a further 10dB, which may be impracticable to achieve, when the plant may only be relocated a few metres and currently achieves an arguably 'suitable' noise level?

Is 10dB below the BNL reasonable?

For a planning condition to be valid it must pass six tests. One of these is that the condition is reasonable. The discussion above shows that in most cases a blanket requirement for the rating level of a new noise source to be at least 10dB below the background noise level is not reasonable. It follows that any planning condition based on this premise is invalid.

Is 10dB below the BNL enforceable?

Another test that planning conditions must pass is that they are enforceable. In order to enforce a condition it is necessary to be able to (accurately) verify whether or not the condition is being complied with, ie whether the noise level from a source exceeds or complies with the specified limit. Where there is a significant distance between a noise source and noise-sensitive location it may be possible to measure the source noise level closer to the source, correct this measurement for the effect of the residual noise level and then calculate the corresponding source noise level further away.

However, given the variation between BNL and residual L_{Aeq} , it is not simply a case of getting close enough to the source so that the source noise level is at least 3dB (ideally at least 10dB) above the BNL. It may be necessary to get close enough to the source so that the source noise level exceeds the residual L_{Aeq} by this margin, with the residual L_{Aeq} being 10dB to 20dB above the BNL. In this case the source noise level will have to be around 20dB to 30dB above the BNL. In order to achieve this, the measurements may need to be taken between 1/32 and 1/100 of the distance from the source to the nearest noise-sensitive location. If the nearest noise-sensitive location is 30m away, the measurements may need to be taken within 0.94m or possibly even 0.3m of the source. This is likely to be in the 'near field' which adds further complexity to the situation. For noise-sensitive locations that are closer to the noise source (usually the case in urban areas) this problem is even worse: eg if the noise-sensitive location is 10m away the measurements must be taken within 0.31m or possibly 100mm of the noise source.

The residual noise level also often fluctuates significantly with time, so that any measurement of the source including the residual noise level must also provide sufficient differential that the variations in the residual noise level do not affect the accuracy of the measurements by an unacceptable amount.

These difficulties mean that in many cases it will not be possible reliably to ascertain whether a noise source is 10dB below the BNL or close to it. One technique that may assist is to measure the L_{A90} and L_{Aeq} of the source and then measure the difference further from the source. However, in urban areas where the source is close to the nearest noise-sensitive locations this is still likely to result in considerable uncertainty in the actual source noise level.

If it cannot accurately be determined whether the source noise level is 5dB or 10dB below the BNL it is not possible to enforce a condition that requires the source noise level to be any more than 5dB below the BNL. This means that any condition requiring a lower level than this is unenforceable and thus invalid.

Other guidance

Having shown that there are significant problems with applying a blanket noise limit that is a certain margin below the BNL, it is worth considering whether other guidance may be more appropriate when setting limits for new noise sources. The purpose of this article is to highlight the inappropriateness of a 'blanket' limit of 10dB below the BNL, rather than providing a review of other guidance relating to noise levels. In view of this it is not appropriate to provide a detailed review here, although it is worth briefly considering some alternatives.

BS.8233:1999 provides significant guidance regarding suitable noise levels depending upon the use of different areas eg a steady level of 30dB(A) in bedrooms represents 'good' conditions for sleeping and 35dB(A) represents 'reasonable' conditions.

The World Health Organisation continues to provide information from which much of the other guidance is derived. Other organisations such as the Chartered Institute of Building Services Engineers (CIBSE) and the American Society of Heating, Refrigeration and Air-conditioning Engineers (ASHRAE) also provide guidance relating to suitable levels of mechanical plant noise for different room uses.

Conclusion

Although there are some situations where it may be reasonable to ensure that noise from new sources is at least 10dB below the existing BNL there are likely to be significant problems with a planning condition stipulating this requirement. Even in these situations such a condition may be invalid because it is unenforceable.

In most cases a requirement for noise from a new source to be 10dB below the existing BNL is unreasonable and likely to be unenforceable. If a Local Authority applies a condition which is known to fail one or two of the six tests, it appears likely that they are relying on the fact that such a condition will not be challenged (presumably owing to the costs of doing so, or the difficulties that would be caused by the delays associated with such a challenge).

If one of an acoustical consultant's duties is to represent the best interests of their client, presumably they should advise the client of the reasonableness (or otherwise) of any such conditions? This will enable an informed decision on whether to accept such a condition or contest it.

Richard Collman MIOA is with Acoustical Control Engineers Ltd, Bourn, Cambridgeshire.

Work experience at AIRO

Anna Ploszajski.

It was an interest in music and physics and a desire to find out more about acoustics that led me to AIRO for four days of work experience in the weeks after my GCSE exams.

AIRO has some very impressive facilities and throughout the week I was given a taster of the many different services provided by an acoustics engineering company. Each morning or afternoon a different member of the organisation showed me what was involved with their branch of work. This was particularly helpful for me, as I wanted to discover as much as possible about the career paths available in this area of engineering.

I was shown the three main branches of acoustics AIRO deals with: electro-acoustics, buildings insulation and environmental sound. I found electro-acoustics the most complicated to follow, and was very impressed by the technology used (although I found operating the systems rather confusing!). I helped to test the range of the radio microphones on a system that had just been finished and was able to see the application of the different switches and buttons on the system itself.

In the AIRO laboratory facilities I was able to carry out a 'pretend' building sound insulation test, measuring the reverberation time of the anechoic chamber (which was of course very low!). I was shown the set-up of the microphones, speakers and measuring instruments, and I was surprised at how time-consuming the 'on-site' element of buildings acoustics can be. In addition to this, I saw an actual experiment taking place - the testing of concert hall chairs for their sound absorption levels which I found interesting as both a musician and budding physicist.

The final area I learned about was environmental sound, an area in which I had almost no previous knowledge. I took sound level measurements of the busy road outside the office buildings, and was shown case studies of potential housing estates, roads and factories so as to learn about the consultancy side of the job. I was surprised at the amount of organisation and planning involved in environmental

acoustics, and there is a lot more paperwork involved than I first thought!

In addition to the main programme planned for me, I was also able to read up on the basics (and not-so-basics!) of acoustics in the AIRO library. This helped to back up what had been explained to me and also give me a broader view of acoustics as a subject. One of the most valuable aspects of the week for me was the chance to talk to members of the team and I was given a lot of useful advice on careers and university courses.

Perhaps the most enjoyable part of the week for me was on the last day, when I was able to make sound measurements of myself playing the trumpet in the AIRO laboratory facilities. We estimated the reverberation time from the decay of staccato notes in the anechoic chamber (which was a very surreal environment to play in) and the reverberation chamber (equally bizarre!). From measurements of the noise level while playing the trumpet, we were able to draw the conclusion that sitting in front of a brass player in an orchestra, you are likely to suffer hearing damage if exposed to the levels of sound we measured for more than a couple of hours each day!

I would like to thank everyone at AIRO for giving up their time to make my week such an enlightening and educational one. I learnt a lot about the world of work, and it really gave me a taste of what a career in acoustics would involve.

Editor's note: We understand that Anna is to be congratulated for gaining ten GCSEs, all at grade A*.



Anna Ploszajski

Noisy classrooms affect teachers' health

Inserm research published

Teachers are being advised to use microphones, loudspeakers and other techniques to save their vocal cords. A team of scientists issued the recommendations after a study of the impact of increasingly noisy classrooms. The survey of 3,904 teachers in France discovered that they were twice as likely as other workers to suffer disorders ranging from sore throats to vocal fold swelling.

A quarter of the men and half the women interviewed said that they often or always suffered vocal problems. Scientists said that women teachers were at greater risk because those with high voices were more likely to put a strain on their vocal cords.

According to the French National Institute of Health and Medical Research (Inserm), the consequences were grave as teachers struggled to make themselves heard above the babble. It can rebound on the professional and social life of the person concerned, affecting their mental, physical and emotional state and their ability to communicate.

Teachers were urged to consider using a portable microphone linked to loudspeakers. Not only was this very efficient, but judiciously-placed loudspeakers avoided the poor sound at the back of the room. Remedies could also involve vocal courses for trainee teachers, to learn breathing exercises and stress control, and a diet to counter voice disorders. Large quantities of water were advisable, but dairy products, spices, chocolate and tomatoes are not.

Classroom acoustics could also be revised, with teachers told to raise themselves rather than their voices. Simple tricks such as standing on a stage, furnishing the room with bookshelves and curtains and equipping the feet of tables and chairs with rubber can have a dramatic effect.

A study in the USA found that teachers took an average of two days of sick leave a year because of vocal disorders. Inserm said that 'acoustical pollution' had been compounded by interactive lessons, where children were invited to communicate and not just to listen. It added that classroom behaviour had changed, with pupils chattering more and more noisily. Teachers in turn suffered stress as they worried that they would become inaudible, and stress led to voice loss.

In Britain, the idea of microphones is less popular: many think it would be more useful for teachers to be taught how better to use their voices. In a classroom with fewer than 30 students, other research has found that children respond to quieter voices.

Tips for 'sore' losers

Do

Control your stress
Rest
Sleep in a humid atmosphere
Drink a lot of water
Breathe from the abdomen

Don't

Stay up all night
Yawn loudly
Clear your throat too often
Go to bed just after a meal
Eat spicy food

JOIN A LEADING FORCE IN ACOUSTICS.

Thales Naval is a European high-technology group renowned worldwide for its expertise in electronics-based defence systems and services, particularly for naval forces. The Group is a leading systems prime contractor and integrator with industrial operations in 10 countries and clients in 50.

Within the Naval Services business line, we provide naval logistic engineering consultancy to ensure our products are fully supported when in service. We take pride in our work, strive continually to improve all aspects of quality, and have a culture of openness and sharing.

Acoustics Group Leader

Templecombe, Somerset

You'll provide technical leadership for a team of Acoustics Engineers engaged in the design, development and support of acoustic transducer products within the PGB group. It's a vital role that will see you leading research in this area, working closely with our Technical Business Unit in the UK.

You'll be involved in all aspects of product development, from creating requirements, designs and models, to overseeing the manufacture of prototypes, to producing Proof of Design reports. Liaising with relevant teams and business units, you'll also support system design activities during bid phases and the development of sub-system specifications.

Obviously, this is a role for a recognised expert in the field of sonar acoustics engineering. In particular, you'll have an in-depth knowledge of sonar transducer design. You should also be a proven leader, with the ability to ensure proposed solutions are robust, have the minimum of technical and financial risk, and can be readily manufactured. Tenacity and determination will be required to push programmes forward when available resources have conflicting requirements. If you have all this, and you're also keen to mentor our graduate intake, then this is the opportunity to make a significant impact in your specialist area.

Structural Dynamics & Acoustics Engineer

Templecombe, Somerset

The Thales Naval Acoustics and Signatures Group operates in the naval and military vehicle domain as well as the commercial sector. We're also currently developing our business in a number of new areas, such as battlefield surveillance systems, services to the renewable energy market, and vehicle survivability.

As a Consultant, you'll provide structural dynamics and acoustics expertise on a range of contracts. You'll be the key point of contact for customers, preparing and delivering technical reports, as well as looking to develop new work opportunities. Liaising with relevant colleagues in adjacent divisions will also be an important part of your role.

To succeed, you'll need to be a degree-qualified professional with a strong background in technical engineering. It's crucial that you're a specialist in the areas of Noise, Vibration and Signature Management. You'll also be a capable leader with membership of an appropriate professional body and knowledge of providing consultancy services.

To find out more about either of these roles please send your CV and current remuneration details to tracy.morris@mythales.com

THALES

**YOU'LL BE SURPRISED
WHERE YOU'LL FIND US**

The Purcell School interview

Getting the acoustical specification right

The first large-scale study on noise in British classrooms conducted by the collaboration of London University Institute of Education and South Bank University in 2002, which was funded by the Government, observed that noise levels in several London schools regularly exceeded World Health Organisation guidelines. Professor Bridget Shield of South Bank University concluded that it was essential that acoustics were given a high priority when new schools were being built or older schools refurbished. Approved Document E of the Building Regulations now applies to schools and requires detailed design checks and on-site inspections to assess compliance with performance targets. In reality, what are the acoustic design implications for a school undertaking a rebuild project?

The Purcell School in Bushey, near Watford, one of Britain's oldest specialist music schools, recently completed a project to design and build a highly specialised music centre. The project team shared their experience and thoughts about some of the more creative ways of combining their acoustic requirements with the skills within their school. The project was designed by Edward Cullinan Architects supported by Arup Acoustics. Nick Rampley, bursar and project manager, said that they had realised when they arrived some eleven years ago that they would need to build a new music centre to provide better teaching, practice and performing facilities. It was important for the school to attract the best music teachers and the facilities offered were a key feature of this

which attracted the best students. The acoustic aspects of the project were therefore of major significance. Getting the specification right was the chief consideration: the requirements of the teachers and students had to be blended within each working area. The acoustical insulation performance between rooms was crucial for teaching needs, and the acoustic quality within practice and technical rooms would be a significant requirement. A long time was spent considering and discussing these points as nothing was to be left to chance.

Nick explained that the framework of the centre was designed in a semicircular structure avoiding parallel-situated walls. The studio, music practice and instrumental teaching rooms were specified as 'floated' constructions: they generated the highest level of sound in relation to the size of the room and were to become the most sensitive to noise intrusion. The addition of acoustic absorption panels to these rooms was a key element to reduce reverberation time and improve sound intelligibility. During the consultation stage an idea developed to combine musically inspired art work from students across the school onto the sound absorbing wall panels. The architects worked with Acoustic ArtPanels, a specialist in this field, to achieve this.

Phil Barrett, Head of Art, said that the project was a wonderful opportunity to involve the work of the students in a highly visual and motivating way. Historically, much of the work within the art department had been to inspire

enthusiasm in music, by encouraging visual expression of the words that the students associated with their music. This project provided a wonderful platform to illustrate this concept, showing these very personal and unique translations of artistic musical thought. The art work was not selected on ability alone, but on individuality and vision. It was very important to create the right feel within each room, many of which would be used for very specific purposes. The architects were able to translate the raw artwork into visually stunning sets of images, cleverly linking colour and subject matter to each individual room. The single addition of these acoustic panels to this project, at a relatively low cost compared with other items, provided probably the highest return of value both visually and functionally. Phil is already considering the benefits in a few years' time of refreshing the current display of acoustic art with work from his next generation of visionary students. He pointed out that this was an easy way to provide a continual focus on the students' work and created a good talking point.

Over 40 sound absorbing wall panels were incorporated into the music technology classrooms, practice rooms and instrumental teaching rooms by Acoustic ArtPanels. The imagery was transposed onto special acoustic fabric using an ink sublimation dye technique. Ink sublimation is the only printing process used by Acoustic ArtPanels as it retains the full acoustic performance of specialist acoustic materials by preventing the closure of the fabric weave, an unavoidable problem with alternative digital printing systems. Sublimation ink is unique in its ability to convert from a solid to a gas without passing through a liquid form. The conversion is initiated by heat and controlled with pressure and time. Sublimation transfer gives a level of colour, richness, vibrancy and permanency that direct printing cannot rival. The permanence of colour and robust durability of the fabric provides qualities ideal for use in a school environment.

Whilst delivering excellent acoustic performance in achieving effective reverberation time, the panels in this context provide visual substance with vibrant designs. Nathaniel Vallois, teacher of the violin, said that visually these were very nice rooms to work in: noise was isolated so that he could concentrate, and he had never had a problem teaching there.

Nick Rampley says that the project went remarkably smoothly, because of the really good hands-on supervision from the architects: the high level of internal consultation certainly paid off. All staff were very pleased with the overall design and the



Sound absorbing wall panels in a music technology room

continued on page 44



Decorative wall panels controlling reverberation time in a practice room

Job Opportunities in Acoustics



01562 881430 : T
info@MSAtd.uk.com : E

If you are considering looking for a new job, it doesn't have to be a headache. Why not let us do the legwork for you and show you why we have become the leading recruiter of acoustics professionals in the UK.

We have an unrivalled knowledge of the current market and have hundreds of established contacts within the industry, so we are confident that we can help you in your search for your next job.

Whether you are a seasoned Senior or Principal Consultant and are looking for a fresh challenge, or a recent Graduate looking to break into the industry, we would very much like the opportunity to work with you.

Dozens of acoustics professionals have already found that working with us has proven to be a refreshing change to what they have come to expect from a modern recruitment consultancy.

Either call us for a confidential discussion or log onto our website to view a selection of our current opportunities.

www.MSAtd.uk.com

The Purcell School interview - continued from page 42

idea to incorporate the art panels was a great inspiration enjoyed by everyone.

The Acoustic ArtPanels were supplied for the Purcell School in various dimensions at a thickness of 50mm. Panels are available either 25mm or 50mm thick in any size up to three metres square. The company specialises in tailored printed products for open-space acoustic specifications where a high-performance acoustical product is required to blend with the visual concept of a project. The panels provide limitless solutions in almost any environment, particularly where sound quality is poor and visibility is high. With a little imagination, simple acoustical applications can become highly personalised - motivating, inspirational or restful - depending on the desired effect and selected artwork. Acoustic Artpanels is part of the BrigePlex group of companies, one of the UK's leading specialists in the field of architectural acoustics. The group has accumulated a wealth of practical and creative experience in projects that have spanned a multitude of sectors and countries: they are well placed to provide guidance to

specifiers in all aspects of acoustic fabrication. The panels are manufactured in-house by a team of specialists, and are inherently flameproof, washable and easy to hang. Artwork can be supplied or taken from the company's web site, where acoustical performance data can also be found.

For more information: Christine Lewis,

Director, email:

Christine@acousticartpanels.com

Web site: **www.AcousticArtPanels.com**

**ICSV16****Call for papers**

Dr W S Gan is again organising a structured session at ICSV15, the 15th International Congress on Sound and Vibration, on 6 to 10 July 2008 at Daejeon Convention Centre, Daejeon, Korea, with the title *Nonlinear acoustics and vibration*. The closing date for 300 word abstracts is 1 December 2007, with notification of acceptance on 28 February 2008 and a deadline for full-length papers of 31 March 2008. The last date is also the deadline for early registration.

Abstracts should be sent by email to Dr W S Gan by 1 December to **wsgan@acousticaltechnologies.com**, or by fax to **+65 67913665**.

For further information and online registration refer to the web site at **www.icsv15.org**.

Whale and Dolphin Conservation Society**Claims cetaceans are endangered by offshore wind farms**

The growth in offshore wind farms poses a potentially devastating threat to whales, dolphins and porpoises, according to a report from an environmental protection group.

The driving of turbine piles and other noises during construction of facilities can be heard by marine creatures in shallow water up to 80km away, while the noises can damage the animals' hearing at close range and cause dramatic changes to behaviour at distances of 20km, claims the Whale and Dolphin Conservation Society in a 122-page report 'The Conservation of British Cetaceans: A review of the threats and protection afforded to whales, dolphins and porpoises in UK waters'. The WDCCS says that the UK government has failed to address the action necessary to avoid the most serious threats to the UK's wildlife.

The laying of cables and disturbances caused by service vessels means that the acoustic impact can continue long after the building of an offshore wind farm is finished. Five wind farms are currently operating offshore Britain, seven more are under construction, and 14 are planned.

The report explains that with regard to offshore wind farms, underwater turbines, wave energy generators and other forms of renewable power generation, consideration needs to be given to the potential impacts of construction, operation and decommissioning. For example, pile driving is a source of considerable underwater noise. Enthusiasm for green

energy should be tempered by genuine marine conservation concerns.

The Society says that cetaceans are being adversely affected by various human activities, the significance of which is poorly known: to make matters worse, little is known of the distribution and habitat needs of the animals. There may be a danger in the seas of repeating the mistakes made earlier on land for many terrestrial species: driving them from their natural habitats, reducing ranges, and depleting animal populations.

In order to provide a source of renewable energy for the UK, there has been considerable investment in the development of alternative technologies and, in particular, wind farms. Land-based wind farms are becoming more difficult to site precisely because of human environmental considerations, including noise, and attention has become focused on marine wind farms.

Being a renewable source of energy, wind farms have a positive environmental impact, but it should not be forgotten that they could possibly have a negative impact on cetaceans owing to the noise produced. The potential to displace animals is one concern, and one that it is particularly difficult to gauge, because so little is known about current cetacean distributions around the UK. In operation, offshore wind farms produce low-frequency noise, calculated to increase background levels of marine noise by 80 to 100 dB. The construction of wind farms also produces considerable amounts of marine noise

(260dB) and the laying of submarine cables can also contribute.

A study funded by a UK statutory authority investigated the possible effects on cetaceans and marine fish from noise and vibrations of offshore wind farms and determined that there would be significant effects during construction, with disturbance reactions likely to a distance of several kilometres. Within 100m of a wind turbine under construction it was estimated that noise levels might be so severe that cetaceans may suffer acoustic trauma.

The report claims that disturbance reactions by cetaceans to noises produced by wind farms have been documented, and researchers playing recordings of noises produced by a 2MW turbine have apparently reported that the typical distance between harbour porpoise surfacings and the sound source significantly increased. There was a significant increase in porpoise echolocation rates, thus indicating disturbance of the harbour porpoises by wind farm noise. The disturbance occurred even though the animals should not have been able to detect these low frequency sounds, according to hearing sensitivity tests conducted on captive porpoises.

(Information provided by *Renewable Energy Focus*, 22 August 2007)

Parliamentary reports

From Hansard

Commons Written Answers

11 July 2007

Explosions: Noise

Mr Whittingdale: To ask the Secretary of State for Defence how many complaints about noise caused by explosions at Shoeburyness were received from residents living in (a) Maldon District, (b) Chelmsford Borough, (c) Rochford District, (d) Colchester Borough, (e) Tendring District, (f) Southend on Sea, (g) Castlepoint District and (h) Kent in each year since 1995.

Derek Twigg: The number of complaints received by the Ministry of Defence about noise caused by explosions, demolition and gunfire at Shoeburyness in each year since 1995 is set out as follows: (see chart below)

Figures up to the end of 2005 are based solely on telephone complaints to a dedicated helpline. Those for 2006 and 2007 are from all sources of complaints.

17 July 2007

Ex-servicemen: Hearing impaired

Dr Murrison: To ask the Secretary of State for Defence when and how ex-servicemen and women waiting for digital hearing aids due to service-related hearing loss will be informed of their priority status.

Derek Twigg: Advice regarding entitlement to priority treatment from the NHS is referenced in Leaflet 2 which is sent out by the Service Personnel and Veterans Agency with the war pension disablement acceptance notification letter.

Regular reminders about priority treatment for war pensioners are circulated by the

Health Departments to senior NHS managers who are tasked to ensure that relevant clinical staff are aware. Reminder action, due this year will reference this issue. Priority for assessment, treatment, aids etc is decided by the clinician in charge based on clinical need.

Dr Murrison: To ask the Secretary of State for Defence what instructions have been sent to NHS trusts in relation to affording priority status to ex-servicemen and women needing digital hearing aids due to service-related hearing loss.

Derek Twigg: MOD is working with the UK Health Departments regarding awareness of NHS priority treatment among health professionals. Later this year Health Departments will distribute reminders to the chief executives of trusts requiring them to ensure that general practitioners and hospital clinicians are aware of all those veterans who are eligible for priority treatment, including the group who have noise-induced sensorineural hearing loss accepted as caused by service. Priority refers to assessment, treatment and provision of aids. Allocation of priority is by the clinician in charge based on clinical need.

23 July 2007

Motorways: Repairs and maintenance

Mrs Maria Miller: To ask the Secretary of State for Transport what the average cost per mile is to resurface a motorway with (a) noise reducing materials and (b) non-noise reducing materials; and if she will make a statement.

Mr Tom Harris: Motorways are only resurfaced with noise reducing materials. The average cost per mile for resurfacing a motorway, with three lanes in each direction plus a hard

shoulder with a noise reducing surface, is approximately £180,000. This excludes the costs for traffic management, contract preliminaries, any road strengthening and other consequential works.

23 July 2007

Aviation: Noise

Sir Paul Beresford: To ask the Secretary of State for Transport (1) what assessment her Department has made of the environmental impact and noise pollution caused by private aircraft; (2) what plans she has to introduce measures to reduce noise and noise pollution caused by private aircraft.

Jim Fitzpatrick: The Department is not aware of any assessment of the environmental impact and noise pollution caused by private aircraft. Propeller driven aircraft weighing under 9000kg - the main 'general aviation' aircraft - have to comply with an internationally agreed noise certification standard, unless they were on the UK register prior to 1980. This standard was tightened for aircraft certificated after 1999. We expect aerodromes to set and to enforce appropriate rules to minimise noise nuisance, reflecting local circumstances. Guidance on recommended measures to help reduce the noise related nuisance from light aircraft is available on the Civil Aviation Authority's website (www.caa.co.uk).

10 September 2007

Noise: Pollution

Justine Greening: To ask the Secretary of State for Transport when she expects to publish the results of the Attitudes to Noise from Aviation sources in England study; and if she will make a statement.

Jim Fitzpatrick: Provisional findings have been submitted and are being subjected to independent review by experts. This review is not yet complete, but I anticipate that the results of this study will be available by the end of this year.

District	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007 ⁽¹⁾
Maldon	56	91	23	49	58	48	51	50	19	8	4	4	7
Chelmsford	5	2	0	0	1	0	0	0	2	0	0	0	0
Rochford	60	48	45	31	86	48	74	16	2	0	0	0	3
Colchester	12	44	5	20	23	38	22	14	13	3	3	10	0
Tendring	107	206	79	129	222	322	239	154	127	56	110	87	7
Southend	33	109	30	65	52	48	35	25	3	6	2	3	1
Castlepoint	2	1	6	5	10	1	3	0	2	0	0	0	0
Kent	360	155	91	335	543	333	477	217	48	75	158	112	30
Total	635	656	279	634	995	838	901	476	218	148	275	219	

(1) Year to 4 July 2007.

Loughborough student won SET Award 2007

Best maritime technology student

Ewan Porteous, a recent graduate from the Aeronautical and Automotive Engineering Department's Acoustics and Vibration Research Group, has won the Science, Engineering & Technology (SET) Award 2007 in the category 'Best maritime technology student'. The SET awards, often called 'the student Oscars', are Britain's most important science and engineering education awards. They are very competitive and highly prestigious. For the category 'Best maritime technology student', the award was sponsored by the Lloyd's Register Educational Trust and judged by the Institute of Marine Engineering, Science & Technology and the Royal Institution of Naval Architects. The award was presented to Ewan by the director of Lloyd's Register Educational Trust, Michael Franklin, at a magnificent gala dinner and presentation ceremony on the evening of Thursday 20 September 2007 at Alexandra Palace, London.

The SET Awards are organised by the World Leadership Forum and sponsored by Airbus, AstraZeneca, AWE, Balfour Beatty, Bentley Motors, Cadbury Schweppes, e2v Technologies, GKN, GlaxoSmithKline, the Institution of Engineering & Technology, Laing O'Rourke, Lloyd's Register Educational Trust, Microsoft Research, Morgan Crucible, the National Physical Laboratory and SAGE. They are supported and judged by the British Computer Society, the British Pharmacological Society, the Institute of Biology, the Institute of Food Research, the Institute of Marine Engineering, Science and Technology, the Institute of Materials, Minerals & Mining, the Institute of Physics, the

Institution of Chemical Engineers, the Institution of Civil Engineers, the Institution of Engineering & Technology, the Institution of Mathematics and its Applications, the Institution of Mechanical Engineers, the London Mathematical Society, the Royal Aeronautical Society, the Royal Institution of Naval Architects and the Royal Society of Chemistry.

Ewan won the award for his final-year project supervised by Prof Victor Krylov FIOA and entitled 'Wave-like propulsion of small marine craft'. The project offered to Ewan was in the novel area of wave-like aquatic propulsion of marine vessels, which has been researched in the department over the last two years. His main aim was to develop and test a reduced-scale working model of the mono-hull marine craft (boat) propelled by localised flexural waves propagating in the attached immersed vertical elastic plate, in a way similar to that used in nature by stingrays. Ewan worked on the project very enthusiastically, demonstrating remarkable skills and ingenuity. As a result, he has designed and built an entirely autonomous and robotically-controlled model boat with wave-like aquatic propulsion which achieved impressive speeds in open water, of the order of one of its body lengths per second. He has also measured such important parameters of the craft as thrust and propulsion efficiency, demonstrating that the wave-like aquatic propulsion under consideration can be a viable alternative to a traditional screw propeller. Its important advantages over the propeller are very low underwater noise, and greater safety for people and marine animals.



Ewan Porteous receives the SET Award 2007 from Michael Franklin, the director of Lloyd's Register Educational Trust



Ewan Porteous and his supervisor Prof Victor Krylov FIOA after receiving the Award

The award is a testimony to the work of Ewan and Victor and also to the high standard of final-year projects in the Department of Aeronautical and Automotive Engineering (AAE). This is the third time an AAE student has won a SET award.

Prof Victor V Krylov FIOA

Dr Stephen Chiles

Recently joined URS as a Senior Acoustic Engineer

Dr Stephen Chiles has recently joined URS as a Senior Acoustic Engineer based in Christchurch, New Zealand. Following his consultancy and research work in the UK, Stephen has spent the last three years working as a consultant for another firm in New Zealand on a wide range of projects such as wind farms, hydroelectric power schemes, a cement plant, coal mines, a dairy factory, an aluminium smelter, roading schemes and substations. He has also been fortunate to have been able to indulge in his performing arts specialism on several projects, including a recent trip to China to oversee the acoustic testing of a 1:20 scale model of the new Guangzhou Opera House. As was the case with his work for the IOA in the UK, Stephen is already actively involved in the New Zealand profession. He played a major role in the organisation of the first joint conference of the Australian and New

Zealand Acoustical Societies at the end of 2006, and he is currently representing the New Zealand Acoustical Society on the Standards New Zealand committee revising the main two environmental noise standards. Having been a Chartered Engineer on the IOA Engineering Division committee, Stephen is now also a New Zealand Chartered Professional Engineer.

Stephen will be leading and developing the URS acoustics team in New Zealand, which will also work throughout the Asia Pacific region and collaborate with other URS acousticians all around the globe. There is a wealth of interesting project work in the area so it will be exciting times ahead. Stephen moved to New Zealand three years ago mainly to get closer to the great outdoors, and he has been overwhelmed by the amazing opportunities which exceeded expectations. Christchurch provides a unique



Dr Stephen Chiles

environment with all imaginable activities from surfing to skiing within an hours drive. Stephen has kept himself busy, particularly with mountaineering, mountain-biking and paragliding. Anyone else looking for an awesome location to do exciting acoustics work, in a fresh and growing team should contact Stephen!
stephen_chiles@urscorp.com

Ian Campbell's 65th Birthday

Celebrating 45 years in the acoustics industry

Ian Campbell is celebrating his 65th Birthday in November this year and we can all look back over 45 years of work within the acoustics industry – and over 13 years championing the Institute of Acoustics.

Having started work with audio equipment Ian moved into acoustics when he participated in MoD research into developing the world's first hearing protection system. Then, after the Wilson Report, Ian assisted with production of the world's first low cost sound level meter. He was first again with the first integrating sound level meter and environmental noise analyser! With Campbell Associates, Ian has been at the forefront of developments as a Norsonic Board member.

Ian has been a significant member of the Institute of Acoustics joining the Council in 1994. As Chair of Business Review Committee in 1996 Ian helped to prepare the Institute for the new millennium. Ian was President of the Institute of Acoustics from 1998 to 2000.

As if all the above would leave you with spare time Ian has also been co-writer of Institute Papers, Convener of Conferences and a specialist member of a DTI working group.



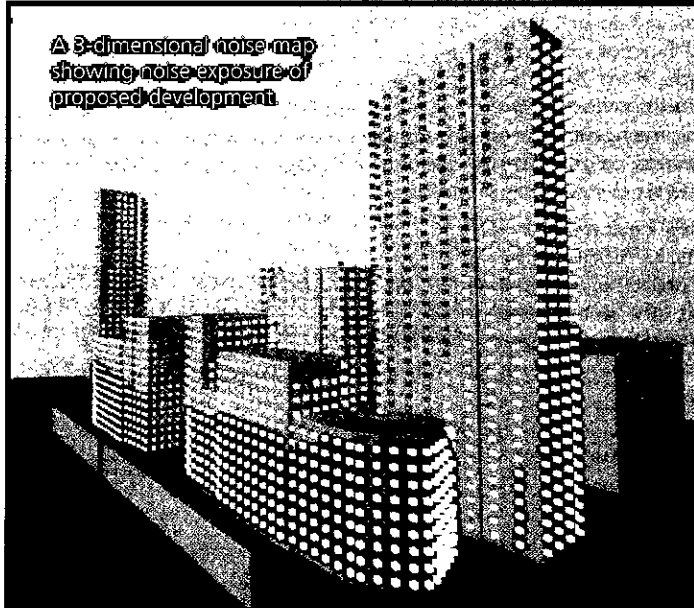
Ian Campbell

Examination dates 2008

DATE	EXAMINATION
7 March	Certificate of Competence in Workplace Noise Risk Assessment
11 April	Certificate of Competence in Environmental Noise Measurement
25 April	Certificate Course in the Management of Occupational Exposure to and Arm Vibration
12/13 June	Diploma in Acoustics and Noise Control
3 October	Certificate of Competence in Environmental Noise Measurement
17 October	Certificate Course in the Management of Occupational Exposure to and Arm Vibration
7 November	Certificate of Competence in Workplace Noise Risk Assessment

 Institute of
Acoustics

A 3-dimensional noise map showing noise exposure of proposed development



Improve your productivity with:

Server Edition

RoadNoise, SiteNoise and RailNoise

What do our users like the most?*

- Ease of use
- User support
- Noise models from digital mapping
- Graphics the public can understand
- It's good value

*Surveyed in July 2007

ATKINS

NOISEMAP



To find out more, visit our website at
www.noisemap.com
or contact Vicky Stewart on 01372 756028
email: vicky.stewart@atkinsglobal.com

www.atkinsglobal.com

Institute Sponsor Members

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

Key Sponsors Brüel & Kjær

CASELLA
CEL

Cirrus
Research plc

Sponsoring Organisations: AcSoft Ltd • AEARO • AMS Acoustics • A. Proctor Group Ltd • Arup Acoustics • Bureau Veritas

Campbell Associates • Castle Group • Chambers and Newman (Manchester) • Civil Aviation Authority • CMS Acoustic Solutions

Eckel Noise Control Technologies • EMTEC Products Ltd • Faber Maunsell • Gracey & Associates • Greenwood Air Management

HannTucker Associates • Hodgson & Hodgson Group Ltd • Industrial Acoustics Company Ltd • Industrial & Commercial Technical Consultants Ltd

LMS UK • Mason UK Ltd • National Physical Laboratory • Rockfon Ltd • Saint-Gobain Ecophon Ltd • Sandy Brown Associates • Scott Wilson Ltd

Shure Brothers Incorporated • Telex Communications (UK) Ltd • Thales Underwater System Ltd • Tiflex Ltd • Wakefield Acoustics • Wardle Storeys

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

Committee meetings 2007-08

DAY	DATE	TIME	MEETING
Thursday	1 November	11.00	Research Co-ordination
Tuesday	6 November	10.30	CCENM Examiners
Tuesday	6 November	1.30	CCENM Committee
Thursday	8 November	10.30	Membership
Tuesday	13 November	10.30	ASBA Examiners
Tuesday	13 November	1.30	ASBA Committee
Thursday	15 November	10.00	Meetings
Tuesday	20 November	10.30	CMOHAV Examiners
Tuesday	20 November	1.30	CMOHAV Committee
Thursday	22 November	11.00	Executive
Thursday	29 November	11.00	Publications
Tuesday	4 December	10.30	CCWPNA Examiners
Tuesday	4 December	1.30	CCWPNA Committee
Thursday	6 December	11.30	Council
Thursday	10 January	10.00	Meetings
Thursday	24 January	10.30	Diploma Tutors and Examiners
Thursday	24 January	1.30	Education
Thursday	31 January	10.30	Membership
Thursday	14 February	11.00	Publications
Thursday	28 February	11.00	Medals & Awards
Thursday	28 February	1.30	Executive
Thursday	6 March	10.30	Engineering Division
Tuesday	11 March	10.30	Diploma Examiners
Thursday	13 March	11.30	Council
Thursday	10 April	10.00	Meetings
Thursday	17 April	11.00	Research Co-ordination
Tuesday	22 April	10.30	CCWPNA Examiners
Tuesday	22 April	1.30	CCWPNA Committee
Thursday	8 May	10.30	Membership
Wednesday	21 May	10.30	CCENM Examiners
Wednesday	21 May	1.30	CCENM Committee
Thursday	22 May	11.00	Publications
Tuesday	3 June	10.30	CMOHAV Examiners
Tuesday	3 June	1.30	CMOHAV Committee
Thursday	5 June	11.00	Executive
Thursday	19 June	11.30	Council
Thursday	26 June	10.30	Distance Learning Tutors WG
Thursday	26 June	1.30	Education
Thursday	3 July	10.30	Engineering Division
Tuesday	8 July	10.30	ASBA Examiners
Tuesday	8 July	1.30	ASBA Committee
Thursday	10 July	10.00	Meetings
Tuesday	5 August	10.30	Diploma Moderators Meeting
Thursday	4 September	10.30	Membership
Thursday	11 September	11.00	Medals & Awards
Thursday	11 September	1.30	Executive
Thursday	18 September	11.00	Publications
Thursday	25 September	11.30	Council
Thursday	2 October	10.30	Diploma Tutors and Examiners
Thursday	2 October	1.30	Education
Thursday	16 October	10.30	Engineering Division
Thursday	30 October	11.00	Research Co-ordination

Refreshments will be served after or before all meetings. In order to facilitate the catering arrangements it would be appreciated if those members unable to attend meetings would send apologies at least 24 hours before the meeting.

Conferences and meetings:

Diary 2007-08

29-30 November 2007
Electroacoustics Group
Reproduced Sound 23 - Hall of Sound: Audio for live events
Gateshead

29 January 2008
Speech & Hearing Group
Speech and hearing in learning environments
London

27 February 2008
Building Acoustics Group
Soundscapes inside/outside future buildings
London

5 March 2008
London Branch
Noise Nuisance
London

12 March 2008
Environmental Noise Group
Transportation noise update
Birmingham

10-12 April 2008
Spring Conference 2008 - Widening horizons in acoustic research
Reading

16 April 2008
Measurement & Instrumentation and Electroacoustics Groups
Playing safe - meeting the Control of Noise at Work Regulations 2005 in music and entertainment
London

16-18 September 2008
Underwater Acoustics Group
Underwater noise measurement, impact and mitigation
Southampton

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

List of advertisers

AcSoft	IFC	Flo-Dyne	31
ANV Measurement Systems	BC	Gracey & Associates	IBC
Association of Noise Consultants (ANC)	13	M.S.A.	43
Brüel & Kjær	4	Oscar Engineering	29
Building Test Centre	37	SoundPlan (TD&I)	21
Campbell Associates	IBC	Soundsorba	17
Cirrus Research	33	Thales	41
Custom Audio Designs	19	Trelleborg Bakker BV	23
Ellison Sage	35	Wardle Storeys	IFC
		WS Atkins	47

Please mention *Acoustics Bulletin* when responding to advertisers

CALLING ALL MEMBERS

MOVED HOUSE LATELY? MOVED COMPANIES? MOVED OFFICES?

Please let us know about it!

Just send an email to ioa@ioa.org.uk giving your new details, or telephone **01727 848195**.

Gracey & Associates

:: Setting Hire Standards ::



We are the largest, independent UK hirer of professional equipment to the acoustics industry and have been supplying sound and vibration instrumentation for over 30 years.

We are an ISO 9001 company, and our Calibration Laboratory is accredited by British Standards. All our analysers, microphones, accelerometers etc., are delivered with current calibration certificates, traceable to the National Physical Laboratory.

We offer next day delivery to your office, or site and can also arrange for our carrier to pick up equipment when the hire is complete.

Our hire stock includes instruments and equipment from Brüel & Kjær, Norsonic, Vibrock, Larson Davis, CEL, DI and GRAS. We also have a large stock of calibrators, environmental and building acoustic kits, microphones, preamplifiers, cables, speakers, tapping machines, noise generators, connectors, adaptors, power supplies, etc.

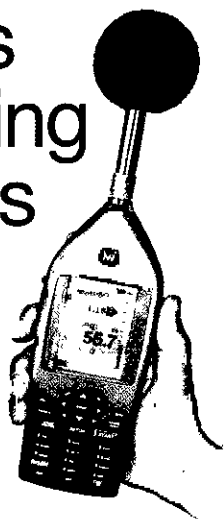
Threeways Chelveston Northamptonshire NN9 6AS
01933 624212 :: hire@gracey.com :: www.gracey.com

Gracey & Associates...Noise and Vibration Instrument Hire

Campbell Associates

SOUND & VIBRATION SOLUTIONS
FOR SALE AND HIRE

Complete measurement solutions for building acoustics



Norsonic
Building Acoustic Instrumentation Specialists - provide a choice of solutions for accurate and efficient sound insulation testing.

- ◎ Single and twin channel cable-free systems, which are simple to use and robust in design.
- ◎ New lightweight Tapping Machine with laser measurement of hammer impact velocity.
- ◎ All instruments in the Norsonic range produce DnTw, LnTw and Ctr on-screen to quickly identify failures.
- ◎ Drag and drop data to the NorBuild software to instantly produce test certificates.



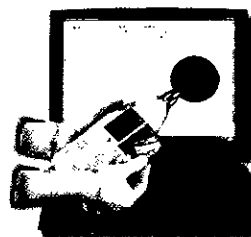
Tel 01371 871030 www.campbell-associates.co.uk www.acoustic-hire.com

A Comprehensive Range of Easy to Use Instruments for Sale and Hire

NEW RION NA-28

Sound Level Meter and Third Octave Band Analyser
The Perfect Fusion of Cutting Edge Technology and Ease of Use

Large Back-lit Colour LCD Display Provides Superb Clarity
Massive Storage Potential of Real Time Octaves and/or Third Octaves
Expandable Functionality Using Program Cards

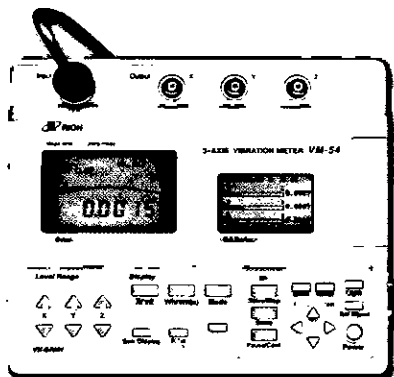
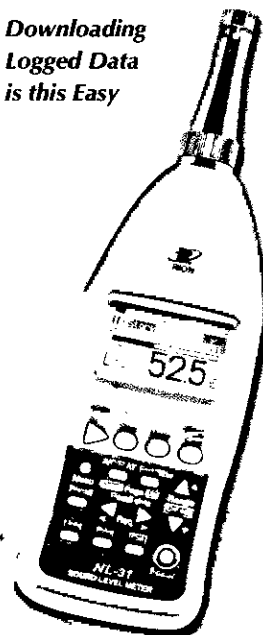


*Downloading
Logged Data
is this Easy*

RION NL Series

Integrating Sound Level Meters
The Simplest Solution for Environmental, Workplace or Product Noise

Class 1 and 2 with these Options: Simple Data Logging; Audio Recording;
Real Time Octaves and Third Octaves; FFT Narrow Band Analysis
AND NOW: GSM Remote Control Download Software (RCDS)
Full Access to Download and Control Instruments Remotely



RION VM-54

Tri-Axial Vibration Meter
Easy to Use Tri-Axial Vibration Meter for Occupational and Environmental Vibration

Complies with Vibration at Work Regulations 2005
Complies with BS 6472 and ISO 2631: Parts 1, 2 and 4
Eight Measures and Logs VDV's

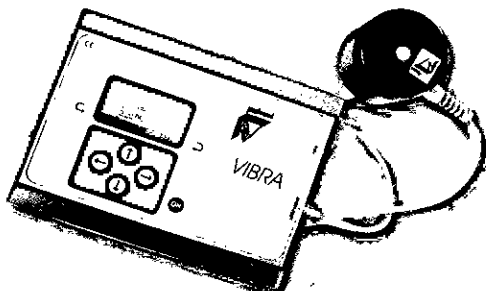
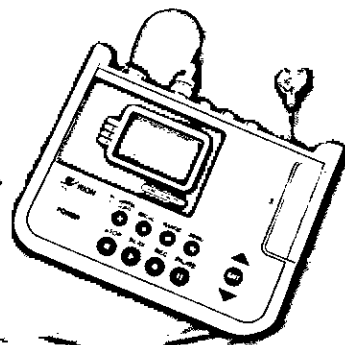
*Logging BS 6472 Version
Now Available*



RION DA-20

4-Channel Data Recorder
Light, Compact and Battery Powered

Simple to Use
Stores Data as WAV Files on to Compact Flash Card
Flexible Channel Input Allows Use with Many Transducers



Profound VIBRA / VIBRA+

Vibration Meter and Datalogger
The Simplest and Most Practical Way to Monitor and Log Vibration Levels

Logs Peak Particle Velocity (PPV) in 3 Dimensions Continuously
Stores Time Traces of Velocity Waveform and FFT Spectra (VIBRA+)
External Alarm and GSM Remote Connection Functions

Excellent Quality ■ Exceptional Value ■ Knowledgeable & Friendly Service

ANV Measurement Systems • Beaufort Court, 17 Roebuck Way, Milton Keynes MK5 8HL



01908 642846



01908 642814



info@noise-and-vibration.co.uk



www.noise-and-vibration.co.uk