Acoustics BULLETIN

VOL 29 No1 Jan/Feb 2004

Wall of sound: the bubble nets of humpback whales

Autumn Conference and Reproduced Sound 19 reports
Acoustic design of Hong Kong's TV City
Implications of the ISO 717 spectrum adaptation terms

Institute of **Acoustics**

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Contents

Institute of Acoustics

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

INSTITUTE COUNCIL

Dear Members

I have been involved in many discussions over the past two years on the future of the profession. My involvement stemmed from a realisation that we weren't producing enough qualified graduates to meet the requirements of the acoustics 'industry' but the discussions have invariably broadened to include the reasons why youngsters aren't attracted into engineering and science generally. We clearly need to look outwards and do more to publicise the value that the engineering and science professions bring to the community. As far as acoustics is concerned, I think we tend to be too reticent about our value to, and our achievements for, society. We need to find ways to show that there are many interesting projects in acoustics that require challenging and novel solutions and that finding those solutions can provide an exciting and rewarding career. I am open to suggestions on how we might best achieve this.

However, we also need to look inwards at our own performance and that includes those of us who have been 'around' for a long time. I have picked up an increasing concern that some members are perhaps not always performing professionally to an adequate standard. We recruit members from a broad range of specialist acoustic areas and the Membership Committee, when processing applications, has a difficult task in assessing the level of competence portrayed. However, it does do an excellent job in ensuring that new members have reached the appropriate level of experience. After that, it is up to you, the member, to manage your own professional development although the Institute can help and guide you. It is felt that some of you may not be giving this important part of being a professional enough priority. The code and rules of conduct are there as a constant reminder that members should recognise their limitations and should only undertake professional tasks for which they are competent. There is therefore a duty on all members to remain competent if they are indeed to perform professionally.
The Institute's programme of meetings and seminars, organised either by specialist groups or by local branches, is aimed at placing the latest information on the table for discussion and debate. The Institute's education programme is aimed at raising levels of competence and the certificate courses are targeted at areas of specific and topical interest. The Institute's events are put together for your benefit, so use them. If you feel that an important area is being missed, let us know.

Things are changing rapidly in the world of acoustics today and at the start of the New Year, I therefore ask 'are you sure that you are up to date?'
Best wishes for 2004.

Geoff

Geoff Kerry
President

Environmental Noise Group

Wilson - Forty years on

The Wilson Committee report on the problem of noise, published in July 1963, was a landmark document which directed future efforts towards improving the UK's noise climate. Since many people reading this conference report were either not alive when it was published and/or have not been aware of its subsequent impact on the efforts to reduce noise in the community, it was thought that a brief resume of its contents and main recommendations would set the scene before a summary of the papers given at this one-day conference, 40 years later.

John W Tyler FIOA reports on this one-day meeting held at the Commonwealth Conference Centre, which reviewed progress made to combat noise since that 1960's landmark report

First, a brief biographical note on Sir Alan Wilson (1906-1995), the committee chairman: 1926-1940 Research at Cambridge on quantum theory; 1945-1962 Director R&D/Chairman Courtaulds; 1962 Director of ICT (ICL); and 1963-1973 Chairman Glaxo.

Thus, when Wilson chaired this committee in 1960 he was an experienced researcher and chairman and director of a leading UK company of the time. His committee of twelve including two women, one of whom was a housewife (albeit also a JP), represented a range of expertise in industry, land and air transport, research, medicine, town planning, employment and law, although none had any experience of acoustics.

The Report, entitled *Noise* and published by HMSO (at 13 shillings net!) gave a comprehensive introduction to the subject of noise, its measurement, sources, effects and mitigation, and the following chapter subjects were included: The law relating to noise (as of 1963); noise in towns; within buildings; from motor vehicles and other surface transport; aircraft; industry; construction and demolition sites; entertainment and advertising; and in the country.

The final chapters dealt with occupational exposure to high noise levels. The one-day meeting being reported on here used the Report chapter headings as titles for nine of the papers. The Wilson Report ended with a comprehensive set of conclusions and recommendations for research into remedial measures and legislation.

It is interesting to read the covering note to the (then) Minister of Science, Rt. Hon. Viscount Hailsham QC which accompanied the report:

You appointed us in April, 1960, 'to examine the nature, sources and effects of the problem of noise and to advise what further measures can be taken to mitigate it.' We have completed our examination and now submit our Report, which includes the substance of an interim Report on noise from motor vehicles [Cmnd 1780: 1962].

People's reactions to noise vary greatly, and in the past this has prevented the framing of rules for its control except in qualitative terms, with consequent difficulties of administration. We therefore felt that an important feature of our task was to try to define, wherever possible, quantitative levels of noise, which should become statutory limits, or, where statutory limits were not desirable or could not be laid down at present, to suggest levels which would serve as guides to what is reasonable.

We found that to do this we had to ask for a number of investigations and to break much fresh ground in measuring the annoyance caused to representative samples of the population by noises of various kinds.

There has recently been a great increase in the study of noise problems in their social setting, and we do not doubt that in the coming years important advances will be made. We hope that our own work will contribute something to this movement and will help to put the problem of noise into perspective with other problems of modern life.

This report on the papers is necessarily brief as, with one exception, there were no printed notes provided by the speakers and I have had to rely on my own, somewhat inadequate, scribbles. I therefore apologise in advance for any errors or shortcomings.

The meeting, chaired by **Nicole Porter** (consultant), was designed to present the progress that has been made since Wilson to combat noise in all fields of human activity and experience.

In opening the conference, **Ken Collins** (RPS), chairman of the IOA Environmental Noise Group, described life and times in early 1960's Britain, when the Wilson committee did its work; times of full employment, exponentially increasing car ownership, increasing air travel, a wide range of industry and rapidly developing technologies, all developing in the 17 years after World War II and contributing to the increase in noise experienced by the population. This was followed by **Rupert Thornely-Taylor** (Rupert Taylor Ltd) with his paper *Strategic planning (noise in towns and noise in the country)*. In outlining the Wilson Report's content and recommendations, he emphasised its wide-ranging scope and praised its strategic vision.

John Seller (BRE) then gave a paper (co-authored by **Les Fothergill**) on *Noise within domestic buildings*. He discussed BRE's involvement in the Wilson Report's preparation and dealt in some detail with the problems of house construction in respect of noise transmission between rooms.

After coffee **Colin English** (The English Cogger Partnership) dealt with *Noise from motor vehicles*. He outlined Wilson's measurements of vehicle and traffic noise, carried out by the Motor Industry Research Association, the National Physical Laboratory and the then Ministry of Transport, the establishment of possible acceptable levels and his recommendations for measures to reduce this noise.

He also described the various BS and EEC/EU legislation enacted since Wilson to reduce the allowable noise from new motor vehicles. (This was of particular interest to me since I was privileged to manage for TRRL/TRL two major projects aimed at reducing noise from heavy goods vehicles - the Quiet Heavy Vehicle Project in the 1970's, a direct result of Wilson, and QHV90 in the late 1980's, a result of the Armitage Report of 1980, *Lorries, people and the environment*).

Colin then summarised the three lines of attack on the vehicle noise problem since Wilson - research, noise limits, the smoothing of traffic flow, reducing the number of vehicles at a point, by-passes and ring roads. However, increased traffic has reduced the benefits of these measures. Colin also suggested that Wilson did not foresee the problem of tyre noise, the use of noise barriers, or the concept of compensation for traffic noise.

Brian Hemsworth (Noise consultant) then introduced his paper *Noise from other surface transport.* As he used to be with British Rail working on railway noise, Brian was well placed to talk on this subject. He covered changes in rail noise since the 1960's, including the effect of phasing out steam and the Beeching 'axe' which removed many miles of track. He mentioned the Advanced Passenger Train of 1970, the plans for CTRL drawn up in 1972 for the White City to Folkestone route, the Channel Tunnel Act of 1986 and the

Ken Collins, chairman IOA Environmental Noise Group, opened the conference by describing life and times in early 1960's Britain

revised plans for CTRL in 1987 for the Channel Tunnel Rail Link. For the future, Brian mentioned the EU White Paper which suggested an aim of no increase in rail noise for twice the present amount of passenger rail traffic and three times the present amount of freight rail traffic. He also outlined some noise reduction possibilities which included tuned wheel and suspensions and track insulation.

The final paper before lunch, given by **Ian Flindell** (ISVR), dealt with *Aircraft noise*. He outlined the problem areas which gave rise to public complaints about aircraft noise, the various types of aircraft including turbojets, military aircraft, helicopters and supersonic flight. He described the reasons for complaints at Heathrow and the fact that in the 1960's landing noise was becoming increasingly important with the use of heavier passenger jets. However, the noise appeared to have little effect on either house prices or rents. The amount spent in R&D on noise reduction in 1963 was about £300k per annum and increasing. Wilson's hopes for the future of aircraft noise rested on quieter aircraft, stricter noise limits and insulation schemes for residents: Ian discussed the progress made during the last forty years.

After lunch **Bernard Berry** (Berry Environmental Ltd) discussed *Noise from industry*. Bernard, who admitted to doing his O-levels in 1963, reviewed a range of aspects of industrial noise, starting with Roman town planning in 100 AD and considering the changing face of industry and the impact on noise inside and outside factories as new processes and materials were introduced. He then considered developments in the relevant standards over the 40 years since Wilson, dealing with the evolution of BS4142 from an appendix in Wilson via 1967 through 1990 to 2003. He also covered the advent and progress of PPG24 and ISO1996 and mentioned that he has chaired BSI committees for twenty years. Bernard then discussed some key current projects, including a new BS9142, a two-year DTI-funded project on Environmental Noise covering recommendations on methods for rating impulsive and tonal noise, guidance on background noise and the treatment of uncertainty.

Although the next paper, *Noise from construction/demolition*, was prepared by Paul Freeborn and Steve Fisher of Casella Stanger, neither of them was available on the day so the task fell to their colleague **Steve Turner.** He outlined the scope of noise from building and demolition activities as described by Wilson and discussed Circular 2/76 which, among other things required a balance between more rapid construction at higher noise levels and lower levels but longer construction times. Steve described several construction projects in London, for example Docklands and Canary Wharf, carried out since Wilson, and gave details of the precautions taken to reduce the problems of noise transmission in the buildings.

We heard again from **Ken Collins,** on the subject *Entertainment and advertising noise*. He gave a comprehensive review of the causes of entertainment and advertising noise, the balance required between customer satisfaction (they like noise) and the need to comply with the various regulations and standards that have arisen since Wilson, providing several interesting examples.

Keith Broughton (HSE) opened the final session of the day with an informed discussion of *Occupational noise*. This chapter in the Wilson report was actually entitled 'Occupational Exposure to High Levels of Noise' because concern then was with the very noisy industrial processes of the time. Keith reviewed the progress in legislation to protect employees in the workplace since Wilson. He included the Woodworking Machines Regulations 1974; the Social Security Acts of 1974 (occupational deafness); Protection of Hearing at Work 1981 (which was eventually overtaken by the promise of EU legislation); the European Directive 1986 (86/188/EEC); the Noise at Work Regulations 1989; and the European Directive 2003/10/EC.

How legislation to protect employees in the workplace has progressed

IOA President **Geoff Kerry** followed with the penultimate paper of the conference - arguably the most important one for the future of acoustics and the IOA - *The Acoustics Profession*. This was, in effect, a plea for ideas to increase the number of young people taking up science in general as a profession but with special emphasis on acoustics. He outlined the principal names in the history of acoustics from Rayleigh 1877 and Sabine 1900 via Curie, Ampere, Faraday, Maxwell, Wood, Berenek and Bruel to Stephens and then described the development of acoustic societies in Britain from 1947 (Acoustics Group of the Institute of Physics) through the Society of Acoustic Technology in 1963 and the British Acoustics Society in 1965 and finally the Institute of Acoustics in 1974. Geoff then highlighted those parts of the Wilson Report which discussed the need for a knowledge of acoustics to be disseminated to other professional people who had to deal with noise problems, as well as a need for the physics departments within universities and technical colleges to increase the training in acoustics. After summarising the IOA's present activities, Geoff concluded by making some pertinent comments and posing questions about the future.

These included: the number of acoustic professionals has increased significantly over the years but the IOA membership has not: was this because there had been a change of emphasis away from the traditional area of noise assessment and control to new subjects like noise/vibration/harshness, sound quality, the entertainment and communication industries? Perhaps the IOA is not thought of as the 'right sort of Institute' by these new professionals. Has 'noise assessment and control' had its day? Would larger, more diverse Institutes better serve the interests of our members? Does the IOA need to diversify to satisfy the needs of tomorrow's professional acoustician? How do we make people, especially young people, aware of the acoustics profession? He concluded by inviting members' views on these critical matters.

Answers sought on pertinent questions about the future

The final paper, *Issues for the future*, was given on behalf of **Tim Williamson** who was unable to attend. The National Society for Clean Air (NSCA) view on where we are now on neighbourhood noise was presented, and the local authorities' system solution based on complaints was criticised. NSCA considered that the challenges for the future included a review of the concept of nuisance, the development of more efficient forms of investigation and enforcement and the establishment of noise zones where different levels of noise would be allowed. On the subject of environmental noise, 'where are we now?', the NSCA view was that the data on noise environment is patchy, scarce and of poor quality, there is no strategic approach. There was a fractured legislative framework and variation in noise standards, and noise was not a priority issue. Mitigation, not avoidance, was the rule.

The NSCA was glad to note the developments in environmental noise planning including noise mapping and other research, the preparation of a strategy for England (although slowly!) some funding for noise reduction from the Highways Agency and the London Noise Strategy.

Nicole Porter and **Ken Collins** then wound up the conference by summarising the situation 40 years after Wilson.

IOA introduces new non-corporate membership grade

Technician Member

The President, Geoff Kerry, took the opportunity at both of the Institute's Autumn and Reproduced Sound 19 conferences, held in November 2003, to announce the creation of a new non-corporate grade of IOA membership, that of Technician Member.

Who is eligible?

The new non-corporate grade of *Technician Member* is intended for practitioners working in a wide variety of areas involving acoustics, noise and vibration - perhaps in noise monitoring, sound insulation testing, vibration testing or in the audio industry - who wish to be involved in the profession or to be able to access the services provided by the Institute to its members, but who are not yet able to qualify for Associate Member or Member grades.

Given the inter-disciplinary nature of the Institute, it is felt that a broad range of technical backgrounds is appropriate.

The Institute will accept a relatively broad range of general educational qualifications (or qualifying experience), at 'NVQ level 3' or higher, supplemented by an acoustics-related qualification, such as one or more of the Institute's Certificate courses (Environmental Noise Measurement; Workplace Noise Assessment; Hand-Arm Vibration) or, in technical areas where there are currently no IOA courses, a relevant award such as a BTEC in Music Technology or Sound Engineering.

Among these general educational qualifications are:

- ❑ A National Certificate or National Diploma in Engineering or Construction and the Built Environment
- ❑ An approved qualification in Engineering or Construction at level 6 in the Scottish Qualifications and Credit Framework
- ❑ A Higher National Certificate or Diploma in Engineering or Construction
- ❑ The City and Guilds Higher Professional Diploma in Engineering
- ❑ A technical certificate within an approved Advanced Modern Apprenticeship programme
- ❑ A NVQ Level 3 in a relevant area
- ❑ Qualifications in cognate areas, subject to academic appraisal by the Institute

Candidates shall be 21 years of age minimum, with a minimum of one year's relevant employment.

An alternative experience-based route is to be developed for 'mature' candidates who have five or more years' relevant experience in acoustics but who do not have the stipulated educational qualifications.

Anyone interested in becoming a Technician Member or who has colleagues who might be interested is urged to contact the Institute in the first instance.

Institute of **Acoustics**

Register of Members 2004/2005

We are now accepting advertising for the 2004/2005 issue, which is due to be published in September 2004 - the beginning of the budgeting and buying season for many of our members' organisations.

If you would like more information about advertising in the

Institute of Acoustics Register of Members: 2004-2005

please contact: Dennis Baylis MIOA, Advertising Manager, Peypouquet
32320 Montesquiou, France Tel/Fax: +33 (0)5 62 70 99 25 email: dbioa@hotmail.com
or via the IOA Head office at St Albans Tel: +44 (0)1727 848195

EXAMINATION RESULTS

Certificate of Competence in Workplace Noise Measurement

The following were successful in the November 2003 examination

Colchester Institute
Moore R D
Needs D R P

University of the West of England, Bristol
Ford L
Harper C J
Hawkins D A
Kearley S J
Kuyser M J
Plumley S C
Evans D K

Leeds Metropolitan University
Maslin P R
Segaran T
Lammas G
Capper J D
Callaghan C
Armstong M A

Amber Acoustics
Kenning G S

EEF Sheffield Association
Balls M R G
McKay I
Owen D G
Parker S
Parkin C
Stewart I M
Stones N B

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

The following were successful in the April 2003 examination

Institute of Naval Medicine
Baker A B
George D
Jenkins A
McCullough D W
Notley H
Walker P J H
Yarnall N J

The following were successful in the November 2003 examination

Institute of Naval Medicine
Lewthwaite, B A
Marsh, D J
Fordham, J
Partridge R E
Peacock M E
Whitlock S J

EEF Sheffield Association
Clarkson W A
Darby A
Davis J
Parkinson M

New Members

At Council on 4 December 2003 the following were elected to the membership grades shown:

Fellow
Howard, D M

Member
Bodsworth, N
Dudman, T
Linfoot, S P
McMorris, S
Miller, I M
Mudd, J D
Sheng, X
Tame, R P
Thomas, D
Wright, C E

Associate Member
Baxter, S R
Daly, J M
Frost, A E
Hodgson, G J
Locke, J A
Monk, L J
Morrow, M J
Perry, S P
Robins, M
Stewart, V L
Swales, R
Tate, M Y
Triner, N G
Weston, E L

Affiliate
Looser, S
Verberkmoes, B

Technician
Dibble, R J

Student
Goodyear, T P
Mackenzie, R K

Hosted by the Institute of Sound and Vibration Research

Spring Conference 2004

Avenue Campus, University of Southampton
***29-30 March* 2004**

The Spring Conference of the Institute of Acoustics provides a forum for the acoustics research, industrial, user and consulting communities. The aim is to review and discuss current research developments and applications, and to highlight current needs and future directions. The conference provides an excellent opportunity for those working in the field to present their work and to learn about activities in other areas.
Contributions related to acoustics interpreted in its broadest sense have been invited, in particular on the following themes:

Acoustics in liquids and tissues;
Aeroacoustics;
Musical acoustics;
Noise control materials;
Ultrasonics;
Active sound field control
Computational acoustics
Noise and vibration control
Transportation noise
Vibroacoustics and structural acoustics

The programme will include keynote lectures, medal addresses and invited and contributed papers. There will be a Student Session and a special student registration rate, to encourage existing research students to present their work.
There will be a special session on ***Acoustics in Liquids and Tissues***, sponsored jointly by the Physical Acoustics and Underwater Acoustics Groups of the Institute of Acoustics and Institute of Physics.
For up-to-date information please visit www.ioa.org.uk

Editor's Notes

Ian F Bennett BSc CEng MIOA
Editor

We are proud to be able to unleash upon the world in this issue a fascinating biophysical discovery. Prof Tim Leighton and his colleagues at the ISVR have found out how humpback whales catch fish in bubble nets. This may not seem all that important in the grand scheme of things (although it matters a great deal to the whales), but I for one was fascinated when I first read the article. My thanks go to Tim for offering the 'scoop' to us (oh dear....).
I hope readers will find it refreshing to learn that acoustics is about more than just beefing up loudspeakers and quietening diesel engines.
This issue also carries reports on 'Sound-bite', (the 2003 Autumn Conference), and Reproduced Sound 19, both held at Oxford in early November. I extend my grateful thanks to John Tyler for his indefatigable work in bringing these reports to you. The programme of meetings for 2004 has already taken shape, and I am particularly looking forward to returning to Southampton for the Spring Conference having been 'up North' on missionary work, more or less since I graduated.
We have roughed-out a publication programme for the *Bulletin* this year: this is subject to alteration depending on the contributions offered, but you may expect to see an issue covering building acoustics in May/June, one on measurement, instrumentation and noise control in September/October, and a focus on environmental noise in November/December to coincide with the theme of the 2004 Autumn Conference. As always, please let me have any material for possible publication in good time: copy date for the March/April 2004 issue is Friday 13 February.

Ian Bennett

Editor

The Oxford Hotel, venue for 'Sound-bite' and RS19

John W Tyler FIOA reviews the Institute's Autumn and Reproduced Sound 19 Conferences, held at the Oxford Hotel in Wolvercote from 5-8 November 2003

I fell into the trap of agreeing to review and photograph both conferences this year so this introduction covers both events. Yet another venue for the November conferences! We were just getting over the pain of leaving glorious Lakeland and getting into Shakespeare at Stratford when we found ourselves in academia. Only joking - there have been very good reasons, both financial and practical, for these moves and the chief executive and his devoted team have put in an enormous amount of work in finding the best location for these important events in the IOA year. As it happens, our new location at the Oxford Hotel proved excellent in every way, apart from being marooned near a roundabout on the northern outskirts of the town!
The lecture space provided was excellent, with good acoustics (ask Ken Dibble), far better than any venue so far. However, the acoustic in the restaurant was not so good; low ceiling and no apparent ceiling absorbent, together with hard floors, made for a very noisy autumn conference dinner with 140 delegates in animated conversations. I suspect that several consultants will be considering tendering to the hotel management for remedial treatment! The RS19 conference dinner was held in the rearranged lecture room and this, together with a smaller number of delegates (around 90) resulted in a more comfortable acoustic ambiance. The food at this modern, comfortable hotel was excellent, while its extremely helpful and courteous members of staff made us feel very much at home. As usual the restrictions of space preclude more than a brief description of each paper. Anybody requiring fuller information should contact IOA HQ for a copy of the CD ROM or a photocopy of any particular paper.

Sound-bite

Stephen Chiles, who chaired the Autumn Conference's organising committee, sets the scene

Following an exceptional year of very successful Building Acoustics Group (BAG) meetings and conferences in 2002 the group was asked to organise the Autumn Conference for the first time in a great many years. Although the recent hot topics in building acoustics (ADE 2003, BB93, RSDs) were perhaps now settling down, there was a solid response to the call for papers. This gave the 2003 Autumn Conference a full, varied and interesting programme covering a wide range of current issues by academics, regulators, manufacturers and practitioners. For once, my worries were confined to how we might fit 140 people in a room that only seats 120 for the conference dinner - thankfully, I had been spared from the conference organiser's usual sleepless nights over not having enough papers offered or, in the week before the event, hoping enough delegates register at the last minute so it breaks even financially!

The conference's new venue, The Oxford Hotel, provided space for a large acoustics trade exhibition to be held during the meeting. In fact, despite early concerns over the excessive size of the rooms, in the end many exhibitors and delegates couldn't be registered as we reached capacity several weeks before the event. One of the joys of holding a residential conference, rather than BAG's usual one day meetings, is the great opportunities for discussing the finer points of acoustics with friends over dinner and at the bar. During the conference dinner the President, Geoff Kerry, awarded the Institute's distinguished service award to John Miller and Robert Hill. The Chairman of the Association of Noise Consultants, Rupert Thornely-Taylor awarded its annual prizes to Rebecca Hutt for the best paper presented at an IOA conference by a young acoustician and to Nigel Triner for the best IOA diploma project.

I would like to thank my fellow BAG committee members for their help in organising the conference. In 2002/2003 the committee has comprised: Nick Antonio, Mike Barron, Bob Craik, Carl Hopkins, Jian Kang, Roger Kelly, Adrian Popplewell, Sean Smith and Alistair Somerville. Thanks also to all those who ensured the event ran smoothly, in particular for AV, Ken Dibble & Michael Morrow, and Linda, Roy and staff at the IOA office.

Personally, this conference was a very enjoyable finale to my seven years as secretary of the Building Acoustics Group; and I'm sure all those who were at Oxford would agree with me that members of BAG shouldn't leave it so many years before they run the Autumn Conference again!

Stephen Chiles opens the conference

This year's exhibitors were: A Proctor Group; AcSoft; ATL Monoglass; ANV; British Gypsum; Bruel & Kjaer UK; Campbell Associates; Casella CEL; CDM-UK; Decoustics; Ecophon; Greenwood Air Management; IAC; Lorient; Oscar Acoustics; Passivent; Rockfon; Renson Fabrications; Selectaglaze; and Sound Reduction Systems.

Wednesday 5 November

Although the time allocated for questions was limited to five minutes (shorter when speakers overran their time), all the papers generated useful discussion, even when the chairmen asked for these to be conducted during the break periods.

Following *Stephen Chiles'* welcome to delegates the first session, chaired by *Nick Antonio* (Arup Acoustics), opened with a paper given by *Andrew Parkin* (R W Gregory) asking: **What confidence can we have for building conversions under ADE2003?** Andrew discussed the problems encountered when converting dilapidated buildings into luxury residential accommodation when requirements of the new Building Regulations, ADE2003, are to be met. Development of such buildings is often constrained by heritage and conservation issues, requiring structural members to be left uncovered or other features to be preserved. Andrew posed and discussed the question - what confidence can we have that the stringent requirements of ADE2003 can be met?

Then followed *Sean Smith* (Napier University) whose paper, **The implications of ISO 717 spectrum adaptation terms for residential dwellings,** was co-authored with *R Mackenzie* and *T Walters-Fuller.* Sean explained that the recent changes to the Approved Document E (2003) have introduced ISO 717 spectrum adaptation terms for the measurement of sound insulation in residential dwellings. Whilst these terms are particularly aimed at improving the airborne sound insulation performance at low frequencies, they introduce interesting characteristics in relation to ISO 140 and ISO 354. He provided a brief overview of the implications of using the spectrum adaptation terms and their relationship to other standards and different dwelling structures. This paper also generated a good, though brief, discussion.

Linda Sheriden shows the beauties of Scotland

Bill Whitfield (noise.co.uk) followed on with the same topic, pointing out that the primary object of the spectrum adaptation term C_{tr} is to weight the assessment of surfaces which perform poorly at low frequencies in relation to their performance at high frequencies. This can cause problems on site, particularly if reliance is placed on knowledge based on assessments carried out under the 1992 Approved Document E and the airborne performance criteria featured in that document. Bill's paper examined the possible problem areas, how improvement in sound insulation affects D_{nTw} and C_{tr} and assessed actual test data from site surveys in the light of the 1992 and 2003 sound insulation criteria.

The final paper before the coffee break was given by *Sophie Maluski* (University of Salford) on **The comparison of building regulations across Europe.** She compared the acoustics Building Regulations of eight European countries - Belgium, Denmark, England and Wales, France, Germany, Netherlands, Norway and Sweden. Her study showed that the acoustic requirements and indices for noise control in buildings vary greatly between countries, although there is a general move towards uniformity based on the EN-ISO acoustics measurement standards. However more work is required before obtaining uniformity of Building Regulations across Europe.

Carl Hopkins (BRE) chaired the next session, as *Linda Sheridan* (Building Standards, Scottish Executive) set the scene for her paper with a colourful slide of a Scottish mountain scene. This stirred memories for me since, many years ago, I spent 15 years in the Scottish branch of TRL working on traffic and safety research. Of no relevance but I thought I would mention it!

As Linda explained, the *Building (Scotland) Act 2003* introduced changes in the Scottish system of building control. With effect from 2005, the current prescriptive standard will be replaced by expanded functional standards accompanied by guidance. As well as reducing constraints on innovation it will allow the adoption of harmonised test methods and product standards without the need for amendments to legislation. She pointed out that Scotland is one of the first countries to arrange its documentation in six sections based on the Essential Requirements of the Construction Products Directive. Her paper discussed the potential differences between the approaches in Scotland and England & Wales to regulation and systems of implementation.

Sean Smith took the stand again with his paper (co-authored with *Chris Steel*) which discussed **The implications on sound insulation performance of using lightweight facades for high rise residential dwellings**. The current emphasis under PPG3 for higher density urban development is leading to an increase in the construction of high-rise multi apartment using steel and reinforced concrete frames. As a result there are increasing pressures on foundation load limits leading to the use of lightweight steel and glass facades. The new ADE 2003 performance criteria from ISO 717 for separating walls and ceilings presents a number of new complications for building acoustic design consultants. Sean presented two case studies involving continuous curved glass and lightweight steel facades discussing the direct key components and system approach in addition to the indirect and unexpected complexities of dealing with the new ADE 2003.

Jian Kang (University of Sheffield) presented the next paper (co-authored with *M W Brocklesby*) on **Application of micro-perforated absorbers in developing window systems for optimum acoustic, ventilation and day-lighting performance.** The objective of this ongoing EPSRC funded research is to develop a series of window systems that will reduce outside noise whilst allowing natural ventilation and also enabling the efficient use of daylight.

The aim of this paper was to examine the feasibility of using transparent micro-perforated absorbers in such a window system. Jian began with a brief introduction to the theory of micro-perforated absorbers and presented the results of some tests between a semi-anechoic and a reverberant chamber using a standard window mock-up. The experiments have demonstrated the effectiveness of these absorbers.

Richard Lyons (Loughborough University) gave the closing paper of the session (co-authored by *J L Horner* and *M T Fletcher*) on **A simple impedance approach to aperture transmission.** This paper was concerned with the higher order mode sound transmission through apertures and noise control devices mounted within apertures. Richard described a simplified impedance formulation

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which was proposed to allow the aperture and the device to be selected to give the desired sound transmission, based upon some independent measurement of the device's performance. In order to use such an impedance approach it was necessary to identify the individual modal contributions to the total field. Richard then presented some measurements showing the impedance of aperture and device and of coupled aperture-device for a range of open areas.

After lunch the main session, chaired by *Jian Kang*, was preceded by a short discussion panel on the subject of RSD.

Robust Standard Details (RSD)

Approved Document E 2003 introduced a new regulatory requirement for pre-completion testing of domestic sound insulation. However, the document delayed the introduction of these tests for new buildings until January 2004 to allow the House Builders Federation time to develop an alternative to testing in the form of Robust Standard Details (RSDs). At the time the Autumn Conference was being finalised in May 2003, it was unknown whether the RSD proposal would be thrown out by the government or would continue to a public consultation, and therefore the programme did not include any contributions on this project. It turned out, however, that the conference coincided with the public consultation period. As all the key people for the project were present, an RSD panel discussion was arranged for the lunch break on Wednesday.

The panel comprised Sean Smith, Phil Dunbavin, Carl Hopkins and Nick Antonio. Questions were invited from the floor and started with issues on the actual constructions proposed, then moved on to difficulties and reliability of the overall scheme. One straightforward issue answered was that the constructions proposed are not necessarily the minimum needed to achieve a performance deemed to be robust, but they are what were practical to test. Other issues such as the validity of the RSD approach didn't have such simple answers but did make for an interesting panel discussion!

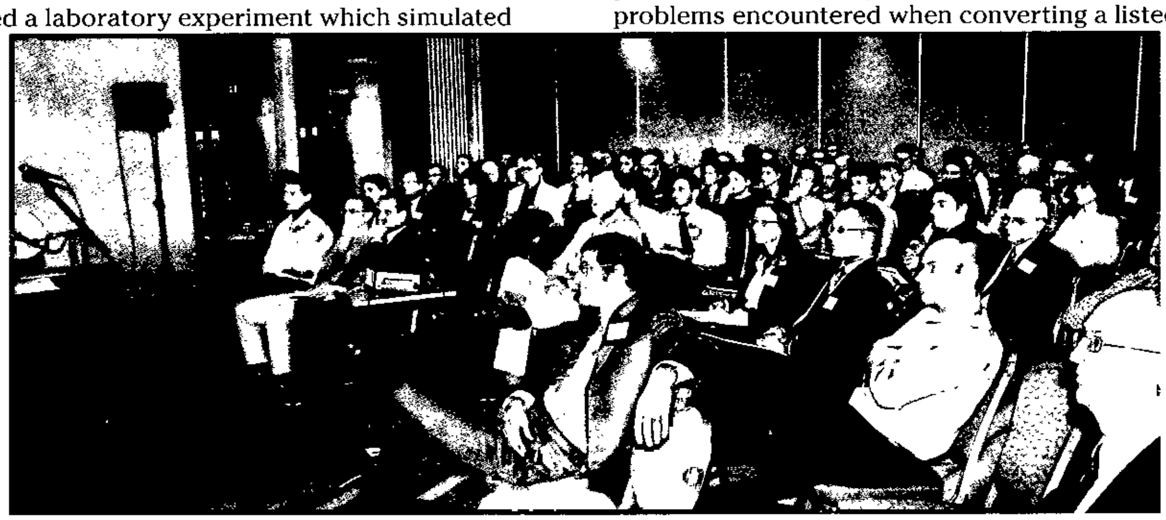
The first paper of the session proper was given by *Stephen Dance* (London South Bank University) on **Modelling of sound fields in enclosed spaces with absorbent room surfaces. Part IV: Anechoic chamber.** He described a laboratory experiment which simulated an internal to external sound field through an aperture, a short corridor. An idealised scenario was organised where a reverberation chamber was used to contain the internal sound field with an anechoic chamber. Measurements were taken to determine the absorption coefficient of the absorbent material in the anechoic chamber. Three computer models, two commercial packages and a South Bank model, were used to simultaneously predict the sound level and reverberation time in the rooms.

Stephen Chiles (University of Bath) followed on with his paper **Sound level distribution in rooms: is it really the same everywhere?** He explained that practitioners regularly use statistical approximations for building acoustic applications. However, for auditoria, Barron and Lee (in 1988) observed decreasing reflected level with increasing source-receiver distance and developed a revised theory that predicts the average behaviour of sound levels in auditoria more accurately. Stephen reported on a model investigation which tested whether this revised theory is also applicable in proportionate spaces with diffuse sound fields, the reference condition for room acoustics. Results were presented of measurements in two physical scale acoustic models, one having non-parallel geometry and the other with heavily scattering surfaces. The spaces were also analysed using computer models.

The next speaker in this session was *Ken Marriott* (Industrial, Commercial & Technical Consultants) with his paper **Practical realistic acoustic measures applied to offshore platforms to meet accommodation sound level criteria.** Ken described the problems arising from the change in the requirements for maximum sound levels in plant rooms on offshore platforms from 88 dB(A) to 85 dB(A) with a lower limit of 80 dB(A); (European Directive 86/188/EEC was repealed by Directive 2003/10/EEC which came into force on 15 February 2003).

This was done with the intention that it would lead to some control of sound pressure levels in the accommodation areas. Ken maintained that in practice this was rarely achieved. His company is working on the plans for two of the largest platforms ever built. He gave an interesting description of them, together with the problems associated with achieving the required noise targets.

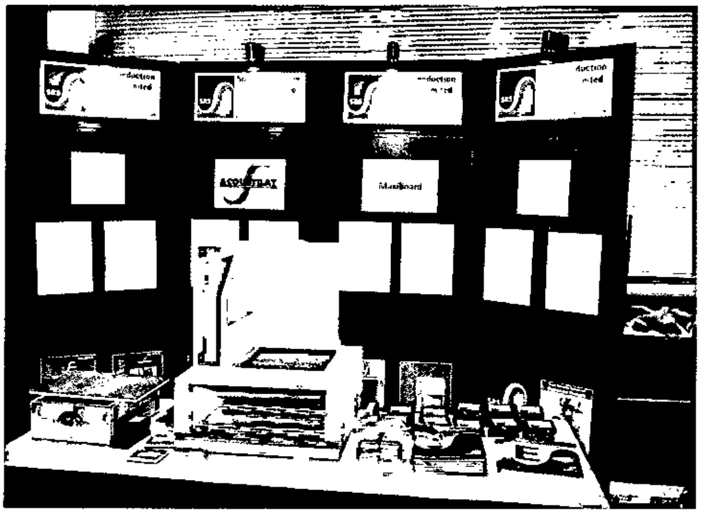
The final speaker before tea was *Nick Boulter* (Arup Acoustics) whose paper, **New music in old buildings - converting a Grade 1 listed building into a music college,** provided a fascinating description of the particular problems encountered when converting a listed building



A packed house for the Autumn Conference

to a specialised use. In this case the conversion involved the transfer of Trinity College of Music from its home in central London to the disused 17th century King Charles Building at Greenwich. Nick explained that to convert the building successfully into a music college involved many constraints, particularly in terms of the loadings that could be imposed on the existing structure and the heritage considerations. The new facilities include 50 music practice rooms, a recital room, multi-purpose space and a recording studio. As a result of tests, a design was developed which allowed floors and walls to be resiliently supported from a common steel frame. Nick outlined the results of tests and described the other acoustic design features of the project.

The next session was chaired by *Stephen Chiles* and a refreshed audience returned to hear *Peter Rogers* (SRL) present his paper (co-authored with *Matthew Naylor* (Hoare Lea Acoustics): **Odeon theory versus practice in open plan office to atrium coupled spaces – how good is it?** This reported on the comparison of measurements that were taken in an attempt to validate the predictions of the geometric acoustic computer model ODEON,



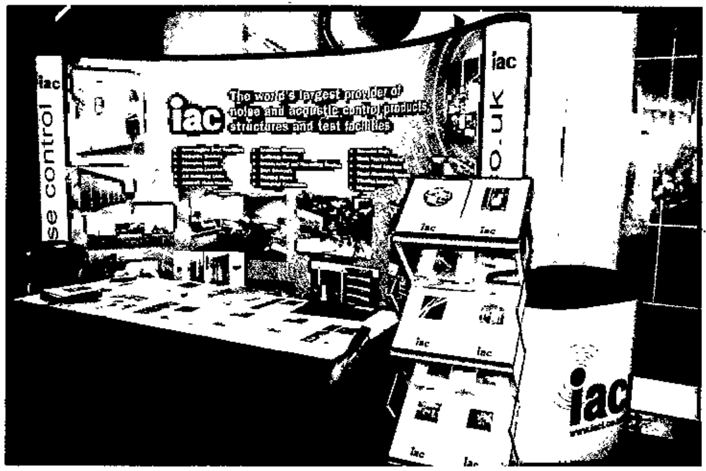
SRS exhibited their range of noise control solutions

for the case of a double atrium space linked by open offices. The analysis made comparisons objectively and also subjectively through the use of the auralisations, as generated by the geometric acoustic model and as measured using a binaural head.

Peter outlined the apparent limitations of ODEON from both objective and subjective aspects and concluded that there is reasonably good agreement between results for the speech frequencies but that at low frequencies there was significant disagreement. The limitations are considered to be attributable to the hybrid ray tracing theory that is used in the computer model.

Then followed *Chris Stepan* (University of Sheffield), who discussed **Acoustic measurements and subjective surveys of five churches in Sheffield.** He described his investigation of the characteristics of sound fields in churches by a series of objective measurements coupled with questionnaire surveys carried out in the churches. The measurements included sound level and reverberation while the questionnaire included people's general feeling about acoustic comfort and evaluation of environmental factors and musical acoustics.

The survey results suggested that within the range of case studies there was no clear correlation between the reverberation time of a church and the acoustic comfort. People were generally satisfied with speech intelligibility.



IAC's stand at Sound-bite

For two of the churches more detailed measurements, including articulation tests, were conducted and with more questions asked on speech and music qualities. The results revealed interesting relationships between acoustic comfort and people's evaluation of speech and music qualities.

Then came a double act of *Mike Wilson* and *Fergus Nicol* (London Metropolitan University) who shared the task of delivering their paper **Some thoughts on acoustic comfort: a look at adaptive standards for noise.** Mike dealt with thermal comfort, outlining the history of the development by humans of structures to protect themselves from the climate, rain, wind, heat, cold, light and noise. Fergus then followed with considerations of acoustic comfort, particularly in offices.

The results of the EU funded SCATs project, designed to investigate the relationship between the comfort of building occupants and the physical world in five European countries was discussed. One conclusion reached by the authors was that, although background noise criteria are specified in the British Standards or CIBSE publications, increasingly these are found to be inappropriate or are ignored.

Again on the acoustic comfort theme, *Jian Kang* (University of Sheffield) spoke about **Acoustic comfort in 'non-acoustic' spaces: a review of recent work in Sheffield.** Explaining that non-acoustic spaces included shopping mall atriums, library reading rooms, football stadia, swimming spaces, churches, dining spaces as well as urban open public spaces, he described a series of studies carried out on this topic by Sheffield University, School of Architecture. These generally included two aspects, characteristics of the sound fields and perceptions of acoustic comfort. Jian's paper gave a brief overview of the studies. The research suggested that current guidelines and technical regulations are insufficient in terms of acoustic design of these spaces and the results would be useful for developing further design guidelines.

This was the last paper of the day and was followed by the **Exhibitor's reception** and **Conference Dinner.** After dinner there was a **Pubs and Clubs Measurement Workshop** conducted by *Stephen Turner* (Casella Stanger) and *John Hinton* (Birmingham City Council).

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Sean Smith chaired the first session of the day which was opened by *Theo Niaounakis* (Bickerdike Allen Partners) whose paper, **Addey and Stanhope School: Acoustic design of a new teaching block – a case study, was** co-

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authored with *John Miller.* Theo introduced the project that was designed to exclude the external traffic noise from naturally ventilated rooms in this new extension block. The design involved consideration of the construction of the external envelope - walls, windows and roofs - and the provision of ventilation.

Natural ventilation was provided by a wind catcher system utilising shafts which supply and discharge air via an air stack which terminates on the roof. Theo presented the design criteria used and compared the predicted results with the measurements made during a post-completion acoustic testing carried out on site. The results demonstrated that it is possible to provide natural ventilation on a noisy urban site and meet the noise limits in Building Bulletin 87 'Guidelines for Environmental Design in Schools'.

Continuing the theme of acoustics in schools, *Nick Charlton Smith* presented his paper, **Some acoustics issues in open plan schools.** As he explained, educators are still looking to open plan designs in schools to provide economy and flexibility of space use with the result that there is a need to establish typical levels of noise within schools as generated by the teaching activities.

Nick summarised some unpublished research which he had carried out between 1969 and 1974 to measure internal noise levels in two open plan middle schools in Yorkshire. Recent check surveys he made in two newly built open plan schools indicate that current measured levels may be similar to those recorded some 30 years ago and that a crude relationship between those determinants and L_{eq} might be established.

Adrian James (Adrian James Acoustics) continued the session with a paper co authored with *Andy Thompson*, **School problems after BB93 – practical problems and solutions.** As he explained, the new Approved Document E and the new Building Bulletin 93 have been in force for several months and designs for both new schools and refurbishments are being developed, both under Private Finance Initiative schemes and under more traditional procurement methods. His paper reviewed some of the issues that have arisen in the interpretation and implementation of the Building Bulletin, highlighted some of the changes that have been made as a result of consultation and revisited some of the questions raised at the IOA seminar held on 15 October 2002.

Sound-bite Conference dinner, complete with passive reverberation system (eliminated for RS19!)

Pictured above left: Rupert Thornely-Taylor, Chairman of the Association of Noise Consultants, presents to Rebecca Hutt, the award for best paper given at an IOA conference by a young acoustician; and (right) to Nigel Triner the award for best IOA diploma project

Pictured below: John Miller (left) and Rob Hill (right) receive their IOA Distinguished Service Awards from the President Geoff Kerry

Peter Mapp (Peter Mapp Associates) developed the same theme through his paper (co authored with *C Boyden*): **Measuring speech intelligibility in classrooms, with and without hearing assistance.** In his usual crisp and clear manner this regular RS speaker expounded his thoughts about intelligibility within classrooms in relation to the requirements of Building Bulletin 93. This generally adopts an indirect approach to intelligibility by specifying reverberation time and background noise level criteria rather than by specifying an intelligibility criterion directly. For open plan areas and study spaces an intelligibility target is specified in terms of STI.

Peter claimed that his extensive experience in testing sound systems suggested that STI measurements are often prone to a number of error mechanisms and a brief study of the classroom situation suggested that this might also be the case here. He outlined a number of case histories and examples of potential STI measurement errors together with examples and comments relating to the assessment of hearing assistance systems for hard of hearing students.

Robin Hall (BRE) followed on with his paper (co authored with *Carl Hopkins*) outlining **An investigation of the acoustic conditions in open plan teaching areas and enclosed classrooms in a secondary school.** Robin described an investigation of the acoustic conditions in a secondary school with both open plan and enclosed classrooms. Measurements of sound pressure level and reverberation time were made in both types of teaching accommodation, the aim being to compare the acoustic environments, and also of STI in the open plan teaching areas. Airborne sound insulation between enclosed classrooms was also measured. He discussed the results and conclusions from the experiments.

After coffee the next session was chaired by *Roger Kelly* (R K Acoustic Systems). Before the first paper *Stephen Turner* summarised results of the

Pubs and Clubs workshop held the previous evening.

Ken Marriott then followed with his second paper of the conference, entitled: **An engineering approach to contemporary entertainment venues.** He outlined the problems arising from the change of music type played at the more recent entertainment venues, that is music having a generic spectrum significantly different from previous styles. Also patrons expected much higher levels of sound if they were to patronise these venues. At the same time there was a move by local authorities to require their environmental officers to adopt 'inaudibility' as a sound level criterion. The high sound levels associated with this type of popular music meant that a more focused approach had to be adopted in the venue design. Ken explained how utilising standard methods applied to acoustic engineering design gave a general approach in resolving this duality problem.

Next to speak was *Jonathan Hargreaves* (University of Salford) who introduced his paper (co authored with *Trevor Cox*) on **Improving the bass response of Schroeder diffusers.** Jonathan explained the design and purpose of Schroeder diffusers, which are used to treat the acoustics of critical listening environments. He described the use of a 2D Boundary Element Method to model the scattered energy from folded and normal versions of a Schroeder diffuser. This prediction model had previously been validated against measurement. At low frequency the diffuser with folded wells mimicked the performance of a standard Schroeder diffuser while at high frequency there is an apparent change in the well depth sequence which can be exploited to reduce the effects of critical frequencies.

Philip Newell (Acoustic consultant) - another regular speaker at RS conferences - presented his paper (co authored with *Keith Holland* (ISVR) on **The acoustic 'trap' absorber system: a review of recent research.** This compared the relative lack of scientific proof of why 'trap' absorber systems work with the fact that the Wright Brothers proved that man could fly without knowing how or why! However, Philip claimed that a small number of studio designers (presumably including himself) using empirical engineering has resulted in a highly efficient absorber design without any real knowledge of the scientific theory. Between 1990 and 2000 four attempts were made by students at ISVR, University of Southampton to gain more insight into the mechanisms involved. Philip's paper reviewed the results of this work and attempted to piece together what is currently known about this subject.

Then followed the AGM of the **Building Acoustics Group** - carried out with remarkable speed, no doubt because lunch followed!

Sophie Maluski chaired the first afternoon session, whose opening paper was given by *Ole-Herman Bjor* (Norsonic) and co-authored with *Igor Nikoli.* In **Building and room acoustics measurements with sine-sweep technique,** Ole-Hermann explained the advantages of the sine-sweep technique over maximum length sequence (MLS) methods in studying building and room acoustics. The work of the ISO to standardise the method for application in building acoustics has encouraged the design of a sound analyser incorporating sine-sweep based measurement. He presented a real-time implementation of this measurement method based on excitation with an exponential sinusoidal sweep and focussed on its practical use and benefits.

This was followed by *Steve Clow* (noise.co.uk) who presented his paper on **Sound insulation testing – sensitivity to reverberation time: T30 v T20.** The accepted difficulties associated with accurate measurement of a true T60 reverberation time have led to the use of extrapolated T30 and T20 reverberation time data in the calculation of airborne sound. Steve's paper examined the differences that occur in the $D_{nTw} + C_{tr}$ and L_{nTw} assessment levels when T20 data is used compared with T30. The data used was from actual field tests carried out during 2002/3 and comprised 100 airborne results and 50 impact results.

Adrian James then gave his second paper of the conference: **Results of the NPL study into comparative room acoustic measurement techniques: Part 1, reverberation time in large rooms.** Following the National Physical Laboratory's 'Deep Study' into standards for Architectural, Room and Building Acoustics, a workshop on acoustic measurements was organised to fulfil, within the limitations of a one-day event, the roles both of a comparative measurement exercise and a technology transfer meeting. Acoustics researchers and consultants took measurements under controlled conditions, using different sources, receivers and instrumentation. Adrian explained the comparative analysis of results for reverberation times in large rooms. He said that the results

Post-session discussion panel

for the small room and other parameters will be published at a later date.

Peter Mapp did his second stint with a survey of **Speech intelligibility measurement – the current state of the art.** Peter's rapid delivery required some degree of concentration from a tiring audience but such was the enthusiasm of the presentation that attention was ensured! He made the point that an accurate and portable machine based method of measuring the potential intelligibility of a classroom, auditorium or sound system has long been recognised. Peter explained that a number of methods are potentially available for assessing intelligibility, Articulation Index (AI), Percentage loss of consonants (% Alcons), D/R ratios (including C50 and C35), Word scores and STI and its derivatives RaSTI & STIPa. Whilst word scores are fundamentally the most accurate method, they are cumbersome and expensive to conduct. Considerable effort has therefore been made over the years into developing machine or computer based or indirect intelligibility assessment techniques.

Ole-Herman Bjor (Norsonic AS) continued the theme of intelligibility with his presentation **STIPA – the golden mean between full STI and RASTI.** He explained that the Speech Transfer Index (STI) as developed by TNO

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in Holland during the last thirty years has proved to be one of the most reliable objective indicators for speech intelligibility prediction. However, the method does require a substantial time to measure and RASTI was developed to overcome this disadvantage. Through the use of RASTI it has been noted that unreliable results can occur when measuring PA systems. He described how a more reliable indicator, STIPA, developed for the measurement of PA systems, has recently been standardised by IEC. He described how the measurement of STIPA may be implemented in a modern digital sound level meter.

After the tea break there commenced a joint session with *Reproduced Sound 19*, which enabled delegates to the latter conference, who had arrived early, to take part in five papers of interest to both groups of delegates.

Adrian Popplewell (Arup Acoustics), who chaired this session, also presented the first paper jointly with *Raj Patel* (Arup Acoustics, New York) entitled: **City of Manchester stadium: maximising acoustic excitement for performer and spectator.** The acoustic response of modern stadia is an integral part of their design. For the City of Manchester stadium an 'acoustic layer' was created as part of the architectural model, using 3-D faces to define surfaces rather than the standard unconnected lines. This allowed rapid room acoustic and public address system analysis using both commercially available acoustical modelling packages and in-house 2-D and 3-D ray tracing routines. These allow accurate visual representation of the dispersion and distribution of sound within a space. A major benefit of these visualisation tools is that they allow complex acoustic effects to be understood by non-specialist engineers and architects.

The angle and curvature of the roof, the need for and location of acoustic absorption, and the location and orientation of the loudspeakers were optimised using these modelling techniques. The resulting design met the core aims of interaction between spectators and performers, maximising the acoustic excitement within the stadium and meeting appropriate speech intelligibility criteria.

The next paper was given by *Ken Collins* (RPS) on **Assessment of noise from new stadia,** who explained the criteria and assessment methodology that have been used in addressing various aspects of noise from stadia and

Past and future presidents - Ian Campbell (left) and Alan Jones

associated developments at the environmental assessment stage. Many sports stadia are used for events other than the original sporting function, for example concerts and big screen events and this results in the need to consider a wide range of noise sources in addition to the crowd noise normally associated with a sports event.

This was followed by *Jim Griffiths* (Symonds Group Ltd) talking about the **Acoustic design of arenas.** The acoustic performance of arenas has become increasingly important for designers as patron expectation has steadily risen as systems are benchmarked against high quality entertainment now available in the home. Jim's paper reviewed the scope of work that is primarily involved with the sound, noise and acoustic design of both stadia and arenas. A case study of the Dome Arena, a 22,000-seat facility, to be built within the Millennium Dome, Greenwich, was described to highlight the acoustic design process for this major project.

Mark Bailey (JBL) explained that although the printed programme stated that he and Dan Eades of Arbiter were giving this paper, circumstances had changed; Dan no longer worked for Arbiter and Arbiter no longer distributed JBL products. So Mark was on his own in delivering a light hearted account of a discussion with a typical customer about what were his requirements for a sound system.

Dennis Baylis, (right) Geoff Kerry, (centre) and Bob Lorenzetto discuss sound level measurement (or so we are told)

Matters of frequency range, sound pressure level and sound distribution, amplifier power and of course cost were included.

Steve Jones (Symonds Group) brought the conference, and this session shared with RS19, to an end with his paper **Sound system design and the digital domain.** He suggested that, some 14 years after the first stadium sound system design using digital signal processing and fibre optic cable for signal distribution at Wembley stadium, the ability to design in anything but the digital domain is all but gone. However, the problem remains one of knowledge and experience. He claimed that there are still a lot of Luddites who would never operate a digital mixing desk. There are some who still say that digital equipment cannot be used in a life safety application, others say that it does not comply with Standards. Steve posed the question, 'is there any truth in these allegations?' and set out to de-mystify digital system design and provide answers to those allegations.

So ended another highly successful autumn conference, well attended, well organised and, we are sure, thoroughly enjoyed by all who attended.

Non-delegates' programme

What have *Harriet's* of Woodstock and *The Copper Kettle* of Burford in common? Those of us accompanying delegates to the conferences soon found out as we tasted the coffee and the cakes. We traversed these villages, nestling in the undulating countryside and well endowed with warm Cotswold stone. Why is the small village of Bladon so much on the map? We made our way up to the tiny church where, laid to rest beside it, was one of the great leaders of our time - Sir Winston Churchill. Sadly, his birthplace, Blenheim Palace, was not open.


Burford Village

Leaving behind the solitude of the countryside, it was time to sample the city's hustle and bustle, taking an open-topped bus for a guided tour of Oxford's colleges and buildings of note.

The following day we were given the rare opportunity for a private visit to Aynhoe Park, a listed building near Banbury. This historic country mansion, seat of the Cartwright family from 1651 to 1960, was the highlight of our outings. The family remained for over 300 years through the direct male line, supplying the adjacent church with Rectors for almost a century. Other family members served as diplomats and ambassadors. An earlier house on the site was mentioned in the Domesday Book (1086). Around 1747 Lancelot 'Capability' Brown was commissioned to landscape the estate to the south of the house. In 1799 Sir John Soane was employed to restyle the house. His passion for arches, curves and niches was very evident throughout. In an anteroom there is a pendentive* dome with curious acoustic properties - a means whereby secret conversations could be heard.

We left the great house with its gracious rooms and headed down leafy Lime Walk towards the ice house hidden beneath a rockery. Entering this vast chamber, its circular brick wall extending deep into the ground, we could see it was surely as good as the day it was built. The ring of echoes would delight the ears of any acoustician. This was indeed the pantry from which the great house would feed. Today, this great house is our heritage on which we too can feed...

Back at the hotel, it was time to get some exercise. The weather was dull but mild. Suitably clad we explored the local lanes and, en route, the river became an attraction. Little did we know we were soon to make an excellent catch - *The Trout* - a place to linger a while over a well earned drink and chat!


Trout Inn Wolvercote

We agreed that the beauty of its towns and villages, the modest cottages and imposing great houses, the impressive churches large and small, all combined to give us a taste of this wonderful English gem ... the Cotswolds.

Doreen Bratby

* **pendentive**: each of the spherical triangles formed by the intersection of a dome by two pairs of opposite arches springing from the four supporting columns. I knew someone would ask - *[Ed.]*

Explaining and sharing audio and acoustics

John W Tyler FIOA reports fron Reproduced Sound 19

Friday 7 November

INTELLIGIBILITY

Following sessions, shared in common with delegates of the Autumn Conference the previous afternoon, the RS 19 proper started, after a welcome by Mark Bailey, with this session chaired by *Paul Malpas* (Arup Acoustics) and *Peter Mapp* (Peter Mapp Associates).

Peter opened proceedings in rousing style, with a presentation on **Some effects of equalisation on sound system intelligibility and STI measurement error.** He began by reviewing sound system equalisation and frequency domain problems. The way in which equalisation affects system response and can improve intelligibility was then discussed and the effects of the upward spread of masking highlighted. The way in which ST1 accounts for such effects was then discussed and the reasons for the discrepancy between ST1/STIPa and perceived intelligibility was examined. He concluded that a new form of masking criterion may be required in order to account for the currently encountered discrepancies.

Glenn Leembruggen (Acoustic Directions pty, Australia) (co authored with *Tony Stacey* (AMS Acoustics) then posed the question **Should the Matrix be reloaded**? A subtle reference to the trio of blockbuster films? Maybe, but the matrix referred to here is MTF matrix as related to the STI process.

Glenn explained that in the experience of the authors and others, the tonal balance of amplified speech has a much more important role in producing subjective intelligibility than is accounted for by measurements of a system's Speech Transmission Index. Even in low noise, low reverberation environments in which the STI is high, subjective intelligibility can be degraded by over or under emphasis of one frequency band. Although the construction of the MTF matrix (from which the STI is derived) includes some compensation for upward masking, it does not seem to account for the subjective effects that have been experienced. To better understand this mismatch between the subjective and objective domains, tests of subjective intelligibility and measured STI were carried out in a reverberant environment with a speaker system that was set to eight different frequency response shapes. Glenn reported on the results of the tests and the process of reloading the MTF matrix.

Next came *Peter Edwards* (AMS Acoustics) who spoke about **STI in practice: the implications of fluctuating acoustics.** He described the purpose of an investigation designed to study how the STI of a system in an underground tube station platform area (and therefore expected intelligibility) is likely to change as the acoustic environment changes, and to compare the results with the traditional method of predicting the STI which assumes the acoustic environment remains constant. In addition it is proposed that the time varying acoustic predictions will be applied to the concept of installing acoustic treatment to the space and to investigate the effects of different quantities of absorption.

Between coffee and lunch an Invited Lecture was given by *Dr Durand Begault* (NASA Ames Research Centre, USA) on **Intelligibility in auditory displays.**

The design of an auditory display is crucial for safe and efficient operations conducted in a high-stress human-machine environment, for example in an aircraft flight deck or in a virtual environment tele-operation activity. The binaural hearing system's advantage over one-ear listening can be demonstrated, not only in a laboratory context but also in practical applications for improving auditory intelligibility. Although these operational environments are necessarily dependent on intelligibility measures for determining the quality of speech communications, there are other criteria that can be equally important for assessing, measuring or predicting an improved auditory display design. These criteria apply not only to speech communications but also to other auditory or multi-modal forms of information related to the operational state of the machine. Evaluation of the auditory display may be conducted in terms of measurement and evaluation of human performance, in terms of error rates, time for task completion; discriminability between simultaneous streams of information; recognisability; and reaction time. Evaluation of perceived quality may also be germane.

Human performance within the display can in turn be predicted by evaluating distortion levels, spectrum of masking background noise, and the configuration in perceived auditory space of multiple information streams. Dr Begault gave examples of applications and research pertinent to auditory display design at NASA Ames Research Center's Spatial Auditory Display laboratory. Funding for this work was provided by the PPSF-AOS Project of NASA's Airspace Systems Programme.

LOUDSPEAKERS AND MEASUREMENTS

The first session after lunch, chaired by *Julian Wright* and *Mark Bailey,* was opened by *Mark Dodd* (Celestion International Ltd) who spoke about **The application of vibro-acoustic, magnetic and thermal FEM to the design of a forward radiating compression driver.** High frequency plane-wave tube limitations are illustrated with Finite Element Method (FEM) models of idealised sources. Mark

OVERVIEW

Mark Bailey (JBL Professional) chaired the conference's organising committee, which included Mark Avis, Robin Cross, Ken Dibble, Stephen Jones, Paul Malpas, Peter Mapp, Martin Roberts, Bob Walker, Sam Wise and Julian Wright. All should be thanked for producing an informative, interesting and very enjoyable two days of lectures and events, well up to the high standard set by previous RS conferences.

During the event IOA President, Geoff Kerry, presented three key awards: the Rayleigh Medal was given to Professor Philip A Nelson (Director ISVR, University of Southampton); Peter Mapp received the 2003 Peter Barnett Memorial Award; and Francis Li (Manchester Metropolitan University) the Peter Barnett Student Award.

The 2002 Peter Barnett Memorial Award Lecture was given by that year's recipient, Dr Wolfgang Ahnert (ADA Acoustic Design, Germany).

described a compression driver with the convex side of a hemispherical diaphragm radiating into a two-slot phase-plug. A new technique was outlined in which steady state sinusoidal vibro-acoustic, transient magnetic and static magnetic FEM results are combined to predict voltage driven driver response. This analysis was applied to the compression driver loaded by a planewave tube and a non-axisymmetric horn, and the results were presented and compared to those measured. Mark outlined a new technique in which steady state sinusoidal vibro-acoustic, transient magnetic and static magnetic FEM results were combined to predict voltage driven driver response. This analysis was applied to the compression driver loaded by a plane wave tube and a non-axi-symmetric horn, and Mark presented the results and compared them with the measured quantities.

Wolfgang Ahnert (ADA Acoustic Design) followed with his paper (co authored with *Stefan Feistel* and *Waldemar Richert*). The processing power available on portable computer platforms is now so far advanced that it is no longer necessary to use dedicated DSP platforms for the intensive analysis required in Time Delay Spectrometry. Moving the processing from a dedicated platform onto a standard PC also opens the way to handle all of the data processing tasks, and simultaneously takes care of test tone generation and data sampling gathering. Wolfgang introduced the new measurement software EASRA including a purely software-based TDS module to obtain ETC and TDS (EFC) data just by post-processing. Additionally EASRA allows one to perform other kinds of measurements like MLS, Sweep-based dual-channel FFT, dual-channel FFT based on noise or custom signals and, last but not least, multi-channel measurements.

Andrew Goldberg (Genelec, Finland) then gave his paper (co authored with *A Mäkivirta*): **An automated in-situ frequency response optimisation algorithm for active loudspeakers, including a statistical analysis of its performance.** He described the rationale of a method of automatically adjusting the acoustical frequency response of active loudspeakers to suit the particular room acoustics. The frequency response (impulse response) of the room is acquired by the system and used to control, via an optimisation algorithm, a discrete set of room response controls on the active loudspeakers. Andrew described the algorithm and gave a statistical analysis of its performance. The algorithm has been implemented and is currently in use by specialist loudspeaker system calibrators in setting up and tuning studios and listening rooms.

The last paper before the tea break, presented by *Steve Temme* (Listen Inc, USA), was entitled **Loudspeaker rub and buzz and loose particle detection.** During loudspeaker production, particles may become trapped in the loudspeaker motor and voice coil vicinity, resulting in a distinctive defect that is easily heard, but difficult to detect by traditional test and measurements. Steve explained that to give a clear view of the problem, time-frequency maps are produced and he showed examples for some significant samples of loudspeakers. He presented a reliable testing procedure using a sine sweep stimulus, high pass filter and an RMS envelope analysis. Further possible enhancements and applications of the method were discussed.

Dr Nick P R Hill (NXT) continued proceedings with his paper covering **Distributed mode loudspeakers: behaviour and measurement.** In describing the characteristics of distributed mode loudspeakers, he explained that they are inherently modal as compared to conventional cone loudspeakers that reproduce a point source through pistonic behaviour. He explained that the extension from single degree of freedom to the complex two-dimensional vibration of a DML opened up a range of possible effects over the frequency range. In particular, there is no one 'reference' DML, rather a range of possibilities determined by the demands of the application, both technical and commercial. Nick's paper provided a broad outline of possible behaviours, focussing on the measurement methods that may be employed to characterise them.

Keith Holland (ISVR) followed with his contribution (co authored by *Philip Newell* and *Peter Mapp*) on **Steady state and transient loudspeaker frequency responses.** Probably the most important and well-known specification for a high quality loudspeaker is its frequency response. Most audio professionals and enthusiasts are quite used to using frequency response plots to make judgements as to the likely quality of sound reproduced by loudspeakers. A major goal in the design of high quality loudspeakers is therefore to achieve a frequency response which evenly covers as much of the audio frequency range as possible. At the high-frequency end of the spectrum, this goal is readily achievable, with many modern high frequency loudspeakers having excellent responses up to frequencies well beyond the audible limit for humans; however, achieving an extended response at low frequencies is always subject to much compromise. Keith looked at the compromises involved in extending the low-frequency response of loudspeakers and the likely audible consequences of these compromises. He compared the steady-state responses and the time-related responses of a number of commercially available loudspeakers.

Patrick Macey (PACSYS Ltd) then required delegates' concentration with his paper **Finite element methods for transient acoustic analysis of audio problems.** Numerical modelling techniques are becoming common in the design of loudspeakers, horns and other devices used in the audio industry. Most commonly steady state sinusoidal response results are computed. However many phenomena are much better understood or more naturally studied in the time domain. The diffraction from cabinet edges is one example. Reflections from walls of a small room are similarly most easily identified in the time domain. Patrick described current work, which compares implicit and explicit transient finite element schemes for some audio applications.

Rayleigh Medal

Next, IOA President Geoff Kerry presented the Institute's *Rayleigh Medal* to **Professor Philip A Nelson,** who then gave his Rayleigh Medal Lecture on **The time domain response**

continued on page 18

Phil Nelson presents his paper

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of some systems for sound reproduction. Philip gave an absorbing review of some theory and practice associated with the production of convincing acoustic illusions by a pair of loudspeakers.

It is possible, by using a pair of loudspeakers, to produce fluctuating sound pressures at the ears of a listener that replicate accurately a pair of prescribed sound pressure time histories. The latter might be those that would be produced by a particular source of sound located at a specified spatial position relative to the listener. This approach is capable of generating the convincing illusion in the listener of the existence of a virtual source of sound at the specified spatial position. Unlike conventional stereophony, the position of the virtual source is not primarily restricted to the range of angular positions in the horizontal plane that falls between the angular positions of the loudspeakers.

This approach, based on 'cross-talk cancellation', is generally attributed to Atal and Schroeder, although Bauer had previously investigated a similar procedure for the reproduction of dummy head recordings. The technique has been further developed by a number of other authors and requires the design of a matrix of filters that operates on a pair of binaurally recorded signals (or a pair of binaurally synthesised signals) in order to derive the inputs to the two loudspeakers. This matrix of 'cross-talk cancellation filters' effectively inverts the matrix of transfer functions relating the loudspeaker input signals to the listener's ears signals, thus ensuring that the binaurally recorded signals are faithfully replicated at the ears of the listener.

After a reception and dinner, the following presentations were made by the President: The *Peter Barnett Memorial Award* to **Peter Mapp**; and the *2003 Diploma Prize* to **Brian Donohoe.**

Dr Wolfgang Ahnert then gave his 2002 Peter Barnett Memorial Award Lecture, **Acoustics behind the Iron Curtain**. An account, both amusing and serious, but very absorbing, of his personal experiences of growing up, being educated and making his career in acoustics in conditions most of us have only read about.

Geoff Kerry presents the 2003 Diploma Prize to Brian Donohoe

Saturday 8 November
LOUDSPEAKER ARRAYS

The first session, chaired by *Peter Mapp* and *Ken Jacob* was opened by *Jim Cousins* (Martin Audio), on behalf of *B Webb* and *J Baird*, with the paper **Advances in line array technology for live sound.** As Jim explained, in recent years the line array loudspeaker system has become the dominant player in the touring sound industry. Line arrays are currently perceived to offer significant benefits over horizontally arrayed clusters, including a more consistent frequency response over the audience area, increased high frequency throw and reduced set-up time. The paper attempted to offer an insight into why the line array principle has been applied to live sound and explained some of the factors to be considered in implementing a practical design.

Then followed a joint presentation by *Ulrich Mall* and *John Taylor* (d&b audiotechnik, Germany) with the intriguing title **D, H & C: a new look at the defining parameters of a curved line array.** Optimising a straight line array for an audience area is an impossible task, due to the far reaching and frequency dependent crossover between near field and far field. The effects of curving in real world line arrays don't seem to be well understood. While novices are enjoying mythical 3dB happiness and experienced practitioners are sweating through the various simulation tools, a clear engineering methodology for setting up and optimising line arrays still seems to be missing.

The two speakers researched into the simulation of line arrays which led to a new understanding of the relationship between the defining parameters distance, height and curving, and the resulting quantities such as max SPL, vertical dispersion, ripple in the frequency response etc. Then the speakers demonstrated an intriguing model line array which could be bent into different curves and produced a distribution of sound which demonstrated very effectively the points they had made in their presentation.

David Gunness (Eastern Acoustic Works, USA) followed with an explanation of **The design and implementation of line arrays using digital signal processing**. He presented the requirements for a wide bandwidth, steerable loudspeaker array and showed how these are used to establish physical criteria for a broadly useful system. David described an implementation which meets these criteria with a high-density, multi-way source array and integrated processing and amplification. The directional characteristics of digitally steered arrays were explored, including some which offer unique advantages. Practical limits of directional performance were also established.

After the coffee break, *Dr Evert Start* (Duran Audio, The Netherlands) opened proceedings with his paper (co-authored with *G van Beuningen*) covering **Design and application of DDS controlled, cardioid loudspeaker arrays.** As he explained, after the introduction of Digital Directivity Synthesis (DDS) three years ago, AXYS DDS-driven arrays (like the Target and Intellivox-XL series) have been successfully applied during many music performances (front-of-house system) and also in a few fixed installs (PA and voice evacuation).

Using DDS, which is based on a 'constrained least squares' optimisation scheme, any desired 3D array response can be synthesized. Starting from a pre-defined array set-up and desired SPL distribution at the boundaries (including the audience area) of a hall, the optimum output filters for the array elements (channels) can be calculated. Then these output filters can be uploaded to all units in the array.

Roger Schwenke (Meyer Sound Laboratories, USA) then

RS19 conference dinner

followed with a presentation (co authored with *P Meyer*) on **Comparison of the directional point source model and BEM model for arrayed loudspeakers**.

There are many approximations to the acoustic wave equation, which can be evaluated numerically, which are more and less accurate at modelling different acoustical phenomena and which are more or less computationally expensive. Roger compared the Directional Point Source model and the Boundary Element Method (BEM) for modelling arrayed loudspeakers.

Mark Bailey (JBL Professional) delivered the final paper before lunch covering **Experiences with line arrays,** which continue to proliferate in the worldwide professional audio market. Mark set out to cover some of the key differences in practical and audio terms that these systems present. He also offered some basic guidelines to the practitioner who has heard that he needs a line array, but is not so sure of why and how best one should be deployed. Mark provided results and experiences from both R&D and real-world testing and evaluation with a view to providing a better understanding of the 'articulated line array' and the differences scaling the size of the array elements can make.

PERCEPTION

Chairing this next session, *Robin Cross* introduced the first speaker, *Dr Shelley Katz* (Layered Sound Technologies Ltd) who presented the paper, co authored with *Peter Mapp*, **Layered sound – a new approach to sound reproduction**. Shelley described a new technique for improving the spaciousness of reproduced sound which uses a combination of conventional pistonic loudspeakers and Distributed Mode (DML) devices. Objective measurements have been made in a range of rooms and show that 'Layered Sound' affects parameters such as the Inter Aural Cross Correlation Coefficient (IACC) and Lateral Energy Fraction as well as Centre Time and Early Decay Time.

A number of conditions were investigated, including listening room configuration and the relative sound levels of the loudspeakers. The configuration of the listening room and the type of programme material (and recording technique) were found to be significant factors. He showed that over a range of conditions, Layered Sound enhances the perceived spaciousness, envelopment and clarity of reproduced sound, though some changes to the original stereo image were noted.

Then followed an Invited Lecture given by *Floyd Toole* (Harman International Industries, USA) on **Art and science in the control room**. In Floyd's words: audio engineering employs both art and science to capture and process the audio experiences of the entertainment industry. Storage and reproduction of the art are - or should be - scientific/technical exercises. Confusion of the two domains has created some colourful audio folklore, assisted by the willingness of the human brain to generate perceptions supporting much of what we want to hear. Our product is sound, and the premise upon which our industry is based is that customers will be able to hear close replicas of the sounds that were created in concert halls, jazz clubs, dubbing stages and recording studios.

The art needs to be preserved and this is a profound challenge, since we know that monitor loudspeakers in control rooms certainly do not all sound alike, and consumer loudspeakers and rooms cover an enormous range of qualities. Evidence of both variable recording and playback quality exists in abundance. It sounds like a hopeless task and, if professionals ignore the existing science, it *is* hopeless. However, thanks to advances in consumer audio, playback quality is improving and examples of genuine excellence can be found. Consequently, the old problem of trying to guess what a recording will sound like through a 'typical' playback system is less of a lottery. Science has given us the means to technically and subjectively identify truly good loudspeakers with high reliability. Equally important, it has given us the means to deliver reliably good sound in different rooms.

Lampos Ferekidis (Wvier, Germany) followed with his paper on **The beneficial coupling of cardioid low frequency sources to the acoustics of small rooms**. He explained that ordinary low frequency sources radiate energy in an omni-directional manner. This often leads to unsatisfying results regarding the reproduction of low frequencies in small listening rooms. The influence of different radiation characteristics were investigated concerning the reproduction of low frequencies in a sparsely modal

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environment. A monopole, a dipole, and a cardioid were compared. The different room mode excitation mechanisms were explained using comparative measurements taken in a reverberation chamber, and the effect of a reflective boundary on the low frequency response was demonstrated. The cardioid, which represented a superposition of a monopole and a dipole, turned out to be the preferable low frequency source for the three types investigated.

Presentation of the Peter Barnett Student Award to Francis Li by Geoff Kerry

ROOM ACOUSTICS, CABLES AND NETWORKS

After the tea break this next session, chaired by *Bob Walker* (BBC), was launched by *Dr Diemer De Vries* (Delft University of Technology). His subject was **Wave field synthesis and analysis: the state of the art**. The concept of wave field synthesis (WFS) was introduced by Berkhout in 1988. It enables the generation of sound fields with natural temporal and spatial properties within a volume or area bounded by arrays of loudspeakers. Applications are found in real time performances as well as in reproduction of multi-track recordings. A logical next step was the formulation of a new wave field analysis (WFA) concept by Berkhout et al. in 1997, where sound fields in enclosures are recorded with arrays of microphones and analysed with post processing techniques commonly used in acoustical imaging. This way, both the temporal and spatial properties of the sound field can be investigated and understood. WFS and WFA meet in auralization applications: sound fields measured (or modelled) along arrays of microphone positions can be generated by arrays of loudspeakers for perceptual evaluation.

Next came a contribution by *Stuart Colam* (Arup Acoustics,UK) and *Glenn Leembruggen* (Acoustics Directions pty, Australia) on **A computational method for analysis and design of acoustic absorbers and low frequency transmission loss.** They outlined the subject area of their paper. Architecture is in a constant state of evolution, with architects striving for increasingly novel designs using materials and geometric forms in new ways. In the light of such advances, the acoustic consultant must often think of similarly novel ways in which the acoustic intent can be accommodated in a design whose impact is primarily visual.

Manufacturers' data is often unreliable or inappropriately tested and it is important that the acoustician is able to place confidence in a design in the absence of a third party. An example of a typical problem is the architectural form that is curved in shape and incorporates large amounts of glass and concrete - this is not ideal for the control of reverberance. Whilst the modular construction of many office buildings gives flexibility to the user, it can be at the expense of providing sufficient levels of sound insulation. It is often necessary, therefore, for the acoustician to design bespoke solutions, tailored to the particular problem. This is especially the case where there are financial constraints on a project.

Dave Neal (BSS Audio) co-authored with *Richard Rowley* their paper **Sharing audio – the convergence of audio and computer networks.** Dave described how the way in which audio systems are installed has radically changed with the advent of programmable DSP systems. Tedious changeovers between sessions with large amounts of equipment to re-program and re-patch are a thing of the past.

A programmable DSP system means that you can have virtually any audio system design and you can change what your audio system is doing according to the type of event you are holding, just by recalling a preset. It means that you can easily and quickly add more processing to the system without increasing the hardware budget and that any specification changes during the design phase can be easily implemented. Typically, these systems are a set of audio processing units that can be linked by a digital communications network. The units are often completely flexible; you program the signal paths and block diagram of the processing using a PC, choosing processing blocks from an extensive library. These units can often be fitted with microphone preamplifiers, so you can create almost any audio system, including all of the processing, all the way from microphone to power amplifier.

The final paper of the session and of the conference proper, given by *Philip Newell* (Reflexion Arts) and co-authored by *Sergio V Castro, Julius P Newell* and *Keith Holland,* was on the subject of **Loudspeaker cables for high frequency transducers – a further assessment.** Philip admitted that it is difficult to raise the subject of audible differences between different loudspeaker cables without also raising heated discussion and provoking polarised view points. The paper continued the objective measurement programmes reported in the *2002 Reproduced Sound Conference*. In the light of comments which were raised after the presentation of that paper, some of the measurements were reconfigured, and the results have been reviewed.

Measurements from a differential amplifier were also presented, highlighting the wide differences in the losses caused by different cable structures and lengths. It was to show how, although no one mechanism is alone responsible for giving rise to great sonic differences from cable to cable, multiple mechanisms do exist which can cumulatively conspire to erode the sonic purity. The interdependent nature of all the component parts of an amplifier/loudspeaker system have made it difficult to make any clearly defined generalisations. Nevertheless, Philip attempted to show how some relatively large effects can be rendered almost insignificant simply by changing one component in a system.

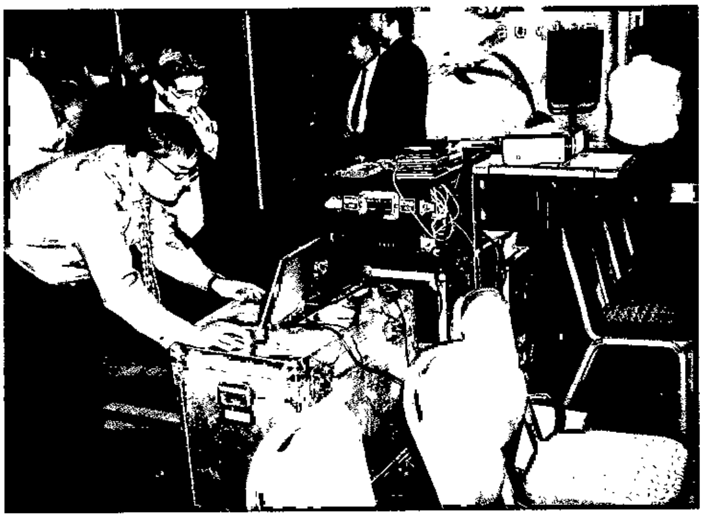
This can help to explain why factual generalisations can be so elusive.

After the scheduled programme of papers, the IOA President presented the 2003 Peter Barnett Student Award to *Francis Li* (Manchester Metropolitan University), who then delivered his paper on **The complexity of speech intelligibility measurements in packetised transmission channels**.

The integration of computer and telecommunications technologies has enabled the transmission of multimedia signals over packetised data communications networks locally and globally. With the rapid growth of the Internet, Voice over Internet Protocol (VoIP) technology has become a potential alternative to and supplement of the traditional Public Switched Telephone Network (PSTN), offering a versatile, flexible and cost-effective solution to peer-to-peer speech communications. Quality of Service (QoS) is an important concern of any Internet based services. Speech intelligibility naturally becomes a key issue of various services around VoIP. Effective assessment methods are sought as an essential step towards assured quality. Time-variance and discontinuity found in packetised networks cause complexity of intelligibility assessments in VoIP. Low-bit-rate and non-linear codecs used in VoIP channels further aggravate the complexity.

Francis' paper discussed the complexity of extending existing speech intelligibility assessment methods to VoIP applications and proposed a framework of a speech-based method to quantify intelligibility of VoIP channels.

Before the Reception and Conference dinner, the **Electroacoustic Group** held its AGM . I was not there so I do not know how speedy they were! Following dinner there was a very impressive demonstration of high definition audio and surround sound (both DVD-A and SACD) given by *Genelec*. So ended the nineteenth RS conference - a resounding success



Demonstration of high definition audio and surround sound by Genelec

with an encouraging increase in delegates from overseas - roll on RS20. I have reported on all of them since the first - I might consider retiring after next year!

Appreciations

Thanks are due to the following: to the St Albans HQ staff who worked so hard in organising both conferences; to Ken and Robin Dibble for providing the usual high standard of sound system for microphones, both roving and attached to the speakers, during both conferences; to Michael Morrow for handling the roving microphone so well; to the exhibitors at both conferences who arranged colourful and informative displays of their wares and provided a congenial location for private discussions during the breaks.

A POETIC POSTSCRIPT

Our conference organiser, Mark Bailey, turned to rhyme in sending this timely message to members

Good evening ladies and gentlemen
And thank you for all being here
To learn more about Reproducing Audio
And drink a little wine and some beer...

At the end of last year's conference,
I was called to one side - over there...
As a long standing committee member,
Would I now mind being the chair?

As long as I'm not the one who gets sat on
(be careful how you say that line)
And remember Robin's famous after dinner speeches,
That are always covered in rhyme

So, rather than find something already written
I decided to write and compose
Something suitably Reproduced Sound 19 linked
Connected in a manner of prose

So, it's always good to have a tag line
Something the audience follow along, so I've found
So I thought I'd use the phrase I've been repeating all year:
Come to Reproduced Sound!

The speakers or talkers are interesting
We get to hear all the latest news
Amplified kindly by Mr Ken Dibble
Through a pair of BOSE 802's

We cover academic questions
And listen to speakers so loud
But if you want to know all the answers
You must Come to Reproduced Sound!

We're a part of the Institute of Acoustics
A conference held in November
And if you don't happen to have a degree
We'd love to have you as a Technician Member

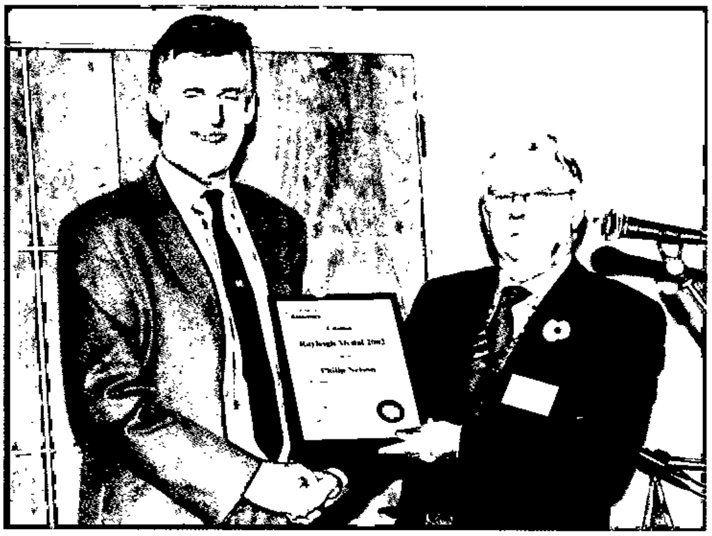
Perhaps you like the new line arrays?
-Or just want to POINT-AND-SHOOT me down!
For a guaranteed lively discussion
Come to Reproduced Sound

This is the nineteenth Conference,
Though more, I hope there'll be plenty
I now really hope that I'll see you next year
For Reproduced Sound - Twenty.

Come down from your ivory towers
Find out what's going on, on the ground
Be you consultants, suppliers contractors
You should Come to Reproduced Sound!

All in all, it's really been quite a conference,
You've travelled from near and from far
So please, sit back to enjoy the evening
And I'll see you all later in the bar.

Because if you need to answer the day's issues
Should your arrays be linear or round?
Answer all in the bar in the wee small hours
Here at Reproduced Sound....



Phil Nelson receives the Rayleigh Medal 2002 and Certificate from IOA President Geoff Kerry during Reproduced Sound 19

Rayleigh Gold Medal 2002

Philip Arthur Nelson

An outstanding contribution Phil Nelson has made to acoustics is in the field of active control of sound and vibration. His early work, in close collaboration with Stephen Elliott, was acknowledged by the Institute of Acoustics with the joint award of the Tyndall Medal in 1992.

That research work has now broadened to encompass automatic control of unsteady flow, inverse problems in acoustics with particular reference to noise source location and quantification, and multi-channel signal processing techniques for the production of virtual acoustic environments. To date, Phil has been the author or co-author of two books, over 70 papers in refereed journals, 12 patents, and over 200 other technical publications.

In addition to his research work, Phil undertakes major administrative duties. He is Director of the Institute for Sound & Vibration Research (ISVR) at the University of Southampton and was previously Director of the Rolls-Royce University Technology Centre in gas turbine noise, also at Southampton.

He is a committed and respected teacher of undergraduates and postgraduates and his courses range from an introduction to acoustics to active control of sound and vibration with specialist options in analytical and numerical acoustics.

Phil graduated from the University of Southampton in 1974 with a first class honours in Mechanical Engineering. He went on to study the aerodynamic production of sound for his doctorate in the ISVR. From 1978 he worked for four years in industry on a wide range of practical problems in noise and vibration control. He returned to the ISVR as a lecturer in 1982, being promoted to senior lecturer in 1988, and professor in 1994.

Phil is a Chartered Engineer, a Fellow of the Institute of Acoustics, a Fellow of the Institution of Mechanical Engineers and a Member of the Institute of Electrical and Electronics Engineers. He is also a Member of the Audio Engineering Society, the Acoustical Society of Japan, and the Acoustical Society of America, and is a Distinguished Corresponding Member of the International Institute of Noise Control Engineers. Phil served on the Council of the Institute of Acoustics from 1990 to 1999, and is now a member of the board of the International Commission for Acoustics. He was elected a Fellow of the Royal Academy of Engineering and a Fellow of the Acoustical Society of America in 2002.

For his outstanding contributions to research, leadership and teaching in acoustics, The Institute of Acoustics is proud to present to Philip Arthur Nelson the Rayleigh Gold Medal for 2002.

Peter Barnett Award 2003

Peter Alan Mapp

Peter Mapp graduated from Liverpool Polytechnic in 1976 with a degree in Applied Physics and went on to obtain a MSc in Acoustics at the Institute of Sound & Vibration Research. He expected to continue his MSc research topic, on the human perception of vibration, into a PhD, but decided to leave the academic world and joined SRL as a consultant specialising in architectural acoustics.

After nearly five years with SRL, including a secondment to Essex University to work on active sound control, Peter joined Arup Acoustics and became their third full-time acoustics consultant. In his spare time, he had begun writing about his passion for Hi-Fi and he became a regular contributor to the UK's audio technical press. He had built up his own extensive electroacoustics laboratory and in 1984 set up his own company so that he could actively pursue his primary interests of audio and room acoustics.

Peter is a prolific author and sharer of information. In total, over the years, he has authored over 72 conference papers and written some 48 other technical journal articles as well as completing 40 equipment reviews. He has also contributed specialist chapters to six international reference books on acoustics and audio systems design. He regularly lectures on university courses - both here in the UK and in the USA. He is also a technical consultant and regular contributor to the *Sound & Video Contractor* magazine, which is read by audio professionals all over the world.

IOA President Geoff Kerry presents the Peter Barnett Award 2003 to Peter Mapp at Reproduced Sound 19

Peter is a Chartered Engineer, a Chartered Physicist, a Fellow of the Institute of Acoustics and Member of the Institute of Electrical Engineers. He is an active member of several BSI, IEC and AES standards committees and is considered a leading international authority on speech intelligibility and its measurement.

The Peter Barnett Memorial Award is awarded in recognition of contributions to the fields of electroacoustics, speech intelligibility or education. Peter Mapp would be a worthy recipient in any one of the categories but in fact falls into all three.

The Institute of Acoustics is pleased to present Peter Alan Mapp with the Peter Barnett Award for 2003.

Trapped within a 'wall of sound'

A possible mechanism for the bubble nets of humpback whales

Timothy G. Leighton FIOA, Simon D. Richards FIOA & Paul R. White

ABSTRACT

It has been known for decades that, to trap prey, humpback whales sometimes employ 'bubble nets' in the form of hollow cylinders. The cylinder wall contains a dense population of bubbles, but the interior is comparatively bubble-free. A group of whales may cooperate, diving and then rising in a helix, releasing bubbles to form nets of 3 to 30 metres diameter. The prey congregate in the bubble-free centre and are then consumed by the whales, which rise from below. The imprecision of the explanations of why prey refuse to escape through the walls is probably the reason why, although the phenomenon is described frequently on the internet, it seldom appears in formal scientific literature. This article suggests that the acoustic properties of the nets warrant investigation, and speculates on possible mechanisms by which the nets might act. For example, the trumpeting calls emitted by the whales, when they produce these nets, may become trapped within the bubble wall, generating high intensities there. These calls (which human reporters have subjectively described as disconcerting and even alarming) are so loud that they resound throughout the hull of any nearby ship. This article shows that, under certain insonification conditions, sound can be concentrated within the wall of the net, leaving the inside of the cylinder (where the fish congregate) almost silent. The natural schooling response of fish to the 'wall of sound' which they encounter if they try to leave the trap makes them a compact meal when the whales rise up from beneath, with their mouths open. The possibilities of this, and related acoustical effects, are discussed.

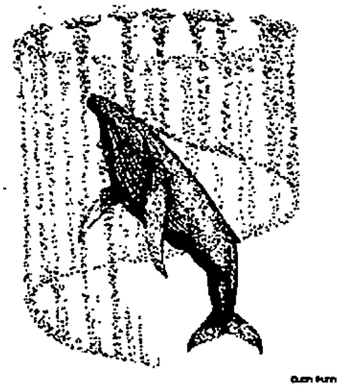


Figure 1 Schematic of a humpback whale creating a bubble net. The whale dives beneath a shoal of prey and slowly begins to spiral upwards, blowing bubbles as it does so, creating a hollow-cored cylindrical bubble net. The prey tend to congregate in the centre of the cylinder. Then the whale dives beneath the shoal, and swims up through the bubble-net with its mouth open to consume the prey ('lunge feeding'). (Image courtesy of cetacea.org)

Humpback whales (*Megaptera novaeangliae*) exhibit a unique feeding behaviour, whereby they encircle schools of prey fish with a hollow cylindrical cloud of bubbles **(1)** up to 30m in diameter, which they create by emitting air through their blowhole, as shown in *Figure 1*. This behaviour is sometimes conducted by a solitary animal and sometimes in groups of 15 or more **(2)**. The humpbacks then lunge feed on the fish (*Figure 2*).

Figure 2 Humpback whales lunge feeding (photograph courtesy of Lisa Walker)

The fish appear to be trapped within the cylindrical bubble cloud: they seem unwilling to pass through the bubble net. This behaviour on the part of the prey is somewhat surprising given the prevalence of bubbles in the upper ocean, and the ability of fish in general to survive breaking waves, waterfalls *etc.* **(3)**. Humpback whales are known to emit very loud calls during feeding activities: 'As the bubbles rise, a whale trumpets a feeding call for a minute or two before sweeping the frequency upwards to cue a synchronous surface lunge. A hydrophone is not needed to hear these sounds. They travel up through the hull and into your ears' **(4)**. Recordings of 'trumpetings' (which can, for example, be heard at **(5)**) may contain energy in the range 100 - 4000 Hz. This paper suggests that the bubble net's trapping ability owes much to the interaction of the whale sounds with the bubbles.

Because the density and sound speed (ρ_c, c_c) of bubbly water differ from those of bubble-free water (ρ_w, c_w), their potential to act as 'bubble screens' for underwater sound (*eg* piling **(6)** and underwater explosions **(7)**) has often been discussed, and even realised. For example, bubble screens have been used to reduce the noise from pile-driving activities in the construction of the new Bay Bridge and Benicia-Martinez Bridge in the San Francisco Bay Area, in order to protect migrating salmon and other fish. Often unsophisticated appeals are made to the way the normal incidence acoustic pressure reflection coefficient $R_{refl} = (\rho_c c_c - \rho_w c_w)/(\rho_c c_c + \rho_w c_w)$ will tend to -1 if the void fraction can be made sufficiently great, through its effect on reducing ρ_c. However the actual effect of underwater bubble clouds is more sophisticated, with refraction in addition to reflection.

Figure 3 illustrates schematically the speculative mechanism for how the bubble nets may cause sound to be trapped within the bubbly region. This plan view shows a section of the bubble net, with the whale emitting sound from outside. As shown by the sound speed graph, the speed of sound varies across the bubbly region, with a minimum on the axis. This will be the case for sound waves of frequencies which are less than the resonant frequencies of the individual bubbles, and where the bubble density is a maximum on the axis. The behaviour of the sound within the bubbly region can be described by Huygens' principle. The new position of a propagating wavefront may be found from the envelope of the small Huygens wavelets spreading out from the previous position of the wavefront. Since the speed of sound near the centre line of the bubbly region is less than that nearer the edge, the wavelets near the axis will have smaller radii than those near the edge (since, in any finite small time, they travel less far). The wavefronts therefore change direction and refract towards the centreline of the region. Even if the interior is not bubble-free, similar refraction occurs provided the void fraction decreases as one moves into the cylinder interior.

Method

(a) Sound speed in bubbly water. A fuller account of the bubble dynamics associated with bubble nets is given by Leighton **(8)**. With the subscript w referring to bubble-free water, and c to water within the bubble cloud, the sound speed can be found through the differential of the liquid pressure P with respect to its density ρ, which in turn is related to the bulk modulus B:

$$c_{w,c} = \sqrt{\partial P_{w,c} / \partial \rho_{w,c}} = \sqrt{B_{w,c} / \rho_{w,c}}, \quad (1)$$

where

$$B_{w,c} = - \frac{dP}{\left(dV_{w,c} / V_{w,c}\right)} \quad . \quad (2)$$

ie the ratio of the imposed pressure in the liquid to the proportional change in volume, the minus sign ensuring that the expected quasi-static behaviour (a compressive pressure leading to a decrease in volume) gives a positive bulk modulus **(9)**.

Whilst the addition of bubbles to previously bubble-free water does reduce the density $(\rho_c < \rho_w)$, in quasi-static conditions the reduction in the bulk modulus outweighs this effect in *Eq.1* and the sound speed is reduced $(c_c < c_w)$. This is because, whilst bubble-free water is relatively incompressible, the free gas in bubbly water is readily compressed by a positive dP, such that $|dV_c / V_c| > |dV_w / V_w|$ *(Eq.2)*.

A bubble pulsating in response to an incident sound field is however an oscillator (the gas providing the stiffness, and the surrounding liquid the inertia) **(9)**. Whilst the above quasi-static scenario corresponds to the stiffness-controlled regimes, where the bubble is driven at frequencies much less than its resonance, in the inertia-controlled regime (when the frequency of the incident sound field exceeds the resonance) the bubbles are expanding during the compressive half-cycle of the oscillating acoustic field. Hence in this regime the addition of bubbles will increase the sound speed, the effect disappearing at the highest frequencies.

Were humpback whales able to exploit the frequencies at which this would occur, and use these for echolocation of the prey within the bubble net by a whale outside it (a controversial hypothesis **(10)**, but raised in the speculative spirit of this article), it is possible that certain signals would not be significantly refracted by the net. Reflections allowing, they might be effective in echolocation despite the fact that lower frequencies may be trapped in the 'wall of sound'. These effects will now be modelled using ray theory.

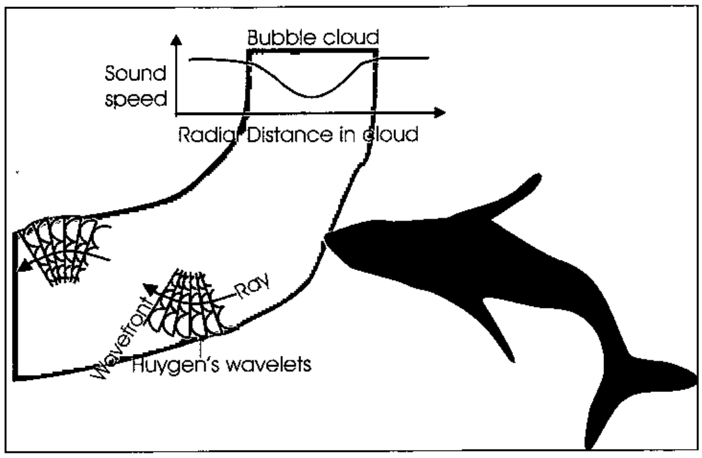


Figure 3 Schematic of a whale insonifying a bubble-net (plan view). According to Huygens' principle, the position of a wavefront (which is locally normal to the rays) can be found from the envelope of small Huygens wavelets which can be thought of as propagating out from the original position of the wavefront. Since the sound speed in the figure is smaller the closer one is to the centre-line of the bubble cloud, the Huygens wavelets form smaller circles there than they do further from this axis. Hence subsequent wavefronts tend to change direction so that the rays refract back into the cloud. Similar effects can of course occur under breaking waves, in vessel wakes, etc.

(b) Ray theory. The propagation of sound into and around the bubble net has been calculated here using standard ray theory **(11)**. The ray equations may be written

$$\frac{dx}{ds} = c\xi(s), \quad \frac{d\xi}{ds} = -\frac{1}{c^2}\frac{dc}{dx},$$
$$\frac{dy}{ds} = c\zeta(s), \quad \frac{d\zeta}{ds} = -\frac{1}{c^2}\frac{dc}{dy}, \quad (3)$$

where $[x(s), y(s)]$ is the ray trajectory in the horizontal plane, c is the local sound speed, and $\xi(s)$ and $\zeta(s)$ are auxiliary variables introduced in order to write the equations in first-order form.

The ray equations have been solved by direct numerical integration, using the initial conditions

$$x = x_s, \quad \xi = \frac{\cos\theta}{c(0)},$$
$$y = y_s, \quad \zeta = \frac{\sin\theta}{c(0)}, \quad (4)$$

where (x_s, y_s) is the source position, θ is the initial launch angle of the ray, and $c(0)$ is the sound speed at the source. This is then repeated for a set of rays representing the beam pattern of the whale's projected sound.

Since field data are lacking, certain parameters needed to be estimated. Whilst there are no data on the size distribution of bubbles in the bubble net, oceanic bubble size distributions produced by breaking waves have sufficient numbers of small bubbles that a frequency of a few kHz or less (such as the humpbacks use) will propagate with reduced sound speed **(12,13,14)**. This is because the buoyant rise speed of bubbles is greater for large bubbles; and, if a bubble descends to greater depth as a result of turbulence or circulation, hydrostatic pressure causes it to shrink. Calculation of the sound

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Trapped within a 'wall of sound'

A possible mechanism for the bubble nets of humpback whales

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speeds within the net would require knowledge of the void fraction (the proportion of bubbly water volume which is free gas). Again, there is no field data on what void fractions whales can generate. If the insonification frequency is sufficiently low compared to the majority of bubble resonances, the sound speed in the cloud c_c is relatively independent of the bubble size distribution and depends on the void fraction V (the proportion of free gas in the bubbly water) through **(9)**:

$$c_c = c_w\left(1 - \frac{V}{2}\frac{\rho_w c_w^2}{\kappa p_0}\right) \quad (5)$$

where p_0 is the total static pressure (atmospheric and hydrostatic) at the location of the bubble, and κ is the polytropic index of the gas (which, if air bubbles pulsate adiabatically, takes a value of 1.4). Under such conditions a sound speed of 750ms^{-1} requires a void fraction at 5m depth of less than 0.01% (compare with the measured sound speeds in the caption to *Figure 6*). For the simulation the sound speed is taken to be 1500ms^{-1} in the bubble-free water to be found outside of the net and inside its bubble-free interior. Within the walls of the net, the sound speed for low frequencies of a few kHz is taken to vary linearly, reaching a minimum of 750ms^{-1} along the circumferential centreline of the cloud (*Figure 4a*).

The beam width of the source to be used in the model is also not available in the literature. An angle of 10° was chosen for *Figures 4 and 5*. If humpback whales are able to form narrow beams, this value is not unreasonable, given that a source of radius a ~ 1m does have a ka of ~ 17 for c = 1500ms^{-1}, and ka~34 for c = 750ms^{-1}, at 4kHz (a frequency the whales can certainly produce **(10,15)**), and therefore has the potential to be highly directional. For ray theory to be valid at the frequencies of interest, the wavelength of the sound should be small compared with the scale lengths over which the sound speed varies (at 4kHz the wavelength is ~ 190mm for c_w= 750ms^{-1}).

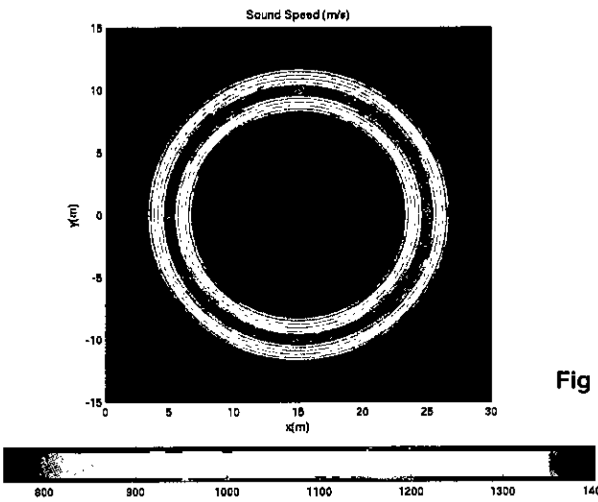

Fig 4a

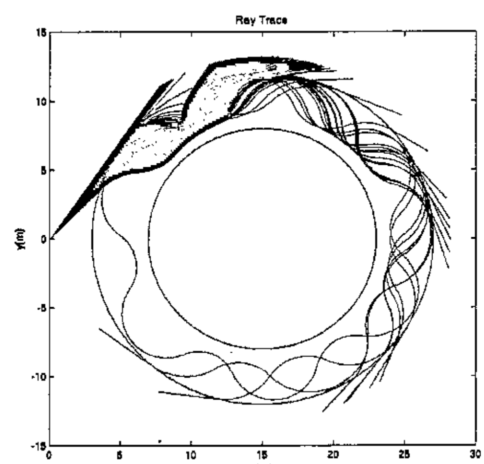

Fig 4b

Figure 4 Simulation of sound trapping in bubble nets, for frequencies appropriate to ray tracing but sufficiently low to generate (a) the sound speed variation in an annular region representing a horizontal slice through the bubble net. (b) The computed paths of 281 rays launched from point (0,0) with an angular extent of 10°. The rays turn about the minimum in the sound speed owing to refraction, resulting in the ducting of sound within the wall of bubbles. The rays gradually leak out, although one ray in this case propagates around the entire circumference.

Results

The bubble net is modelled as an annular region containing the bubble population, whilst the regions in the centre of and outside the annulus are free of bubbles. *Figure 4b* shows a two-dimensional ray diagram representing, in plan view, the interaction of sound with a bubble net, for the sound speed profile shown in *Figure 4a*. This assumes that the insonifying frequency is sufficiently low compared to the resonances of most of the bubbles, such that the sound speed in the net will be lower than that in bubble-free water.

A set of 281 rays covering a beamwidth of 10° is launched from the origin (0,0) and the raypaths are computed by successive numerical integrations of the ray equations. The resulting raypaths are shown in *Fig. 4b*. It will be noted that the rays with launch angles farthest from the y=0 axis travel in straight lines and do not interact with the bubble net. However, those rays which do interact with the bubble net are refracted by the radial sound speed profile. The sound speed is decreasing towards the mid-line of the bubble annulus, and the rays are therefore refracted toward this. Rays which cross the mid-line then propagate through regions of increasing sound speed as they travel towards the inner or outer face of the bubble net, and are thus refracted back inwards. This radial sound speed profile thus forms a waveguide in which sound can be trapped.

The distance which individual rays travel within this waveguide clearly depends upon their initial angle. Many of the rays escape from the bubble net after having been turned only once by the radial sound speed profile. Once they have left the bubble net they will continue to travel in a straight line in the isovelocity ambient water. These rays therefore escape and can never interact with the bubble net again, so the ray tracing algorithm is then terminated. Other rays perform two or three turns about the sound speed minimum before being lost, whilst yet others perform sufficient turns about the minimum to propagate all the way around the circumference of the bubble net. This simulation therefore demonstrates the partial trapping of sound from a single source within the bubble net. The process becomes increasingly effective

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Trapped within a 'wall of sound'

A possible mechanism for the bubble nets of humpback whales

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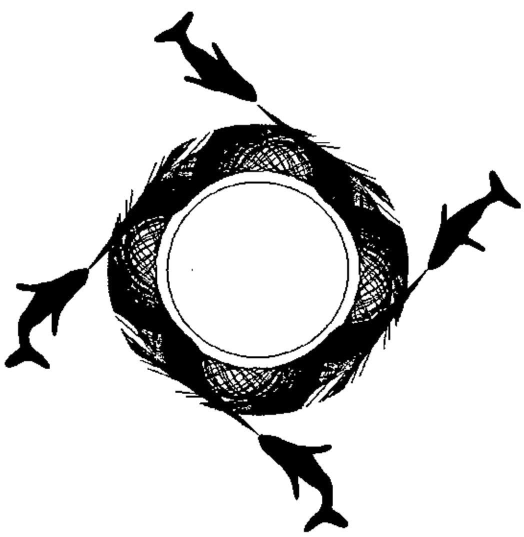

Figure 5 Four whales insonify an annular bubble net having the sound speed profile of Figure 4a, and the launch conditions of Figure 4b.

as more sound sources (whales), distributed around the circumference, become involved (Figure 5).

It is therefore proposed that the whales can create regions of high sound intensity within the walls of the bubble net, whilst the region in the centre, where the prey are concentrated, is relatively free of sound. It is further proposed that this 'wall of sound' is at least partially responsible for containing the prey within the central, quiet region where they are then consumed by the hunting whales.

The ability of the walls of the bubble net to trap sound, with a quiet interior, clearly has potential for herding prey. It would also act as a reverberant cylindrical cavity if insonified from below, examples of which have been demonstrated in the laboratory (*Figure 6*). The whale could generate high amplitude fields in such a reverberant cavity, speculatively to startle the herded prey just prior to feeding. The schooling response of fish to startling (either within the cylinder, or as they approach the walls) will, in the bubble net, be transformed from a survival response into one that aids the predator in feeding.

The actual acoustics of the cloud will of course be complicated by 3D effects and the possibility of collective oscillations **(16,17)**; and even, speculatively, parametric sonar effects **(9)** which might be utilised by whales, for example to reduce beam width or generate harmonics, sum-and difference frequencies *etc.*

The refraction is frequency dependent. If, as discussed earlier, the whales were to utilise frequencies that were sufficiently high, the presence of bubbles in the wall would produce an increase in sound speed, decreasing to the bubble-free value at even higher frequencies (for which there would be no refraction, only scattering and some absorption). For the intermediate situation profiled in *Figure 7a*, where the bubbles in the cloud raise the sound speed to a maximum value of 2250ms^{-1}, a variety of ray behaviour is possible, from reflecting straight off the cloud to traversing it and the interior with barely any refraction. An example is shown in *Figure 7b*.

Such frequencies would not be effective in trapping prey, even if the prey could perceive them. However were sufficiently high frequencies being used to echolocate prey contained within the net (a possibility which is by no means certain **(10)**), by a whale outside it, it is possible that certain signals would not be significantly refracted by the net and so, reflections allowing, might be effective in echolocation. This is despite the fact that lower frequencies may be trapped in the 'wall of sound'.

Conclusions

This article speculates on the previously unconsidered acoustic effects of bubble nets produced by humpback whales. The phenomena described may go beyond the bubble nets themselves, and be used by humpback whales for other purposes (such as by males to guard females during breeding). Man-made bubble clouds might generate similar effects (for example in vessel wakes), and could be exploited in enhancing the acoustic screening of noise by bubble curtains. The generation of 'walls of sound', quiet regions, and reverberant volumes might, speculatively, be

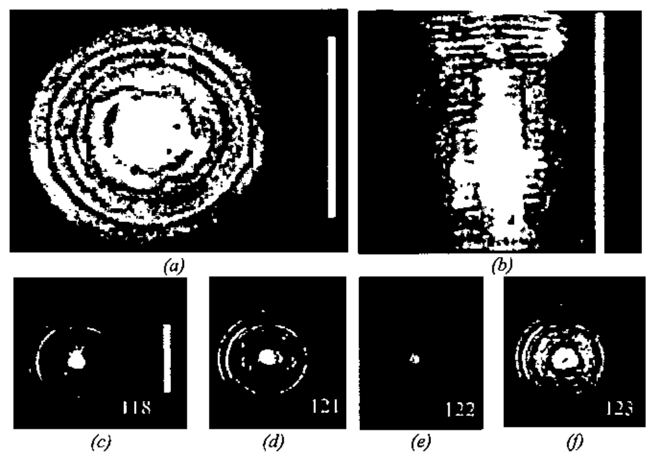

Figure 6 The acoustic pressure antinodes within reverberant water-filled cylinders (insonified from below) are made visible through the chemiluminescence which occurs there. (a) Plan and (b) side views of luminescence (which occurs at pressure antinodes) in a water-filled cell which had a polymethylmethacrylate wall (9.4cm internal diameter, 10cm external diameter; height of aqueous solution 14cm) for insonification at 132.44kHz where the spatial peak acoustic pressure in the liquid was 0.75 bar. The scale bar in frame (a) represents 9.4cm, while the scale bar in frame (b) represents 14cm. Frames (c)-(f) (to which the scale bar of length 5.8cm in frame (c) refers) were taken in a double-walled, water-jacketed cell (5.8cm internal diameter, 8.5cm external diameter, and liquid height 8cm) which was maintained at a constant liquid temperature of 25°C. As the insonifying frequency changed, so too did the spatial peak acoustic pressure, providing the following combinations: (c) 118kHz; 1.36 bar; (d) 121kHz; 1.39 bar; (e) 122kHz; 1.50 bar; (f) 123kHz; 1.80 bar. The effect of tuning into particular acoustic modes is evident. By noting the modal resonance frequencies in these and similar cylinders, the sound speed in this bubbly water was found to be in the range 868 - 1063 ms^{-1}, implying void fractions of 2.9 - 4.2 x 10^{-3} % (it is recognised that the source of bubbles and their dynamics here will differ from those generated in bubble nets). Frames selected from several figures in 'Birkin PR, Leighton TG, Power JF, Simpson MD, Vincotte AML & Joseph PF. *J. Phys. Chem. A*,107, 2003, 306-320'.

used in the protection of fish farms and shellfish beds from predators, and protection of bathing beaches from sharks.

The preliminary tests so far support the speculations. Nevertheless it is recognised that the approach adopted here has limitations, associated for example with the use of ray theory, and the fact that the simple model proposed does not take into account the scattering of sound by the bubbles (such scattering would result in reverberation within the bubble cloud, which would tend to enhance its ability to trap sound). Further testing would require much greater detail on field conditions (*eg* the bubble size distributions and void fractions, and the sound source characteristics) than is currently available. This would apply not just to simulation, but also to any tank testing: if either the experimenter, or whales themselves, provided inappropriate bubble populations or launch conditions, the conditions for the mechanisms discussed above might not be met.

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3 It should be noted that SDR's response, when TGL suggested the possibility of acoustic effects (*eg* the refraction of *figure 3*) in the net, was to point out that, if the void fraction in the cloud were sufficiently high, fish within it might lose buoyancy and 'sink like stones', in a manner similar to one proposal for the mechanism by which vessels are lost in the Bermuda Triangle.

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5 Examples available at
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http://www.sfu.ca/biology/berg/whale/abcwhale.html
http://students.ceid.upatras.gr/~pirli/whales/whales.html

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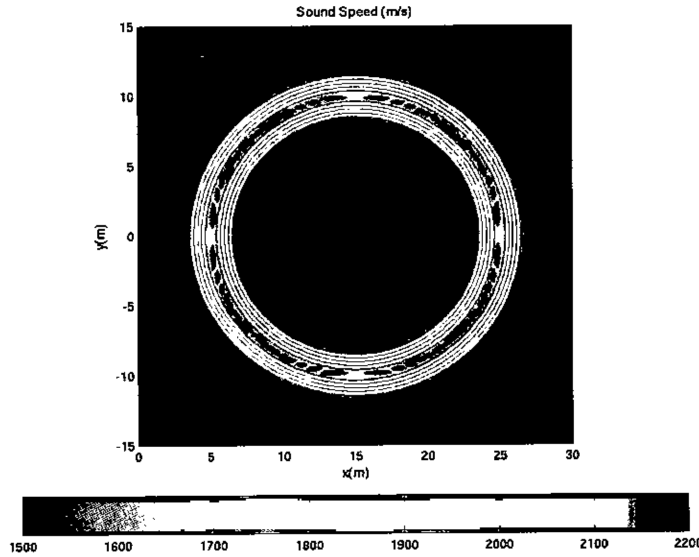

Fig 7a

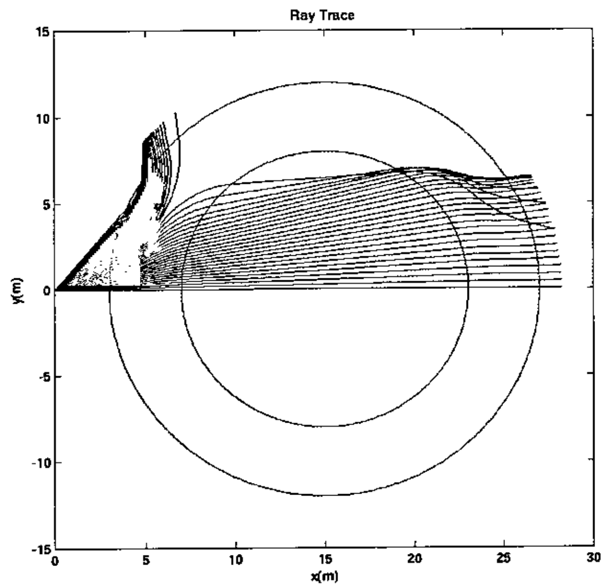

Fig 7b

Figure 7 (a) Sound speed profile possible for acoustic waves of sufficiently high frequency. (b) Example ray paths computed for this sound speed. For this simulation, however, the source has a 45° beamwidth in order to illustrate the variety of ray bending that is possible (a 10° beam, as used in Figures 4 and 5, tends to cause all rays to follow a similar path, either traversing the net or refracting out of it, depending on the angle with which it intercepts the outer wall of the net)

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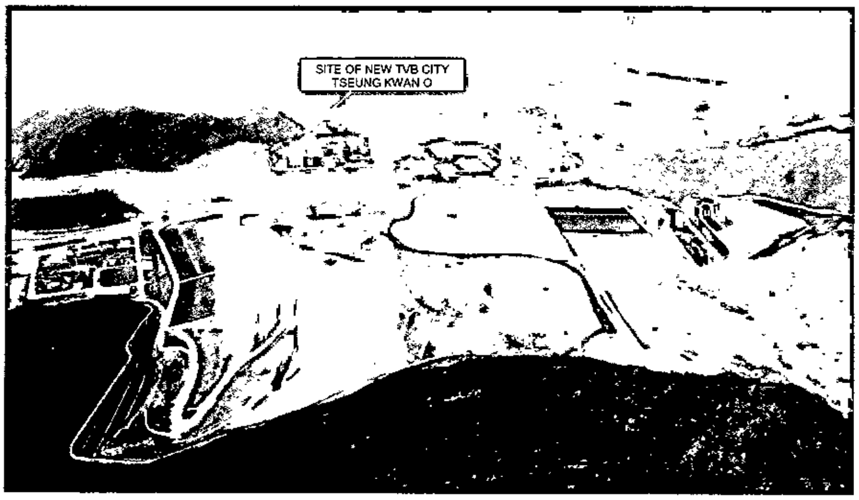


1 The facility is built on a 9.2 hectare site

Acoustic design of Hong Kong's new TVB City

Kyri Kyriakides FIOA and Kelvin Leung Kwok Fu AMIOA

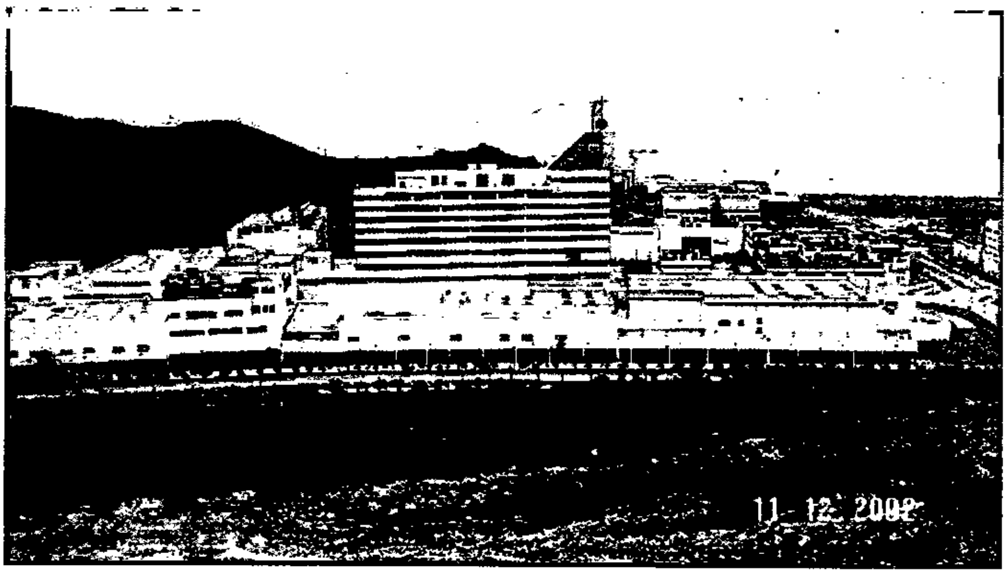
Hong Kong's dominant broadcaster is Television Broadcasts Limited (TVB), which operates one of the largest TV production facilities in Asia, together with two terrestrial TV channels, satellite channels and a news operation. TVB is also the largest Chinese programme producer in the world. It employs about 5,000 people, including contract artists and staff in overseas subsidiary companies. At peak hours there would be about 2,000-2,500 persons in TVB City.

The organisation has developed a completely new facility on a 9.2-hectare site within an industrial estate at Tseung Kwan O, Kowloon, HKSAR. This new development, with a gross building area of about 117,000 square metres, is replacing its facilities in Clearwater Bay and will enable TVB to achieve its acoustic and other technical aspirations as well as providing for future expansion needs. The facilities include an outside shooting area incorporating the 'Old China City' and 'early nineteenth century Shanghai Street', both of which will be used for the production of traditional Chinese drama. There are also many studios and technical areas. *Photograph 1* shows the site before work commenced and *Photograph 2* the development nearing completion. *Photograph 3* forms part of the outside shooting area.

Sandy Brown Associates (SBA) was appointed as the acoustic consultant following a selection process that considered, as well as other factors, the practical experience and technical capabilities of a number of international and local acoustic consultancy firms. SBA was appointed early, which meant that the firm was able to play a part in the design process from the outset, including planning of the site. This was very important because the site was affected by a number of noise sources including a jet engine test facility right next door! It is not uncommon for the acoustic consultant to be appointed last, frequently after the rest of the design team has started its work, which makes early input impossible. Fortunately TVB was well aware of the possible serious consequences of not taking acoustic advice from the outset.

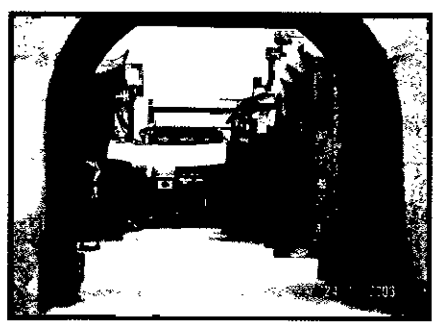
The brief

The brief was developed over a series of meetings and discussions with the different users of the various facilities. SBA established exactly how each space would



2 (left)The development nears completion

3 (below)The outside shooting area will be used to produce traditional Chinese drama



be used and then proposed standards for the acoustics, sound insulation and background noise levels that were consistent with the intended uses. The studios and control rooms were of particular concern. The users were striving for excellence; the client on the other hand was keen to provide standards that were appropriate and cost effective. The most stringent standards were adopted for critical areas such as dubbing studios, where the design was based on floated 'box within a box' construction.

SBA also had to take into account a number of crucial constraints. The first was TVB's lease on the Clearwater Bay facilities, which had an absolute deadline (end of 2003) that was non-negotiable. Secondly, development of the Tsueng Kwan O site was to be phased to allow for progressive equipment and system set-up, and thus enable operations to be moved to the new location with minimum disruption and a seamless switch over for 'on-air' and production services. Finally, any construction noise was to be minimised, to allow full TVB production output once occupation of the new facilities started.

The site

The site is next to busy roads carrying mostly heavy vehicles making traffic noise an important consideration. It is also affected by noise from the exhaust and intake stacks serving an adjacent jet engine test facility. A flight path to the new Hong Kong airport at Chek Lap Kok takes aircraft directly over the site, but this is at a high level so aircraft noise is less of an issue.

Site surveys established the following:

- ❑ Vibration from the engine test facility was unlikely to result in structure-borne noise in any of the studios or control rooms;
- ❑ Environmental noise could be controlled with suitable sound insulating constructions for the various building envelopes;
- ❑ The outside shooting area would need to be shielded to reduce the effect of noise from the nearby roads and from the jet engine test facility; and
- ❑ Any low frequency vibration resulting from heavy road vehicles was unlikely to have an adverse affect on cameras being used in the television studios.

SBA's early involvement with the project meant that the consultant was able to influence site planning and secure substantial noise shielding of the Old City and Shanghai Street by the new TVB buildings surrounding these sensitive outdoor shooting areas. A noise barrier to reduce the impact of road traffic noise was specified at the site's boundary.

Accommodation

Main block

This building consists of a four-level technical block with a master control room (shown in *Photograph 4*), 17 dubbing suites (studios and controls rooms), two sound

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4 The master control room

Acoustic design of Hong Kong's new TVB City

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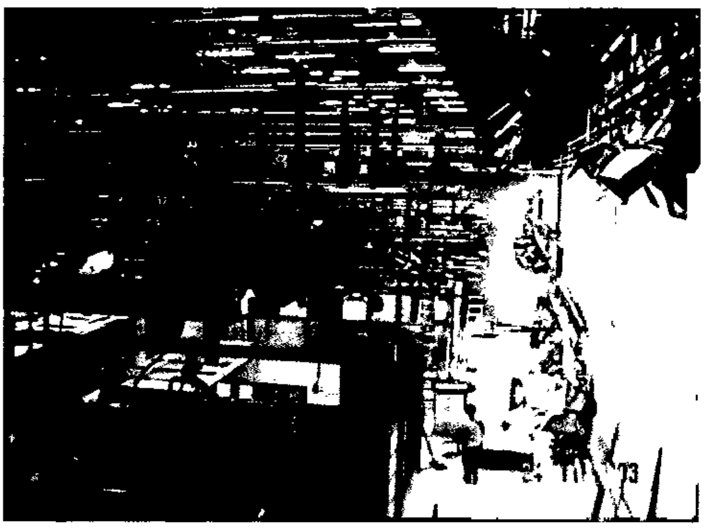
effects rooms, editing suites plus a seven-storey tower each with a 2,700m^2 floor plate above the technical block. The approximate gross floor area (GFA) of the whole technical/administrative tower is 36,000m^2.

Drama and variety studios

These studios, with their control rooms and support areas, are located along the eastern portion of the site. Generally, they are two storeys high with long clear spans. The approximate GFA is 25,000m^2.

The drama studio block consists of five studios and control rooms. The sound insulation between studios is sufficient to allow their simultaneous use. Therefore, programme production in one studio involving high noise levels will not affect production work in adjacent studios. The clear headroom of the drama studios is 9m from the fixed lighting grids to the finished floor level. *Photograph 5* shows one of the drama studios being prepared.

The variety studio block consists of two variety studios that are mainly for live shows, two entertainment studios constructed in the same way as the drama studios, and six other small studios including two dance studios. Variety studios 1 and 2 have clear floor areas of 1000m^2 and 530m^2 and seating capacities of 630 and 220 respectively. The clear headroom of these studios is 13.5m. Studio 1 is the largest and most advanced commercial live studio in

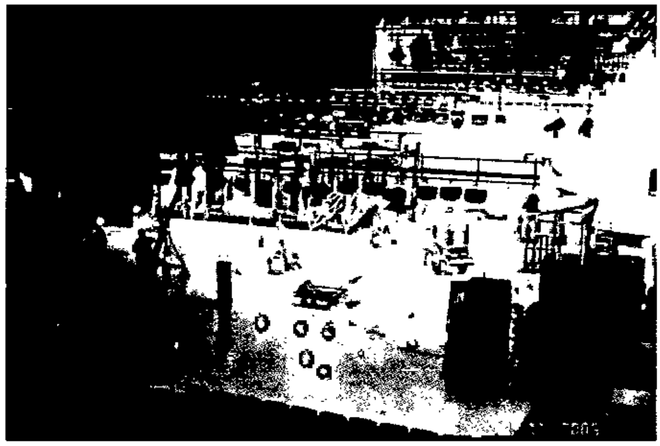


5 Preparing one of the drama studios

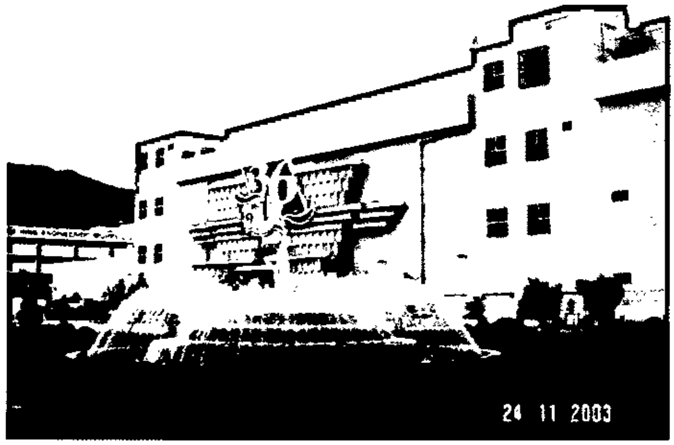
Asia and is provided with state-of-the-art technology and equipment. *Photograph 6* shows the studio being prepared and *Photograph 7* shows the area immediately outside, which can be used as part of the studio by opening the large acoustic doors.

News and car park block

There are five news studios, a number of editing suites and a news library. The news studios and support areas are located on the ground floor. On the first floor are offices, production studios and technical areas for TVB's international programme production and distribution. The second to fifth floors accommodate 380 parking spaces. The news area is approximately 5,800m^2.



6 Studio 1 is Asia's largest and most advanced commercial live studio



7 This outside area can be used as part of Studio 1 (above) by opening the large acoustic doors

Workshop block

This is a support block - the ground, first and second floors accommodate workshops for the production of sets and props, and storage space, while the third floor houses offices for production coordination and a training centre. It has an approximate GFA of 15,000m^2.

Virtual visits

Notwithstanding its UK (London) location - and the lack of an office in Hong Kong - SBA played a full part in the project's design and construction phases. The consultants attended design team meetings, held regular discussions with other design team members and carried out site inspections when necessary. Telephone calls, teleconferences and video conferencing all played a part. Some actual visits were of course essential. However, using the technology available, and the technical knowhow and facilities of TVB, they were also able to carry out virtual visits primarily to inspect critical constructions and to answer queries. This involved a cameraman on site being directed from London. The (moving) pictures were transmitted back to SBA simultaneously making it possible for them to comment, and after the 'visit' a written report was submitted. Snapshots taken during the virtual visits - which incidentally were of excellent quality - were used to illustrate the reports. Because the cost of a virtual visit was a fraction of that for a real visit, it was possible to 'visit' the site much more frequently.

Mock-ups

To provide comfort that the acoustic design would deliver the agreed standards and to ensure that the contractor understood what was required, it was decided early on in the design process that some critical (floating) spaces and heavy acoustic props doors would be mocked-up on site. A dubbing suite and a drama studio were used for this purpose. *Photograph 8* shows the preparations to float the floor on elastomeric bearings.

The mock-ups provided the contractor with an invaluable opportunity to gain a first-hand understanding of the requirements of the specification. Once the mock-ups were constructed, snagged and tested they were used by all those involved as the benchmark for the implementation of the remainder of the acoustically critical rooms.

Construction details

Construction of the most sensitive studios was based on a 'box within a box' design with elastomeric bearings providing the resilient supports. The acoustic partitions were generally drywalls comprising inner and outer leaves, each made up of two or three sheets of plasterboard with an overall width up to 300mm. The higher performance partitions employed independent studs. Where rooms were a 'box within a box', the inner skin of plasterboard was supported on a floating slab and returned over to form a 'lid' to the room. Commissioning measurements showed that the airborne sound insulation requirements were met, with apparent weighted sound reduction indices (R'_w) reaching values of 70dB.

High performance sound insulating windows were required between control rooms and studios, between controls, and in audio booths. Their sound insulation was specified and guidance on suitable glazing constructions capable of delivering the required performance was provided. The highest performance was achieved with double windows in independent skin walls, with no rigid connection between the two leaves of the wall, using laminated glass 10mm and 12mm thick separated by an airspace of 400mm.

The drama studios were fitted with very large and heavy acoustic scenery doors to maintain the required sound insulation once they were closed. Personnel access to acoustically critical spaces was via lobbied doors. In a few cases space constraints made the use of lobbies difficult, but the piggyback door arrangement shown in *Photograph 9*, without a rigid connection between the two leaves, provided an acceptable compromise.

Floor, wall and ceiling finishes in the studios were designed to provide the required listening conditions and prevent undesirable acoustic effects. Carpet was specified for control rooms, dubbing studios, edit rooms and a number of other spaces. The wall finishes specified were 50, 100 or 150 mm thick glass fibre of various densities. Some wall areas were covered with 0.7mm steel sheeting, and where decorative fabrics were required these were acoustically transparent open weave materials with a low flow resistance. Acoustic ceilings of suspended 50mm thick foil faced tissue backed mineral fibre, were specified for the technical areas.

9 Space constraints necessitated a compromise 'piggyback' door arrangement

Conclusion

The commissioning measurements show that the specified criteria have been achieved and more importantly, with the move to the new facilities now complete, the indications are that user expectations have been realised.

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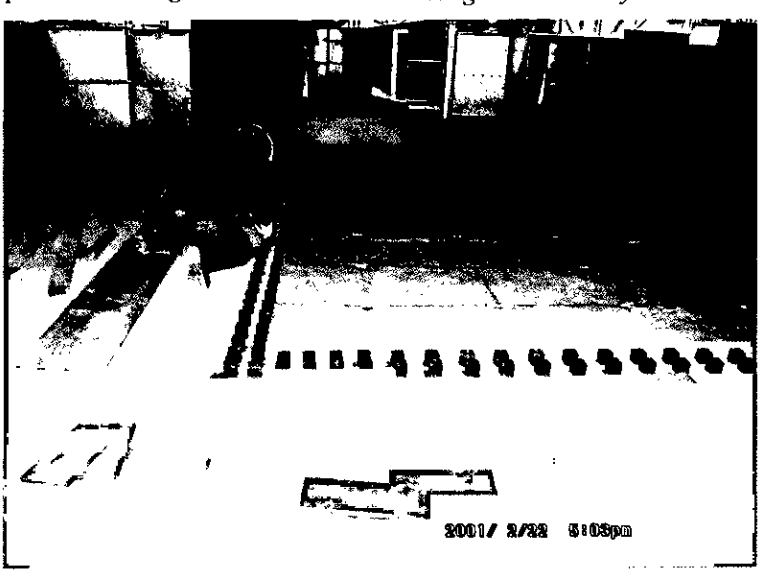
The authors would like to thank TVB for kindly permitting publication of this article and would also like to acknowledge the invaluable contribution made by Ian Knowles, who is no longer with Sandy Brown Associates.



8 An on-site mock-up, showing preparations to float the floor on elastomeric bearings

The implications of ISO 717 spectrum adaptation terms for residential dwellings

Sean Smith, Robin Mackenzie, Richard Mackenzie and Tim Waters-Fuller

In 2001 new proposals **(1)** were issued for public consultation regarding changes to the English and Welsh Building Regulations Part E 'Resistance to the passage of sound' and the accompanying Approved Document E. These subsequently came into effect in July 2003. Several major changes were proposed in these documents such as new levels of sound insulation for internal walls and floors, incorporation of hotels and hostels and pre-completion testing (PCT). One of the most important changes was the proposal to introduce ISO 717 **(2)** spectrum adaptation terms; C_{tr} for airborne sound insulation of separating walls and floors and C_i for impact sound transmission for separating floors. Changing to the new measurement criteria and sound insulation levels meant that the current sound insulation performance would be improved by 3dB for walls and 4dB for floors.

To evaluate the impact of introducing such *proposals* to the Scottish Building Regulations Part H **(3)** 'Resistance to the transmission of sound' a study was undertaken to investigate their implications in relation to the current standards and methods of rating sound insulation used in Scotland. Both the Part H standards and ADE guidance documents contain similar documented constructions which are able to achieve compliance with the performance criteria.

Comparing standards

The current sound insulation standards in Scotland are set within the Technical Standards (Scotland) Part H. The levels of sound insulation to be achieved in new build and converted dwellings are the same: the airborne sound insulation criterion is $D_{nT,w}$ and the impact criterion is $L'_{nT,w}$.

The comparison proposals offer lower target levels of sound insulation for conversions compared with new buildings: the airborne sound insulation criterion would be $D_{nTw} + C_{tr}$ and the impact criteria $L'_{nT,w} + C_i$.

Table 1 shows the performance target levels for Scotland (Part H) and as proposed in England and Wales (Part E) for newly built dwellings.

As it is not possible to compare set performance insulation values with different base rating criteria, the study focused on the implications of the different criteria in real buildings using on-site measurements. To compare current standards against the proposals the levels of fails and passes were recorded for each criterion using the same set of on-site measured test data. This meant, for example, that if a series of walls were to record failures of 5% under the existing standards, and 10% under the proposals, the failure rate increased so standards were being raised.

Table 1: Current Part H criteria compared with the proposals

element	Scotland Part H	proposals
Airborne sound insulation		
separating walls	target mean minimum 53dB* $D_{nT,w}$	minimum 45dB** $D_{nT,w}+C_{tr}$
separating floors	target mean minimum 52dB* $D_{nT,w}$	minimum 45dB** $D_{nTw}+C_{tr}$
Impact sound transmission		
separating floors	target mean maximum 61dB* $L_{nT,w}$	maximum 62dB** $L_{nT,w}+C_i$

* For 2 or more measurements an individual value may be 4dB worse than the mean, but the mean target must regardless be achieved.
** Value may be 2dB worse than the minimum/maximum on any measurement (at Building Authority's discretion)

In addition to the initial study of the BPC database of existing test data, a series of tests was undertaken on a range of sites across the UK.

ISO 717 spectrum adaptation term (C_{TR})

The use of the C_{tr} spectrum adaptation term now used in England and Wales for airborne sound insulation of separating walls and floors introduces a significant emphasis on low frequencies, particularly between 100 and 315 Hz. This term **(3)** is normally used for external façades for buildings adjacent to low frequency noise sources such as diesel locomotives or propeller driven aircraft. It can also be used for buildings adjacent to discotheques or roads carrying heavy goods vehicles. It is not representative of the standard living noises which occur between dwellings, and the strong emphasis on low frequencies places great importance on the accuracy of measurement at these frequencies. Variations in measurement of 2 or 3 dB at these lower frequencies can result in a significant negative C_{tr} correction value, typically between -5 and -12dB.

Measurement accuracy at these frequencies is restricted by the modal response of the room and the separating wall or floor under test. A low modal overlap between the test structure and adjacent rooms results in significant variations when carrying out repeat measurements on the same structure. The room size and the flexibility of the wall or floor/ceiling linings can also influence the final result significantly when using C_{tr}. The mass of the structure, cavities present, and the quality of isolation or decoupling all make important contributions to the result at these low frequencies. Whilst they may not often affect the overall measured curve at important frequencies for normal living noises such as speech, the impact within the low frequency zone of 100 to 315 Hz and the outcome of the final weighted single value should not be underestimated. A change in C_{tr} from -5dB to -12dB as a result of slight variations in the low frequency measurement could result in a single weighted value dropping by -7dB without any influence of the mid and high frequencies.

The possible consequences of using the C_{tr} term from the measurement perspective include:

- restricted room volumes capable of being tested
- inaccuracy in measurement compared with using only $D_{nT,w}$
- significant variation in measuring the same structures using different testers
- structures which would normally fail because of noise transmission at speech frequencies would now be able to pass
- different industry types of wall or floor structures, (eg timber or concrete) being influenced markedly (and perhaps unfairly) in their ability to pass or fail the performance standards
- significant emphasis on the accuracy of L_2 and T_2 measurements at low frequencies
- pass or fail influence of T_{20} or T_{30} reverberation time measurements
- possible alteration of the current ISO 140 minimum distances between source loudspeaker or measurement microphone and the test room envelope
- additional restraints on the level of background noise permissible during tests on site, and on the implications of development locations under test.

Field test data analysis

New buildings

The field test data used for the comparison study was collated for the period between 1992 and 2001. The starting date of 1992 was chosen because the previous changes to the Building Regulations in Scotland were in 1990. The post-construction testing results at any one site may involve only one test, or as many as 40 tests. A maximum of three tests were therefore chosen from any one site in random order as far as possible. A total of 1104 field tests involving new-build dwellings were included in the study. The majority of test data in the study came from test reports involving four tests or fewer.

The C_{tr} term was expected to have a different emphasis as a result of the mass and material used within a wall or floor, so the test structures were divided into the categories shown in *Figure 1*. Further subdivisions per structure type were also undertaken

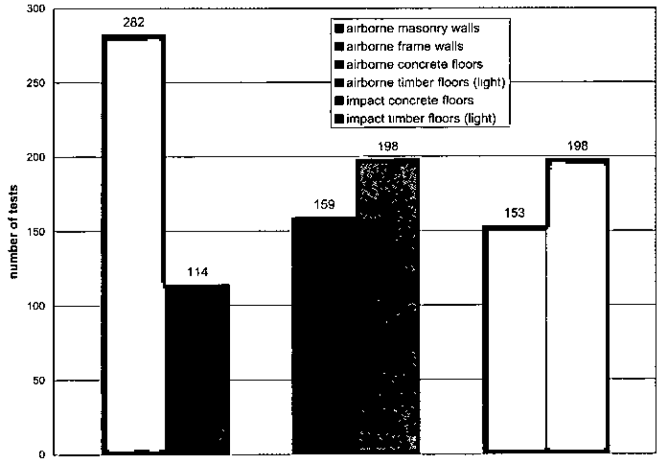


Figure 1

but are not presented here. The single weighted values ($D_{nT,w}$) of each of the test results were recalculated from the original third octave data (100Hz – 3.15kHz) as a check on the values recorded at that time, and the new single weighted value ($D_{nT,w} + C_{tr}$) was then calculated with the additional spectrum adaptation term C_{tr}.

The following analysis lists the average fail rate recorded over a nine-year period. As a result of on-site testing it was found that many of the regulation guidance structures in Part H (Scotland) similar to Part E (England and Wales) would struggle to cope with the required performance targets. The industry has over the period 1992 to 2001 tended not to use some of the low-performing Part H/ADE guidance structures, and builds more and more often to a higher specification. The resultant fail rate as a consequence of building more robust constructions has fallen from (typically) 40% pre-1992 to less than 5% in 2001, and may fall further.

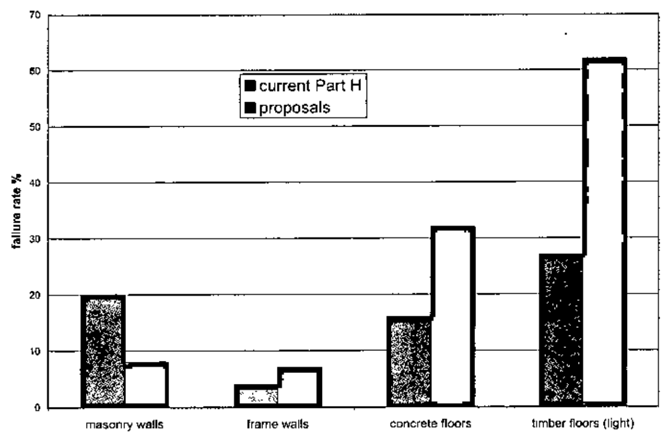


Figure 2

Comparison of standards

Figure 2 shows a comparison between the required target performance values for new build walls and floors at any one site under the current Scottish standards and the proposals. It can be seen that different structures are affected in different ways.

Under the new minimum proposals for masonry walls the fail rate drops by 12%. On review of the measured curves it was found that the mass of the walls was sufficient to cope with the negative influence of the C_{tr} spectrum adaptation term and achieved satisfactory low frequency performance; however, walls which would

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The implications of ISO 717 spectrum adaptation terms for residential dwellings

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fail because of poor insulation of speech frequencies would now be able to pass. Cavity walls with their faces rendered before the application of plasterboard performed well for both criteria, but a wall with plasterboard applied directly on dabs, with a current fail rate of 50%, would now often pass.

Single frame walls, which are lighter and are structurally coupled, did not have sufficient isolation and more often failed. Timber twin frame walls still maintained a high performance under both current and proposed criteria. The increase from 4% to 7% fail resulted only from the inclusion of single frame walls.

Floors in general do not have the benefits of isolation cavities and must be structurally connected to the flanking walls: as a result flanking paths become increasingly important as does the depth of ceiling void. For concrete floors the use of C_{tr} necessitates a greater depth, leading to reduced floor-to-ceiling heights. This has a negative impact as regards sustainability issues, and planning applications may be rejected because of the consequent need for increased storey heights, the only practical way to maintain minimum ceiling levels. Standard 150mm pre-cast floor slabs (300kgm^{-2}) may struggle to achieve the required minimum airborne standard if the depth of ceiling void is too low. Thicker 200mm floor slabs (also 300kgm^{-2}) have better stiffness and resonance properties for sound insulation at low frequencies, as well as providing better impedance at the junction with adjacent walls reducing the flanking transmission contribution. The fail rate for concrete floors would effectively double from 16% to 33% under the proposals.

Standard timber floors (light floors, *ie* those using quilt) with directly coupled ceilings to the underside of joists have high levels of sound transmission at low frequencies owing to the mass-spring-mass frequencies and structural coupling transmission. The change to more robust timber floor designs in Scotland has been more recent (2001 onwards), and many of the recorded old-standard style timber floors within the study test data would struggle to cope with the new criterion and would no longer be built. These floors would move from a 27% to a 63% fail rate with particularly poor results from platform floor finishes. The more robust timber floor designs which now use resilient ceiling bars and batten floor finishes would cope well with the new criterion.

If the discretionary airborne value of 43dB were used instead of the current mean standards almost all structures would have a lower performance target to meet, resulting in higher pass rates and poorer sound insulation for residents. The only structure under the discretionary proposals that would have to achieve a higher performance target would be timber floors (light).

Whilst the mean target represents the required performance level, the minimum individual value permissible under a group of tests is 4dB lower. If the 45dB minimum value were compared with the individual minimum, the proposals would affect different structures by raising standards, or at least, by not lowering them.

However, the comparison between the current individual value and the proposals is effectively not a correct comparison of target values, so the improvement

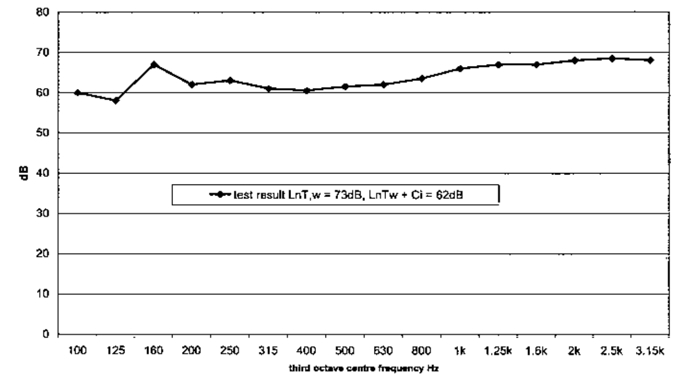

Figure 3

sought should be one above the current mean minimum standards. Only lightweight timber floors would truly see a 3dB increase. If the proposals were adopted in Scotland, masonry walls would see a -2dB reduction in standards, frame walls and concrete floors an increase of 1dB, and timber floors (light) an increase of 3dB.

Influence of reverberation time measurement

At present, reverberation time (RT) measurements may be recorded as T_{20} or T_{30} and converted into an equivalent T_{60} value. As the slope or rate of decay can be slightly different between T_{20} and T_{30} such variations may affect the overall single weighted value. On-site testing measures the RT of real rooms (whereas laboratory measurements are in larger rooms) and it may be difficult to determine accurately the RT of a dwelling room from the limited measurements in ISO 140. The inaccuracies at lower frequencies as a result of room size and shape, the resulting variation between T_{20} and T_{30}, and the application of C_{tr} after the RT correction can amplify the differences at frequencies of 100Hz to 315Hz. It has been found that as a result, whilst the $D_{nT,w}$ value may remain constant regardless of whether T_{20} or T_{30} is used, the minor differences at low frequencies with the subsequent application of C_{tr} can sometimes lead to a 2dB variation in the reported $D_{nT,w} + C_{tr}$ single weighted value (where L_1 and L_2 are the same, but either T_{20} or T_{30} is used).

Different operatives

Owing to measurement inaccuracies at low frequencies, and the C_{tr} emphasis, different operatives can achieve different results. For example, using the same equipment, and testing exactly the same separating wall on a particular site, it was found that two different operatives reported $D_{nT,w}$ values 1dB apart, but $D_{nT,w} + C_{tr}$ values 3dB apart, using the same reverberation time (from T_{30}).

Different operatives and different equipment

Extending the study further, several different sound sources are commercially available, and either fixed or rotating microphone positions can be used. Given the inaccuracies at low frequencies, and analysing the combined effects of different operatives and different equipment, it was found that the maximum change in

$D_{nT,w}$ was 2dB but the maximum change in $D_{nT,w} + C_{tr}$ was 4dB for a cavity wall and 5dB for a floor.

ISO 717-2 impact term C_I

To investigate the influence of the impact term C_I **(4)** the field test database was used to evaluate the effect on passes and fails under the current criteria and the proposals. It was found that in general there was no improvement. In some cases, where the low frequency performance was quite good and high frequency performance was poor, the mid-frequency and high frequency performances were almost ignored in the final weighted value. *Figure 3* shows an example where a concrete floor had failed under the current impact standards by 12dB, because of a poor resilient layer. Under the new proposals this floor would pass. From some occupier surveys of response to sound insulation, impact values in excess of 62dB $L'_{nT,w}$ are described as 'intolerable'. The floor result shown in *Figure 3* would be able to pass under the new proposals, despite recording a value of 73dB L'_{nTw}.

Conclusions

The study found that the use of some of ISO 717 spectrum adaptation terms were not suitable as rating criteria for sound insulation between adjoining dwellings. The adoption of C_{tr} for airborne sound insulation between adjoining dwellings raises a number of inaccuracies which may have legal implications for the regulatory body, housebuilder, material manufacturer, developer and resident.

Since this study was undertaken in 2001 the ADE guidance document **(5)** removed the C_I spectrum adaptation term and also dispensed with the lower airborne discretionary value given to building control authorities. However, the minimum airborne value has been set at 45dB, and whilst this raises some standards for some structures it lowers the performance targets for other structures.

Acknowledgements

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Road traffic noise, A38 and A50

Mrs Janet Dean (Burton): I welcome the opportunity for a debate on traffic noise on the A50 and A38 in my constituency. I was very pleased when, in July 1998, the government announced its quieter roads programme. That was a good step forward, because for too long, roads had been built with materials such as concrete, which, although hard-wearing, was noisy both for local people and for road users.
Naturally, we can all argue for earlier dates, but I understand the need for the assessments that have taken place over recent years, and I know that we must make the best use of resources, by fitting the programme in with maintenance programmes due to take place. However, the A50 and the A38 have both been unfortunate with the assessment process and the timing of the programme. I shall discuss the two roads separately.
The A38, which passes through - indeed, in places, over - Burton upon Trent is, as the Minister will know, a major cross-country route from the west to east midlands. I first received complaints from constituents in Burton upon Trent and Branston about the noise from the road in late 1998.
The northbound carriageway had been surface-dressed in August 1998, which appears to have exacerbated the noise problem. According to a response that I received from Lord Whitty when he was Under-Secretary of State for Environment, Transport and the Regions, the work had been ordered from the contractor in spring 1998, prior to the publication in July of the government's new noise policy, set out in 'A New Deal for Trunk Roads in England'. That was the first instance of unfortunate timing.
In 1999, the new surface started to fail due to defective materials. Repairs were carried out at the contractor's expense, using the same materials. I raised my concerns with Ministers and the Highways Agency.
I said that although the government had announced its intention to introduce quieter roads, a noisier surface had been laid on a major trunk road. The difference was even more significant because in 1983, 1984 and 1987, porous asphalt had been used on a section of the A38 as a trial to evaluate the material's drainage performance. One side effect of the porous asphalt was that noise levels were reduced.
Although the northbound test surface was removed in 1996, there was incremental increase in noise between then and 1998, when my constituents complained to me.
Following an assessment of the scheme and the programme for road surfacing, I was advised by the Highways Agency in 2001 that the A38 Burton bypass was included in the programme for the 2003-04 financial year. I have received a further letter from the Highways Agency which says that work on the A38 between Branston junction and Clay Mills is scheduled to take place in the financial year 2004-05. I seek a reassurance that this work will be carried

FROM HANSARD

Adjournment Debate
19 November 2003

out in the next financial year, and not put back again.
I also ask for clarification on behalf of a Branston constituent, who tells me that he believes the noise from which residents in the area of the village's main street suffer comes from the road south of the Branston junction. Will the Minister tell me whether resurfacing of that section will also be carried out in the near future?
The A50 is another major east-west route, which runs to the north of Uttoxeter in my constituency. I have received complaints about the noise from the road from residents of both Uttoxeter and the rural area of Leigh, to the west of the town. Again, I have been in contact with Ministers and the Highways Agency about my constituents' complaints for some time. The A50 has been improved in stages over the years, resulting in a great increase in traffic along its whole length. The parts of the A50 that most affect my constituents are the concrete section between Blythe Bridge and the New road - A522 - junction in Uttoxeter, and the length between that junction and the Ashbourne road - B503 - junction, which is surfaced with hot-rolled asphalt.
I am concerned that in the current programme for resurfacing concrete roads, the Blythe Bridge to Uttoxeter section will not be resurfaced until between 2007-08 and 2010-11. I have also been advised that the length between New road and Ashbourne road will be resurfaced in sections between 2004 and 2008. The Doveridge bypass, which is the section east of Uttoxeter, was opened after June 1988, so it is timetabled to have a quieter road surface applied between 2004-05 and 2006-07.

'The A38 and A50 have both been unfortunate with assessment and timing'

Although I am pleased that the problems of residents in Doveridge, west Derbyshire are recognised, I do not believe that it is right the Blythe Bridge to Uttoxeter section should have to wait longer than the Doveridge bypass, simply because of when the roads were built.
The opening of Doveridge bypass in February 1998, along with other major improvements along the A50, resulted in traffic increasing by 51.3% between 1997 and 1998 along the whole route. The increase along the Blythe Bridge to Uttoxeter section was even greater, at 57%. The route total has risen from 19,075 vehicles for a 24-hour, seven-day-a-week average in 1997, to 43,132 in 2002. The Blythe Bridge to Uttoxeter section has risen from 15,657 to an average of 36,591.
As traffic has more than doubled since upgrading of the A50 was completed in 1998, the noise emanating from both concrete and hot-rolled asphalt sections in Uttoxeter has increased dramatically. The way in which schemes are assessed means that the length west of Uttoxeter may have to wait up to six years longer than the length east of Uttoxeter, yet the traffic and noise increase has been the same. That cannot be just or sensible.
I hope the Minister will reassure me that the timetable for work on the Blythe Bridge to Uttoxeter section will be reviewed to take into account the impact of improvements on the whole route. This is an exceptional case, which I believe should be recognised in the programme of works. I hope the Minister will also reassure me that a quieter surface will be applied to the length between New road and Ashbourne road early in the period 2004 to 2008.
As I said, I know everyone hopes that schemes in their particular area will be put at the start of any programme. In the case of the A38 and the A50, however, the arguments for the early relief of the difficulties that my constituents face are strong.
The Parliamentary Under-Secretary of State for Transport (Mr David Jamieson): I congratulate my hon. Friend the Member for Burton (Mrs Dean) on securing the debate and on recognising the benefits of the government's policy on quieter roads.
I also thank her for her proportionate opening remarks about the government's need to ensure that work in progress is a priority. Her contribution today, and her correspondence with the Highways Agency and my Department, show her to be an effective voice for her constituents in Burton. Long may she continue to be so.
My hon. Friend wanted to be sure that our approach was just and sensible, which I believe it is, but before I go into details of the two roads in question - the A38 and the A50 - it would be helpful to say a little about the background to development of the government's quieter roads programme.
The strategic road network helps to support a healthy economy by providing the backbone for effective distribution of goods and services and easy movement of people, but it is not without disadvantages. People who live close to major roads sometimes experience the effects of increased noise, and expansion of the road network inevitably disturbs the local environment, as my hon. Friend described.
A balance that satisfies our economic and environmental needs must be struck. Indeed, much can be done to minimise any negative impact on the environment. I often say that the Highways Agency is the second largest planter of trees in this country - second only to the Forestry Commission - so we do take environmental matters very seriously.
The government recognises that traffic noise is a concern for many people, and in the White Paper, 'A New Deal for Trunk

Roads in England', published in July 1998, we gave a commitment that: 'In future, whenever a road needs to be resurfaced, we shall ensure that the most appropriate noise reducing surfaces are used for those areas where noise is a particular concern.' I am sure that that will be comfort to my hon. Friend.

In March 1999, we announced sift criteria for identifying the most serious and pressing cases, and a ring-fenced budget of £5 million a year for dealing with the most serious cases in which practical, cost-effective noise mitigation measures could be found. The criteria are as follows. First, trunk roads must have been opened before June 1988, but priority attention is to be given to locations affected by roads that have remained unaltered since October 1969 - the qualifying date for the first introduction of noise mitigation measures. Secondly, current - that is, 1998 - noise levels immediately adjacent to the road must have been at least 80 dB. Thirdly, in the case of roads opened or altered after October 1969, noise levels must be at least 3 dB greater than predicted for the design when the road was being planned. The aim was to address people's disappointment that noise levels mentioned during the planning process were different from those experienced when the road eventually opened.

'The government recognises that traffic noise is a concern for many people'

In November 1999, a list appeared in Hansard under cover of a letter from the chief executive of the Highways Agency, showing the most serious and pressing cases to be studied to ascertain the most practical and cost-effective solutions. That became familiarly known as the 'Hansard list'. By the time of the government's 10-year plan, published in July 2000, the Highways Agency had been set the target of installing quieter surfaces on more than 60% of the trunk road and motorway network, including all concrete stretches, by 2010-11. That will benefit approximately 3 million people living within about one third of a mile from such roads.

The government's trunk road noise reduction policy over the period of the 10-year plan can be summarised as follows: a noise mitigation programme costing £5 million a year to address sites that meet the 'Hansard list' criteria; resurfacing all concrete roads with quieter materials; and resurfacing black-top roads with quieter materials when normal maintenance is required.

About 5% of the trunk road network at some 70 different locations is constructed with a concrete surface. Clearly, given the scale of the problem, work cannot be completed overnight. To ensure that cases are dealt with in order of priority, we have established criteria to be used to phase in work over the 10 years. That will also ensure effective use of resources and minimise disruption to road users.

In October 2001, the government announced the criteria to be used by the Highways Agency to determine the priority for different parts of the network to be resurfaced by 2010-11. I shall set out those criteria. Where possible, the application of quieter surfaces will fit in with normal maintenance needs. Priority will be given to sites where treatment will benefit the greatest number of people. Works will be carried out in such a way as to minimise disruption to the general public and users of the trunk road and motorway network. Priority will be given to roads opened since June 1988 where noise levels have turned out to be significantly higher than was predicted when they were planned.

Following the announcement, the Highways Agency continued study work to identify schemes that satisfied the criteria. The fourth criterion was introduced because the extra noise arising from concrete surfaces remained the most significant factor causing excess nuisance from traffic once we had rectified the under-prediction attributable to underestimating traffic growth in assessments made before 1988. The agency also identified 17 roads with concrete surfaces that had been open since 1988, and undertook a programme of noise surveys to identify those that satisfied the fourth criterion. Following completion of that work, the government announced in April 2003 a timetable for removing all concrete surfaces on the motorway and trunk road network by 2010-11. The report on the surveys of the 17 lengths of concrete road was placed in the Library.

In the first phase, between 2004-05 and 2006-07, more than 11,500 homes throughout the country will benefit from reduced traffic noise, and journeys on those roads will, of course, be quieter for motorists, too. Priority for the first phase of work has been given to schemes where resurfacing will benefit more than 100 properties per kilometre or, if the road was opened after June 1988, where the current noise level is 3 dB greater than predicted. That is equivalent to the noise increase expected from doubling the volume of traffic on the road. Of necessity, the arrangements are somewhat complex, but they are designed to ensure that the resurfacing work is carried out as equitably as possible.

'Quieter surfacing targets will benefit around 3m people'

My hon. Friend raised specific points about the A38 and A50 trunk roads, and I fully understand her concerns about resurfacing the A38. Because of pressure to undertake urgent maintenance elsewhere in the region, since 1998 we have had to carry out minor works to keep the surface of the A38 intact. My hon. Friend referred to that. The section involved is between Branston and Clay Mills, to the west of Burton on Trent, and is known as the Burton bypass.

That section of road does not have a concrete surface. Various forms of an experimental quiet surfacing material, now known generically as porous asphalt, were put on trial there between 1984 and 1994. The experimental sections, which were about 100m long, were spread over a length of about 4km along the southbound carriageway between the junctions at Branston and Clay Mills. The northbound carriageway was mainly constructed with conventional hot-rolled asphalt.

The original reason for the experiment was to test the effectiveness of such material at reducing spray, which was a problem on the road because of the relatively high number of heavy goods vehicles that used it. It was realised that the porous surface, originally designed for airport runways to stop aquaplaning, might be useful for roads, but might also deteriorate rather quickly. Because of wear and tear over the 10 years, most trial surfaces had to be replaced with hot-rolled asphalt, which generates considerably more tyre noise than the new porous asphalt.

The resurfacing undertaken on the Burton bypass in 1998 was necessary to restore its skid-resistance. The most cost-effective treatment selected was surface dressing, as the underlying carriageway construction was sound. It was inevitable that restoring the surface roughness would increase noise to some extent. However, surface dressing is recognised as a treatment with a relatively short life, and in due course, it would be necessary to undertake some major works on the carriageway and replace the whole surface layer.

I am pleased to say that, as part of the normal maintenance programme, this section of the A38 is included in a major resurfacing scheme between Branston and Clay Mills programmed to take place in 2004-05. That is subject to funding availability - and my hon. Friend knows we have been generous in funding our roads. I can confirm that the work will go ahead in the time scale that she described. It will include provision of the quieter road surface she asked about, which is likely to reduce traffic noise by as much as 30%. That will be welcome to her constituents, some of whom live close to the road, particularly in the northern section. I hope that that is a sign of good news on the horizon for my hon. Friend.

The announcement by the Secretary of State in April 2003 listed the concrete section of the A50 between Blythe Bridge and Uttoxeter among those scheduled for resurfacing in the period between 2007-08 and 2010-11, subject to funding availability.

My hon. Friend expressed concern that the Blythe Bridge to Uttoxeter section was treated differently from the Doveridge bypass, which was listed among those to be treated in the preceding three-year period. I assure my hon. Friend that that was not the case. Resurfacing of the Blythe Bridge to Uttoxeter section has been prioritised on a consistent basis with all other concrete sections, according to the criteria outlined earlier.

Doveridge bypass is scheduled for resurfacing before the Blythe Bridge to Uttoxeter section. That is because the Doveridge bypass, which was opened in 1998, meets the criterion of having been opened after June 1988, and having a

continued on page 40

FROM HANSARD

Adjournment Debate

continued from page 39

noise level 3dB greater than predicted. The section from Blythe Bridge to Uttoxeter, which opened in 1985, does not meet that criterion. Furthermore, resurfacing would not benefit more than 100 properties per kilometre.

Mrs Dean: Does my hon. Friend accept that the increase in traffic has been greater, if anything, on the Blythe Bridge to Uttoxeter section? I accept the way in which things were worked out using the criteria. However, I would suggest that the effect on the ground is that the section of road between Blythe Bridge and Uttoxeter has noisier concrete than the Doveridge section. I do not want to push Doveridge back at all, but we should look at the case again. When a road is made up of sections built at different times, as the Uttoxeter to Blythe Bridge section is, the increase in noise may be equivalent to the increase in noise when traffic more than doubles, as it has done on the Doveridge section.

Mr Jamieson: I accept my hon. Friend's point. I undertake to examine the recent surveys to reassure her that the matter has been dealt with consistently. Although we try to be fair, those further back in the process always feel a little hard done by, which I accept because the stress and anxiety caused by noise make them impatient to get the work done.

The Blythe Bridge to Uttoxeter section was considered for noise mitigation measures under criteria announced in March 1999 to identify the most serious and pressing cases meriting further detailed study, as promised in 'A New Deal for Trunk Roads in England'. Because the A50 from Blythe Bridge to Uttoxeter met the sift criteria, a detailed study was completed in April this year. The study revealed that the wide scatter of affected properties makes replacement of the concrete surface the most appropriate treatment to address the noise issues. Given the road's nature, I think my hon. Friend would agree that other mitigation measures would have a marginal effect on the properties; the road needs a different surface.

Mrs Dean: Is it possible to examine pockets of properties along the Blythe Bridge to Uttoxeter section to see whether specific areas would benefit from planting? For example, Leigh's residents are affected by noise from the A50.

Mr Jamieson: I imagine that work has already been done. I undertake to examine the survey to see whether a proportionate amount of money can be spent. Obviously, we do not want to spend money disproportionately, because that might push back the programme for resurfacing the whole road. If there are particular hot spots and we can deal with them economically, however, I will be happy to examine them. I think my hon. Friend accepts that the answer is getting the road resurfaced, and when that happens, many of the other measures will become otiose. It was decided resurfacing would be achieved within the commitment in the 10-year plan for transport, and priority was assigned according to the criteria I have described. It is too early to provide a more specific indication of when resurfacing may take place within the time frame set out by the Secretary of State for Transport in his April statement. However, I assure my hon. Friend that the Highways Agency will keep her informed as its detailed in-year programme develops. Although mitigating noise from trunk roads and motorways is a complex subject, I hope she agrees that the government is doing all it can to ensure we have the fairest system that will benefit the greatest number of people over the next few years.

I congratulate my hon. Friend on raising this matter, because noise from roads intrudes on people's lives. It can cause a great deal of upset and makes people angry. That is especially true when traffic grows, which has clearly happened in Burton; Burton's economy is thriving, which means more vehicles on the road. I will make sure that my hon. Friend gets full and proper answers to the questions she has raised.

Question put and agreed to.

Adjourned accordingly at seventeen minutes to Five o'clock.

Commons written answers

23 October 2003

Aircraft Noise

David Taylor: To ask the Secretary of State for Transport what plans he has to include the measurement of aircraft noise in noise mapping the Department is required to carry out under terms of the EU Noise Directive 2002/49/EC; and what methods it will employ to measure these noise levels.

Mr McNulty: Major airports will be covered by the Directive. A major airport is defined in the Directive as a civil airport, designated by the member state, which has more than 50,000 movements (a movement being a take-off or a landing) per year excluding those purely for training purposes on light aircraft. The noise maps will be produced by computation using the standard methodology as set out in ECAC Document 29.

3 November 2003

Noise Nuisance

Mr Edwards: To ask the Secretary of State for Environment, Food and Rural Affairs if she will bring forward proposals to amend statutory noise nuisance provisions of the Environmental and Protection Act 1990 to include excessive noise from cars driven off road on public open spaces.

Mr Bradshaw: The government sees no need to amend existing provisions under the Environmental Protection Act 1990 which could be used to abate excessive noise from cars driven off road on public open spaces. Police lead on this issue as they have a wide range of relevant powers, and unlike local authority officers, are able to pursue offenders across ground. From 1 January 2003 the police have new powers under sections 59 and 60 of the Police Reform Act 2002 to seize vehicles, which are being driven in a careless and inconsiderate manner, and in a way which causes alarm, distress or annoyance.

19 November 2003

Traffic Noise (PPG 24)

Mr Heald: To ask the Deputy Prime Minister *(1)* if he will reduce the maximum noise thresholds in PPG 24 for aircraft noise to below those for other traffic noise sources; *(2)* if he will set lower maximum traffic noise thresholds for rural areas than for urban areas in PPG 24 when assessing new development areas; *(3)* if he will remove the two to three decibel allowance included in PPG 24 for aircraft noise; and *(4)* if he will amend PPG 24 to bring maximum recommended traffic noise levels for assessing new development areas into line with recommendations of the World Health Organisation.

Keith Hill: The Office of the Deputy Prime Minister is currently undertaking a comprehensive review of Planning Policy Guidance Note 24: 'Planning and Noise'. The review will include a re-assessment of Noise Exposure Categories (NECs) in light of the World Health Organisation's guidelines and other recommendations and research.

With regards to traffic noise thresholds for rural areas as compared with urban areas, the existing guidance already contains provision for local authorities, where appropriate, to vary the recommended levels contained in the NEC tables by up to three dB(A) decibels of average weighted sound.

20 November 2003

Aircraft Pollution

Mr Colman: To ask the Secretary of State for Transport if he will press the International Civil Aviation Organisation to examine the issue of night flights and aircraft noise at their next meeting.

Mr McNulty: Reduction of aircraft noise is a major strand of work within the International Civil Aviation Organisation's (ICAO) environmental programme. ICAO Resolution A33-7, adopted in 2001, emphasises the need for states to adopt a balanced approach to aircraft noise management, on an airport-by-airport basis. Key elements were incorporated into EU Directive 2002/30/EC and are now enshrined in UK law by The Aerodromes (Noise Restrictions) (Rules and Procedures) Regulations 2003(S.I.No. 1742). The agenda for the next meeting of ICAO's Committee on Aviation Environmental Protection (CAEP) in February 2004 will allow for substantial discussion of noise issues.

4 December 2003

Road Noise

Mr Robathan: To ask the Secretary of State for Transport what systems are in place to ensure that road renewal schemes are prioritised for funding according to the number of people who suffer greater than 65 decibels levels of noise.

Mr Jamieson: Local roads are a matter for the relevant local authority. As far as the strategic road network in England is concerned low noise surfaces will generally be used as a matter of course when maintenance is due. And the Secretary of State announced to the House on 1 April 2003 that we expect quieter surfacing to have been installed on over 60% of the trunk road network, including all concrete stretches, within the 10 year plan. Following consultation, we announced that four criteria would be used to prioritise the resurfacing of concrete roads. They are: wherever possible, the application of quieter surfaces will fit in with normal maintenance needs; priority will be given to those sites where treatment would benefit the greatest number of people; the works will be carried out in such a way as to minimise disruption to the general public and other users of the network; and priority will be given to roads opened since June 1988 where actual noise levels have turned out to be significantly higher than predicted at the time of the public inquiry.

8 December 2003

Road Noise

Mr Robathan: To ask the Secretary of State for Transport what targets are in place for noise reduction on the motorway and trunk road network; and whether they are on course to be met.

Mr Jamieson: The target stated in the 10-Year Plan for the reduction of noise from the motorway and trunk road network is that 60% of the network including all concrete roads will be surfaced with quieter surfacing by March 2011. All resurfacing work now uses quieter surfacing, and work is proceeding in line with maintenance need.

Mr Robathan: To ask the Secretary of State for Transport if he will list: *(a)* the schedule of planned noise reduction improvements for the motorway and trunk road network; *(b)* the average level of noise in the area of those improvements; and *(c)* the number of people affected by above acceptable noise levels in those areas.

Mr Jamieson: The Secretary of State announced on 1 April 2003 a programme of measures to reduce the impact of traffic noise. Details were placed in the Library of the House together with details of the criteria used for prioritisation. We do not use the average levels of noise over a wide area as a criterion. However, measures indicated in the 10-Year Plan to surface approximately 60% of the strategic road network with quieter surfaces, including all concrete trunk roads and motorways, by March 2011 are expected to provide significant reductions in traffic noise levels for approximately three million people.

15 December 2003

Aircraft Noise

Mrs Gillan: To ask the Secretary of State for Transport which areas he expects would be affected by aircraft noise following the possible construction of a third runway at Heathrow Airport.

Mr McNulty: The areas that would be affected are set out in Chapter 7 of the consultation document 'The Future Development of Air Transport in the United Kingdom: South East, Second Edition', published in February 2003, pages 56 and 57.

Mrs Gillan: To ask the Secretary of State for Transport what estimate his Department has made of the level of increase in noise that residents living under and around the flight path would experience following the possible construction of a third runway at Heathrow Airport.

Mr McNulty: The level of increase in noise would depend on the distance of individual residents from the proposed runway and its flight paths and the level of other existing noise sources. Illustrative noise contours, and the areas and populations contained within them at 3dBA intervals from 54dBA L_{eq} up to 72dBA L_{eq} are set out in Chapter 7 of the consultation document, 'The Future Development of Air Transport in the United Kingdom: South East, Second Edition', published in February 2003, pages 56 and 57.

Mrs Gillan: To ask the Secretary of State for Transport what action he would take to mitigate the effects of aircraft noise on residents living under or around the flight path if a third runway at Heathrow Airport was constructed.

Mr McNulty: We asked for views on noise mitigation and compensation measures in Chapter 16 of the consultation document, 'The Future Development of Air Transport in the United Kingdom: South East, Second Edition', published in February 2003, pages 144 to 149. Having considered the responses carefully, we will set out our conclusions in the White Paper to be published shortly.

Mrs Gillan: To ask the Secretary of State for Transport whether the expected noise impact of a third runway at Heathrow Airport would breach the limitations on noise set out in the package of measures imposed by the Inspector for the Terminal 5 Inquiry as a condition for construction of a fifth terminal.

Mr McNulty: The planning conditions for construction of Terminal 5, which were imposed by my right hon. Friend the Member for Tyneside, North included a restriction, to apply from 2016, on the area enclosed by the 57dBA L_{eq} 16-hour (0700–2300) noise contour to 145 square kilometres. Information illustrating the likely noise impact of a third runway was set out in Chapter 7 of the consultation document, 'The Future Development of Air Transport in the United Kingdom: South East, Second Edition', published in February 2003, page 56.

Mrs Gillan: To ask the Secretary of State for Transport whether aircraft using the proposed third runway at Heathrow Airport would be permitted to take off and land during the night.

Mr McNulty: Restrictions on night movements at Heathrow will be decided in the light of periodic consultations on that issue.

Dr Tonge: To ask the Secretary of State for Transport what action his Department is taking to reduce the level of noise pollution caused by *(a)* aircraft flying into and out of Heathrow airport *(b)* surface access routes into and out of Heathrow airport; and whether these measures would be affected by a further runway.

Mr McNulty: Noise from aircraft flying into and out of Heathrow airport is regulated by Notices made under section 78 of the Civil Aviation Act 1982. These include night restrictions, departure noise limits, noise preferential routes and approach procedures. Noise from surface access modes is treated essentially as for those sources on non-airport routes or journeys. The noise implications of a further runway at Heathrow were set out in consultation on the 'Future Development of Air Transport in the United Kingdom (South East)'.

Simon Hughes: To ask the Secretary of State for Transport what the total *(a)* area and *(b)* population affected by aircraft noise was within *(i)* 57 L_{eq} Contour, *(ii)* 63 L_{eq} Contour and *(iii)* 69 L_{eq} Contour and above at (A) Gatwick, (B) Stansted and (C) City airports in each of the last five years.

Mr McNulty: The information for Gatwick and Stansted airports is provided in the tables below. London City airport produces maps showing the 57dBA L_{eq} contour and 60dBA L_{eq} contour but the information is not available in the form requested.

15 December 2003

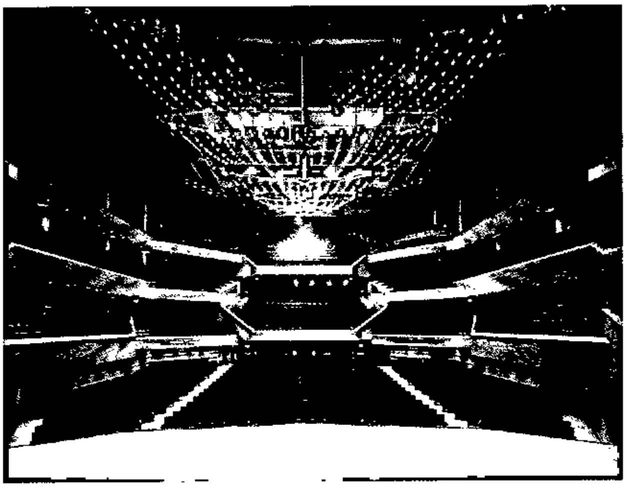
Airports

Mrs Gillan: To ask the Secretary of State for Transport what comparison he has made of the noise impact upon local residents of *(a)* the proposal to construct a third runway at Heathrow Airport and *(b)* other proposals for airport expansion in the South East.

Mr McNulty: The data to inform such comparison are set out in Chapters 7 and following of the consultation document, 'The Future Development of Air Transport in the United Kingdom: South East, Second Edition', published in February 2003. We will announce the government's conclusions in the White Paper to be published shortly.

Gatwick airport	1998	1999	2000	2001	2002
	Area (sq. kms) within:				
57 L_{eq} contour	76.8	71.4	71.9	55.9	45.2
63 L_{eq} contour	28.2	26.4	26.4	19.6	15.8
69 L_{eq} contour	9.7	8.9	9.0	6.0	4.6
	Population (thousand) within:				
57 L_{eq} contour	9.0	7.8	8.7	5.2	3.5
63 L_{eq} contour	1.4	1.4	1.4	0.8	0.5
69 L_{eq} contour	0.3	0.3	0.2	0.1	0.1

Stansted airport	1998	1999	2000	2001	2002
	Area (sq. kms) within:				
57 L_{eq} contour	64.5	52.3	52.4	32.1	31.7
63 L_{eq} contour	22.3	20.5	20.4	11.6	11.3
69 L_{eq} contour	8.7	7.9	7.6	3.6	3.4
	Population (thousand) within:				
57 L_{eq} contour	7.6	4.4	5.7	2.3	2.0
63 L_{eq} contour	1.3	1.4	1.3	0.4	0.3
69 L_{eq} contour	0.3	0.2	0.2	0.1	0.1



Audio Alliance

Helping the BBC celebrate Christmas at the Bridgewater Hall

Corporate sound and design specialists **Audio Alliance** provided the BBC with a complete sound system for the *Songs of Praise* 2003 Christmas special. Hosted at Manchester's Bridgewater Hall on Sunday 2 November and broadcast on Sunday 7 December, the event was presented by Aled Jones before an audience of 2,000. Highlights of the show included Sir Cliff Richard performing his new single *Santa's List* and previous Christmas favourite *Saviour's Day*, Pete Waterman's new prodigy Lauren, who sang *Mary's Boy Child* and *Ave Maria* and violin duet Duel, also discovered by Waterman whilst busking in Manchester. Traditional Christmas carols were sung by the Saint Michael's Singers.
The company used a range of Meyer Sound loudspeakers, including the *M1D* and *M2D* line arrays. The latter system was specified by the BBC following previous impressive results. The sound system was designed by Driver and engineered by Ken Woodward.
The central array of seven M2Ds and two M2D subwoofers were used for the main auditorium, while the smaller M1D was used in three clusters for the choir, enabling them to hear the playback without sound hitting the organ or other hard surfaces.
The single hang of the M2Ds pleased the BBC as it made them unobtrusive to the audience and recording cameras. A *Midas Heritage 2000* mixing desk and *XTA* processors were also supplied.
Meyer Sound self-powered *UPM-1Ps* were used for front fills, chosen for their combination of high quality and compact size. There was an unusual request that required the UM-1 monitors to be covered in a natural wood laminate in order to camouflage them!
Further details tel: 0161 273 5888 or email: sound@audioalliance.net

Bruel & Kjaer

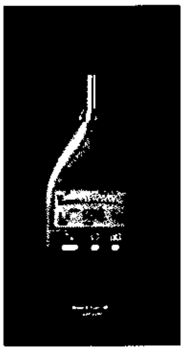
PULSE 8.0 reduces testing times

The new **Bruel & Kjaer** *PULSE 8.0* platform system is a fast, high-resolution, application specific, stackable PULSE™ multi-analyser system which supports up to 220 channels and has been expanded to reduce testing times of a broader range of sound and vibration measurement applications. The system also now offers the ability to have a high-speed, wireless connection between the PC and front-end.

The modular, scalable PULSE 8.0 is based on proven Windows® technology and broadens the scope of advanced acoustic and vibration measurement and analysis applications. The multi-analyser features a new generation of hardware acquisition modules, such as the compact 3560-B Frame portable PULSE front-end that is claimed to be 58% smaller than the original. The five input channel module has room for two batteries and can continuously measure for a minimum of five hours. Other new hardware acquisition modules include 1 output Type 7537; a high density 12-channel input module Type 3038 as well as a general purpose, low power 24-bit acquisition module Type 3039.
The PULSE 8.0 release also includes a wide range of new advanced application modules such as the *PULSE Vehicle Pass-by Test Software Type 7788* which is a scalable system for exterior vehicle noise measurements. The system covers ISO 362, SAEJ 1470 and ISO 13325 (tyre noise) standards. Also new is the *PULSE Indoor Pass-by System Type 7793* which provides simulation of a vehicle pass-by test with the test vehicle placed on rotating drums. The system adapts to sites where space restrictions would otherwise affect standard requirements.
Many major improvements in the usability of the PULSE 8.0 platform have been implemented for a wide range of new advanced applications including faster detection of TEDS (Transducer Electronic Data Sheet) transducers; a massive increase in data recorder throughput-to-disk speeds; a resource-optimised level meter with an improved interface for handling many channels; and simultaneous, multi-channel acoustic calibration.

New sound level meter for spot check noise measurements

Bruel & Kjaer has also launched a new, easy-to-use, point and shoot sound level meter, designed specifically for spot check measurements and surveys of environmental or workplace noise.
The lightweight *Type 2240 Integrating-averaging Sound Level Meter* provides an entry-level, hand-held instrument for checking simple sound levels, controlling noise levels in the workplace or investigating complaints. Ideal for novices or engineers in a hurry, the instrument requires no set up procedures because the relevant parameters are always measured simultaneously.
The accurate instrument is ready to measure as soon as the user presses 'start'. The measurement range is 30 to 140 dB in two overlapping 80dB ranges. Accurate, reliable and cost effective, the Type 2240 requires no training to use and users can be up and running within five minutes.
The instrument is able to measure simultaneously L_{AF}, L_{AFmax}, L_{Aeq} and L_{Cpeak} with an averaging time between one second and 60 minutes. It is designed for measuring time-averaged sound levels as defined by the IEC 61672 Class 1 standard, and complies with IEC 60651 Type 1 and IEC 60804 Type 1 standards as well as ANSI S1.4 and S1.43.

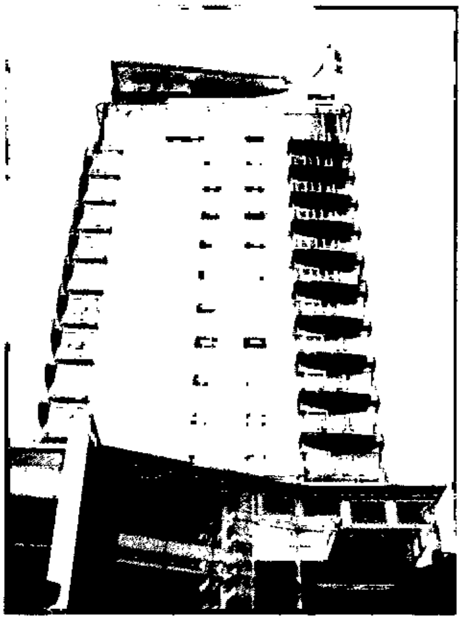


The meter's capabilities are ideal for: on-the-spot checks of environmental noise; workplace noise level checks; noise surveys indoors and outdoors; noise emissions checks from installations such as HVAC systems; quality checks at machine manufacturers, and PA system sound level checks. It comes complete with a Type 4188 microphone and pouch.
Further details: Amanda d'Abreu,
tel: 01438 739000 fax: 01438 739099
e-mail: ukinfo@bksv.com
web site: www.bksv.co.uk

British Gypsum

Scaling the heights

Drywall market leader and acoustic specialist **British Gypsum**, has helped to create one of the most exciting and innovative developments in West Yorkshire. With its 19 storeys of mixed living, retail and leisure facilities, the K2 building is the tallest residential development in Leeds.
Perched atop the distinctive building, with unbroken panoramic views of the city, three £750,000 penthouse apartments boast near-perfect levels of acoustic isolation, thanks to a special high performance wall system originally developed for use in modern multi-screen cinemas.
The former 1960's office block has been completely stripped, re-clad and refurbished to provide an ultramodern building with 84 apartments, duplexes and penthouses. It also combines office accommodation, restaurants and leisure facilities to offer a live, work and play ethic for prospective buyers.
The *GypWall AUDIO* system, which consists of acoustically braced twin independent

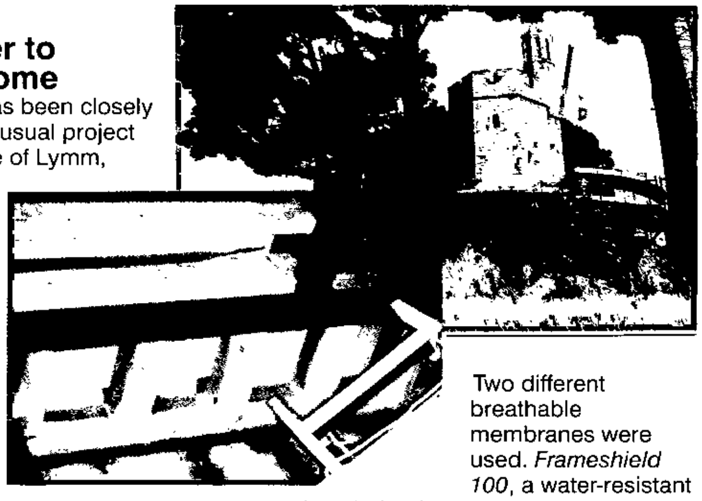


Gypframe metal frames lined to both sides with *Gyproc Plank* and *Gyproc DuraLine* performance boards, provides the penthouses with exceptional levels of sound insulation as well as 120 minutes fire protection and a damage-resistant high impact surface.
Further details: Jo Doxey or Paul Smith,
tel: 0115 945 1996 or 1938
fax: 0115 945 1111
email: joanne.doxey@bpb.com
paul.smith@bpb.com or
www.british-gypsum.com

A Proctor Group

From water tower to contemporary home

The **A Proctor Group** has been closely involved with a highly unusual project in the picturesque village of Lymm, Cheshire, where a derelict Grade II listed water tower is being converted into a contemporary home for its current owners. The octagonal stone building has been redundant for some 30 years, although the upper part of the tower is used by several mobile phone companies to support their masts.
The company has supplied many products to the project, including *Sylomer Strips* for the floor of the control room, as the telecommunications equipment applied a considerable dead load. The product is a technically-advanced resilient foam whose unique cellular structure has excellent acoustic properties. *Profloor Acoustic Mat* was used to overcome impact noise problems through floors.

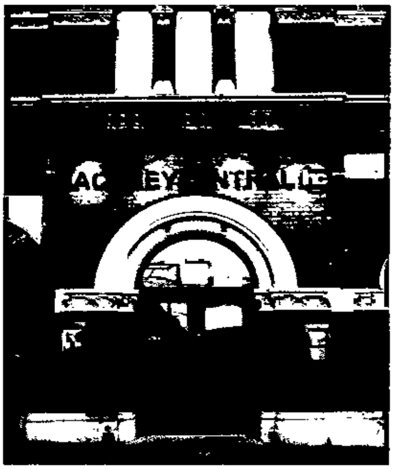


Two different breathable membranes were used. *Frameshield 100*, a water-resistant spun bonded polypropylene was used as a breather membrane behind timber cladding, and *Roofshield*, a triple laminate, was used temporarily to waterproof the window openings. This is primarily designed as a vapour permeable underlay for use in both warm and cold pitched roofs, without the need for roof void ventilation.
Further details: tel: 01250 872261
web site: www.proctorgroup.com

Autograph Sales

Meyer sounds at London's newest hotspot

Professional audio sales company **Autograph Sales** has sold a complete sound system, including ten *Meyer Sound UPJ-1Ps,* to London's latest hotspot, Hackney Central. The club, also a bar and restaurant, is sited on the former Hackney Central Station. A massive refurbishment has turned this into one of the trendiest new venues in the capital.
The UPJ-1P combines the advantages of self-powered systems with the placement and arraying flexibility afforded by a horn that can rotate and therefore be used either singly as a primary loudspeaker or in multi-cabinet horizontal or vertical arrays.
The company also supplied various other products, including *Meyer Sound UMS-1P* and *USW-1* subwoofers. The club is the latest to be opened by management company Drinking Fish and its owner David Catlin was delighted that everything was completed in time for the opening night. He "absolutely loves" the sound.'
Autograph Sales' other successes on the London scene include a number of sound systems for the high-profile restaurant, bar and gallery space Sketch, as well as supplying and installing a new sound system for Attica, one the trendiest clubs in town.
Further details: Aviva Ozin, tel: 020 8346 6131
email: aviva@faithcommunications.co.uk



ERRATUM

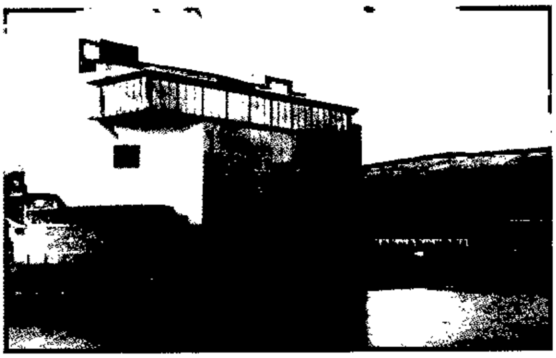
The piece headed "The Doppler Effect explained" on page 41 of *Acoustics Bulletin* Vol.28, no.6 includes an assertion that a moving medium can cause a Doppler shift. I am grateful to a reader for pointing out that this is not so. Apologies are offered to anyone who has been inadvertently misled.

For Sale

Fiat 2.0 JTD van (Bravo shape) 02 registration, quick and very economical common rail turbodiesel, 37500 miles, excellent condition, full service history.
Offers around £5500 invited
Contact the Editor on 0161 476 0919 for more details

Hodgson & Hodgson

Acoustic panels specified for Loch Lomond visitor centre

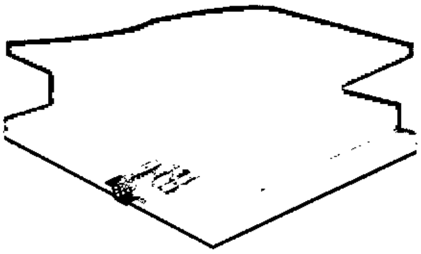


The new Loch Lomond Visitor Centre in Scotland is a state-of-the-art development accommodating an impressive auditorium. Acoustic panels supplied by **Hodgson & Hodgson** had to meet the requirements of an innovative design layout and an exacting acoustic environment.
The company produced and installed specially designed wall panels to absorb low and medium frequency noise, using a combination of perforated, fabric-faced and plain surfaces. Visitors to Loch Lomond can enjoy the Centre's presentation facilities in an attractive environment where they can hear every word.
This is another example of expertise in providing acoustic solutions for any project, large or small. The company's range of wall, floor and ceiling panel types and systems enable specifiers to satisfy complex requirements.
Hodgson & Hodgson has previously supplied panels and systems for use within a wide variety of buildings, including luxury apartments, theatres, conference rooms, auditoriums, cinemas, universities, hospitals, shopping centres, hotels, restaurants, discos, exhibition centres, metro stations, schools and libraries.

Further details: Glynne Balshaw-Jones, tel: 01606 76593 fax: 0160674315

Sound Reduction Systems

Maxiboard's effectiveness shown in test results



Maxiboard, from **Sound Reduction Systems**, is designed to offer a complete wall and ceiling solution for the provision of maximum sound protection in the most complex of domestic and commercial situations. Its effectiveness is shown in new test results which demonstrate the versatile building board's ability to meet stringent new building regulations regarding sound insulation.
Under test conditions, the *Maxi 60* ceiling system achieved Building Regulations Approved Document 'E' standards for both new-build and conversions. Constructed on resilient bars, the system provides an isolated ceiling which maximises the performance of the board. It also achieved one-hour fire resistance to BS EN 1365-2 floor/roof.
Another versatile option, the *Maxi HP Partition*, also achieved Building Regulations Approved Document 'E' standards for both new-build and conversions, as well as one hour's fire resistance. The partition is constructed onto acoustic studwork, which helps to combat the passage of sound.
These results, and its versatility, make it the perfect product for a wide range of building applications where sound and fire protection is an issue and the stringent new building regulations must be met.
Although it is only 17mm thick, Maxiboard can provide high performance acoustic and fire insulation.
Full details of the test results achieved and a comprehensive guide to the product range are available from:
Sound Reduction Systems on
tel: 01204 380074,
email info@soundreduction.co.uk
or visit the company's website at www.soundreduction.co.uk where all product literature and acoustic insulation data is available.

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