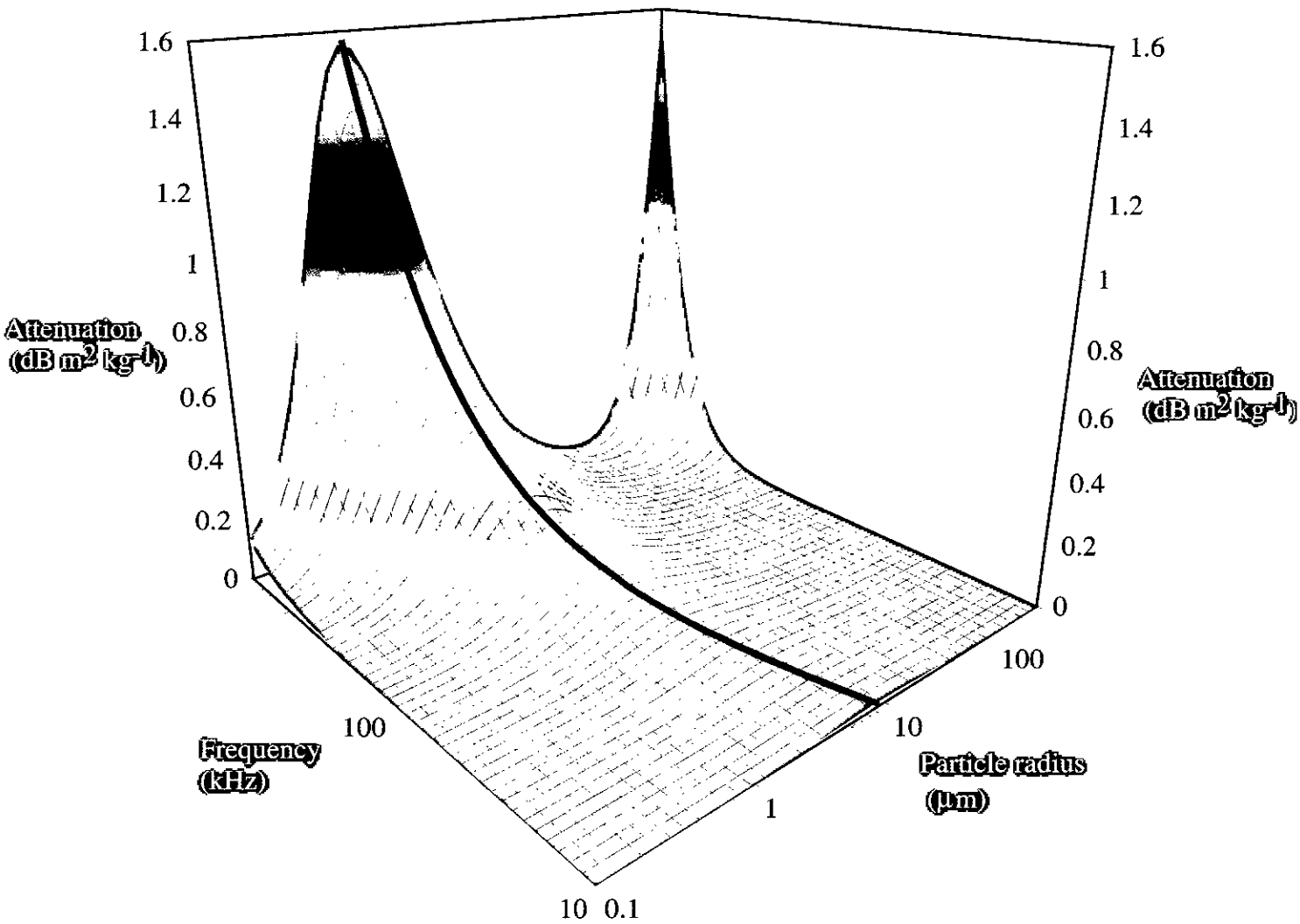
Acoustics BULLETIN

VOL 26 No 1 JAN/FEB 2001



Sonar Performance in Coastal Environments

Case Study: a Structured Approach to Controlling Tonal Noise
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Institute of Acoustics

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Acoustics BULLETIN

Vol 26 No 1 Jan/Feb 2001

Contents

Institute of Acoustics

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

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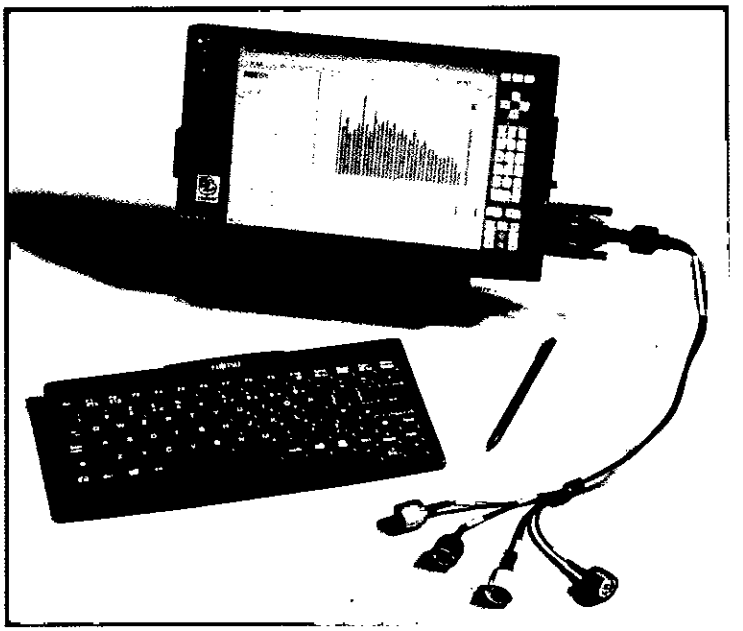

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Fellow Members

Welcome to the first issue of the new design Acoustics Bulletin. The content is evolving a little, but all the familiar sections which have made the Bulletin so successful are still here.

2001 should see the consolidation of a number of different projects which have been taking shape over the past few years in our main areas of strength: continued integration of our professional, engineering and academic interests, expansion of our unique educational programme, and further publications and meetings ventures. These and other changes are providing the impetus for a renewed vigour in the Institute.

But 2001 will also see a new membership drive. Attracting new professionals to the Institute's membership will, I hope, assume a high priority this year - increased membership will provide the basis for enhanced services for all, as, along with our sister organisations, we tackle the shifting demands and expectations of the membership, Government and the public at large.

Sincerely, and with best wishes for 2001,

Mark Tatham

Mark Tatham

Dr Roy Lawrence

IOA Honorary Fellowship 2000

Born of Liverpool parents in the Red Rose county, Roy Lawrence was schooled in St Albans after which he joined ICI Plastics in Welwyn Garden City.

Over a period of eight years, he progressed from Laboratory Assistant there, to Assistant Professor of Physics at the Haile Selassie 1 University in Addis Ababa. There he acquired the splendid accolade of Sometime Tutor to the Imperial Grandchildren.

Meantime, he attended the University of Liverpool, where he graduated with an honours degree in Physics and was awarded his PhD for work on ultrasonic propagation through dilute polyatomic gases under Professor H D Parbrook.

In 1965, after returning from Africa, Roy joined Liverpool College of Technology (now Liverpool John Moores University) where he was appointed Lecturer, Senior Lecturer and Principal Lecturer.

During his 23 years there, he was a very active member of the Institute of Physics (IOP) being a member of their Education Committee, Chairman of the Physics at Work Committee, and for eight years, Honorary Secretary of the IOP Liverpool and North Wales Branch.

Roy was deeply involved in the Graduateship Examination of the IOP, through which he developed a devotion to the principle of external examinations as a means of securing academic standards, and he served as a CNAA Physics Board member where he was much impressed by the CNAA 's regulatory role.

He was also seconded part-time to an investigation into teaching methods in undergraduate physics; his task was to visit many university physics departments to develop an understanding of the proper role of project work in undergraduate physics - an interest that has continued.

In due course, these formative experiences were to benefit the Institute of Acoustics, as Roy's interests turned to noise and its control. At Liverpool, he set up the Acoustics Group within the Physics Department and also started the course for the Institute' s Diploma in Acoustics and Noise Control, which was to prove a very successful venture over the years.

His close involvement with Institute affairs started in 1976, as organiser of the Spring Conference at Liverpool. This successful meeting established Roy's place in the Institute, and he rapidly became supremo for meetings.

He progressed through a variety of Institute posts, first as Vice President, followed by Meetings Committee Chairman, Honorary Treasurer and Chair of the Education Committee.

While serving as the latter Roy, in collaboration with Alan Dove and Cathy Mackenzie, set up the *Certificate of Competence in Workplace Noise Assessment* and worked hard to gain its acceptance among the wider acoustics and noise control fraternity. This paved the way for the Institute to develop a range of Certificate courses over the years.

Within the Institute education, meetings and publications have benefited from Roy's innovative approach

Roy took an early pension from Liverpool John Moores and in 1988 joined Oscar Faber Consulting Engineers in St Albans, as head of acoustics. He readily acknowledges that through his eight year stint there he became acquainted with real acoustics, albeit on occasions through mistakes.

Overlapping with this period, the Institute moved its office to various locations around St Albans, not entirely unconnected with Roy's presence there, and with the incidental benefit that the Institute's computer activities, which Roy had assumed responsibility for, no longer had to be conducted on the telephone to Edinburgh!

From then on his involvement with the Institute both intensified and diversified. He became Deputy to the Institute' s Secretary, Cathy Mackenzie, thus consolidating the team which has developed and organised the Institute's affairs so successfully over many years.

Roy and Cathy have been responsible for many innovations in the field of publications. In 1987, they decided to produce *Acoustics Index,* which was a large ring binder comprising a text section of some 300 pages, plus descriptive advertising literature from firms offering products and services.

Roy and Cathy were so convinced of the value of the publication in the life of the developing Institute, that they funded the production and distribution of some 4500 copies from Roy's pension lump sum.

From 1991 they took over responsibility for producing *Acoustics Bulletin,* using the emerging desktop publishing technology of the day. They redesigned the Bulletin to make for an easier read and the publication schedule was increased to six issues per year.

Also in 1991, Roy created the annual Institute *Register of Members*, as a logical antidote to the difficulties he experienced at Oscar Faber when trying to converse with representatives of product suppliers. More recently, Roy designed the Buyers' Guide which was an enterprise initiated by Keith Rose, the Institute's Advertising Manager.

1996 saw *Inter-Noise 96* at the Adelphi Hotel and Roy was the Congress Organiser for that prodigious

Pictured during Reproduced Sound 16, Dr Roy Lawrence (right) receives his Honorary Fellowship from the Institute's President, Professor Mark Tatham. Full Conference report starts on page 30.

event, when every hotel bedroom in Liverpool seemed to be occupied by an acoustician. Roy implemented a number of organisational innovations, many of which have been incorporated into later congresses, and the accolade of 'the best Inter-Noise Congress ever' was thoroughly deserved.

His involvement in teaching for the Diploma survived his departure from Liverpool John Moores University. This was mainly through the Institute's *Tutored Distance Learning* programme, which in Roy's case was really a distance teaching programme. In 1997/8, which saw his last year of involvement, he routinely visited 13 centres with 54 students in groups from Aberdeen to Dublin to Plymouth.

It is particularly apt that Roy should receive his Honorary Fellowship at *Reproduced Sound 16*. He invented the Reproduced Sound series of residential conferences and, by also moving the Autumn Conferences to the Hydro Hotel at Windermere, started a tradition that maintained a special place in the Institute's life until 1998, after which these conferences were moved to their new home at Stratford upon Avon.

The Institute of Acoustics is delighted to confer an Honorary Fellowship on Dr Roy Lawrence in recognition of his dedicated and distinguished service to the Institute over the last twenty five years.

New Editor for Acoustics Bulletin

The Publications Committee is pleased to announce that a new editor has been appointed by the Institute to be responsible for the *Acoustics Bulletin,* commencing with the March/April 2001 issue.

He is **Ian F Bennett** BSc CEng MIOA who has been a member of the Institute since 1983.

Ian graduated in mechanical engineering at Southampton University in 1977.

He subsequently gained broad experience in engineering acoustics with several companies until 1989 when he became a founding partner of his independent firm of acoustic consulting engineers, ACIA (listed in the Institute Register).

Now, with his firm well established and stable, Ian was looking for a part time activity which would extend his interests in acoustics and he felt that the IOA post would be ideal. He convinced us that his views on the Bulletin, its development and its importance to IOA members coincided with ours.

We welcome Ian to the IOA publications arena and feel sure that he will provide a valuable contribution in the future development of the *Bulletin.*

John Miller MIOA
Chairman Publications Committee

IOA Diploma

Best Student of the year - Best Project of the year

The award given to the best IOA Diploma student is usually only acknowledged in the report of the conference during which the award is made, together with a photograph of the certificate being handed over. Not so this year. On this occasion the student in question, Geoff Young, is at 60, the oldest student in the history of the IOA Diploma and as such has a length of career unmatched by previous students who have been much younger. In addition to best student he also received an award from the Association of Noise Consultants for the best Diploma project. *(see Report on RS16).*

Citation

Geoff M Young

MSc, CEng, FIEE, FRAeS

Geoff Young worked for British Aerospace plc for 30 years, the final six years of which,1992 to 1998, was as Director-Technology in the Head Office of British Aerospace at Farnborough. He was responsible for co-ordinating all the collective measures for technology acquisition throughout the company. The task covered all areas of aerospace technology including ensuring that the acoustic research activities carried out by the subsidiary companies were sufficient and complementary to one another.

Previous to this, Geoff was the

Geoff M. Young

Technical Director of British Aerospace Space and Communications Ltd at Stevenage. concerned with the development of scientific and communication satellites plus satellite to ground communication links. This work included acoustics research and development.

Before 1968 Geoff worked at the Royal Aircraft Establishment, Bedford, on blind landing of aircraft and then did a full time MSc in Aviation Electronics at Cranfield University. On retirement from BAe he formed his present company, Geoff Young Associates.

Professional Development

Professional Development is something everyone in the IOA should undertake. As individual members it is the best way to maximise your talents and to tailor your skills and competencies to your present and future career.

As employers, agreeing a programme of professional development is a good way to get the best out of your staff. For large and small businesses staff training and professional development, when it is correctly targeted, is an important investment.

Members of the IOA by definition have attained a level of technical knowledge and skills, and continually update that knowledge with a variety of information which is provided by the Institute in different ways in meetings, conferences, seminars and courses.

Other skills may be required, and the Institute could provide information on these if the call is there. Issues such as health and safety, time and people management, effective writing, giving presentations, negotiation skills and many others are extremely important. Large organisations will often do this type of training in-house, but many of our members work in smaller organisations without access to such facilities.

The PD Committee would be interested to know whether members have had any difficulty in finding providers of high-quality non-technical development courses or material, and whether there are any particular subjects which are important to them for which they have not found any provision.

The new scheme for PD is progressing, and a short brochure will be available soon. There will also be information available at conferences and seminars.

Please send any comments to Sue Bird at the IOA office, or on sue@birdacoustics.co.uk

BRANCH REPORT

Yorkshire and Humberside

After a period of inactivity, the Yorkshire and Humberside branch has held two successful meetings in the autumn of 2000.

Porous materials in acoustics

On 19 October we were the guests of Professor Keith Attenborough and his colleagues at the University of Hull. The meeting was entitled *'Put a Sock in It'* and its subject was the use of porous materials in acoustics.

Philippe Leclaire explained some of the more interesting aspects of the behaviour of an acoustic wave travelling through a porous medium.

Alan Cummings concentrated on practical applications of porous materials and finished with some demonstrations of sound control using porous absorbers.

As a finale, and to justify the meeting's title, he demonstrated the effectiveness of a metal cylinder stuffed with socks as a silencer!

Branch AGM

On 23 November, the branch AGM at Leeds Metropolitan University was attended by David Bull in his capacity as Vice-president for Groups and Branches. As well as the normal AGM business of choosing branch officers and discussing future meetings, we visited LMU's new acoustics laboratory facilities.

The design of the facility was the subject of two presentations. Tim South of LMU discussed the requirements of a laboratory for teaching acoustics to a wide variety of students, and tried to explain why such an unconventional location had been chosen on the ninth floor of a building overlooking the city centre.

Philip Durell of Philip Dunbavin Acoustics then described, with the aid of a large number of photographs, how he had set about converting LMU's requirements into practical specifications. Phil emphasised the importance of attention to detail and of ensuring the integrity of cavities and other structure breaks.

Less obviously, he made it clear that an important factor in achieving targets is the establishment of a good working relationship between the acoustic consultant, the site manager, and the tradesmen who put the designs into practice.

The AGM supported the aim of organising a one-day meeting during 2001 on *Noise and Integrated Pollution Prevention and Control* (IPPC). This meeting is likely to be held in South Yorkshire, and a call for papers will appear shortly.

BUILDING ACOUSTICS GROUP

DETR invites comments

The IoA are currently being consulted by the Department for the Environment, Transport and the Regions (DETR) on their Proposals for Amending Part E of the Building Regulations 2000 *Resistance to the Passage of Sound*.

Any comments from members are welcomed for consideration in the official IoA response. All comments should be received at the IoA office by **30 March 2001.**

The draft document is available directly from the DETR at:

DETR Free Literature, PO Box 236, Wetherby, West Yorkshire LS23 7NB, Tel: 0870 1226236, Fax: 0870 226237, Textphone: 0870 1207405
Email: detr@twoten.press.net
Or from the DETR website, http://www.construction.detr.gov.uk/conindex.htm

Members are also free to comment directly to the DETR at:
Jo Withers, DETR, Zone 3/A1, Eland House, Bressenden Place, London SW1E 5DU, Tel: 020 7944 5739, Email: partsefkn_br@detr.gov.uk

Comments to the DETR must be received by 20 April 2001.

Certificate Courses

Examination dates

27 April	Management of Occupational Exposure to Hand Arm Vibration
18 May	Certificate of Competence in Workplace Noise Assessment
8 June	Certificate of Competence in Environmental Noise Measurement
14-15 June	Diploma in Acoustics and Noise Control
26 October	Certificate of Competence in Environmental Noise Measurement
9 November	Certificate of Competence in Workplace Noise Assessment
16 November	Management of Occupational Exposure to Hand Arm Vibration

Institute Register 2001/2002

A number of entry forms for the Institute Register are still outstanding. An early response would be appreciated.

Correction
Acoustics Bulletin *(Nov/Dec 2000)*

Unfortunately, in the article **Acoustics World,** by Geoff Leventhall, the scale of the abscissa has not printed clearly in *Figure 1* on page 25. The scale for engine bypass ratio runs from 0.0 to 9.0, with the value at the red ordinate being 3.0.

UKAS accreditation underpins market confidence

Lord Sainsbury of Turville, Parliamentary Under-Secretary of State for Science and Innovation, has launched a campaign to demonstrate how the use of accreditation is removing technical barriers to trade in a host of business areas for the benefit of the whole business community.

The campaign is being run by UKAS and supported by the Department of Trade and Industry. Lord Sainsbury reaffirmed the government's commitment to accreditation and stressed the important contribution made by accreditation in providing confidence in the market, underpinning the competitiveness of UK business and facilitating the free movement of goods in the global market place.

Linda Campbell, Chief Executive of UKAS, said "UKAS accreditation is increasingly seen as the means by which the confidence in the systems, facilities and people who test, calibrate, inspect and certificate business is authenticated. With UKAS taking its place within the European and international market for accreditation, our mission is to reduce technical barriers to trade still further".

For more information on how accreditation benefits British business, contact the UKAS Information Desk on 020 8917 8555 or e-mail: ikc@ukas.com

New UKAS accredited lab for acoustic calibration

AV Calibration is the new UKAS accredited calibration laboratory (no.0653) from **A.V.I. Ltd.** Calibration available under this accreditation covers sound level meters to BS 7580:Part 1:1997, acoustic calibrators and pistonphones. The typical turnround time is just 7 working days.

AV Calibration is independent of all the major manufacturers, and has developed its accredited calibration procedures from the standard calibration service already offered. Most makes of equipment can be calibrated in the one laboratory.

Whatever manufacturer is involved, the equipment must meet certain standards. Sound level meters should claim compliance with IEC 60651 Type 1 and integrating meters with IEC 60804 Type 1 or their equivalents; Type 2 instruments are not included for UKAS accredited calibration. Calibrators and pistonphones should claim compliance with IEC 942 or IEC 60942 (or equivalents) if used with a sound level meter in a BS 7580 verification. Very few instruments manufactured in the last 20 years do not claim conformance to these requirements.

For more information, pricing and any questions answered, please contact Richard Tyler at:- AV Calibration, A.V.I. Ltd.,13C, Old Bridge Way, Shefford, Beds. SG17 5HQ. U.K.
Tel: 01462 638600. Fax: 01462 638601. e-mail: sales@avi.f2s.com
or visit our website at www.avcalibration.co.uk.

(Editor's note: Notification of this new ACAS accredited laboratory came just too late to be included in the list given in the report on the visit to Casella CEL published in *Acoustics Bulletin, Sept/ Oct 2000).*

Company acquisitions

❑ **The Casella Group** has made its fifth acquisition in 12 months with the purchase of **Monitor Environmental Consultants** (MONITOR EC), the environmental consultancy, from The Monitor Group Ltd.
Commenting on the further growth of Casella, managing director, William Pope said: "We are pleased with the MONITOR EC acquisition, following on closely as it does the purchase of Stanger Science & Environment. MONITOR EC adds considerable strengths to the company, particularly in the areas of contaminated land, air pollution and environmental management amongst others".

For further information contact:
Natalie Sedden, Casella CEL, Regency House, Wolseley Road, Kempston, Bedford MK42 7JY. Tel: 01234 841441
Fax: 01234 841490
email: info@casella.co.uk
Web: www.casella.co.uk

❑ **Ferguson & Timpson Ltd** has been acquired by **Caledonian Industries,** also based in Hillington Park, Glasgow. Although the customer base of both companies overlap, Caledonian Industries' products are aimed at precision foam packaging and supplies to the electronics, automotive and engineering sectors.

The acquisition was one of the first moves made by Alan Thornton, who acquired Caledonian Industries in March 1999.

"The two companies have been working together on a number of ventures", said Mr Thornton, "and there is a high degree of compatibility in the materials and plant used. By joining forces we will be able to offer our clients an enhanced service with a wider product range and greater depth of management experience.

"We aim," said Alan Thornton, "to consolidate operations on one site. We are already established in the supply chain of many blue-chip enterprises and are well known for our progressive attitude towards customer care and innovation".

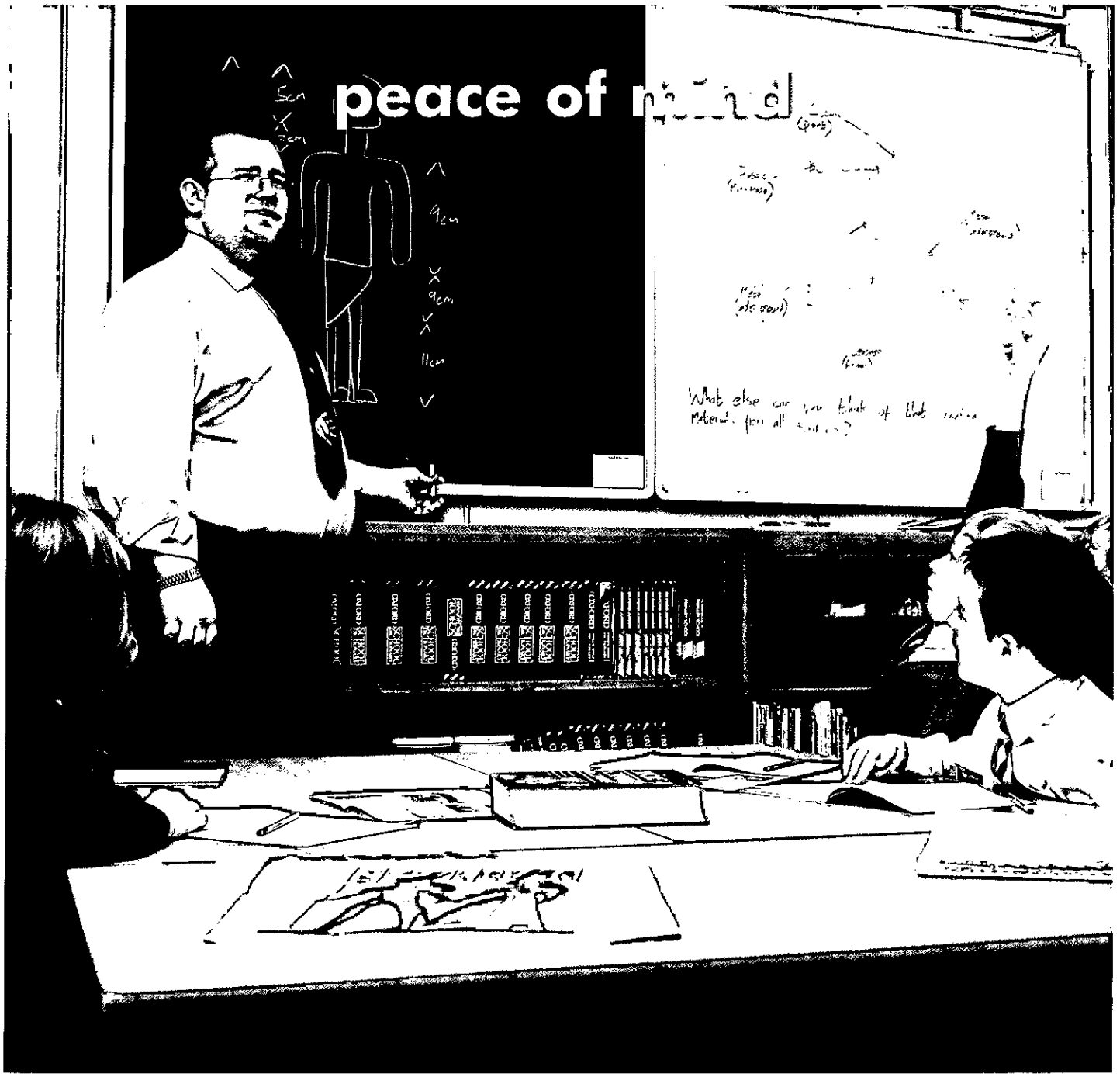
UNIVERSITY NEWS

Liverpool wins EC funding

The Acoustics Research Unit at the University of Liverpool has received a major award from the EC Framework V Programme as part of a consortium of 6 Industrial and 4 Technical Partners from 6 EC countries. The project, *'Nabucco'*, will take three years to complete with a team headed by Dr. Andy Moorhouse with Mr Qi Ning as full time Research Assistant. The aim is to provide the Industrial partners with a design tool which will give them a competitive edge over non-European manufacturers. The Acoustics Research Unit was selected because of its expertise in characterisation of structure-borne sound sources, and is the leader of the largest work package in the project on source charactersitation methods.

Research visitor studies Low Frequency Noise

Gustavo (Guga) Melo has joined a team researching into *'Sound transmission between dwellings at low frequencies'* at the University of Liverpool. Guga will spend 18 months in the Acoustics Research Unit before returning to his native Brazil. His work, on the effect of furniture on low frequency sound fields in rooms, will contribute to an ongoing EPSRC funded project on sound insulation at low frequency, and will also form part of a PhD thesis.



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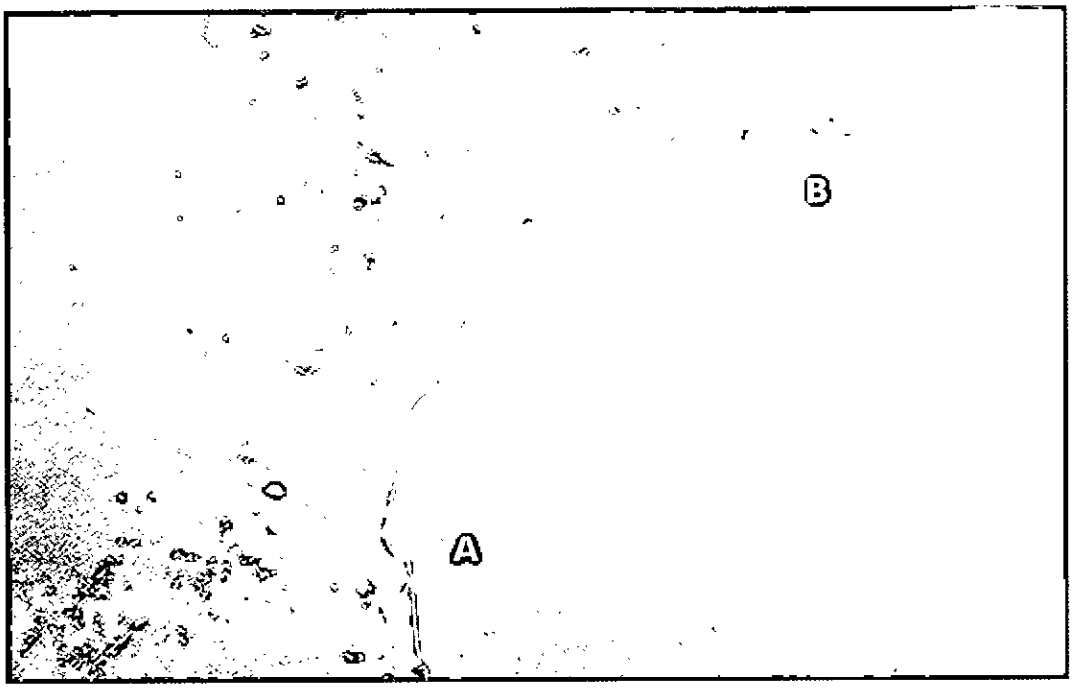

Figure 1: Photograph showing coastal turbidity along the Texas and Louisiana Gulf coast. Galveston Bay is shown at the bottom of the picture, with the Mississippi Delta at the top right. [Source: Lunar and Planetary Institute]

Sonar performance in coastal environments

suspended sediments and microbubbles

Simon D Richards MIOA ***and Timothy G Leighton*** FIOA

Research into sonar performance has traditionally focussed on long range, low frequency propagation in the deep ocean. Over the last decade or so attention has turned towards the study of sonar performance in coastal seas. Sonars operating in shallow, coastal waters are subject to many complexities of the environment which present problems for sonar performance. One such complexity is that coastal environments may be characterized by suspensions of mineral particles and populations of microbubbles which can degrade the performance of high frequency sonar systems in particular. Such systems may employ frequencies in the range tens to hundreds of kHz (wavelengths of order centimetres) in order to locate and classify relatively small targets, with propagation ranges of the order of hundreds of metres.

SUSPENDED PARTICLES

High concentrations of suspended mineral particles may be found in coastal waters as a result of rivers discharging their sediment load, wind and tide generated currents stirring up bottom sediments, and human activity. *Figure 1* shows an example of a turbid coastal environment. This photograph (NASA Image STS41C-51-2422. *Source:* **Lunar and Planetary Institute**), taken from the NASA Space Shuttle, shows the Texas and Louisiana coastline of the Gulf of Mexico, extending from Houston at the bottom left of the frame, to the Mississippi Delta at the top right. High levels of coastal turbidity may clearly be seen all along the coastline in this image, with the Trinity River discharging a balloon-shaped sediment plume **[A]** through Galveston Bay, and a very high sediment load disgorging from the Atchafalaya River through Atchafalaya Bay **[B]**. The presence of these suspended particles may influence acoustic propagation through absorption, scattering, and changes to the sound speed.

Absorption

The principal acoustic absorption mechanisms associated with suspended particles are viscous and

thermal absorption. *Viscous absorption* occurs as a result of the density contrast between the particles and the suspending water. Unless the particle is neutrally buoyant, its inertia will differ from that of the fluid it displaces. As a result of this the oscillations which the particles undergo in response to an acoustic field will have a phase-lag relative to the oscillations of the ambient fluid. This phase-lag leads to a boundary layer at the surface of the particle in which there is a velocity gradient. As a consequence of internal friction (viscosity) this velocity gradient results in conversion of energy to heat, and hence a loss of energy from the acoustic field. This represents the dominant energy loss mechanism due to suspended particles over the parameter range of interest for sonar performance. Thermal waves may be generated as a result of the adiabatic compression and rarefaction associated with the passage of the acoustic wave. Phase differences between the thermal waves in the solid and fluid lead to *thermal absorption*, although this effect may generally be neglected at sonar frequencies for mineral particles suspended in seawater.

Scattering

Acoustic waves incident on an inhomogeneity, such as a particle suspended in an ambient fluid, are scattered in all directions. Energy which is scattered in this way, whilst remaining part of the overall acoustic field, is effectively lost from a transmitted or reflected sonar pulse. It will, however, contribute to the volume reverberation if it propagates to the sonar receiver array. The amount of energy scattered by a particle in this way depends upon the ratio of the particle size to the acoustic wavelength. For practical sonar applications the wavelength is usually large compared to the particle size and under this regime the scattered power varies as the fourth power of this ratio. As a result scattering is usually a small contribution to the absorption, becoming important only at the upper extremes of frequency and particle size.

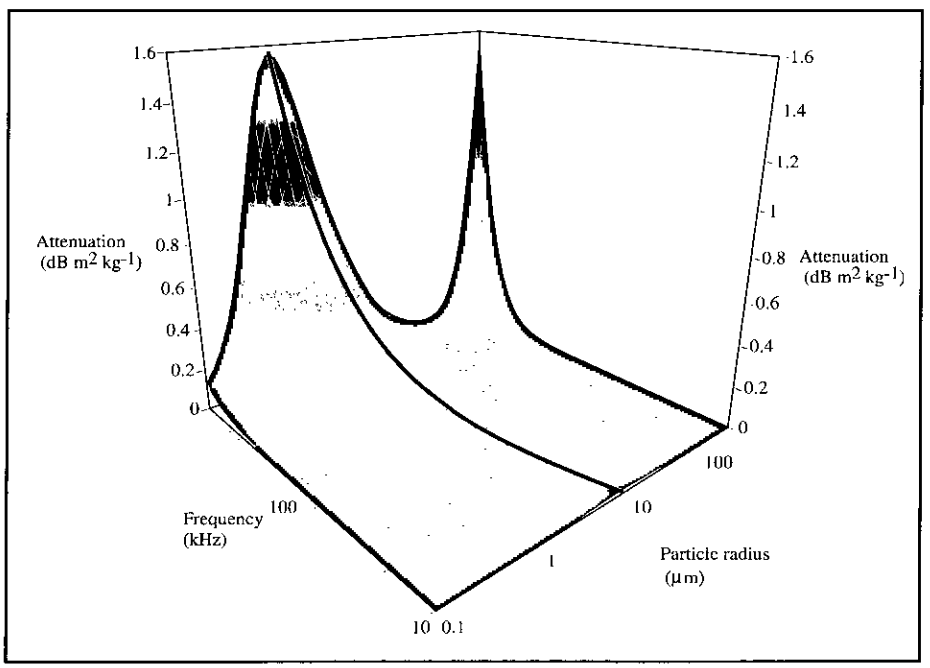

Figure 2: Attenuation coefficient for a suspension of quartz-like spheres

Sound speed

The speed of sound in a suspension may differ from that in the suspending fluid by virtue of the fact that the suspended particles modify the bulk compressibility and density. This effect is small for naturally occurring suspension concentrations[1] and may therefore be neglected in sonar performance predictions.

Calculations

Over the parameter range under consideration for the sonar performance problem, it may be found that the simplest, intuitive models give predictions which are in reasonable agreement with the more complete models. Urick[2] obtained an expression for the viscous absorption coefficient based on energy balancing arguments for a solid sphere oscillating in a viscous fluid. The scattering attenuation coefficient may be estimated using a simple polynomial fit to the scattering form function[3]. These models have been used to produce the result shown in *Figure 2*. This shows the normalized attenuation coefficient in water containing a suspension of spherical particles with physical properties representative of typical mineral particles. The main peak dominating much of the parameter range is the contribution due to viscous absorption, and the sharp increase in attenuation at the extremes of high frequency and large particle size is due to scattering. The black curve shows how the peak in the viscous absorption shifts to larger particle sizes as the frequency is reduced.

Laboratory measurements

In order to validate the models for viscous absorption and test their applicability to non-spherical particles, a laboratory technique for measuring ultrasonic absorption in dilute suspensions was developed[4]. Whilst the absorption by dilute suspensions can be significant over propagation ranges of hundreds of metres, it is a challenging quantity to measure in a laboratory tank as the losses at the walls of the tank are much

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greater than the volume losses. Consequently, a novel experimental approach was required to measure these small volume absorption coefficients.

The experimental method is based on measuring the reverberation time of an enclosure, defined as the time taken for the sound pressure level to fall by 60 dB after the sound source is switched off. The reverberation time depends on the total acoustic attenuation in the system, and by measuring changes in the reverberation time changes in the attenuation may be inferred. This technique measures only the absorption, as scattering merely contributes to the reverberation and does not therefore represent a loss of acoustic energy from the system. *Figure 3* shows the measurement system schematically and *Figure 4* shows a photograph of the apparatus. The test volume of around 16 litres of filtered, degassed water is contained within a thin-walled plastic membrane. This configuration was chosen to give a boundary condition approaching the idealised pressure-release boundary, ensuring that sound reflection at the interface is maximised, resulting in minimum boundary losses. The photograph shows four items penetrating the water surface. These are, from left to right, a light scattering sensor for monitoring

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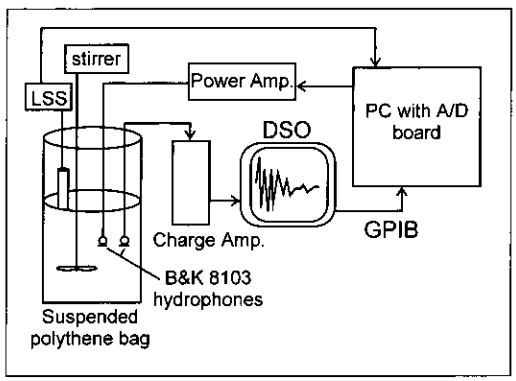

Figure 3: Schematic of experimental apparatus for measuring ultrasonic absorption in dilute suspensions

Figure 4: Photograph of experimental apparatus for measuring ultrasonic absorption in dilute suspensions

Sonar performance in coastal environments

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suspended particle concentration, the two hydrophones (source and receiver) and a mechanical stirrer. A diffuse, reverberant sound field is established by exciting the volume with broadband sound. The reverberation time is then determined by switching off the source hydrophone and measuring the decay of the sound field using the receiver hydrophone. This is done first in clear water and then a known quantity of particulate matter is added and the procedure is repeated. The mechanical stirrer is used to suspend the particles and ensure that they are evenly distributed. The clear water reference measurement is also made on stirred water to ensure consistency and the stirrer is removed from the water prior to making the acoustic measurements. The additional attenuation arising from the addition of the particles is inferred from the difference in reverberation time. Initial experiments were performed using spherical glass particles, in order to compare results with the predictions of the models, which assume the particles to be spherical. These experiments showed very good agreement between the measurements and predictions of the model integrated over the particle size distribution, which was measured by laser diffraction analysis[4].

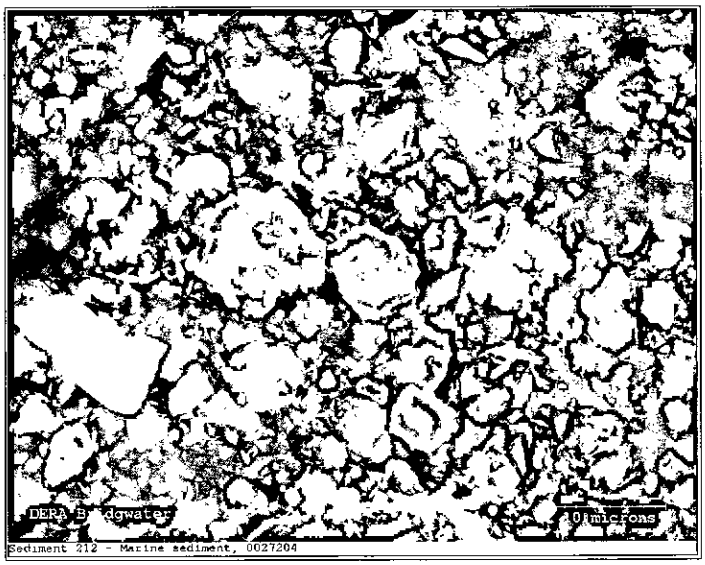

Figure 5: Scanning electron microscope image of a typical fine-grained marine sediment

Naturally occurring marine sediment particles are not, of course, spherical. Instead they typically look more like the particles shown in *Figure 5*, which shows a scanning electron micrograph of a sample of fine sediment taken from the seabed. Clearly the particles are very granular and irregular in nature. The absorption coefficients of dilute suspensions of this material were measured as before, and the results are shown in *Figure 6*. The absorption was modelled assuming the particles to be spherical, with the size distribution again determined by laser

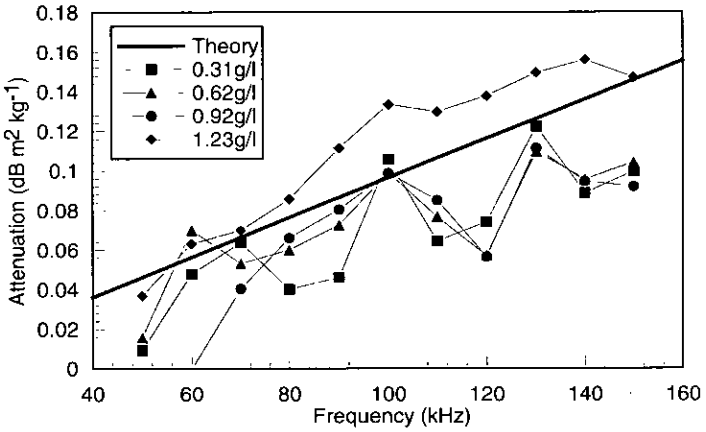

Figure 6: Measured attenuation coefficient for sediment type shown in Figure 5.

diffraction analysis. The measurements were made at different concentrations, and the results normalized with respect to concentration. Clearly there is a spread in the measurements and this is largely due to uncertainties in the estimation of the water content of the sediment sample. Surprisingly, the results of the model for viscous absorption by spherical particles are in reasonable agreement with the measured absorption due to these irregular particles. Other measurements made with pure samples of highly non-spherical particles show significant departures from the spherical model, as is to be expected[5]. It is thought that, in the case of the marine sediment, the agreement between the measurements and the spherical particle theory is a result of ensemble averaging over many different particle shapes. This gives some encouragement that the simple model of viscous absorption by spherical particles may be used to estimate absorption by dilute suspensions of natural marine mineral particles.

MICROBUBBLES

Coastal waters may also be populated by microbubbles, not only near the surface but extending throughout the water column. Near-surface bubble populations are generated by the entrainment of air through wave activity, and these populations may be taken into account implicitly in sonar performance models by empirical surface scattering algorithms which include a dependence on wind speed. Some models may also include the effects of a surface bubble layer in a surface loss term.

Current sonar performance models do not, however, include the effects of microbubble populations on volume attenuation. Bubbles contribute to acoustic attenuation through both absorption and scattering, as do suspended particles. Additionally gas bubbles in liquids cause

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the compressibility to be complex, resulting in a dispersive medium. The additional attenuation due to microbubbles, and their effect on the sound speed may be determined from the dispersion relation for bubbly water[6]. Depth dependent versions of this dispersion relation were used in this work[7].

SONAR PERFORMANCE

The effects of suspended particles and microbubbles may be particularly significant for the performance of high frequency sonars, operating in the frequency range tens to hundreds of kHz, and these effects have therefore been integrated into a high frequency sonar performance prediction model.

The model uses ray-tracing techniques based on the vertical sound speed gradient to determine ray paths in a horizontally stratified environment. It then calculates the signal-to-noise ratio along each ray path by calculating: directivity; absorption; geometric spreading loss; surface, bottom and volume reverberation; ambient, flow and receiver noise; and applying the active sonar equation. The model uses direct paths only, assumes a flat, homogeneous seabed and employs a single sound speed profile.

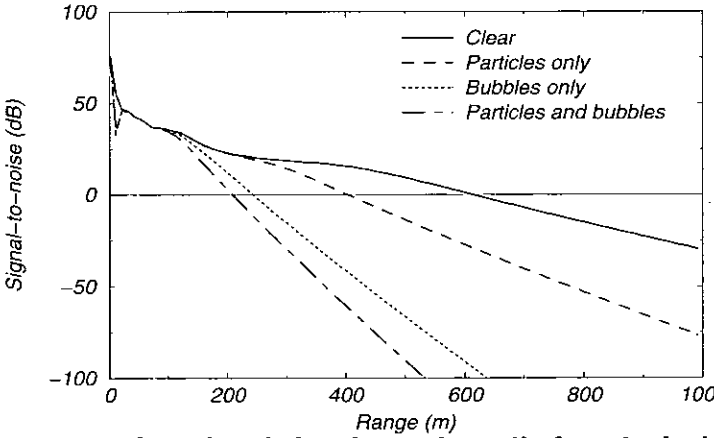

Figure 7: Calculated signal-to-noise ratio for a typical high frequency, shallow water scenario (see text), showing the effects of suspended solid particles and microbubbles.

The additional attenuation due to viscous absorption and scattering by suspended particles has been added to the volume absorption algorithm, ensuring that the total attenuation coefficient is used in all propagation calculations within the model (transmitted and reflected signals; reverberation terms; propagating noise terms). The viscosity and the density of the seawater must be known in order to calculate the additional attenuation terms, and viscosity and density profiles are therefore computed within the model. The temperature profile is obtained from the sound speed profile (assuming constant salinity) and this is used to determine the viscosity and density using temperature, pressure and salinity dependent expressions[8]. The effects of suspended particles on the sound speed are considered to be negligible and have not been included in the model.

The depth-dependent dispersion relation for bubbly water is computed within the model. The real part of the derived complex wavenumber is used to modify the sound speed profile to take the effect of the bubble population into account. The imaginary part of the wavenumber is used in the volume absorption algorithm to include the bubbles' contribution to the attenuation coefficient. The bubbles may contribute significantly to the volume reverberation and this contribution has not yet been incorporated into the model.

EXAMPLE RESULTS

Figure 7 shows the calculated signal-to-noise ratio for a typical high frequency, shallow water scenario. In this example the water depth was 40 m, the bottom type was mud and the water column was isothermal. The horizontally-looking sonar was at a depth of 20 m and the source frequency was 80 kHz. The calculations for water containing suspended particles assume a monodisperse population of particles with radius 2 mm, density 2600 kgm^{-3}, and a constant concentration of 0.2 kgm^{-3} throughout the water column. A depth dependent distribution[9] of microbubbles with radii in the range 10-200 mm was used, with coefficients chosen to approximate at-sea bubble density measurements[10,11]. This is appropriate for persistent background bubble populations in calm, isothermal, coastal waters and not for conditions where there is a large surface-generated bubble population.

If we assume, for the sake of argument, that a signal-to-noise ratio of 0 dB is required, shown by the horizontal line in the figure, then we can see that in this example a detection range of around 615 m is predicted for clear water.

The additional attenuation due to the chosen population of suspended solid particles reduces this range to 403 m. The bubble population has an even greater effect, reducing the detection range to 243 m, whilst the combined effect of bubbles and suspended particles reduces the detection range to just 209 m.

SUMMARY

Populations of suspended solid particles and microbubbles are just one of the many complexities which can influence the performance of sonars operating in shallow, coastal waters. Such populations can significantly degrade the performance of high frequency active sonars and

should therefore be taken into account in predictive modelling of sonar performance.

ACKNOWLEDGEMENTS

The authors are grateful to the Lunar and Planetary Institute, Houston, Texas, for their assistance in providing the image shown in *Figure 1*.

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a structured approach to CONTROLLING TONAL NOISE

*Pete Simpson and Ray Woolley*MIOA
Sound Research Laboratories

This paper describes an investigation by SRL into the cause of tonal noise alleged to be emanating from a UK aluminium conversion plant in the United Kingdom. The case was politically very sensitive, almost resulting in a court hearing. Consequently the name of the factory and other references have been omitted from this paper.

SRL's investigation arose as a result of an appeal from the factory management against the extent of the remedial work that the Local Authority required to abate the nuisance. The Local Authority had issued an Abatement Notice in respect of Noise Nuisance under the terms of the *Environmental Protection Act, 1990, section 80.*

This paper starts at the issuing of the abatement notice and highlights the conflict between the need to impose suitable works to remedy a problem, whilst avoiding measures that are unduly restrictive.

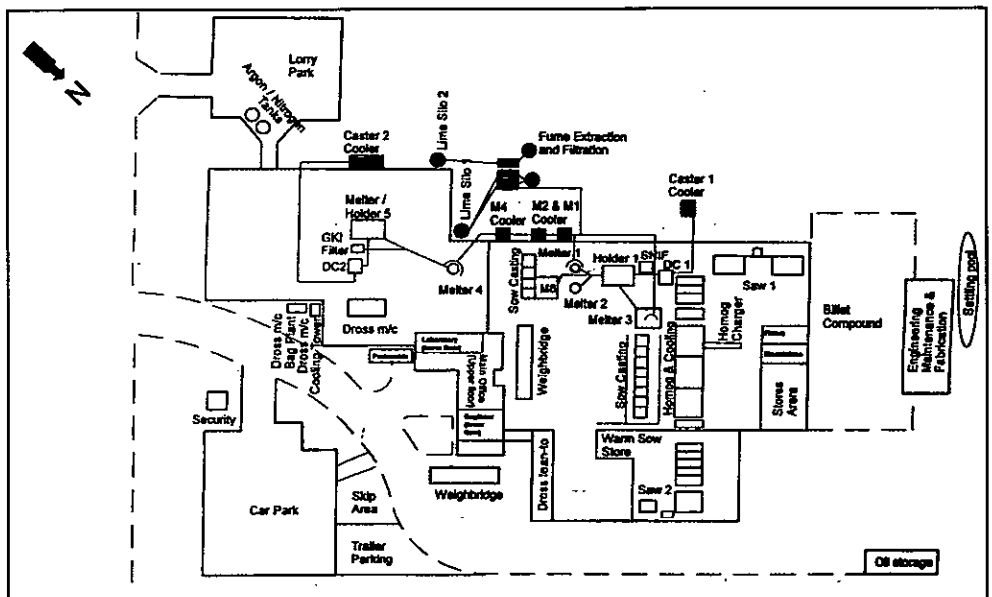


Figure 1: the plant layout

CONTEXT

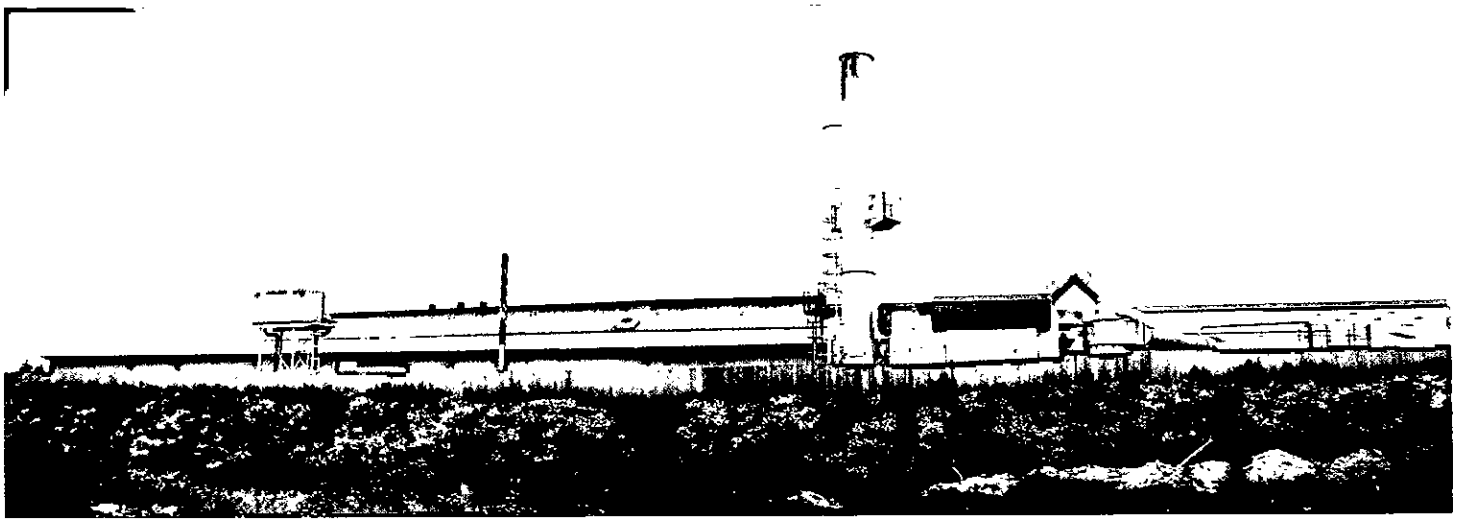
Plant

The factory under consideration is one which recycles scrap aluminium and recasts it into billets. The process involves the use of furnaces, or 'Melters', followed by casting and a gradual cooling process .

The plant layout is shown in *Figure 1.* The factory building, which is constructed largely of profiled steel cladding houses most of the plant including the furnaces. At the rear of the factory, there is some external plant comprising a dust and fume extraction system and several cooler units.

This paper deals largely with the fume extraction and filtration system. This needs to be a fairly comprehensive system, because of the requirements of the Environment Agency to trap particulate emissions, and comprises of three bag filtration units. Two of the bag plants, numbers 1 and 2, are served by centrifugal fans which discharge into a common stack.

Figure 3



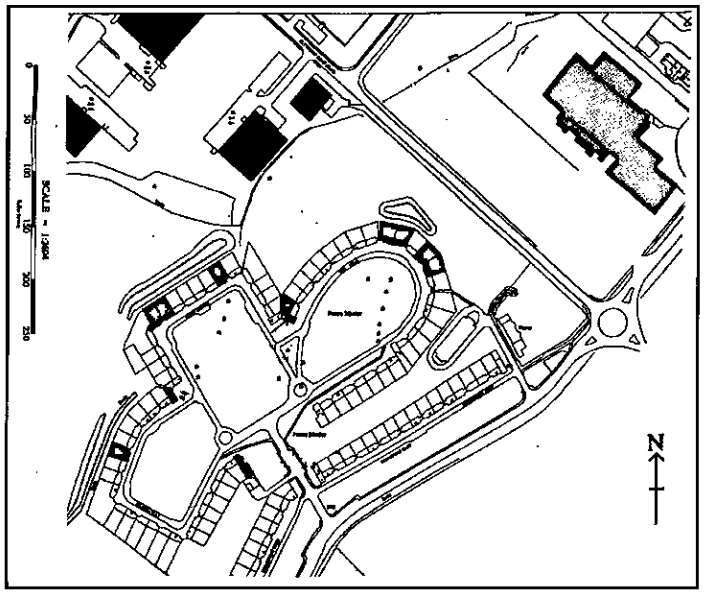


Figure 2 shows factory location in relation to nearest properties

Case Study at an Aluminium Recovery Plant

The filter bags are mounted at high level and are periodically shaken by mechanical excitation in the 'Scavenger Area'. This area is mounted above the plant. There are also two cyclones which collect the larger particulate emissions. One of the features of this assessment was that it was essential that the efficiency of the plant was unimpaired in the attempt to satisfy the demands of the Environmental Agency for the local residents.

Location

The area surrounding the factory can be characterized as classic *British Standard BS4142* territory, namely mixed residential and industrial development. The location is shown on *Figure 2*, where the factory is highlighted in blue and several of the nearest properties are highlighted in red. Other factories in the area, can be clearly seen to the north of the residential estate.

The entrance for vehicles is at the front or east side of the factory and the rear or west side of the factory faces a residential estate some 200m distance.

Complaints

For several years some of the residents of the estate had been complaining about their perception of unpleasant low frequency noise which appeared to emanate from the factory. The noise was identified as being tonal in nature.

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This noise had been investigated by the local authority and by other consultants previously, leading to the definition of the noise as a nuisance. Review of this information at the start of the project had convinced us that there was a nuisance that needed to be addressed.

A previous study demonstrated that there were measurable tones at 12 Hz, 16 Hz and 38 Hz at the complainants' properties.

Figure 3 illustrates how close the back of the factory was to the nearest properties.

ABATEMENT NOTICE

A notice was served by the local Environmental Directorate, based on recommendations from their external consultant. This notice turned out to be very specific, in several respects.

Level

Compliance with the *Noise Abatement Notice* was defined to be as follows.....

*'The requirements in this notice will be considered to be satisfied if the sound pressure level of **48 dB** in the one-third Octave Band centered on **40 Hertz** is not exceeded in any of the 5 minute measuring periods...'*

This was based on the level described in the German Standard DIN 45680. The typical level existing at the complainants when the plant was operating was 56 to 57 L_{eq}dB in the 40 Hz one third octave band.

Much discussion was had with the client and with the Environmental Inspectorate and their consultant about the merits of using a German Standard when it could be argued that BS 4142 used in conjunction with BS 7445 part II would be appropriate. However, this debate is beyond the scope of this paper.

Schedule

In addition to specifying a noise limit within a defined third-octave frequency band, the Notice contained a detailed schedule of work split into two phases. The following is a summary of the mitigation schedule that was specified, as it was written in the notice:

Phase 1

- Acoustically treat the scavenger area on Bagging plant 1 and 2 by fully enclosing the area using acoustic panels (3mm mild steel with 50mm Class 'O' foam with lead lining)
- Fit/replace inlet and exhaust silencers on the main fans of Bagging plants 1 and 2 to attenuate low

frequency noise (300mm wide splitters, 150 mm airways)
- ✦ Acoustically clad the fan casing with 100mm thick insulation
- ✦ Stiffen and clad the existing/replaced outlet silencer casing
- ✦ Fit silencer to the homogeniser cooler designed to attenuate low frequency noise

Phase 2
- ✦ A secondary stack silencer shall be introduced
- ✦ A frequency tuned expansion box should be fitted inside the factory to control low frequency duct born noise from the Melters
- ✦ The cyclones should be sealed and stiffened to prevent drumming.
- ✦ The platform which sits close to the cyclones should be isolated using anti-vibration mounts

Timetable

Not only was a specific level set, together with specific mitigation measures, but a defined timescale was imposed by which all of the above measures had to be implemented.

This timetable was defined as 6 weeks for the most urgent, Phase 1, works and 12 weeks for the Phase 2 works.

INVESTIGATION

Method

SRL was not convinced about the need to do all of the work set out in the schedule nor about the priority given to each item. It was decided that the best way was to adopt a structured approach to analysing the noise and identifying the actual noise source.

In particular, noise measurements were made under a number of different operating conditions to isolate the source of the low frequency noise from the offending areas. The areas which were comprehensively surveyed included the three bag plants, No 5 stack, the roof area and the ductwork from Melters 3 and 4 to the bagging plant. We also measured noise from the homogeniser cooler fans on the roof and on the caster 2 cooling tower. DAT recordings of specific noise sources were made for subsequent post analysis using a laboratory-based narrow band analyser. Some vibration measurements on the cyclones and the scavenger area building were also taken with particular attention being given to vibration in the 40 Hz region.

An aerial platform was used to gain access to the top of the bagging plant stacks and the high level extraction ductwork.

Findings

A large number of readings were taken, with the following summary of results, as shown in *Table 1* below:

Table 1 - Summary of Results

Source	Results of near field and narrow band analysis
Bag plants 1 and 2 (stack and fans)	Clear peaks found at 38 Hz & 34 Hz. The 38 Hz peak remained with plant 2 off.
Bag plants 1 & 2 (main ductwork)	Clear tones at 38 Hz were observed on the ductwork which runs from the fans to the bagging plant itself.
Bag plant 3 (stack)	No discrete tone found in the 40 Hz one-third octave band and the measured levels was 10 dB less than that for bag plant 2 at 40 Hz.
Bag plant 3 (fan)	Although a clear tone could be heard emanating close to the fan on bag plant 3, measurements shown occurred in the 50 Hz one-third octave band with a lesser peak at 38 Hz which was found to originate from the nearby ductwork from bagging plant 1 and 2.
Melters 3 and 4 (ductwork)	Measurements made of the ductwork linking bag plant 1 to the melters showed significant levels in the 40 Hz one-third octave band but only close to fan and the closed off section of ductwork.Thus it was concluded that the noise radiated from the ductwork was due to the fan and not low frequency transfer from the melters.
Melters 3 & 4 (stack)	Measurements at 10m distance from the stack showed no tonal component in the 40 Hz one-third octave band.
Roof	No significant radiation in the 40 Hz one-third octave band was detected over the whole roof area.
Scavenger area	Readings were taken in the whole of the Scavenger Area. Analysis of the readings without the fans running showed a significant component of 15-25 Hz with a very small peak at 38 Hz. With the scavenger fans running the peak at 38 Hz did not increase.
Cyclones	Measurements taken at the top of cyclones on bagging plants 1 and 2 showed a clear peak at 32 Hz but not in the 40 Hz one-third octave band. On top of the cyclone for bagging plant 2 a peak at 30 Hz was discovered.
Homogeniser fan area	Measurements made over the inlet and exhaust opening of the homogeniser fans revealed a broad band noise spectrum with no obvious tonal components.
Caster 2 cooling tower	A tonal component at 38 Hz was determined at the base of the Caster 2 cooling tower. However complaints were known to occur irrespective of Caster 2 cooling tower operation

In summary, the only sources that were found to be generating significant levels of noise at 38Hz (or anywhere within the 40 Hz third-octave frequency

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band) were sources associated with Bag Plants 1 and 2. An illustration of this is given by *Figure 4,* which shows print outs from the narrow band analysis of two DAT recording. The first is a recording made on the site boundary and the second was recorded by the fan casing for Bag Plant 1. The peak at 38 Hz is shown clearly in both cases.

PREDICTIONS

Having performed the measurements set out in 6 above, SRL established the sound power level of the individual plant items in one-third octaves and predicted the sound pressure level in the 40 Hz one-third octave band which would have occurred at the claimants property as follows:

Table 2: prediction of levels at nearest property

PLANT ITEM	PREDICTED LP IN 40 Hz ONE-THIRD OCTAVE BAND
Bag Plants 1 & 2 Stack	49 dB
Bag Plant 1 Main Ductwork	49 dB
Bag Plant 2 Main Ductwork	53 dB
Caster 2 Cooler Main Body	45 dB
Caster 2 Cooler Fans	41 dB
Total at Complainants Property	*56 dB*

Thus, just taking the contribution from these key sources, it can be seen that the predicted sound pressure level at the complainants property in the 40 Hz one-third octave band is very similar to the level of 56-57 dB that was measured in practice .

All of the above pointed to the fans and ductwork associated with Bag Plants 1 or 2 being responsible for the noise source.

One of the key limiting factors experienced throughout this project was that the need to maintain effective atmospheric pollution control meant that the fans operating by Plants 1 and 2 could not be switched off so that we could have a look inside. It was known at the outset that the rotational speed of the centrifugal fan on No 1 Bag Plant was 2280 rpm, which coincides with a frequency of 38 Hz and so appeared to be a strong candidate for the noise source. However, we had been assured that the fan had been regularly balanced and was in good

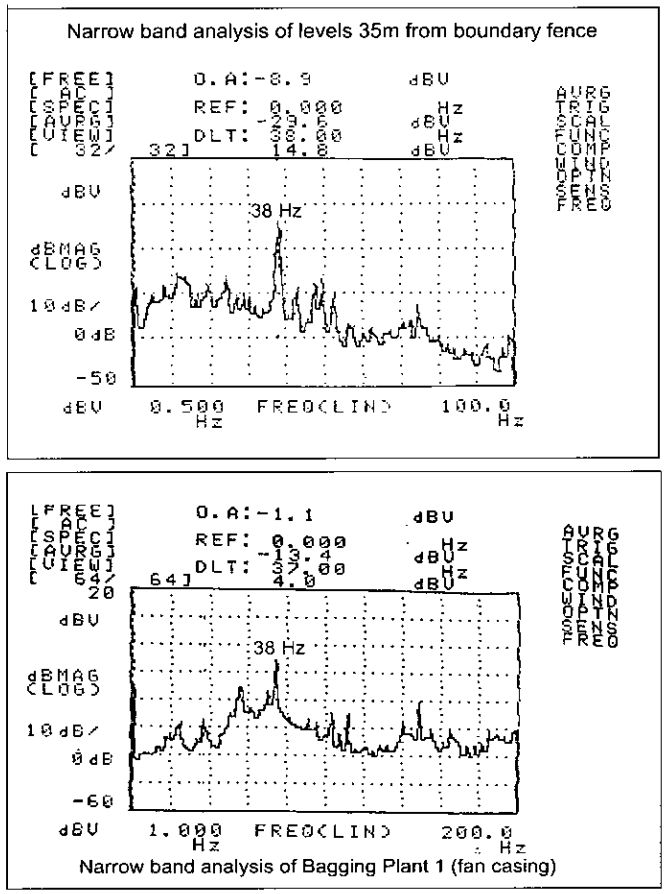

Figure 4

order. The fan was belt driven so the prospect of misalignment being a cause of unacceptable vibration at the rotational frequency was unlikely.

With the fan discounted, we were left with the possible conclusion that the 38 Hz tone was due to a strange effect in the ductwork. For example, we found a closed off section of ductwork having a length of 4.5 metres, which happens to be approximately 1/2 the wavelength of a 38 Hz noise.

MITIGATION

The investigation described above meant that we were able to approach the original Schedule of Works with a better idea of what would actually be effective. We therefore provided a revised scope of work which differed considerably from the schedule that had been included in the notice.

So, taking each of the items as listed in the *Schedule of Works,* we defined whether the mitigation was required, as follows:

Phase 1

Acoustically Treat Scavenger Area

Our measurements had determined that the scavenger area on the bagging plants was not a cause of noise in the 40 Hz one-third octave band and so this item was eliminated.

Fit/replace inlet and exhaust silencers on the main fans of bagging plants

Fitting or replacing inlet or exhaust silencers on the main fans on bagging Plants 1 and 2 was physically

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ONE-DAY MEETING

Organised by the Measurement and Instrumentation Group

To verify or not to verify? - that is the question

14 February 2001

Royal Society, London

As the concepts of legal metrology become more accepted the pattern evaluation of new designs of instruments by their manufacturers along with the routine independent periodic verification of their performance by users are being written in to the International Standards. The meeting will therefore be of interest to all users of acoustic instrumentation for legal or commercial measurements who will have to manage the logistical and cost implications of these new requirements.

Programme

10:00	*Registration*
10:30	**Uncertainty budgets; are we sure we understand them?** *Richard Tyler FIOA. AVI Ltd.*
10:55	**Standards for Sound Level Meters and Sound Calibrators, the current status** *Sue Dowson. National Physical Laboratory*
11:20	**Management of the verification process** Tim South MIOA. Leeds Metropolitan University
12:05	*Coffee*
12:25	**Is there a need to verify sound level meters when new?** *Liz Brueck MIOA. Health and Safety Laboratory*
12:50	**Beyond verification – The role of measurement uncertainties in noise measurements** Geoff Kerry FIOA and Nick Craven. Salford University
13:15	*Lunch*
14:15	**A system for the Verification of Interfaceable Sound Level Meters** *Nigel Milton. National Physical Laboratory*
14:40	**Implementation of pattern evaluation and verification requirements** *Thor Carlsen. Norsonic AS*
15:05	**The Consultants Perspective** *Jim Connors MIOA. Association of Noise Consultants*
15:30	*Tea*
15:50	**Self-verifying instrumentation. If possible, is it a manufacturer's nightmare or a competitive advantage?** *Richard A. Collman MIOA. Acoustical Control Engineers and Bellair Research Ltd*
16:15	**Discussion**
16:30	*Close of meeting*

To verify or not to verify that is the question - 14 February 2001
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WORKSHOP

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The emerging role of BS 4142

Thursday 8 March 2001

Basingstoke & Deane District Council, Basingstoke

BS 4142 is over 30 years old. Its origins can be traced back to the Wilson Committee report of 1963 and since its formal publication in 1967, it has been used to assist in the assessment of a wide variety of environmental noise situations.

The most recent edition came out in 1997 and next year, BSI will have to decide whether they should embark on a formal review of this standard.

To aid this decision, the Environmental Noise Group is holding a workshop to enable members to come together and share their views on the standard and to consider its current function and whether or not its role is or should be changing.

Programme

1200	*Registration & Buffet Lunch*
1300	Introduction
1305	**Experience of Using BS 4142**
	Nigel Cogger, The Cogger-English Partnership
1325	**BS 4142 in an international context**
	Ian Flindell, ISVR
1345	**The Case for Change**
	Colin Cobbing, London Borough of Hillingdon
1405	Introduction to the particular issues for discussion
1415	Group Discussion Session 1
1500	*Coffee/tea*
1520	Group Discussion Session 2
1600	Feedback Session
1645	*Close*

CPD Certificates will be available (4 hours)

The Emerging role of BS 4142, Thursday 8 March 2001

Name:

Address:

Tel: Fax: email:

Please register me as a delegate. Cancellations are payable in full

☐ Fee for Authors & Members £50 + VAT £58.75

☐ Fee for all others £60 + VAT £70.50

I enclose cheque/credit card details for the full amount. Please give a purchase order number if you need to be invoiced.

ONE DAY MEETING

Organised by the Measurement and Instrumentation Group

CALL FOR PAPERS

Long-term Noise Measurement - just for the SEL of it?

6 June 2001

East Midlands Airport

Long-term measurement using fixed noise monitoring terminals is used more and more to provide data to both the noise producers and the noise sufferers. In recent years the majority of installations have been used for airport systems but the usage is expanding. Many noise sources such as Construction sites, Military sites, Power stations, Quarries, Racetracks and Railways are requiring such equipment to reduce noise complaints.

Recent developments have raised the questions:-

Have battery-powered systems with GSM links proved a simpler and cheaper alternative compared to mains and landline linked systems?

When the system is in place has the data available proved insufficient, adequate or excessive?

Do you have a case study, paper or other presentation relating to this field of measurement that you would like to put forward?

If so please send an outline contribution to the meeting organiser:-

Steve O'Rourke
Cirrus Research plc
Acoustic House
Bridlington Road
Hunmanby
North Yorkshire
YO14 OPH

Email: steve@cirrusresearch.co.uk
Fax: 01723 891742

INSTITUTE DIARY 2001

14 FEB
To verify or not to verify, Measurement & Instrumentation Group, One day meeting, London

15 FEB
Distance Learning Sub Committee, Education Committee, *St Albans*

21 FEB
Meetings Committee, *St Albans*

21 FEB
London Branch Afternoon Meeting, BBC Radio Studios, London

22 FEB
Membership Committee, *St Albans*

27 FEB
Engineering Division Committee, *St Albans*

8 MAR
The role of BS4142, Environmental Noise Group in conjunction with British Standards Institution, Half-day meeting, *Basingstoke*

8 MAR
Executive Committee, *St Albans*

22 MAR
Medals & Awards, Council, *St Albans*

2-3 APR
WISP 2001, Speech Group, *Stratford-upon-Avon*

9-12 APR
Acoustical Oceanography, Underwater Acoustics Group, Southampton

27 APR
CCMHAV Exam, *Accredited Centres*

15 MAY
Research Committee, Professional Development Committee, *St Albans*

18 MAY
CCWPNA Exam, *Accredited Centres*

22 MAY
CCMHAV Advisory Committee, *St Albans*

24 MAY
Meetings Committee, Publications Committee, *St Albans*

31 MAY
Distance Learning Sub Committee, Education Committee, *St Albans*

5 JUN
Engineering Division Committee, *St Albans*

6 JUN
Long Term Noise Measurements, Measurement & Instrumentation Group, One-day meeting, *East Midlands*

7 JUN
Membership Committee, *St Albans*

8 JUN
CCENM Exam, *Accredited Centres*

12 JUN
CCWPNA Advisory Committee, *St Albans*

14-15 JUN
Diploma Examinations, *Accredited Centres*

28 JUN
Executive Committee, *St Albans*

5 JUL
Medals & Awards, Council, *St Albans*

12 JUL
CCENV Advisory Committee, *St Albans*

23-24 JUL
Bio-Sonar & Bioacoustics Symposium, Underwater Acoustics Group, *Loughborough*

6 SEP
Meetings Committee, Publications Committee, *St Albans*

11 SEP
Research Committee, Professional Development Committee, *St Albans*

13 SEP
Distance Learning Sub Committee, Education Committee, *St Albans*

18 SEP
Engineering Division Committee, *St Albans*

20 SEP
Membership Committee, *St Albans*

4 OCT
Executive Committee, *St Albans*

11 OCT
Medals & Awards, Council, *St Albans*

25 OCT
Meetings Committee, Publications Committee, *St Albans*

26 OCT
CCENM Exam, *Accredited Centres*

30 OCT
Research Committee, Professional Development Committee, *St Albans*

1 NOV
Distance Learning Sub-Committee, Education Committee, *St Albans*

6 NOV
Engineering Division Committee, *St Albans*

8 NOV
Membership Committee, *St Albans*

9 NOV
CCWPNA Exam, *Accredited Centres*

14-15 NOV
Autumn Conference, Environmental Noise & Measurement & Instrumentation Groups, *Stratford-upon-Avon*

16 NOV
CCMHAV Exam, *Accredited Centres*

16-18 NOV
Reproduced Sound 17 Electroacoustics Group, *Stratford upon Avon*

22 NOV
Executive Committee, *St Albans*

27 NOV
CCENV Advisory Committee Meeting, *St Albans*

4 DEC
CCWPNA Advisory Committee, *St Albans*

6 DEC
Medals & Awards, Council, *St Albans*

11 DEC
CCMHAV Advisory Committee, *St Albans*

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not possible because of space restrictions and implications of additional pressure drop. The additional pressure drop could not have been tolerated either by the Factory Inspectorate or the Environmental Agency.

Acoustically clad the fan casing

Acoustically cladding the fan casing was an option but for the fan casing to be adequately clad it would have required cladding of some 400 mm thickness.

Fit silencer to the homogeniser cooler

We were able to avoid the need to fit a silencer to the homogeniser cooler as the factory management made a commitment not to use the unit.

Stiffen and clad the existing/replaced outlet silencer casing

We agreed that stiffening of the ductwork was a good first step to combating the problem.

Thus all of the items suggested in the first phase of the schedule of works were considered not to be necessary except perhaps stiffening of the ductwork. This work was therefore implemented, as is shown in ***Figure 5***, where the added cross-bracing can be clearly seen.

Figure 5

Phase 2

Expansion Box to Control Noise from Melters

Our investigation had already shown that the noise radiating from the ductwork was not low frequency transfer from the melters and so mitigation in this area would have no purpose.

Cyclones should be sealed and stiffened, with isolated platform

We had demonstrated that the cyclones are not a significant source of noise in the 40 Hz one-third octave band, negating the need for this mitigation work.

continued on page 29

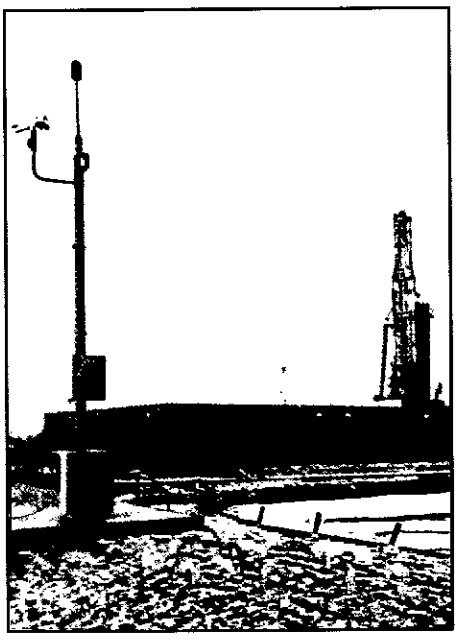
Been There... Done That...

since 1986

The competition proclaims a "new technology" which results in a microphone which is more resistant to shock and hostile environments. Well folks, Larson•Davis has been producing robust, corrosion resistant microphones with special alloy diaphragms for over ten years while "they" were vehemently denying the necessity for such a technological advance. Welcome to modern times!

If you find that surprising, you may want to know about our exceptional performance in high humidity environments resulting from our proprietary quartz coating technology.

Or, that every microphone we produce is exposed to a hot, humid environment (50 °C and 95% R.H.) for four hours before being tested to verify its exceptionally high leakage resistance.



Or, that Larson•Davis microphones have earned their reputation by years of dependable service in permanent multi-station noise monitoring systems from Florida to Minnesota, Thailand to Tel-Aviv* and London to Warsaw.

By the way, we have some real nice calibrators, microphone power supplies, sound level meters, real-time analyzers and noise monitoring systems to go with our microphones.

For Sound/Vibration Measurement Look to Larson•Davis

ProsCon Environmental Limited
Abbey Mill, Station Road,
Bishops Waltham,
Southampton, SO32 1GN
ENGLAND
Tel: 44 (0) 1489 891853
Fax: 44 (0) 1489 895488
E-mail: drpclark@proscon.com

CONTROLLING TONAL NOISE

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Introduce a Secondary Stack Silencer

We believed that this measure should be the first priority as it would have the effect of reducing noise emanating from the exhaust stack of Bagging plants 1 and 2, albeit the reduction being broad band in nature.

Thus all of the items suggested in the second phase of the schedule of works were considered not to be necessary except the introduction of the stack silencer. Consequently a silencer in the form of a 4 m x 300 mm diameter pod was inserted into the stack and a reduction of 5 dB at 38 Hz plus a broad band reduction in noise was obtained.

Residual Noise Levels

There was, however, still a much reduced but noticeable tonal component in the 40 Hz one-third octave band which was found to be radiating from the stiffened ductwork.

At this stage of the exercise it was possible to shutdown the bagging plant and we were able to inspect the rotor of the fan on Bagging plant 1. We were somewhat surprised when we found that the fan rotor had actually been repaired rather crudely and the blades of the rotor were very asymmetrical, a discovery which effectively justified our original conclusions about the source! Although a fan rotor may be in balance, if it is asymmetrical, one naturally would expect that a tone at the rotational frequency would be generated. In finding this, we advised the client to install a new fan with a symmetrical, well balanced rotor. This was done and the fan was chosen so that it had a different rotational speed to the original one but was still able to perform the same duty.

OUTCOME

The result of changing the fan to the new type, installing the stack silencer and stiffening the ductwork was such that the noise level in the 40 Hz one-third octave band was reduced to 46 dB, thus achieving the Environmental Directorate's target, even though there had been some dispute about the standard to be used.

Figure 6 shows the one-third octave band spectrum at the complainants property before and after the implementation of the few noise control measures described above.

It is important to remember that this was achieved at a fraction of the cost that would have been involved had the client followed the schedule of works recommended by the Environmental Director Consultant. Amicable consultation with the local authority throughout the whole process did ensure that a satisfactory resolution was achieved.

It is also worth noting that the comprehensive

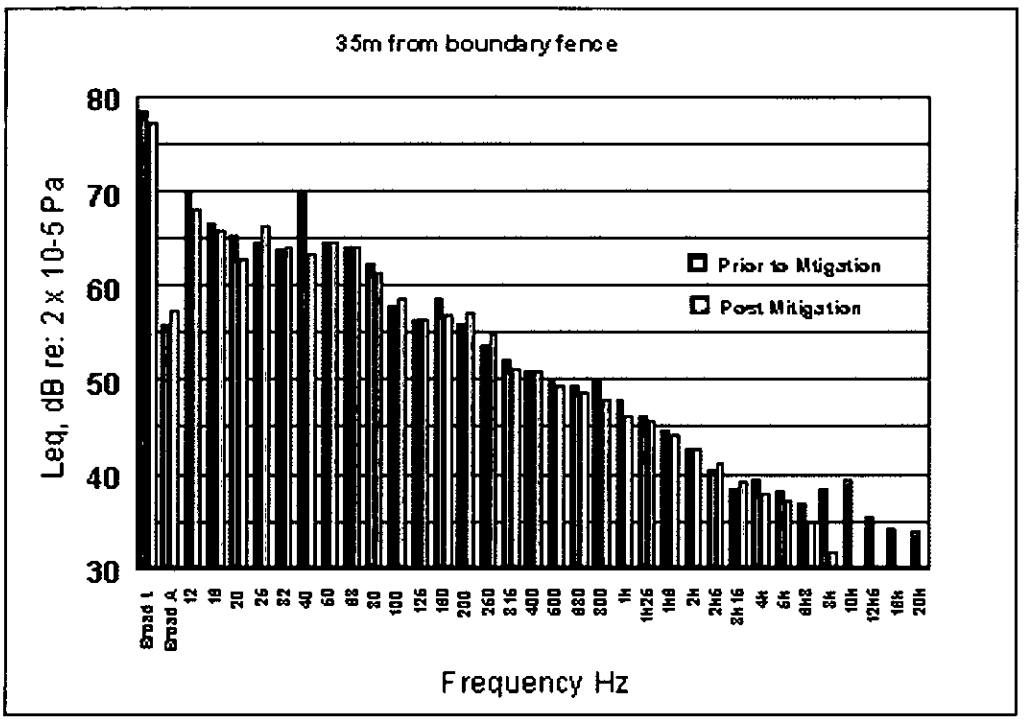


Figure 6

measures proposed by the local authority will have been based on recommendations from their external consultants, who in turn, will have been working to a specific brief of doing all that is required to abate a nuisance. Maybe a problem with the existing confrontational system is that extreme positions tend to be adopted on both sides, without sufficient consideration of what is actually required.

The message is that we, as consultants, should never adopt the 'broad brush' approach to a noise issue. By careful investigation and analysis, problems can be solved without incurring unnecessary expense.

Pete Simpson and Ray Woolley MIOA are with Sound Research Laboratories Ltd, Wilmslow House, Grove Way, Wilmslow, Cheshire SK9 5AQ. Tel: 01625 536736; Fax: 01625 536735; e-mail: srl@soundresearch.co.uk

The consultancy advises on architectural, environmental, planning, litigation industrial and power.

REPRODUCED SOUND 16

Sound Reinforcement

17-19 November 2000

Robin Cross, Chairman of the organising committee, opens the conference

John W. Tyler FIOA reports

The report on the Industrial noise conference appeared in *Acoustics Bulletin* (Nov/Dec 2000). The following report on RS16 completes the review of the IOA autumn conferences. As usual, my thanks to the session chairmen who provided most useful notes to aid the compilation of this report.

Introductory comments

Robin Cross

Chairman, organising committee

The working title of this year's **Reproduced Sound 16 Conference** was *Sound Reinforcement.* This didn't appear on the conference programme - but with impeccable hindsight, it didn't have to. The rich mixture of disciplines under the Reproduced Sound Umbrella - namely: Loudspeakers, Intelligibility, Multidimensional Sound, Environmental Noise Management of Music Events, Auditorium Design and Signal Processing, all combined to deliver a conference with remarkable breadth and depth - with some real nuggets of information and insight to be mined.

Delegate numbers were up this year and the usual warm, relaxed atmosphere made a significant contribution to the success of the event.

My thanks are due to the members of the organising committee: **James Angus, Mark Bailey, Peter Barnett, Ken Dibble, Stephen Jones, Peter Philipson, BobWalker, Sam Wise, Allen Mornington-West and Julian Wright.**

I am sure that readers will have been saddened to learn from the obituary notice in the Nov/Dec issue that Peter Barnett died suddenly only a few weeks after the conference.

Thanks are also due to **Roy Bratby and Linda Canty** for their ideas and hard work and to **Ken Dibble** for his efforts with his PA system, which as usual ensured that the speakers and the questioners could be heard clearly; also Stephen Chiles, who dealt most effectively with the roving microphone and with problems arising with the projection equipment, not to mention help at the IOA desk.

Special demonstrations

Friday evening saw a demonstration by Duran Audio of an Intellivox DSP controlled beam steering array. I was personally impressed by the sonic performance - knowing that the column was at least 5 metres away, yet hearing high intelligibility speech suspended in my near field. Steering the beam up to a wall at the far end of the brick built rehearsal room excited the room and caused the intelligibility to drop dramatically.

Ian Drumm from Salford University provided the Saturday evening demonstration. A PC based conferencing platform demonstrated the possibility of virtual collaborative sound spaces with an almost limitless range of uses. Delegates were able to fly through a virtual party and separate out individual conversations by proximity and/or spatialising techniques. Ian provided us with a well executed glimpse of what's around the corner ..... PC processing power is presently following square law growth - so watch - and listen to this space.

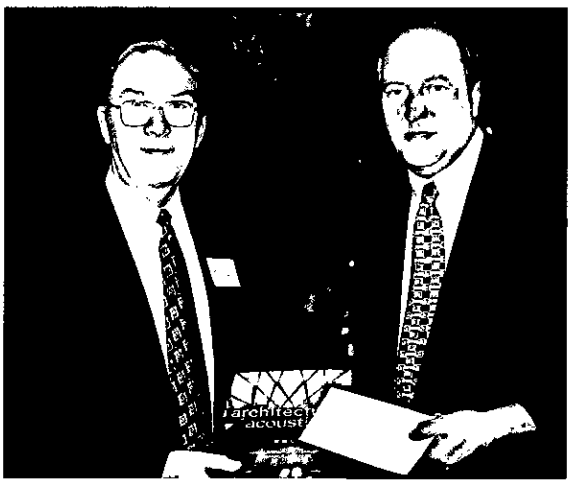
Earlier on Saturday evening, the Conference was particularly honoured to be the chosen event at which **Dr Roy Lawrence** was presented with an **Honorary Fellowship** by the **IOA President Mark Tatham**. The Hon Sec, **Tony Jones**, read out the very impressive citation (printed elsewhere in this issue). Roy received a richly deserved and heartfelt standing applause from the delegates. As a personal mark of appreciation for

The conference venue: Stratford Victoria Hotel, Stratford upon Avon

their immense contribution to IOA publications, from members of the Publications Committee, **Cathy and Roy** were presented with gifts jointly **by John Miller, Chairman, Publications Committee and John Tyler, Associate Editor of the Acoustics Bulletin**.

Other award presentations on the same evening were made to **Geoff Young**, firstly for the **best IOA Diploma student of the year** presented by **Mark Tatham** and secondly, on behalf of the **Association of Noise Consultants (ANC)** for the **best Diploma project** by **Alan Saunders, Chairman of ANC**. Geoff has the distinction at 60 years of being the oldest diploma student in the history of the Institute.

Thanks are due to the exhibitors who provided us with the opportunity to sample their wares. The exhibitors this year were the **Institute of Sound and Vibration Research, University of Southampton; Autograph Sales; M&D Design; and Peavey Electronics.**



Alan Saunders (right) Chairman of the Association of Noise Consultants, presents the award for best IOA Diploma project to Geoff Young

FRIDAY 17 NOVEMBER

Session: Loudspeakers

Chairman: Julian Wright, Celestion International

Measuring the unknown driver *(Keith R Holland, ISVR,* University of Southampton)

❑ In the first paper of the conference, Keith introduced the elegant concept of non-destructive 'blocked' impedance measurement by 'blocking' the fluid velocity instead of the diaphragm velocity. The paper describes a set of easy-to-apply measurements which result in data which can be used to model the behaviour of a wide variety of loudspeaker drive units, regardless of construction or method of transduction.

Multi acoustic prediction program (MAPP^{tm}): recent results *(John and Perrin Meyer,* Meyer Sound Laboratories, USA)

❑ John and Perrin did an impressive father and son double act for this paper when reporting recent results from a program aimed at modelling the

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acoustic interaction of multiple loudspeakers. They are piloting an internet-based client-server system and are looking for beta testers.

Invited paper

Optimising directivity properties of DSP controlled loudspeaker arrays *(Gerald W Beuningen and Evert W Start, Duran Audio BV, Zaltbommel,* The Netherlands)

❑ Gerald and Evert discussed the control and optimisation of loudspeaker array directivity using DSP, providing convincing auralisations of the technique. This paper was a precursor to the evening's workshop.

Modelling DML panels using classical theory *(Mark R Avis and L D Copley,* University of Salford)

❑ After coffee Mark described work on modelling DML panels with classical plate theory, allowing some fundamental insight into their behaviour.

Finite element analysis of surface scattering properties *(Patrick Macey,* PACSYS Ltd)

❑ Patrick closed the morning session with a study of surface scattering using a novel hybrid Finite Element/series solution approach.

Session: Speech Intelligibility: part 1

Chairman: Peter Barnett (AMS Acoustics Ltd)

Extraction of room acoustic parameters from speech using artificial neural networks (*F F Li and Trevor Cox,* University of Salford)

❑ F Li presented a novel method to extract room acoustical parameters from speech utterances using artificial neural networks. The proposed method can correctly identify room reverberation time, early decay time and speech transmission index from a closed set of speech examples.

The effects of varying bandwidth on speech intelligibility in reverberant spaces (*Rob Dolling,* Symonds Group Ltd)

❑ Rob discussed the importance of maintaining the full bandwidth of speech reproduction through a sound system in a reverberant space. From the results of measurements it was clear that as the bandwidth increased, the objective speech intelligibility rating as expressed by STI improved. The subjective assessment of speech also improved, although syllable masking was detected from the lower frequency sounds as the speech rate was increased.

Presentation by John Miller (left) Chairman Publications Committee and John Tyler, Associate Editor, Acoustics Bulletin, of gifts to Cathy Mackenzie and Roy Lawrence

Father and son team John and Perrin Mayor of Mayorsound

From word scores to RASTI and back (an experimental study of the relationship between RASTI and word scores.) (*Peter W Barnett and Paul H Scarborough,* AMS Acoustics)

❑ As chairman, Peter introduced himself, although little introduction was necessary for such a well known and regarded researcher into speech intelligibility.

Peter described an experiment designed to question the assumption suggested by the Common Intelligibility Scale that there is a unique relationship between Word Scores and RASTI. The conclusion was that such a relationship was not unique and was affected by reverberation products and noise in the space. He concluded that care should be exercised in using RASTI especially when the results are not in accord with subjective impressions.

Session: Speech intelligibility: part 2

Chairman: Paul H Scarborough (AMS Acoustics)

The design and commissioning of integrated production audio/voice alarm systems at the Millennium Dome (*James Hurst,* Symonds Group)

❑ James outlined the challenges and discussed the results obtained with respect to their designs for an integrated production audio and voice alarm system in the Millennium Dome. Challenges included the lateness of their engagement to do the designs, the political environment of the project and aesthetic concerns which limited loudspeaker selections and locations. Symonds did extensive modelling and predictive work along with an onsite demonstration before committing to a strategy. James showed the between predicted and actual RASTI values. He also

showed how the poor characteristics of a cheap microphone denigrated the response of the whole system.

Case studies using current technology steerable line arrays *(Helen Goddard and Tony Stacey,* AMS Acoustics)

❑ Helen had hoped to present the results and audio demonstrations from three installations of Intellivox DSP-controlled line arrays. Unfortunately construction delays meant that none of the three were completed. Helen discussed the development of line arrays and the challenges of modelling the performance of DSP controlled arrays. She proposed a method for assuming the directivity of such devices for modelling which appears to produce good agreement with results in actual installations.

Determination of loudspeaker sound power and directivity of reverberation and anechoic chamber methods *(Tony Stacey and Peter W Barnett,* AMS Acoustics)

❑ Tony discussed the results obtained in a series of measurements of loudspeaker power in both reverberant and anechoic chambers. Curiously the two different methods produced significantly different results. Similar differences were observed with different types of loudspeaker (projector and ceiling types). Thinking that the differences might have resulted from limitations in the, admittedly small, AMS reverberant chamber, the results were repeated in the larger chamber at BRE. The differences were still there and in fact there was good agreement between the measurements in the two chambers. Tony suggested that further investigation of these effects is needed to determine why they occur.

The paper generated a number of questions about whether AMS had reviewed the literature on this subject and applied appropriate corrections. Tony replied that some material had been reviewed but more effort was needed here. Two delegates suggested that the discrepancies at low frequencies might reflect LF loading effects due to the positioning of the device in the chamber.

Relaxing atmosphere between sessions

Saturday 18 November

Session: Multidimensional sound

Chairman: Peter Phillipson (University of Salford)

Invited Paper

Full reality surround sound-the challenge of the future *(Dave Malham,* University of York)

❑ Dave took the audience through the background to the development of surround sound technology including 5.1, Ambisonics, holophonics, Wave Field Synthesis and Hyper-Dense Transducer Array technology and discussed the possible futures. He covered the issues involved in producing true reality mimicking performances. He concluded that none of the approaches to spatialisation he covered in his survey can meet the criteria for true reality equivalence and the best option at present appears to be to develop the hybrid speaker/headphone approach.

Multi-channel spatialisation techniques for musical synthesis *(Jonathon M Hirst, W J Davies and P Philipson,* University of Salford)

❑ Jonathan described a method of synthesising music by means of decomposing a complex musical signal into its individual harmonics and then spatially spreading the harmonics over a circular loudspeaker array. The techniques were subject to a psychoacoustic preference test by means of rank ordering.

The implementation and application of virtual environments in teleconferencing *(Ian Drumm and P Philipson,* University of Salford)

❑ Ian took the audience through the application of real-time auralisation in teleconferencing. By generating binaural cues to position human speakers at different virtual locations, speech intelligibility was improved. There were questions on where the future work will go and on the accuracy of Head Related Transfer Function (HRTF) . (A demonstration of this work was given after the conference dinner).

How many channels are enough? *(Fred Ampel,* Technology Visions, USA)

❑ Fred gave the delegates his usual attractive and amusing delivery, this time on developments in multi-channel audio. He discussed the requirements for spatial perception/illusion and concluded that, given the current state of the art and the physical requirements determined by the need to use loudspeakers, somewhere between six and eight data streams, properly decoded and manipulated, will produce an extremely convincing auditory reality. Fred's paper produced an interesting discussion including questions about sub-woofer position in multi-channel audio.

Approximation functions for virtual acoustic modelling *(Bob Walker,* BBC)

❑ Bob described his room modelling techniques for virtual production in TV and included discussion of the directivity of the human voice, diffraction around virtual objects and the accounting for air absorption. This paper was an extension of one which Bob gave at last year's RS conference.

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Multidimensional sound in sound reinforcement for theatre (*Robin Whittaker,* Out Board Electronics Ltd)

❑ Robin explained that significant improvements in the delivery of amplified sound in a large listening area, such as a theatre, are possible using Source Oriented Reinforcement (SOR) techniques from a distributed rather than two channel loudspeaker system. This results in the widening of the area where spatial effects can be detected from 10 to 90 per cent of the audience listening positions. Recent developments in digital signal processing have made SOR implementations a practical reality.

Matrix3™ audio control system: structure and capabilities (*Steve Ellison,* Level Control Systems, USA)

❑ Steve explained that Matrix3 is a new modular computer-controlled multichannel audio system for a wide range of functions including electroacoustic enhancement, sound reinforcement, theatrical sound and large-scale distributed audio systems. He said that each application presents distinct challenges and can be served by a core system that adheres to a set of design principles. Steve discussed Matrix3's hardware and software structure, programming approach and creative capabilities and outlined an example configuration for a multipurpose theatre.

Further investigations into the performance of 'bass traps' (*Stuart J Colam and Keith R Holland, ISVR,* University of Southampton)

❑ Stuart outlined the continuing research into the performance of an empirically designed passive low frequency absorber, or bass trap, for use in rooms. He described the experimental procedure and discussed some of the results. The experiments were made on a 1/10 scale using a duct constructed of concrete paving slabs. The purpose of the experiments was to gauge the effect a side wall of a room covered in 'bass traps' would have on the sound transmission along its length. The transmission was measured for different numbers of panels at a range of different angles to the wall and different panel spacing.

Professor Mark Tatham, IOA President and Robin Cross, Conference Chairman, pictured in discussion

Session: Environmental noise management of music events and venues

Chairman: James Angus (JASA)

Live music sound management – from the womb to the tomb (*Jim Griffiths, J Staunton and B Jobling* (Symonds Group Ltd)

❑ Jim presented the paper which belied its frivolous title by being a serious overview of noise control at music events. He talked about the history of noise control and the various versions of the codes of practice produced by the GLC and the Noise council. He pointed out that the noise control consultant was now involved all the way through the concert process from concept (e.g. feasibility studies), planning, implementations and tidying up afterwards.

The practical implementation of noise control at outdoor events *(Chris Beale)*

❑ Chris explained that large scale outdoor musical events are here to stay. He pointed out that there are two distinct processes that are necessary to achieve good environmental noise control, informed sound design at an early stage in the planning of the event and implementation of effective monitoring and control during the event. He highlighted the problems experienced by equipment suppliers. Chris then intrigued the delegates by describing the use of 350kg temporary roadway panels to construct a bass enhancing baffle behind bass cabinets.

Music noise management at the University of Birmingham centenary weekend (*John Hinton*, City of Birmingham Environmental Policy Unit and *Ken Dibble*, Ken Dibble Acoustics)

❑ Both authors contributed to the presentation of this paper. John explained the series of events that were planned to celebrate the centenary. These were a gala dinner, a one day open air festival of fun for staff students, alumni and their families and an all night club event for the students and their friends. The University Square where these events were to be held lay between two expensive residential areas and close to three large hospital complexes. Ken described the use of his own noise mapping methods to predict noise levels at the event. A music noise management scheme was agreed between the local authority, the event organisers, the University and the noise consultant.

The event did take place and was so managed that it did not cause excessive disturbance or result in a high number of complaints.

After tea there was a paper on The *IOA Code of Practice for Control of noise from Pubs and Clubs* by John Hinton and Ken Dibble. This was an update on the progress of this Code and was followed by a workshop session on revised music noise criteria.

Sunday 19 November

Session: auditorium design

Chairman: Bob Essert (Arup Acoustics)

The measurement and analysis of a control room acoustic treatment during construction (*Philip R Newell*, Reflexion Arts, Spain and *Keith R Holland, ISVR*, University of Southampton)

❑ Phil presented the results of a continuous series of measurements of the low frequency performance of a small sound control room during its construction from a bare shell, through eleven stages of construction, to the fully acoustically controlled product. The objective was to learn if any of the results could contribute to a reduction in the space taken up by acoustic control materials. This was an important objective since the great majority of recordings are currently made using inadequately controlled small rooms.

James Angus takes extreme measures to check coverage of the Intellivox DSP controlled beam steering array during a demonstration given by Duran Audio

Contrasting diffusers (*Trevor J Cox*, University of Salford and *Peter D'Antonio, RPG* Diffuser Systems Inc, USA)

❑ Trevor gave an overview of the mechanisms exploited in diffusers including surface roughness, geometric scattering and the changing of the impedance of a surface. He also considered the use of diffsorbers, a combination of variable impedance and surface roughness.

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Diffuser design using Huffman sequences (*James Angus*, JASA Consultancy)

❑ James gave his usual erudite presentation of his subject but disappointed his regular listeners by not illustrating his subject with some visual caricature – in previous RS's we have been treated to bottles of gin, balloons and latterly, whipping panels a la Rolf Harris. However, as can be seen from the photograph taken at the Duran Audio demonstration of a DSP based column loudspeaker on Saturday evening, *(see page 35)* James had already done his bit! He described his suggested method of generating diffusion structures using Huffman sequences based on non integer phase reflection gratings as an alternative to integer based sequences. By using Huffman sequences a diffuser can be designed which does not suffer from the flat plate frequency of conventional integer based diffusers. James explained the theory, design, advantages and limitations of these structures and presented simulation results of their performance.

Variable room acoustics system: philosophy and application (*Steve Ellison*, Level Control Systems, USA and *M Poletti*, Industrial Research Ltd, New Zealand)

❑ Steve outlined the factors that govern the acoustics of a concert hall and the sound quality perceived by the audience. He explained the operation of the electronic room enhancement technique, Variable Room Acoustics System (VRAS) which offers global reverberation enhancement with low coloration. VRAS may be utilised to provide an in-line early reflection system for local reflection enhancement. System presets can be recalled from external control systems allowing the room acoustics to be altered dynamically.

Designing the acoustics of auditoria for powerful sound systems (*Nick Edwards, D Kahn and C Janssen*, Acoustic Dimensions)

❑ Nick gave an interesting review of the techniques his company has employed to overcome the problems associated with high-powered sound systems for live performances in enclosed spaces. Many ingenious methods for overcoming these problems were described together with particular case studies in a variety of space configurations.

Session: Signal processing/transmission

Chairman: Paul Malpas (Arup Acoustics)

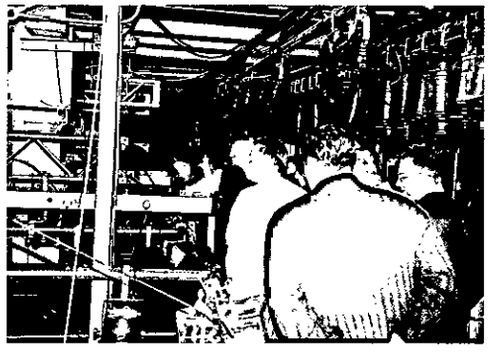
Improved integrity monitoring in digital sound systems (*Stephen P Jones*, Symonds Group)

❑ The requirement to monitor the integrity of life safety systems was first brought into the Standards in BS5839 in 1980 and, more specifically monitoring of

Behind the scenes at the Shakespeare theatres

Pictured right: Delegates on stage at the Royal Shakespeare Company Theatre, during their tour of the sound facilities

Pictured below: 'backstage' complexities at the Swan Theatre



After lunch a dedicated group went on a guided tour behind the scenes at the Swan Theatre and the main Royal Shakespeare Company Theatre, to see the complex sound reinforcement systems in use. Jeremy Dunn, Sound Manager for the theatres, gave us a fascinating insight into the complex tasks involved in planning a new production including off stage sound effects (even the barking dog has to be the correct breed!) and surround sound for the main auditorium. Members had the privilege of standing on the stage of the main theatre that was set up for the current production of the Secret Garden. (Alas not Hamlet!)

sound systems in BS7443 in 1991. Steve said that the degree of monitoring and what methods are acceptable is extremely woolly and undefined for the most part in BS5839. He described the various monitoring systems in use and some of their shortcomings. He concluded that digital sound systems and intelligent amplifiers connected over fibre optic cables can achieve an improved level of integrity monitoring compared to analogue systems and at a similar or may be lower cost.

Digital audio networks; practical issues in making the system work *(Dave G Tyas,* M&D Design Ltd)

❑ Dave highlighted the hidden problems facing the uninitiated in the implementation of distributed digital audio systems. He considered these issues using experiences gained from the implementation of three main system types as exemplified by BSS Soundweb, Peak Audio Cobranet and Klotz Digital VADIS. New distributed systems scheduled for release in 2001 will address many of the issues raised and will widen designer options. Dave emphasised that successful implementation of distributed digital networks needs careful forward planning of both the network system itself as well as the method of installation. Choosing the most suitable product for the intended purpose will alleviate many potential problems but still leaves the system designer and installer with a number of important decisions if the process is to be as painless as possible.

Wha wha what wa wa was tha tha that – or – Latency in multichannel digital audio transmission systems and its practical effects (*Sam Wise,* Arup Acoustics

❑ Unfortunately Sam Wise was too unwell to attend the conference to give his paper and Glen Leembruggen of Arup Acoustics (Aus) presented it.

Glen described the concept of latency (signal delays hidden in the process) in multichannel digital audio transmission systems as a latent (concealed) problem that can produce unexpected effects in the acoustic domain. He considered latency effects in real systems and warned that as digital audio becomes more prominent in the live environment, designers and users need to be aware of the potential effects of delays, or latency, in the signal and take these into careful consideration when designing and operating the systems.

Thus ended the main business of another successful Reproduced Sound Conference.

Photographs by John W. Tyler

Missing Exhibitor

Sincere apologies to Torvale Building Products for the omission of their name in the list of exhibitors at the IOA Industrial Noise Conference, reported in the last issue of *Acoustics Bulletin.* Torvale manufactures wood wool cement slabs for acoustic control in buildings.

Forthcoming Conference

Underwater Acoustics Group

Acoustical Oceanography

9-11 April 2001

Southampton Oceanographic Centre
University of Southampton

The Institute Diploma Examination 2000

Professor Keith Attenborough FIOA assesses the results

The numbers of candidates gaining Merits (M), Passes (P) or Fails (F) in each Module are shown for each centre in the Table of Results. The total number of candidates was 199 (183 entered in 1999). 109 candidates have been awarded the Diploma. Candidates who did not submit their project report by the set date are included as having failed in the Table.

GRADES AWARDED TO DIPLOMA CANDIDATES IN 2000

		GPA	ABA	L&A	NCE	TN	VC	SR	M	Project
NESCOT	M	2	0	1	2	0				5
	P	26	6	12	11	15				21
	F	1	1	2	2	2				3
Newcastle	M	0	0	0	0					2
	P	4	3	2	3					2
	F	1	1	1	0					1
Leeds	M	1	0	1	0		1			4
	P	12	5	7	7		1			6
	F	2	2	2	5					4
Bristol	M	1			0					1
	P	16			3					2
	F	0			0					2
Derby	M	8	0	1	1	0				4
	P	11	8	15	5	12				13
	F	0	0	0	0	1				1
Colchester	M	1		0	0		0			1
	P	10		7	9		2			7
	F	0		1	1		0			2
CoNEL	M	6	2	2	1	0				
	P	6	3	6	7	4				
	F	0	1	0	0	0				
Ulster	M	1	0	0	0				0	3
	P	4	2	3	6				1	5
	F	0	0	0	1				0	0
Salford	M	0	0	0	0	0				
	P	10	8	5	5	1				
	F	1	2	0	1	0				
Sheffield	M				0					2
	P				1					0
	F				0					1
Distance Learning	M	1	1	2	3		1	0		2
	P	17	11	10	16		2	0		6
	F	1	1	0	0		0	1		7

The marks for the General Principles of Acoustics Module in 1998 were calculated by the current 70/30 split of written examination/continuous assessment.

Question 6 on diffusion and absorption and a low frequency acoustic problem in a room was fairly universally unpopular. Nevertheless, students who attempted it gained useful marks. Questions 3 and 5 on workplace noise and reverberation time respectively were popular and were answered particularly well at Derby. An overall good performance is noticeable also on Question 8 relating to BS4142.

The prize for best candidate performance has been awarded to G. Young (CoNEL) and Special Commendations were made to H. Barrett (CoNEL) and J. Dixon (Derby).

The Education Committee has suggested that it is a useful part of the Diploma record to give the titles of projects and these are listed for the 1999/2000 presentation below. This list may be useful also for new candidates.

The Education Committee has agreed to modify the coursework for the Diploma, for the 2000/2001 presentation, by introducing an element of coursework for the Specialist Modules. There is a corresponding reduction in the amount of coursework required for the GPA module and, potentially, in the length of the examinations for the Specialist Modules. The marks for each module will be calculated on the basis of 70%/30% exam/coursework.

DIPLOMA IN ACOUSTICS AND NOISE CONTROL PROJECT LIST 2000

Test of the performance of a separatory wall between two flats which has been treated to improve sound insulation	NESCOT
Assessment of Vibration in Residential Premises due to Road Traffic	NESCOT
Investigation into possible noise from proposed Waste Transfer Station Development	NESCOT
Control of noise from church bells	NESCOT
Assessing noise due to music breakout from an Entertainment Venue	NESCOT
Effect of adding ac absorption to an enclosure around an air handling unit	NESCOT
To establish the sound power levels of two types of domestic vaccum cleaners	NESCOT
Acoustics performance of multipurpose floors for dance & performing arts based on field testing	NESCOT
Sound Insulation between converted Victorian dwellings	NESCOT
Barrier attenuation of road traffic noise from a motorway in a cutting close to a residential development	NESCOT
A study into various ways to reduce noise produced by a circular saw	NESCOT
The effects of floor coverings to reduce transmissibility of impact noise	NESCOT
An investigation into shotgun noise from clay target shooting	NESCOT
Helicopter noise a significant source of annoyance to residents in R B of Kensington & Chelsea	NESCOT
An investigation into noise annoyance in an open plan office	NESCOT
Assessment and improvement of noise environment in the print room of a Council office	NESCOT
An assessment of noise exposure levels at a Ten-Pin bowling club	NESCOT
Noise assessment of a mobile concrete crusher	NESCOT
A noise at work assessment for Epsom waste Transfer station	NESCOT
An investigation to assess accuracy of predicted traffic noise along roads with traffic calming measure	NESCOT
The exposure & control of Entertainment noise to DJ's & Bar staff	NESCOT
An investigation into the noise exposure of Pub & Nightclubs staff	NESCOT
Comparing methods for determining the levels of sound insulation in Buildings	NESCOT
An investigation into the application of PPG24 & BS4142 when considering planning application	NESCOT
An investigation into an acoustic environment in cinemas and its impact on employee and members of staff	NESCOT
A practical application of Draft Code of Practice on the control of noise from Pubs and Clubs	NESCOT
Acoustics survey on RLM 6000PD gas turbines & generator package	Newcastle
Assessment of the impact of the Newcastle airport development on the acoustics of woolsington	Newcastle
The use of Conventional Noise Mapping in Three dimensional Urban Environments	Derby
Sound Levels in Cinema Theatres	Derby
Impact of Data Entry Accuracy on Road Traffic Noise Modelling	Derby
Measurement and Comparison of Insulation of Acoustics Enclosure Design	Derby
Noise Exposure to Street Cleaning Staff in Chesterfield, Derbyshire	Derby
The Noise Climate outside homes within the District of Cannock Chase	Derby
The Influence of Angle of Incidence on Environmental Noise Measurements	Derby
Propagation and Directivity of a Grain Drier	Derby

continued on page 42

The Institute Diploma Examination 2000

continued from page 41

The difference in Traffic Noise Indices with height	Derby
The Relationship of the New European Environmental Indicator to Current Indices	Derby
The potential for Noise Emitting Toy Guns to cause Hearing Damage to Children	Derby
Comparison of the Noise from Steam Powered and Diesel Trains	Derby
The Use of BS4142 in the Assessment of Noise from a Plasma Cutter	Derby
The use of Vegetation to attenuate Reflected Noise	Derby
Hearing Risk from Noisy Garden Machinery	Derby
The Attenuation Properties of Louvres	Derby
Assessment of the Hearing Loss Risk to members of a small band	Derby
Speech intelligibility in a Hall used for teaching	Derby
Comparison of the performance of "rigid" and "Semi-Rigid" Enclosures	Derby
The low frequency Insulation Performance of Lightweight Separating Floors	Derby
Noise Wapping – Astun Ski Resort	Colchester
Air Conditioning Units – Breakout Noise	Colchester
Noise Attenuation for a Computer Server (Acoustics Enclosure)	Colchester
Assessment of the Performance of an Acoustic Inculpture	Colchester
Investigation of noise precautions when planning a new housing development	Colchester
Investigation of noise from all other air concert	Colchester
CO_2 detector alarm suitability for motor vehicle cars	Colchester
Investigation of a new road development	Colchester
Test & compare the performance of a dissipative and reactive silencer	CoNEL
Airborne insulation of Acoustics Panel	CoNEL
Investigation into the accuracy of investigating railway noise	CoNEL
Investigating extent of error in noise measurement from body reflections	CoNEL
Testing of noise barriers: Field/Theoretical	CoNEL
Investigation into the velocity of the Rathe Method for calculating the sound pressure level	CoNEL
Validation of equation used to predict enclosure performance	CoNEL
Investigation of the calculations used for assessing the sound insulation dwelling	CoNEL
Investigation into facade correction when taking field measurement	CoNEL
Comparison of absorption coefficient measurement of normal incidence by time delay Spectroscopy	CoNEL
Investigation into the suitability of sound insulation treatment in converted properties	CoNEL
A review of the measurement procedure in calculations of road traffic noise	CoNEL
An investigation into sound fields in a transmission suite	Ulster
A Study of the acoustics of a church hall	Ulster
Health effects to grounds maintenance staff from occupational noise exposure	Ulster
Use of sound exposure levels for the calculation of L_{Aeq} for aircraft noise	Ulster
An Assessment of a simplified sound insulation measurement method	Ulster
Prediction of road traffic noise using CRTN	Ulster
Effects of introducing elements into a reverberant field	Ulster
Acoustics of an open plan office	Ulster
Noise breakout from a music practice centre	Salford
Noise complaints arising from improved road grip surfaces	Salford
Performance of ear defenders by REAT and MIRE	Salford
Music Noise Breakout from small venues	Salford
Noise from a HVAC system in an auditorium	Salford
Environmental Noise Impact of Mini hovercraft	Salford
Calculating the performance of barriers	Salford
Measurement Vs Subjective Response	Sheffield
Physical scale Modelling of Earth Mounds	Sheffield
Investigation of noise and Vibration from a domestic central heating system	DL
An Assessment of the Effect of Windchimes Noise on microphone response	DL
Assessment of noise from Domestic Kettles	DL
A Field study to determine the Acoustic Performance of an Enclosure	DL
A Study into the effects of masking noise on speech intelligibility	DL
A Study into the effects of a rear window on the sound levels in a bedroom	DL
The code of practice for Environmental Noise Control at Concerts	DL

Call for Papers

17th Residential Week-end Conference

Organised by the Electroacoustics Group of the Institute of Acoustics

REPRODUCED SOUND 17

this year's theme

Measuring, Modelling and Muddling!

Stratford Victoria Hotel, Stratford-upon-Avon

16 - 18 November 2001

Technical Programme Committee Chairman: Robin Cross FIOA

Call for papers on topics relating to the following:

Room acoustics

Room modelling

Measurement

Intelligibility

Loudspeakers

Digital signal processing

Please send abstracts of not more than 200 words to the Institute of Acoustics office by 14 May 2001. Notification of acceptance will be mailed by 31 May 2001. Final written papers for the proceedings must be received by 28 September 2001.

from Brüel & Kjær

WorkFlow manager

Brüel and Kjær has introduced *WorkFlow Manager Type 7756,* a new tool that helps to streamline and organise repetitive sound and vibration tests performed with the company's PULSE ™ multi-analyser system.

Designed for use in busy test cell environments, its main features are guidance and assistance in data storage, efficient test programme administration and structured test object documentation. Output is available as annotated PULSE formatted data files with extended file headers containing user-selected information.

The electronic test plan facility provides a highly efficient and intuitive means of ordering and documenting tests while automated reporting is available via the PULSE report organiser.

Additional features include structured archiving of test data and predefined test set-ups (PULSE Projects), creation and display of reference curves for pass-fail criteria, streamlined testing with fast switching between different types of test, storage of test data and test documentation in a single, open format data file and high visibility overload status monitoring.

The *WorkFlow Manager* also links PULSE with other Microsoft WindowsTM-based applications for further data display or post-processing. Effectively, *WorkFlow Manager* transforms PULSE into a 'test suite' supporting all stages of the test process from the test cell to the desktop. The system's simple measurement data storage and retrieval make it particularly suitable for office network environments.

Additional benefits include high test cell utilisation due to minimal measurement set up times and rapid switching between predefined measurement setups and real-time assessment of product performance using benchmark data (reference curves).

Environmental Noise Handbook

A new educational handbook dealing with *Environmental Noise* has been published by **Brüel & Kjær** (B&K).

Aimed at anyone involved in measuring and assessing environmental noise, for example noise from industrial sites, road and rail traffic, airports and outdoor events, B&K's new 65-page handbook offers a wealth of information on the subject.

An introduction to environmental noise is followed by sections on the definition of sound, types of noise, environmental noise propagation and identification of noise sources.

Measurement of sound and calibration sections are featured with coverage of rating level, assessment (limits), measurement reports and noise prediction. The handbook also covers planning, noise reduction, types of monitoring (attended, unattended and permanent), international standards parameters and terminology and environmental noise.

In all, the handbook offers an indispensable resource for those involved in the field of environmental noise and at a list price of just £5 per copy represents excellent value for money.

For a limited period the company is giving away free copies.

More information from: Lene Gerstrom, Brüel and Kjær, Bedford House, Rutherford Close, Stevenage, Herts, SG1 2ND. Tel: 01438 739000; Fax: 01438 739099.
e-mail: info@bkgb,co.uk.
Web site: http://www.bk.dk.

Brüel & Kjær is a Key Sponsor of the Institute

from Cirrus Research plc

Noise Nuisance Recorder

The **Cirrus CR:281A Noise Nuisance Recorder** is a complete package which contains a DAT Recorder together with a CR:703B Type 1 Data Logging Sound Level Meter in a secure enclosure.

The Sound Level Meter provides and stores an accurate measurement of the noise climate which can be later downloaded and analysed to give many different acoustic parameters. The DAT Recorder stores an audio record of the actual noise heard by the complainant which can then be replayed through loudspeakers or headphones.

Featuring a quick set-up procedure, along with a two button remote control, battery or mains operation, and all of the accessories required including download and analysis software, remote microphone and acoustic calibrator.

For further information contact: James Tingay, Cirrus Research plc, Acoustic House, Bridlington Road, Hunmanby, North Yorkshire YO14 0PH. Tel: 01723 891655; Fax: 01723 891742 e-mail: sales@cirrusresearch.co.uk

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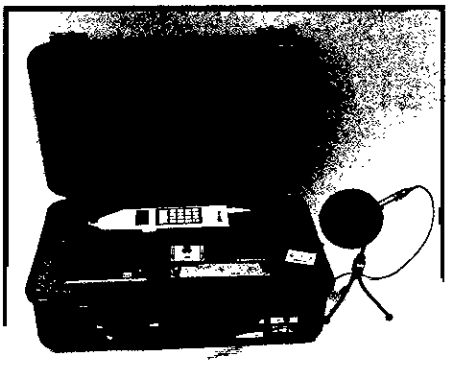


from Cambell Associates

Norsonic software

The new EU Directive 2000/14/EC *(see article by Fran Buckle on page 38 of this issue)* will, when it becomes mandatory on 3 January 2002, require manufacturers of equipment for use outdoors to ensure that their product conforms to prescribed sound power levels.

Norsonic have been specialists in sound power measurements for many years and have two software packages available to assist in making the measurements required.

1. *Nor-Power* implements both the free and reverberant field methods set out in the International Standards for the measurement of sound power level.

From the input data the program will calculate the sound power level and produce a full measurement report. It will operate in conjunction with the instrument to form a fully automated multi-channel measurement system.

2. *Nor-9614* is a support program for the Norsonic sound intensity measurement system that will guide the operator through all the steps of the standards for sound power measurement using either the scanning or point measurement methods.

Again a full measurement report is produced giving full information including the measurement uncertainty information.

For those just becoming involved in the topic Norsonic has produced a simple-to-operate hand held sound power meter. The Nor-116/08 makes a measurement as required by the survey method of the International Standard.

Technical data sheets on all three solutions are available from: Ian

Campbell Associates, 'Chiswell Cottage', 11 Broad Street', Hatfield Broad Oak, Bishops Stortford, Herts, CM22 7JD. Tel: 01279 718898; Fax: 01279 71896.
e-mail: ian@campbell-associates.co.uk

Campbell Associates is a Sponsor Member of the Institute

from CEP Acoustics

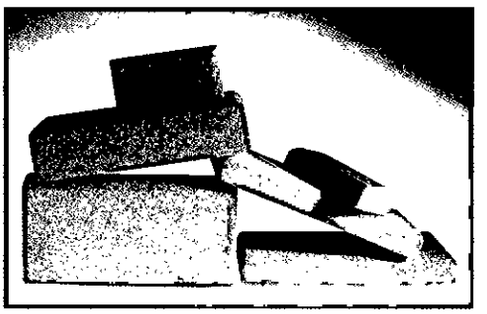
High performance brick

A high performance *Coustone acoustic brick* introduced by **CEP Acoustics**, is designed for architecturally complex surfaces where the use of flat acoustic panels is impractical, yet the control of sound is imperative.

Manufactured in a range of sizes, Coustone bricks retain the sound absorbing and sound insulating properties associated with CEP's Coustone panels. Yet, their compact size enables the lines of intricate architectural contours to be followed.

A double-bonded fixing method has been developed, using mechanical and chemical adhesion for extra security.

Constructed from bonded flint with scientifically designed air cavities, Coustone has high sound absorption up to 0.95 NRC and sound insulation properties averaging 46 dB SRI. This specification has been retained within the bricks.



Coustone can be used where the control of sound or good speech intelligibility is essential. This encompasses traditional applications including recording studios, taped interview rooms, speech therapy and audiology suites, and other sound critical environments.

However, the product has also been applied to sports halls, swimming pools, schools, and industrial complexes, where intrusive or ambient noise is undesirable or potentially damaging.

For further information contact: Tim Crowther, Harris Associates, St Michael's Hall, Bennett Road, Headingly, Leeds LS6 3HN Tel: 0113 4411 Fax: 0113 230 4737
e-mail: response@harris-associates.com

from The Mathworks

Advanced maths functionality for Visual Basic users

A new library that will significantly reduce the time needed for mathematical computation in the development of technical applications using Visual Basic, is available from **The Mathworks.**

The company claims that the new *MatrixVB library* makes powerful mathematical functionality available in the Visual Basic environment for the first time.

The *MatrixVB library* provides more than 600 functions ranging from fast Fourier transforms and singular value decompositions to random number generators. These provide powerful extensions to Visual Basic in the areas of matrix computation, data analysis and engineering graphics.

For further information contact: Nicki Day, The MathWorks Ltd, Matrix House, Cowley Park, Cambridge CB4 0HH. Tel: 01223 423200; Fax: 01223 423289
e-mail: nday@uk.mathworks.com
Website: http://www.mathworks.com

BOOK REVIEWS

Dictionary of Hearing

Michael Martin & Ian Summers
Paperback, 108 pages
Whurr Publishing
Price £19.50

The authors have aimed this book at the wide audience of specialists and non-specialists in the multi-disciplinary field of acoustics. Audiologists should find the physics references useful. Acousticians should be drawn to the physiology etc. The very broad range of terms defined in the book meets this objective.

The style of presentation is varied, some terms are described very fully whilst others with only the most scant entries. Some are brilliantly clear while others are quite the opposite.

I am not sure that the length of the entries relates to the importance of the subject, for example, hearing aids are treated with a fraction of the space allocated to hearing aid earmoulds.

Critical bands and adaptive hearing tests are described in detail while other important entries are extremely short. The longer entries are far more informative, and I would have preferred to see consistently fuller entries throughout.

It was concerning to find several apparent errors. For example, glue ear is defined as chronic otitis; media and congenital is said to mean hereditary. Compression in hearing aids is said to be the same as output compression, although the latter term actually has a very specific meaning.

As an audiologist I will use the dictionary, albeit with caution, when seeking information slightly outside my field. It is not the type of book to recommend to students and in its current form does not really represent good value for money.

Robert Rendell

BSI NEWS

BS EN Publications

BS EN 12354: Building Acoustics - Estimation of acoustic performance of buildings from the performance of elements.
BS EN 12354-4:2000 Transmission indoor sound to the outside. No current standard is superseded.
BS EN 50332: Sound system equipment - Headphones and earphones associated with portable audio equipment - Maximum sound pressure level measurement and methodology and limit considerations.
BS EN 50332-1:2000 General method for 'one package equipment'. No current standard is superseded.

British Standard Implementations

BS ISO 230: Test code for machine tools.
BS ISO 230-5:2000 Determination of the noise emission. No current standard is superseded.

Drafts for Public Comment

00/564932 DC *BS EN 352-5* Hearing protectors - Safety requirements and testing - Part 5: Active noise reduction ear-muffs.
00/565264 DC *BS EN ISO 16032* Acoustics - Measurement of sound pressure level from service equipment in buildings - Engineering method *(ISO/DIS 16032:2000).*
00/565268 DC *BS EN ISO 10052* Acoustics - Field measurements of airborne and impact sound insulation and of equipment sound-Survey methods *(ISO/DIS 10052:2000).*
00/713944 DC *ISO/DIS 14695* Industrial fans - Method of measurement of fan vibration *(supersedes BS 848-6:1989).*

Other Documents Not Issued as DPCs

ENV 28041:1993 Human response to vibration - Measuring instrumentation *(ISO 8041:1990/ Amd. 1:1999).*

ISO Publications

ISO 2922:2000 (Edition 2) Acoustics - Measurement of airborne sound emitted by vessels on inland waterways and harbours. *(Will be implemented as BS EN ISO 2922).*
ISO 3740:2000 (Edition 2) Acoustics - Determination of sound power levels of noise sources - Guidelines for the use of basic standards.
ISO/TS 13475 Acoustics - Stationary audible warning devices used outdoors.
ISO/TS 13475-2:2000 Precision methods for determination of sound emission quantities.
ISO 14509:2000 Small craft - Measurement of airborne sound emitted by powered recreational craft. *(Will be published as BS EN ISO 14509).*

This information was announced in the November and December 2000 issues of *BSI Update*

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