Acoustics BULLETIN

VOL 28 No4 July/Aug 2003

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Wall vibrations in musical wind instruments
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Institute of Acoustics

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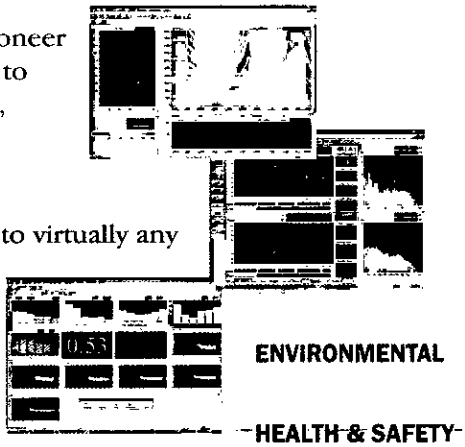

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Acoustics BULLETIN

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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.

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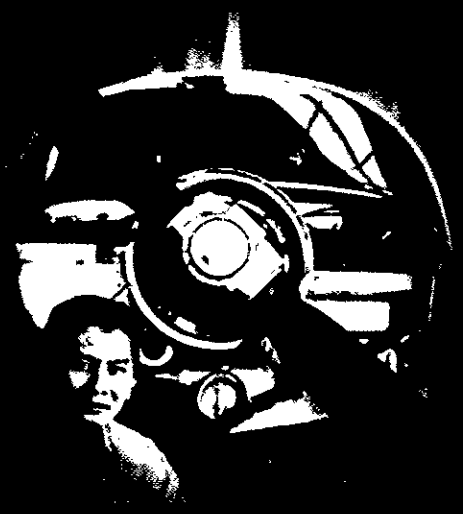

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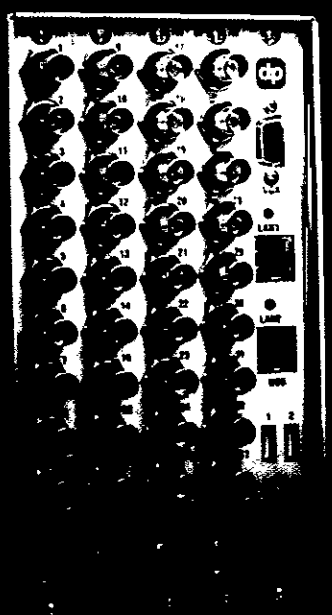

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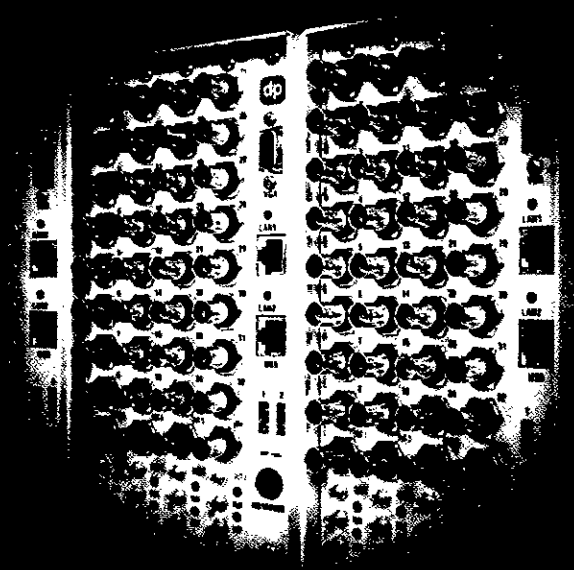

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Dear Members

The annual report for the Institute's twenty-ninth year (ending in December 2002) is printed in this edition of the Bulletin. Reading the draft copy I was struck by the large number of meetings that we hold during each year and particularly by the number of branch meetings that took place last year. The 'knowledge transfer' at all levels within the Institute is obviously quite significant, but I hope those who attend group and branch meetings — and main meetings for that matter — get a lot more out of an event by using the opportunity to network with their fellow acousticians. For those of you who are not regular attendees, why not go along to your next regional branch meeting? Your colleagues have put a lot of effort into organising the programme, and their payback will be your attendance. What will your payback be? Remember the more you put in, the more you will get out.

At the recent EGM, we approved the modifications to the Articles of Association that will allow us to introduce the new grade of Technician Member. This non-corporate grade is intended for practitioners working in a variety of areas involving acoustics, noise and vibration — perhaps in noise monitoring, vibration testing or sound insulation testing, or in the audio industry — who wish to be involved in the profession or to access the services provided to members, but who are not yet able to qualify for Associate Member or Member grades. If you know someone, or perhaps employ someone, who may be interested please get in touch with the office and we will let you have more details.

Thanks to a tremendous effort by Phil Dunbavin, the ANC www.careers-in-acoustics.info web site went live on 3 May 2003. The initial response appears to be good and I would like to thank all those who have sent in cameos. If yours hasn't been posted yet, it soon will be. The site will grow and change in response to your suggestions. So please have a look and let Phil have your views.

Perhaps I'll see you at one of our meetings in the autumn.

With best wishes

Geoff Kerry
President

Institute of Acoustics

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Summary

The Institute has continued to serve the interests of its members through its established programmes in the areas of education, professional development, meetings and publications, and by providing representation in areas such as the Engineering Council and international affairs.

During the year:

- A very successful Theme Day in acoustics was held at the University of Salford in collaboration with the Engineering and Physical Sciences Research Council (EPSRC)
- An ambitious programme of technical meetings and conferences was undertaken both at Branch level and nationally
- A Strategic Development Group has been set up under the chairmanship of Bernard Berry, charged with identifying and implementing key initiatives in the continuing development of the Institute
- An archive fund has been created with an initial donation of £5000 from the Association of Noise Consultants which has been matched with a transfer of £5000 from the Institute's reserves
- Following the death of Keith Rose, Dennis Baylis was appointed Advertising Manager
- Concern was expressed about the level of recruitment into the acoustics profession and in conjunction with the Association of Noise Consultants an attempt is being made to promote education and careers in acoustics
- The Institute has been more proactive in responding to consultation documents produced by government departments
- The working party which has been developing the good practice guide on the control of noise from pubs and clubs produced the final document and this was to be published early in the new year
- It was decided that the Professional Development Committee should merge with the Membership Committee
- An Electronic Publications Sub-Committee was formed to develop the existing web site and other publications.

Standing Committees

The operation of the Institute is guided by Council through standing committees concerned with education, medals and awards, meetings, membership, publications, and research co-ordination. There is also a committee of the Engineering Division.

❑ Education Committee

This year has seen significant progress in advancing our education plans. This progress has been greatly helped by the presence of our part-time Education Manager but the Institute should be thankful for the efforts of the full time staff at Head Office and the many hours given by examiners, tutors and members of the Education Committee in making the education provision of the Institute as successful as it is.

The Diploma in Acoustics and Noise Control has seen further progress in the setting and moderation of coursework assignments. The specialist modules are now partially assessed by course work and accordingly the length of the specialist module examinations has been reduced. Course work that extends the student beyond the mere regurgitation of facts is an essential component of the modern postgraduate programme for the Diploma. However, there is a need to prevent plagiarism in coursework and guidance notes on this matter have been prepared and circulated to all centres. A revised marking scheme for the project module has been piloted this year and will be adopted for 2003 after some modification in the light of feedback from the pilot scheme.

Following the publication of new guidance to all students, the number of appeals to examiners fell to four during the year. The issue of new distance learning notes for the law and administration module was a success with significant numbers of notes being purchased by students other than those on the distance learning programme. New notes for the transportation noise module have been written and were to be issued in March 2003. Published by the Institute, they will be available for purchase by any interested parties.

Progress on the syllabus review has been maintained and a new noise control syllabus will be issued in 2003. The number of specialist modules offered is under consideration as some attract economically unsustainable candidate numbers. The certificate programmes have continued to recruit significant numbers of candidates throughout the year. Student handbooks for workplace noise assessment, environmental noise measurement and management of occupational exposure to hand arm vibration have been prepared. Recognition of the Certificate in Environmental Noise Measurement by the Environment Agency has been delayed by the lack of progress in the whole MCERTS scheme.

Education Committee members have been active in pursuing the development of a high level five-day course in maths for acousticians. This is planned for July 2003 and will probably be held at Loughborough University for around 50 PhD students. It is hoped that this initiative will be successful and assist with the greater recognition of acoustics as a vital research area. A number of new courses has been discussed. Further market research and interaction with the Meetings Committee is required. Topics under consideration include: Building Regulations; Physical Agents Directive; reproduced sound; entertainment noise; and airport noise. Some of these topics may suit assessed short courses leading to an award whereas others may be more suited to one day meetings.

❑ Engineering Division Committee

The committee met three times during the year. Frank Shaw, our long-standing IMechE member and interviewer, who has worked with the Institute on the CEng scheme since its inception in 1989, retired from the committee during the year. Frank's outstanding contribution to the development and operation of the Institute's CEng scheme had been marked by an award ceremony at the Institute's 25th Anniversary celebrations in 1999.

The final stage in the development of the Engineering Division's *Policy and Procedures Manual* was completed, with the release of Issue 3 amendments. The Institute has continued to contribute to the work of the new Engineering

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Council (UK) and the associated revision of SARTOR. Two internal audits of the registration process took place, and no non-compliances were identified. The flow of enquiries from members for registration has continued throughout the year, although it is becoming increasingly apparent that many members are deterred from completing and submitting their final applications despite the personal guidance and support provided. Other engineering institutes have reported this trend and the information has been fed into the Engineering Council's SARTOR review process.

One to one registration workshops were organised for Institute members at the Spring Conference in Salford and at a special one-day event at a Qinetiq site. A presentation was given to members at one of the major acoustical consultancies, with video links to three other sites. Seven members of the Institute were registered as Chartered Engineers and a further five candidates were registered at the interim (academic) stage.

❑ Medals and Awards Committee

The 2002 Rayleigh Medal has been awarded to Professor Phil Nelson from ISVR and will be presented at the *Reproduced Sound 19* meeting in Oxford later in 2003. The 2003 Rayleigh Medal has been awarded to Professor Hugo Fastl from AG Technische Akustik for his work in sound quality and will be presented at the Spring Conference held in Coventry in 2003. The 2002 Tyndall Medal has been awarded to Professor Tim Leighton also from ISVR and will be presented in the near future at an Underwater Acoustics Group meeting. The 2002 A B Wood Medal has been awarded to Simon Richards of Qinetiq, Winfrith and the 2003 Medal to Anthony P Lyons from Penn State University. Both presentations await a suitable meeting. The R W B Stephens Award was presented to Dr Geoff Leventhall, at the Autumn Conference, who gave a paper on *35 years of low frequency noise*. An Honorary Fellowship has been awarded to Professor Chris Rice, a past President, who recently retired from ISVR.

At the Autumn Conference the Institute's prize for the best Diploma student was presented to Patrick Abbott. The Association of Noise Consultants (ANC) prize for the best Diploma project went to Joe McElhinney of Nottingham City Council and the ANC prize for the best paper given by a young person at an Institute meeting went to Laurent Galbrun, of Heriot Watt University. Both were presented by the ANC Chairman, Mr Phil Dunbavin. The award for outstanding contributions to the life of the Institute was presented to John Tyler for his support over many years for the Institute's publications and to Ken Dibble for his support, also given over many years, for meetings activities.

Council has agreed to adopt the Peter Barnett Memorial Award instigated by the Electro-acoustics Group as a main award. It was presented to Wolfgang Ahnert of ADA Acoustic Design at *RS18*. A new IOA engineering award has also been approved and an announcement and call for nominations will be made in the near future.

❑ Meetings Committee

During the year, the Meetings Committee continued its strategic function of guiding the number and types of meetings held by the Institute. Regional Branches held a total of 29 meetings during the year covering a wide range of topics. In addition, 14 workshops and conferences were held including the *Spring Conference* at the University of Salford, and the *Autumn Conference* and *RS 18* at Stratford-upon-Avon. The year provided many topical issues for discussion and the conferences were generally well attended with the *Building Regulations* meeting in November attracting nearly 150 delegates. As always, none of the meetings would occur without the assistance of the committees of the various Groups and Branches who identify the topics and arrange speakers etc. Thanks should also go to the Head Office staff who carry out all the vital administration for the conferences and are remarkably patient as the important deadlines are stretched to the limit and beyond.

The Peel Building at Salford University, venue for the Spring Conference 2002

Nearly 150 delegates came to November's Building Regulations meeting, held at the headquarters of the Royal Institute of British Architects in London's Portland Place

❑ Membership Committee

There were the usual four meetings during the year, and a total of 245 individual applications (all grades) were considered, including potential new members and transfers between grades; 232 (94 corporate, 138 non-corporate) were approved, including 7 reinstatements, and 2 new sponsor members were welcomed. There was a net gain in individual membership of 43, compared with 34 in the previous year. The detailed figures are shown in the tables.

One complaint under the Code of Conduct arose during the year, but there was no case to answer as the person against whom the complaint was made was no longer a member.

The formal implementation of the revised by-laws to include Technician Members and to rename Associates as Affiliates

TABLE 1 MEMBERSHIP

Grade	*2001*	*2002*
Hon Fellow	*16*	*18*
Fellow	*209*	*204*
Member	*1315*	*1346*
Associate Member	*686*	*704*
Associate	*117*	*113*
Student	*55*	*56*
Totals	*2398*	*2441*
Key Sponsor	*3*	*3*
Sponsor	*26*	*29*
Institutional Subscriber	*15*	*13*

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was delayed as the Articles of Association also have to be changed. With the retirement of the present chair, the Professional Development Committee is to be subsumed into the Membership Committee. The terms of reference of the combined committee are still under discussion. Tony Garton has joined the committee.

❑ Professional Development Committee

The new goal-based CPD scheme was promoted at the Spring Conference and at some Branch meetings by members of the committee. Liaison with the Engineering Council's professional development forum continues to provide a two-way flow of ideas and examples of good practice. As a result of extensive dialogue and debate within the committees and at Council, it has been agreed that the Professional Development Committee will merge with the Membership Committee in 2003. This will facilitate the development of a framework of professional competence requirements for the various grades of institute membership to support the work of the Membership Committee. Close liaison will continue to be maintained with the Engineering Division Committee.

TABLE 2 GROUP MEMBERSHIP

Group	2001	2002
Building Acoustics	440	424
Electroacoustics	100	93
Environmental Noise	591	565
Noise and Vibration Engineering	362	350
Measurement & Instrumentation	89	86
Musical Acoustics	82	79
Physical Acoustics	62	61
Speech	69	64
Underwater Acoustics	119	116

TABLE 3 BRANCH MEMBERSHIP

Branch	2001	2002
Eastern	247	253
Irish	104	115
London	569	558
Midlands	360	370
North West	262	270
Scottish	125	129
South West	209	215
Southern	457	443
Yorks/Humberside	185	190

TABLE 4 DETAILS OF EMPLOYMENT

Employment Category	2001	2002
Architectural Practice	11	11
Consultancy	519	501
Industry/Commerce	248	237
Education	168	158
Public Authority	362	343
Research & Development	159	150
Other	47	43
Retired	51	47

❑ Publications Committee

This has been a steady year for the Publications Committee. The *Bulletin* has continued to be produced and published under the same arrangements as last year; edited by Ian Bennett and published by International Labmate. The printer has been changed to improve efficiency and also to reduce costs. The *Bulletin* has generally been produced on time, and there is a continued effort to increase both the quality of its presentation and style and maintain a breadth of content to ensure its appeal to as many members as possible. The contract with International Labmate has been renewed for the forthcoming year. The sad loss of Keith Rose as Advertising Manager presented a challenge. After a transition period during which John Tyler very capably acted as Advertising Manager, Dennis Baylis was appointed in the autumn. A smooth handover was achieved and both John and Dennis are to be thanked for their efforts.

The latest edition of the *Buyers' Guide* has been published. It is anticipated that this will be the last time a paper copy is produced. The impact of electronic publications has featured regularly during the year, with the Electronic Publications Sub-Committee beginning to set down the requirements and specification to take the Institute forward. Continued pressure on members' available time has limited progress in this area. However, *Proceedings* are now exclusively produced in electronic format on CD, a change that has enabled significant cost savings.

The web site is increasingly seen and used as an essential source of information for members and non-members, with the amount of accessible information increasing. This is reflected in increased costs for the maintenance and design of the web site. Discussions are ongoing to improve its accessibility and ease of use, as well as the integration with on-line resources such as the *Register of Members* and the *Buyers' Guide*. The growing archive of library and historic material has been an ongoing challenge to the Institute for a number of years. John Miller produced a welcome report from the Library Working Group making a number of recommendations. One outcome from this has been a £5000 donation from the ANC which has been matched by the Institute to assist with archiving. Bridget Shield is now taking this project forward.

❑ Research Co-ordination Committee

The Committee met on four occasions in 2002. During the early part of the year, the main activity of the Committee was liaison with EPSRC concerning the Theme Day held in conjunction with the Institute's *Spring Conference* at Salford. This involved advising on grants to be reviewed, on membership of the theme day panel and on the format of the Theme Day sessions. Another continuing item has been liaison over the EPSRC research topics concerning acoustics. Since the Theme Day the committee has expanded its membership, most notably in respect of the Institute of Physics (IOP) Physical Acoustics Group, updated the web page and continued its review of acoustics research activities in the UK. The Chair has been involved with a proposal for a summer school devoted to mathematics for acoustics, for postgraduate students of acoustics. The committee is also following up various aspects of the Theme Day.

Institute of Acoustics

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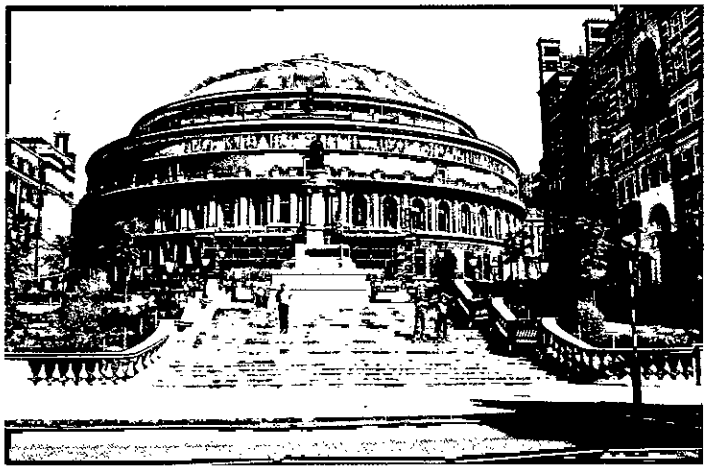
Specialist Groups

The Institute reflects the broad spectrum of the science and application of acoustics and several Groups exist to foster contacts between members with various specialist interests.

❑ Building Acoustics Group

The Building Acoustics Group had a very successful year with a wide range of activities and events. The year began with a master class on flanking transmission, *EN 2354*, attended by 55 delegates. This event was a mixture of lecture presentations and hands on workshops with delegates using the standard to solve their own flanking problems. Although the *Spring Conference* was not a Building Acoustics Group event there was clear evidence of the wide range of activity in building acoustics both in the formal presentations and in the EPSRC Theme Day. This event also provided the venue for the AGM where new meetings were planned. This planning continued throughout the spring and has resulted in a varied programme for the next two years.

The biggest event of the year was another very successful three-day conference on auditorium acoustics held in London in July. This international conference was attended by 115 delegates and is now firmly established as a regular event in the international conference circuit. During the autumn there were two consultative meetings. In October there was a consultation on BB93 on school acoustics. This meeting was a mixture of presentations and discussions on the key issues and resulted in a formal response from the Institute on the proposed guidelines. A similar meeting was held in November on the proposed new Building Regulations and was one of a series of ongoing meetings informing delegates of the new regulations and obtaining feedback from members.



London's Royal Albert Hall provided an appropriate setting for a very successful three day conference on auditorium acoustics

❑ Electroacoustics Group

The main activity of the Electroacoustics Group was the organisation and production of the weekend conference, *Reproduced Sound 18*. The conference ran from 15 to 17 November and was again held in the Stratford Victoria Hotel, Stratford-upon-Avon. The conference title was *Perception, reception, deception: How do you know?* . The cryptic title belied the good solid technical debate and discussion which took place over the weekend. Topics included loudspeaker technology, intelligibility, and room acoustics and perception. Ken Dibble received the *Institute's Award* for his many years of unstinting service to the Institute. Dr Wolfgang Ahnert, ADA Acoustic Design, was presented with the *Peter Barnett Memorial Award*. The conference attracted a loyal following from as far away as America and Australia and a total of 74 delegates attended. The Electroacoustics Group Committee of Robin Cross (chairman), Paul Malpas, Peter Mapp, Mark Bailey, Julian Wright, Ken Dibble, Sam Wise, Peter Philipson, Bob Walker, Martin Roberts and Steve Jones were also the core of the organising committee for the conference.

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James Angus from Salford University displays his inimitable style in giving the opening paper at Reproduced Sound 18

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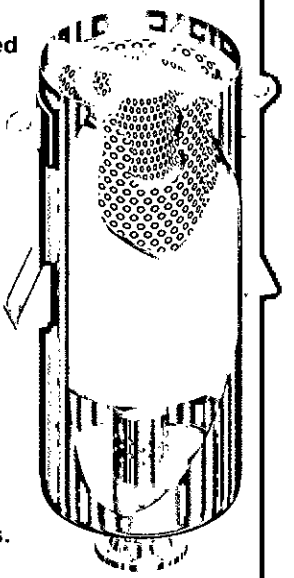

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❑ Environmental Noise Group

The Environmental Noise Group organised the Autumn Conference, *Action on environmental noise*, which was held at Stratford-upon-Avon in November, which proved to be a great success. The conference considered issues associated with noise mapping, and looked at how the UK

The Royal Shakespeare Theatre, Stratford-upon-Avon

modelling methods would tie in with the EU Directive. Noise action plans and how these will fit in with the national strategy were also discussed and the Group's AGM was held during the Conference. A lively informal debate on the topic of attracting young people into the profession, led by the Institute's President, followed the conference dinner.

The Group also organised a one-day meeting on the *Ambient noise strategy*, and the resulting feedback was sent to DEFRA and reported in the *Bulletin*. The working party which has been drafting the code of practice on the control of noise from pubs and clubs passed a final draft to the Publications Committee, and this should be available shortly. The joint IOA/IEMA 'Guidelines on noise assessment' were issued as a consultation draft, and useful feedback has been received.

❑ Measurement and Instrumentation Group

The Group has continued to flourish throughout the year and has organised three one-day meetings, all of which were lively events. On 28 February, 91 attendees crammed into the Royal Society in London to be updated on *Noise mapping: which way now?*. A very full programme of ten papers and two tutorials organised by Ian Campbell brought delegates up to date on all aspects of this hot topic. The venue moved to the National Space Centre in Leicester on 22 May for *Weather or not ... to measure* covering many aspects of outdoor noise measurement and the difficulties to be overcome in obtaining reliable data. Geoff Kerry opened the event with an overview of the basic effects of temperature, humidity and wind on the propagation of sound. Meeting organiser Simon Bull then steered the 63 delegates through a further nine papers and a special 3D presentation at the National Space Centre on *How big is the universe?* The AGM of the Group was held after the Leicester meeting, and the three committee members required to stand down were duly re-elected, together with a new member, Susan Dowson from the National Physical Laboratory.

The final meeting of the year took place on 9 October in a very unusual venue for acoustics meetings — The Natural History Museum in London. Entitled *Did the earth move for you,* it covered many aspects of measuring and predicting ground-borne vibration and its effects on people. There were 68 delegates, who enjoyed seven presentations and a lively discussion session led by the meeting organiser, John Shelton. Thanks are due to all members of the Committee for the active roles they take in all aspects of the Group's activities. A full programme is well in hand for 2003, new members have been co-opted onto the Committee, and the successful events look set to continue.

❑ Musical Acoustics Group

There has been no significant activity this year.

❑ Noise and Vibration Engineering Group

During the year, the Industrial Noise Group underwent a rebirth as the Noise and Vibration Engineering Group. This was in response to comments that the Industrial Noise Group was only interested in workplace noise assessment. The new name is designed to reflect the wide scope of activities and interests that its members really represent. Despite this change, a busy year has included the presentation of *Noise control in practice*, a one day workshop held in Birmingham. It was attended by 58 delegates from a mixed industrial and local authority background, who were treated to an excellent practical demonstration of noise generation by David Bull. All types of noise generation were tackled including impact, vibration, and turbulence, all with simple examples set against a structure of simple yet relevant theory. The afternoon session comprised several case studies of practical noise control at the design stage by practising consultants.

In September, a one day workshop was co-hosted with the University of Liverpool and the ENABLE network. This was aimed at strengthening research and industry partnerships, both to improve the take-up of acoustic research by industry and to inform researchers about industrial needs for acoustics research. Sixteen delegates from various universities attended, and were joined by 14 representatives from industry and consultancy. The Group also took on the responsibility of organising the *Spring Conference* to be held in Coventry next year.

❑ Joint IOA/IOP Physical Acoustics Group

This was another successful year for the Group. The highlight of the year was the second *Anglo-French Physical Acoustics Conference (AFPAC '02)* which took place in December at Hôtel le Bellevue, Wissant, France. This was a joint event between the Group and the corresponding Specialist Group of the Societé Français d'Acoustique and followed on from the meeting held in Kent the previous year. The purpose of the meeting was to review progress, discuss ongoing work and to enhance collaboration. The meeting covered a wide range of topics in Physical acoustics. The Group also held a very successful one-day meeting on medical and biomedical acoustics at Nottingham Trent University in September. This smaller meeting was well attended and very well received by the delegates.

❑ Speech Group

There has been no significant activity this year.

❑ Underwater Acoustics Group

The Group contributed a session at the Institute's *Spring Conference*, and the organisation of the Group's next conference, on *Calibration and measurement,* taking place at

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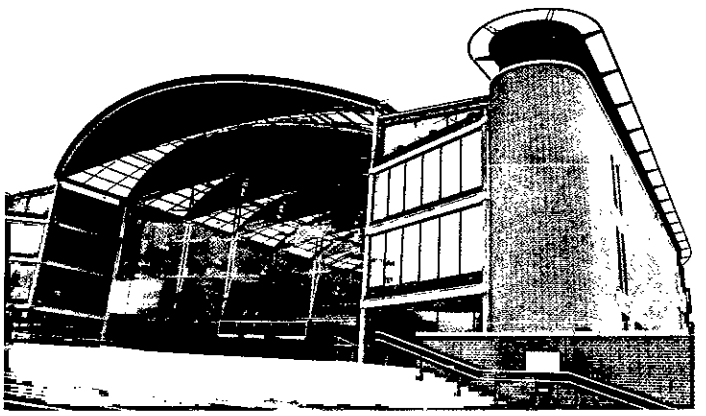
NPL in January 2003, was virtually completed. Planning for the next conferences, on *Sonar transducers* and *Signal processing*, has been slow in getting started and it is now hoped to hold them in 2004. Dave Goodson and Dick Hazelwood were elected to the Committee, having been co-opted previously, Stephen Robinson was co-opted as the organiser for the conference on signal processing, and David Hardie for that on sonar transducers, otherwise the Committee was unchanged. In the long term the viability of the Group's conferences is uncertain, as there are now more international conferences on underwater acoustics which attract larger, although declining, audiences. The policy now is to concentrate on specialist meetings only.

Regional Branches

The Regional Branches of the Institute were established to further the technical and social activities of the Institute at local level.



A 'very interesting' *Visit to the Forum* in Norwich was organised by the Eastern Branch

❑ Eastern Branch

The Eastern Branch had a good year with seven technical meetings and one social meeting. These were organised from four committee meetings, with an average attendance of around 18 members. As always, the committee members have tried to provide a wide cross-section of topics with venues spread across the Eastern Region. At our first meeting in March, Chris Gilbert gave a lecture on *Human vibration* at a Colchester venue. This was closely followed in April by a very interesting presentation delivered by Keith Broughton, entitled *Forward into a quieter Europe*. In May, Roger Willmott gave an illustrated talk on the *parameters of the new NPL design*.

The Group was very fortunate to be able to have a behind the scenes visit to Stansted Airport. Following the planned social meeting for this year - a very enjoyable and interesting return voyage along the River Orwell between Ipswich and Shotley, including a meal - our branch members returned in September to enjoy an afternoon meeting by David Baguley on *Recent advances in tinnitus and hyperacusis*, closely followed in October by a very interesting *Visit to the Forum* in Norwich by Adrian James. Finally our AGM was combined with a final meeting in November at Colchester Institute where David Hiller addressed *Vibration from construction sites*.

❑ Irish Branch

This was the fifth year of the Branch and started off in February with an evening meeting in Dublin at which Dave Meredith of Kinetics spoke on *Noise and vibration control*. The AGM followed in late April and was preceded by a very enjoyable talk by Ralph Weston on *Continuous professional development*. During the year the Branch organised its first one day seminar which was held on 30 May at the Citywest Hotel in Dublin. The topic, *Road traffic noise*, attracted 75 delegates. Following the summer a further evening meeting was held in Sligo, at which a paper on *Entertainment noise - the whys and wherefores of measurement and assessment*, was delivered by Ken Dibble. The final meeting of the year was held on 12 December at the new Gerald Moag Campus of the Belfast Institute of Further and Higher Education. The guest speaker at the meeting was Keith Broughton, the Institute's Treasurer, whose talk was entitled *The Physical Agents (Noise & Vibration) Directive — an update*.

As in the past year, an arrangement was made for an insertion in the Yearbook of the Association of Professional Engineers in Ireland (APEI) which publicised the activities of the Institute of Acoustics and the local Branch. Over the year there were four committee meetings, all of which were held in Dundalk, to facilitate attendance of members from both North and South.

❑ London Branch

The London Branch had another active year. A regular programme of evening meetings covered a wide range of topics including *Synergies and conflicts between noise and air quality action plans; The acoustics of the Royal Festival Hall; Uncertainties in noise measurement; An engineering solution to entertainment noise*; and *Common intelligibility standards*. The Group is particularly grateful to Dani Fiumicelli for stepping in at short notice to lead a discussion when the programmed talk was cancelled due to illness. Our February meeting was a half-day visit to see the manufacture of KEF loudspeakers at Maidstone. We were given a comprehensive tour of the facilities showing the design, manufacture and testing of loudspeakers including developments expected in the next few years. Our thanks go to the company for their hospitality.

In October the Branch organised a one-day conference at the Commonwealth Conference Centre on the subject of *Health effects of noise*. The conference was well attended and attracted an excellent group of speakers. Traditionally our November meeting is the annual dinner, and this year we went to the Bleeding Heart Restaurant. After a meal that lived up to our highest expectations we were entertained by our guest speaker John Seller who told us of interesting and amusing incidents in his career in acoustics. The London Branch remains in a healthy state and we look forward to another active year.

❑ Midlands Branch

The Midlands Branch held four evening meetings during the year. The first was held on 14 February, at the University of Derby, where Keith Broughton of the HSE spoke on *Developments in the EC Directive on Physical Agents*. On 16 May, Richard Tyler of A V Calibration gave a very informa-

continued on page 10

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continued from page 9

tive talk on *Calibration: what do you get for your money?*. This was held at a new venue for the Midlands Branch at PowerTechnology Offices in Radcliffe-on-Soar. After a summer break the autumn programme resumed with a talk from Colin Grimwood of BRE on the recent *NIS and NAS*. This meeting was held at the Council Offices, Coventry on 25 September. The final meeting of the year and the AGM was held on 20 November, at Birmingham University. Our Chairman, John Hinton of Birmingham City Council gave a talk entitled *The implementation of the Environmental Noise Directive - a piece of cake?*.

The existing committee was re-elected for 2003, with its numbers supplemented by the welcome addition of two younger members, Paul Shields of Scott Wilson and Chris Mansley of WS Atkins. A half-day visit to Arrows Formula One team works at Wilton had been arranged but was cancelled owing to financial troubles at Arrows. It is hoped that this or a similar visit will be arranged for next year.

TABLE 5 MEETINGS ATTENDANCE IN 2002

Topic, Date & Venue	Attendance
BS EN 12354 *29 January* *London*	*57*
Noise Mapping - Which way now? *28 February* *London*	*101*
Towards an Ambient Noise Strategy *6 March* *Birmingham*	*32*
Spring Conference and EPSRC Theme Day *Past, Present and Future Acoustics* *25-27 March* *Salford*	*152*
Noise Control in Practice *11 April* *Birmingham*	*59*
Weather or not ... to measure *22 May* *Leicester*	*70*
Road Traffic Noise *30 May* *Dublin*	*75*
Auditorium Acoustics: Historical and Contemporary Design and Performance *19-21 July* *London*	*116*
Did the Earth move for you? *9 October* *London*	*68*
School Acoustics *15 October* *London*	*80*
Noise and Health *23 October* *London*	*98*
Autumn Conference: *Action on Environmental Noise* *13-14 November* *Stratford-upon-Avon*	*104*
Reproduced Sound 18 *Perception, Reception, Deception - How do you know?* *15-17 November* *Stratford-upon-Avon*	*74*
Changes to the Building Regulations *28 November* *London*	*150*

❑ North West Branch

The year began for the North West Branch with a meeting held at Building Design Partnership' s offices (BDP). Alan Fry gave a presentation on the design of floating floors and how more dBs can be realised in the airborne sound insulation without increasing the mass of floors. Some useful guidance on the selection of different floating floor types was provided in addition to pitfalls to be avoided. In February at the offices of Ove Arup & Partners, Keith Broughton of HSE provided a valuable update on *The requirements of the European Physical Agents Directive for both noise and vibration*. A well-attended afternoon meeting was held in May at Salford University on the latest situation relating to a potential update on BS4142. Ian Flindell of the University of Southampton presented his considerable experience from the sub-committee dealing with this standard and his personal views on how the standard might be improved.

The Group had a long break while Manchester held the Commonwealth Games, and reconvened in October, when Lesley Ormorod of the Environmental Agency gave a particularly helpful talk, again at Ove Arup & Partners, on *Integrated Pollution Prevention and Control: noise issues*. The end of the year was marked by the AGM and a workshop on acoustic design in residential buildings and schools held, again, at BDP. Nick Antonio, of Arup Acoustics, led the meeting using his experience to outline the latest situation relating to Approved Document E of the Building Regulations and Peter Sacre of Acoustic & Engineering Consultants Ltd gave a brief outline of the Department of Education and Skills Building Bulletin 93 *Acoustic design of schools*. Thanks to all the hosts of the meetings and to Paul Michel for at least keeping Head Office amused with his meeting minutes and keeping us on track.

❑ Scottish Branch

The Scottish Branch enjoyed two events in 2002. The first was a visit to the BBC studios in Glasgow. The visit was well attended and enjoyed by all. The second event, in November, was a joint IOA/REHIS meeting in Edinburgh. A wide range of topics was covered and there was considerable amount of discussion on topics such as BS 4142, noise mapping issues and ventilation systems. This event will hopefully be repeated in future years. There were no changes to the committee in 2002 with Bernadette McKell continuing as Chair, Lilianne Lauder as Secretary and Andy Watson as Treasurer.

❑ Southern Branch

The Southern Branch had a somewhat quiet year, demonstrating the contribution that Dawn Connor made to the organisation of meetings prior to her retirement to France last year! The Committee and members wish her a long and noise-free retirement and thank her for the considerable work she has done on behalf of the Branch. A programme for 2003-2004 is currently being arranged, with the help of Hardial Sagoo, and our first meeting, a talk by Keith Broughton of HSE *Forward into a quieter Europe — Can they hear?* was planned for March.

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❑ South West Branch

The South West Branch did not hold any meetings during the year but the committee welcomed fresh faces to its ranks, and has arranged a varied programme for the forthcoming year, the first meeting to be entitled *Noise modelling in practice*.

❑ Yorkshire and Humberside Branch

During the year the committee of the Yorkshire and Humberside Branch organised an eventful series of meetings. Keith Attenborough of Hull University ran an exciting regional event in the Deep Submarium in June which coincided with the official launch of the new Acoustics Research Centre at Hull. The visitors had the opportunity to enjoy the unique facilities in The Deep followed by the excellent presentation on the acoustics of mammals by David Goodson of Loughborough University.

In November Andrew Parking of RW Gregory LLP presented to members the new version of the Building Bulletin (BB93) which relates to classroom acoustics. This document, which becomes statutory in July 2003, is likely to have serious consequences for the construction industry and acoustic consultancy practices. At the same meeting, which was held at Bradford University, Kirill Horoshenkov offered a talk and audio demonstration on the temporal variation of the predicted performance of railway noise barriers. Lesley Ormerod of the Environment Agency ran a highly useful meeting at Sheffield University which outlined the current state and the future of the IPPC and explained its implications to noise and vibration emission control. This meeting was held in December and was attended by many members of the Branch.

A workshop entitled *Noise control by natural means* took place in February. This event, organised at Hull University by the ENABLE network, was hosted by Keith Attenborough, and attracted a considerable number of members of the acoustics community in the UK and professionals from other areas which included horticulture, forestry, landscape design and architecture. There are plans to continue the series of regional meetings and link them to demonstrations of noise mapping software (Bradford), ultrasonic instrumentation (Leeds) and soundscape design tools (Sheffield).

TABLE 6 INSTITUTE PERSONNEL AT 31 DECEMBER 2002

COUNCIL		
Officers		**Ordinary Members**
President	Mr G Kerry FIOA	Dr T J Cox MIOA
President Elect	Dr A J Jones FIOA	Professor R J M Craik FIOA
Immediate Past President	Professor M A A Tatham FIOA	Professor B M Gibbs FIOA
Honorary Secretary	Dr R J Orlowski FIOA	Mr C J Grimwood MIOA
Honorary Treasurer	Mr K A Broughton MIOA	Professor T G Leighton FIOA
Vice Presidents	Dr G C McCullagh MIOA	Professor B M Shield FIOA
Engineering	Mr C E English FIOA	Mr A W M Somerville MIOA
Groups & Branches	Mr I J Campbell MIOA	Mr S W Turner FIOA
International	Mr B F Berry FIOA	
Committees & Sub-Committees		**Chairman**
Education		Dr M E Fillery FIOA
Diploma in Acoustics and Noise Control, Board of Examiners		Professor K Attenborough FIOA
Certificate of Competence in Environmental Noise Measurement		Mr D Trevor-Jones FIOA
Certificate of Competence in Workplace Noise Assessment		Mr A E Watson MIOA
Certificate in Measurement of Sound Transmission in Buildings		Professor R J M Craik FIOA
Certificate in Management of Occupational Hand Arm Vibration		Mr T M South MIOA
Engineering Division		Mr C E English FIOA
Medals & Awards		Mr G Kerry FIOA
Meetings		Mr S W Turner FIOA
Membership		Mr J R Dunn MIOA
Publications		Mr M Ling MIOA
Research Co-ordination		Professor K Attenborough FIOA
Specialist Groups	**Chairman**	**Secretary**
Building Acoustics	Professor R J M Craik FIOA	Mr S G Chiles MIOA
Electroacoustics	Mr R C Cross FIOA	Vacant
Environmental Noise	Mr K M Collins MIOA	Dr N D Cogger FIOA
Noise and Vibration Engineering	Mr M D Hewett MIOA	Mr A R Raymond MIOA
Measurement & Instrumentation	Mr R G Tyler FIOA	Mr M Armstrong
Musical Acoustics	Dr P F Dobbins FIOA	Vacant
Physical Acoustics (Joint with the Institute of Physics)	Mr D Cartwright	Dr N Saffri
Speech	Vacant	Vacant
Underwater Acoustics	Mr J R Dunn MIOA	Dr P D Thorne FIOA
Regional Branches	**Chairman**	**Secretary**
Eastern	Mr J M Hustwick MIOA	Mr M P Alston MIOA
Midlands	Mr J F Hinton MIOA	Dr M E Fillery FIOA
Irish	Dr G C McCullagh MIOA	Mr J O Hetherington MIOA
London	Mr J E T Griffiths FIOA	MrA J Garton MIOA
North West	Mr P E Sacre MIOA	Mr P G Michel MIOA
Scottish	Dr B McKell MIOA	Ms L Lauder AMIOA
Southern	Vacant	Dr N D Cogger FIOA
South West	Mr T Clarke MIOA	Mr S Simpson MIOA
Yorks & Humberside	Mr P Horsley MIOA	Dr K V Horoshenkov AMIOA

INSTITUTE AWARDS

Honorary Fellowships

Prof Philip Ellis Doak

Phil Doak was born in Grand Forks, North Dakota, USA and spent most of his early years there before moving to New York where he studied music. He saw service in the Second World War in Europe obtaining the rank of Technical Sergeant. In 1946, he became a student at Oklahoma University where he studied at both undergraduate and postgraduate levels before moving to study Physics at MIT. In 1950 he became a postgraduate student at Manchester University and from 1951 to 1954 was the ICI Research Fellow there. From 1954 to 1957, he was the research fellow in fluid mechanics before taking up a post at Liverpool University for five years as a lecturer in Applied Mathematics. During this time, he became a naturalised UK citizen.
From 1962 until 1982 he was successively Hawker Siddeley (from 1975, British Aerospace) Lecturer, Reader, and Professor of Acoustics at the Institute of Sound and Vibration Research at the University of Southampton. Following retirement, he became an Emeritus Professor there.
In 1962 he was a founding editor of the *Journal of Sound and Vibration* and became its editor-in-chief in January 1996. From 1965 to 1970, he was the public member of the Noise Research Committee of the Aeronautical Research Council (UK).
From 1974 to 1979, he was a member of the British National Committee on Theoretical and Applied Mechanics and from 1980 to 1983, he was a member of the BAe committee on Aircraft Noise Sources. Between 1961 and 1980 he was a consultant, variously for Rolls Royce (UK) Ltd, the Ministry of Power, the British Gas Corporation and Lockheed Georgia (USA).
His interest in architectural acoustics and music is demonstrated by his membership of the Westminster Abbey Sound Advisory Panel and of the Environmental Design and Engineering Research Committee of the BRE. For a time, he was a member of the 'expert listeners' panels providing preliminary assessments of the Royal Festival Hall, London and the Free Trade Hall, Manchester. He also undertook the design of the Turner-Sims Concert Hall at the University of Southampton.
In 1971 he was elected a Fellow of the Acoustical Society of America and in 1975 a Fellow of the Institute of Acoustics having served previously as a member of Council of the former British Acoustical Society. In 1980 he was awarded the *Rayleigh Medal* of the Institute of Acoustics and in 1985 the *silver medal* of the Groupement des Acousticiens de Langue Francaise. In 1990, he received the *Aeroacoustics Medal* of the American Institute of Aeronautics and Astronautics.

During the Spring Conference Prof Chris Rice (left) received his Honorary Fellowship from the President, Geoff Kerry and also accepted Prof Philip Doak's on his behalf

The author of countless scientific papers, a well respected lecturer and contributor to the science of acoustics and its profession, the Institute of Acoustics is pleased to award Philip Ellis Doak, Professor Emeritus, an Honorary Fellowship.

Prof Christopher George Rice

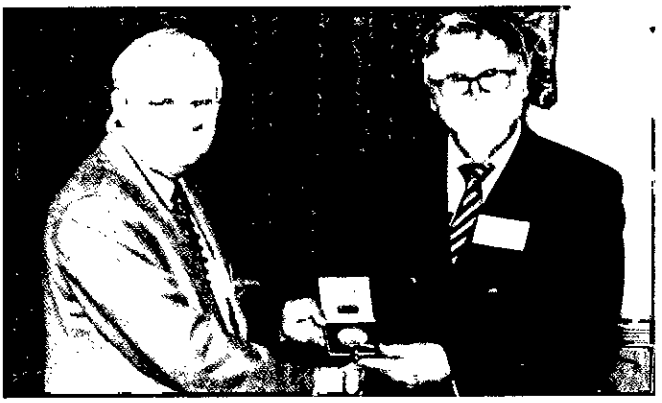
Following a period of National Service, Chris Rice became a graduate trainee at AEI Ltd and in 1959 obtained a degree in Physics from Southampton University. In 1960, he became a scientist at the MRC Wernher Research Unit on Deafness and obtained an MSc in 1963.
From 1964 to 1974 Chris was first a Research Fellow, then a Lecturer, and then a Senior Lecturer at the Institute of Sound and Vibration Research, University of Southampton. Between 1976 and 1979, he was Assistant Dean Academic in the Faculty of Engineering and Applied Science. In 1981, he became Reader in Subjective Acoustics and in 1986, Deputy Director of ISVR. He took over as Director in 1989 having been Chairman of the Audiology and Human Effects Group between 1980 and 1989.
In 1990, he became the Professor of Subjective Acoustics and in 1992, Dean of Engineering. Chris retired from full time employment in 2000.
Prof Rice has held a number of committee appointments including membership of the IUPAP, Commission on Acoustics, The DTI Standards Quality and Measurement Advisory Committee, and Delphi Questionnaire Steering Group. He was Chairman of the DTI Acoustics and Radiation Panel and a member of the Advisory Forum for the Development of RN Personnel as well as an Advisor to the Health Council of the Netherlands. He has also been a member of the Editorial Board of the Journal of Sound and Vibration.
Internally at the University of Southampton, he has been a member of Senate, Council and Court, and for the Hampshire TEC a member of the Higher Education Task Group.
Chris became President of the Institute of Acoustics in 1988 and successfully steered the Institute through a difficult period in its development. In 1991, he received an Honorary MD from the University of Turin.
Throughout his academic life, Chris has been a very active researcher, and has supervised research contracts covering a variety of topics in acoustics but particularly ones concerning impulse noise, noise induced hearing loss, environmental noise annoyance, audiology and underwater acoustics. He has published many significant scientific papers, supervised postgraduate researchers and been a member of many conference organising committees.
The Institute of Acoustics is pleased to award an Honorary Fellowship to Professor Christopher George Rice for his significant contribution to acoustics and outstanding service to the Institute.

Rayleigh Medal 2003

Prof Dr-Ing. Hugo Fastl

Hugo Fastl's first degree was in Music, from the Academy of Music of Munich, closely followed by a degree in Electrical Engineering from the Technical University of Munich.
It has been said that, in these early days, he was at something of a crossroads and could have become either a professional musician, being a highly accomplished player of the double bass, or an engineer. Thankfully his solution was a wide-ranging career in acoustics, and in particular in psychoacoustics – but the music has never been far away.
His Doctorate was completed in Munich in 1974; he became an Academic Director at the Technical University in 1987 and Professor of Technical Acoustics in 1991.
He worked closely with the late and much-missed Professor Zwicker for many years making pioneering psychoacoustic experiments on concepts such as loudness, sharpness and roughness. His many influential publications include the

book (with Zwicker) *Facts and Models in Psychoacoustics*. Perhaps his most important contribution has been in putting the psychoacoustic concepts and models into practical application, with, for example, the first analogue meter, and then the digital loudness meter. These developments put vital tools into the hands of noise control engineers, and have formed the basis for the field of sound quality. He has shown continued leadership in efforts to standardise methods and metrics through ISO, the German DIN organisation, and American National Standards Institute (ANSI).
He has held a wide range of extra-mural positions including the Boards of Directors of the International Institute of Noise Control Engineering and the Acoustical Society of Germany (DEGA).
He has been Guest Professor at Osaka University in Japan and at the Technical University of Lyngby in Denmark.
He has been given a number of Awards including, in 1998, the Research Award of the Japan Society for the Promotion of Science
The Institute of Acoustics is delighted to award the Rayleigh Medal for 2003 to Professor Dr-Ing Hugo Fastl for his outstanding and lasting contributions to acoustics, in particular his leadership in psychoacoustics and his pioneering work on sound quality.



Prof Dr-Ing. Hugo Fastl (right) receives the Rayleigh Medal 2003 from the President, Geoff Kerry

Examination results

Certificate of Competence in Environmental Noise Measurement

Liverpool
Bergus A J
Bradley R
Cookson R D
Haron Z
Hillary J D
Hunt M J
Nicholson A J
Pollitt R J
Silverster A
Steele H J
Sykes, R D
Tiffin R J N
Turner P J
Yates C J

Colchester
Bass D J
Kirtley I
Walther B
Wood M

NESCOT
Brown F C
Goodhand C D
Johnson L J
Palmer R J
Vine M D

Derby
Davis S J
Eames C S
Forster J H
Leighton M J
Pollard S J P

Bristol
Brown S M
Carne B B E
Gibbs A W
Roberts S G
Thomas D

Bell College
Crothers L
Flood C
Gilchrist W
Graham I
Lindsay S
MacPhail N
McGuigan K
McQuarrie G
Murray D
Sanderson P J
Skinner Z L
Smith A

Leeds
Ball J S
Cross D B
Kears M R
Powell S A

Birmingham
Cane A R
Cooper A K
Dimmick R A
Fowler C E
Griffiths M J
Hall A J
Thomas T S

New Members

At Council meetings on 12 December 2002 and 20 March 2003 the following were elected to the membership grades shown

Fellow
Fleming, C
Kang, J
Macey, P C
Wright, M C M

Member
Atkinson, D J
Chan, C W
Chong, F
Copley, L D
Duncan, P J
Dunne, J D
Greenhalgh, M J
Griffiths, K F
Ham, S R
Holden, A P
Hornby, G
Housley, R J
Howell, J A
Kirby, L D
Lawrence, M R
Leung, C F
Leung, W Y K
Maddock, P
Muir, D A
Or, W S
Powlson, J G
Quick, S C
Quinn, D
Richardson, J R
Ross, C D
Sadiq, Z
Shade, N T
Simpson, C R
Steel, C
Stuart-Moonlight, B I
Watson, R
Wong, H W
Wood, C

Associate Member
Abbott, H M
Arthur, A
Beamish, L D
Broadbent, C E
Calvert, D M
Chinelis, T
Connor, P M
Darling, S J
Drury, R
Eaves, L M
Frost, D
Fruteau, E J
Gatland, C D
Goodman, R C
Heal, C J G
Herries, D L
Houldsworth, S
Huston, R J
Jones, N D
Keegan, M J
Lawrence, D J
Leslie, K
Matthews, I P
Murray, B A
Naylor, M J
Ni Eidhin, C
Pacey, C J
Parry, G
Phillips, G
Pilla, P
Pritchard, W
Tate-Harte, E E
Thwaites, P
Turnbull, N R
Wallbank, I J

Associate
Daltrey, D J
Huggard, R J
Palmer, D E
Peakall, S J
Walden, M J

Student
Billis, G
Trow, J W

Sponsors

Arup Acoustics
Sponsoring Organisation
Wardle Storeys (Holdings) Ltd
Sponsoring Organisation
London Borough of Brent
Institutional Subscriber
States of Jersey
Institutional Subscriber

Editor's Notes

Ian F Bennett BSc CEng MIOA
Editor

My brief as Editor is to give publication space to what I like to call the more esoteric branches of our discipline. The issue you hold in your hands is the public face of that commitment, with technical contributions on a few subjects we 'mainstream' acoustic consultants rarely, if ever, encounter. It is a source of constant amazement that a scientific discipline able to enhance the highest musical achievements is also able to help us find fish in the planet's oceans, map the seabed, and perform functions central to what we perceive as our national security. My thanks, as always, go to all our contributors for making possible the fascinating (I hope) reading matter that drops through your letterbox every other month.

Unfortunately, mistakes do sometimes creep in, and not all the content pleases all the membership all the time. I would like to thank several individual members (you all know who you are!) for pointing out that there were one or two typographical errors in the last issue's piece about the European Noise Directive. Different software suites are not always mutually compatible, and we do try to spot any substituted characters at the proof-reading stage of production, but I have found that Greek letters give us particular grief. Quandoque bonus dormitat Homerus is my defence.

The Spring Conference at Coventry was an excellent meeting, both in terms of the quality of the papers and the opportunities for what we are apparently supposed to call 'networking'. Those like me who work for small consultancy practices are very appreciative of these opportunities to discuss successes and failures with their colleagues: perhaps those who work for larger organisations sometimes take 'peer review' for granted. Roll on the Autumn Conference!

Could I make a public appeal to all meetings organisers, and secretaries of Groups and Branches, to ensure that they have provided meeting reports for any events held over the last few months? As you can see from the Annual Report, 43 meetings, conferences and workshops were held in 2002, but nothing like that number of reports appeared in the Bulletin. Copy for the September/October 2003 issue should reach me by 8 August, but please feel free to suggest articles or themes for future issues too. We are already planning for 2004.

Ian Bennett

LONDON BRANCH REPORT

The Mayor of London's Ambient Noise Strategy

This one-day meeting at The Royal Society on 30 April 2003 attracted over 40 delegates who came to hear details of the draft ambient noise strategy. The meeting included a discussion at the end of the day to form the Institute's response to the strategy.

Max Dixon and **Alan Bloomfield**, from the Greater London Authority, started by explaining that in an ideal world a strategy would start with an assessment of the current situation. Owing to a shortage of evidence for some aspects of noise in London, the strategy has been written as a toolkit of ideas. In order to select those with the greatest benefit more information was required.

Three key issues were raised:

- Good noise reducing surfaces on Transport for London's roads;
- Night aircraft ban across London; and
- Better planning and design of new houses

They identified that more information was needed on noise across the whole of London and on the aspirations and attitudes of Londoners.

Colin Grimwood (BRE) gave a paper on noise in London, past, present and future. He drew on the 1960's *London Noise Survey* and the London data from the 1990 and 2000 *National Noise Incidence Surveys* to show that noise trends in London were different from those in England and Wales. For the majority of indices, A-weighted noise levels in London are 1-6 dB higher than elsewhere in England and Wales, owing to higher noise levels at the quieter sites. He showed that the night-time quiet period in London had shortened from more than five hours in the 1960s to only a couple of hours nowadays.

The Strategy has been written as a toolkit of ideas

Prof Stephen Stansfeld (Queen Mary University of London) talked about the health effects of noise in London. He discussed how noise may affect verbal memory, influence the selectivity process and alter the choice of task strategy. In relation to social behaviour noise may lower the mood, interfere with communication, divert attention from social cues and influence judgement. He indicated that it would be relatively easy to incorporate health questions into a noise attitude survey questionnaire.

Dr Mike Fillery (Symonds Group) began by discussing how a quiet area is defined. If it means 'no noise' then it is easy to quantify, but difficult to find: if it means 'an area of benign calm that is conducive to relaxation and enjoyment' then other factors need to be considered. He identified dangers for quiet areas, which include that most of the attention is focused on reducing the highest noise levels, diverting attention away from the quiet areas. This trend will route traffic through existing quiet areas since these have a low population.

Emma Clarke (Camden Council) discussed a pilot Environmental Management Zone scheme in Camden to improve management of areas which are popular in the evening. She described the situation where there are evening entertainment venues near residential properties, and this raises a series of issues since there is a need to protect the sensitive uses of land.

Roger Tompsett (Atkins Noise and Air) talked about both road traffic noise and noise mapping. Road traffic noise is the most widespread source of noise and related annoyance in London; traffic has tended to grow at those times which used to be less busy, so that there is less relief from noise. He discussed mitigation measures for road traffic noise including quieter vehicles; traffic reduction and routing; quieter, smoother, safer driving; and better street works and maintenance. Noise mapping addresses the continuous drone of traffic noise, but does not address individual events. Roger demonstrated a series of noise maps showing how noise propagates under different conditions, and how different assessment values can be shown.

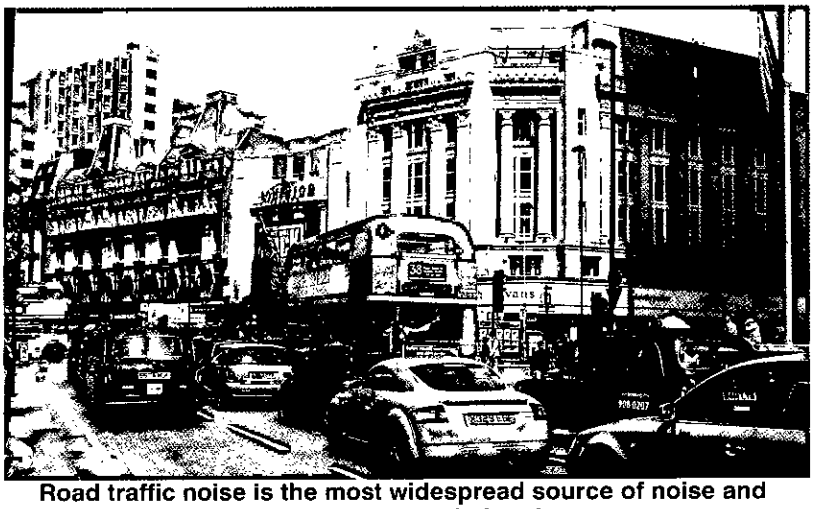
Rick Jones (AEA Technology) talked about railway noise, which consists of airborne noise, groundborne noise and re-radiated noise. He discussed the generation of airborne noise, which in this country is driven by the combined roughness at the wheel/rail interface. The noise is controlled by ensuring that smooth wheels are in contact with smooth rails. He discussed the effectiveness of wheel shields and trackside barriers and the reduction of wheel squeal on curved track. For traction noise from locomotives, the problem is one of gauge size, because there is not enough space to fit the engine and noise reduction measures in such a way that the trains can still get through bridges and tunnels.

Stephen Turner (Casella Stanger) gave the last of the day's presentations by discussing aircraft noise. This is a difficult issue for London, and aviation presents some of the starkest tensions between environment and economy. He discussed the question of whether aircraft should be contained within a small number of routes, or dispersed over a wider area to give some communities some periods of respite. There is a balance to be struck between affecting a few people a lot, and a lot of people not so much.

Discussion

The day concluded with an open discussion about the issues raised by the GLA and the speakers. This started by debating the L_{DEN} index for noise mapping, and asking if this was the best choice of index, since the most appropriate index for a particular effect may not be an L_{eq} based one.

The strategy aims to increase the evidence



Road traffic noise is the most widespread source of noise and related annoyance in London

base by measurements and surveys of noise in London and also to implement some pilot schemes to investigate and demonstrate some beneficial outcomes. It was seen as important that all the pilot schemes should include measurements and surveys before and after their implementation in order to assess their effectiveness.

The main targets of the actions have to be prioritised, and there were three suggestions for how this could be done:

- to reduce health effects;
- according to public demand; and
- according to the results of mapping or surveys.

It was argued that members of the public may complain about one type of noise and want action, but they were subject to other types of noise which had a bigger effect on their lives.

The opinion was expressed that if night flights across London were banned, there may not be a need to do anything about the daytime flights since people had what they wanted - a night ban.

It was the general view that significant improvements could be made in road traffic noise by filling in pot-holes and replacing wonky manhole covers, and generally improving the maintenance of the road network in London. Other benefits may be possible by improving the timings and flows through junctions to reduce queuing and congestion. This type of improvement would not show up on the noise maps. It was appreciated that the long-term benefits of thin wearing-course road surfaces was not known.

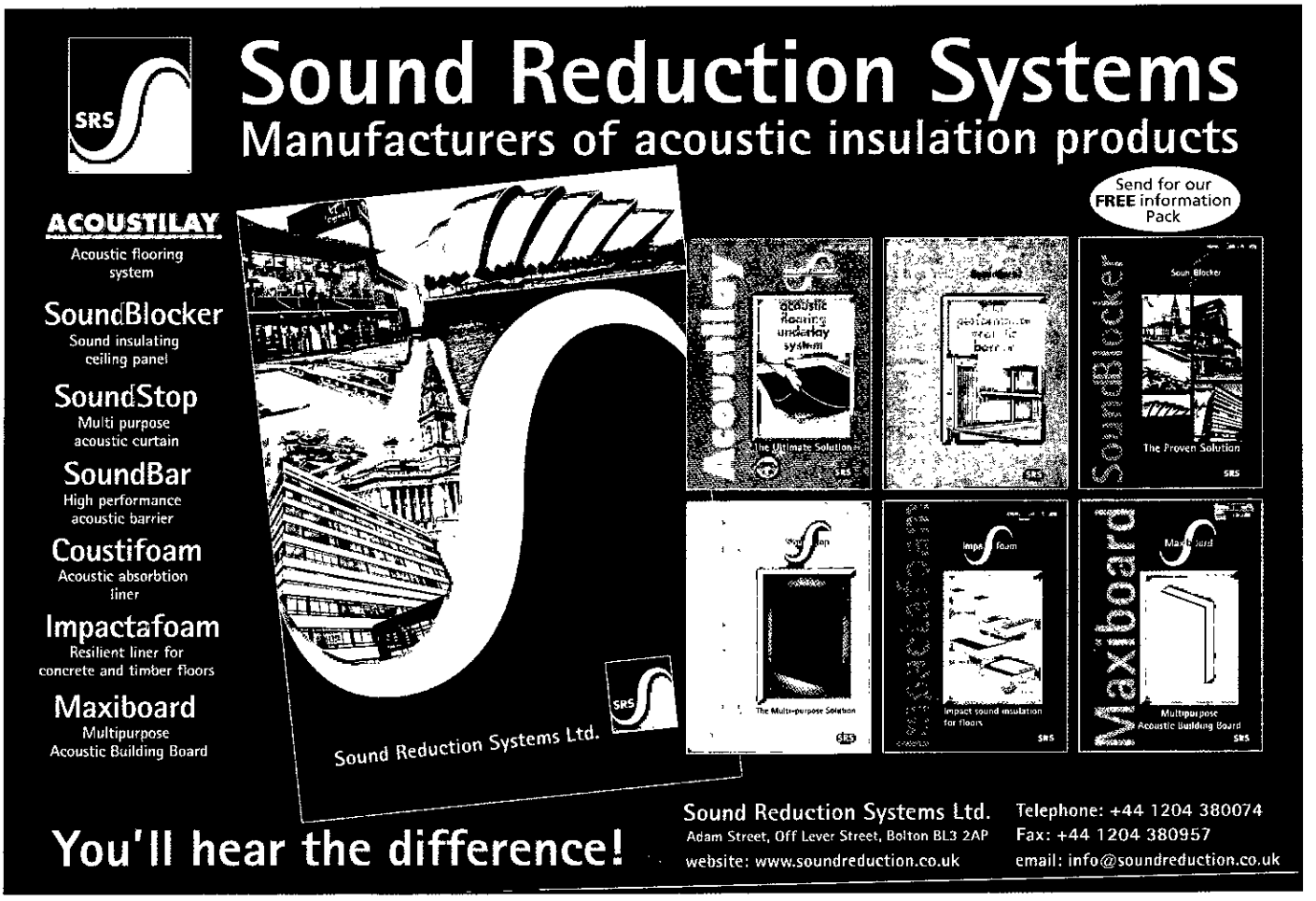
Use of the Noise Abatement Zone powers in connection with tranquil areas was also discussed. If there were a register of these areas, it would be useful as a flag for planning purposes and would be included in searches for sites and properties.

The strategy needs to tie in with other strategies and directives, and there is probably a need to trade between the different disciplines to get the best overall results. Each action or pilot project should consider its implications for sustainable development.

It was suggested that a forum or think-tank was needed to discuss the areas where the evidence base was lacking, and to develop packages for the best options for pilot schemes. This group should include representation from local authorities, the acoustics industry and transportation. It was thought that a rolling programme of studies to demonstrate worthwhile noise reductions would encourage more people to think about noise in design, and gain more interest and enthusiasm for noise, with a view to getting it embedded in city management.

In summary, the approach of the noise strategy was viewed positively. The policies and proposals within the strategy are positive and beneficial, and this allows them to be used when developing designs and management schemes.

Adam Lawrence MIOA



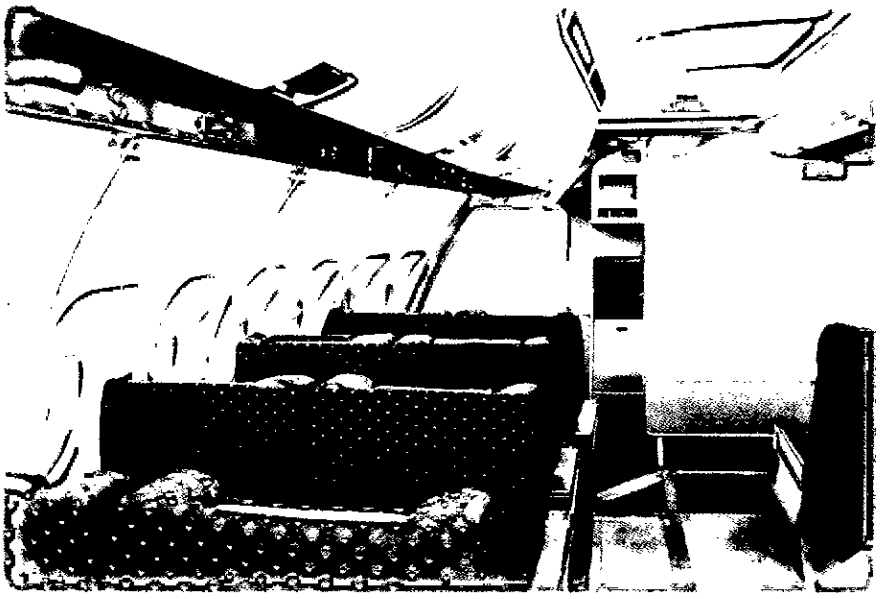


Fig 1: A300 main cabin interior

A new application of closed-loop time history simulation

Steve Coe, Geoff Murphy and John Seller MIOA

The use of multi-axis closed loop time domain simulation software has hitherto been confined primarily to ground vehicle road load simulation and earthquake testing. The advances in the speed of digital computers and data acquisition systems, combined with the use of miniature inertial shakers, has enabled the noise environment, as well as vibration, to be replicated in a passenger aircraft test facility. The technique could be employed to simulate the sound field inside other types of passenger vehicle.

In an innovative new application of closed-loop 'road' simulation, a Data Physics *SignalStar* Matrix multi-shaker vibration control system is being used at BRE Environment to simulate the sound and vibration environment inside a passenger aircraft. The simulator is used in studying many aspects of concern for the health of passengers and crew during flight. A realistic illusion of flying is created using miniature inertial shakers to create a controlled sound field radiated from the aircraft fuselage and larger inertial shakers to provide realistic floor vibration.

BRE is playing a leading role in two European projects that require an aircraft simulator: *Health Effects in the Aircraft Cabin Environment* (HEACE) and *Friendly Aircraft Cabin Environment* (FACE). These projects are funded under the European Commission (EC) Fifth Framework Programme and are being carried out by two international consortia. The aim is to improve the comfort and health of passengers and crew in cabins and cockpits of future European turbofan aircraft. The research addresses the environmental comfort parameters that depend on noise, vibration and air quality technology, and includes effects from multimedia use. The information gained from these projects will be translated into improved guidelines for future aircraft design.

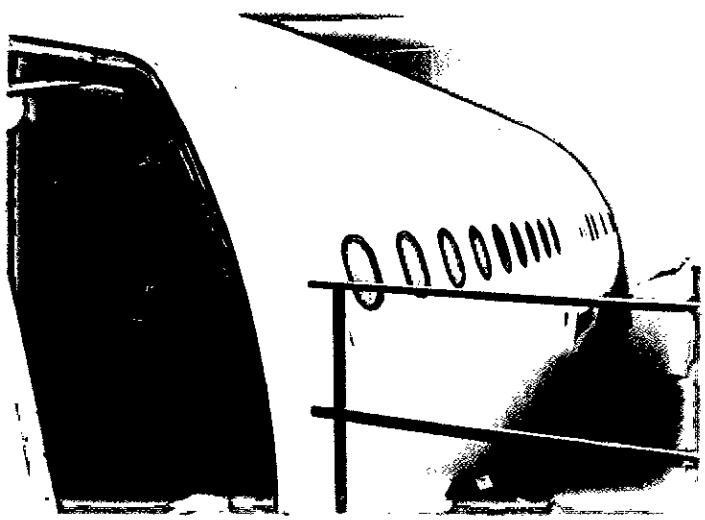
The front section of an A300 Airbus fuselage has been installed into a purpose-designed test facility to recreate (as closely as possible) the environmental conditions inside the main cabin and cockpit when cruising at altitude. This includes noise, vibration, air-conditioning, humidity and temperature, but excludes atmospheric pressure. Up to 48 passengers and flight crew are employed to be in the aircraft for the duration of typical flights (both long and short haul).

Operational areas of the cabin experience characteristic noise profiles. This means that the galleys and cockpit have individual equalised sound fields enabling health studies not only on the passengers but also on the flight crew. The effect of different noise and vibration levels forms part of the overall investigation into flight comfort.

Overview

The interior sound field is created with 38 miniature inertial shakers fixed to the structure of the aircraft. The skin of the aircraft fuselage acts in effect as a diaphragm which generates the required sound and vibration environment within the passenger cabin area and cockpit. The floor vibration is created using three Data Physics *SignalStar* large inertial shaker systems. An array of microphones

Fig 2: A300 fuselage section installed in the test facility



and accelerometers supplies the response feedback signals for control. The time domain reference data is edited from digital recordings taken during typical commercial flights. The sound fields inside the passenger cabins, galleys, toilets and cockpits are individually controlled to simulate as accurately as possible the actual noise in flight. The sound and vibration drive signals are pre-equalised before the 'flight'. In some 'flights' the sound and vibration profile is sectioned into different phases such as take-off, cruise and descent.

SignalStar Matrix testing procedure

1. Positioning of inertial exciters around the aircraft

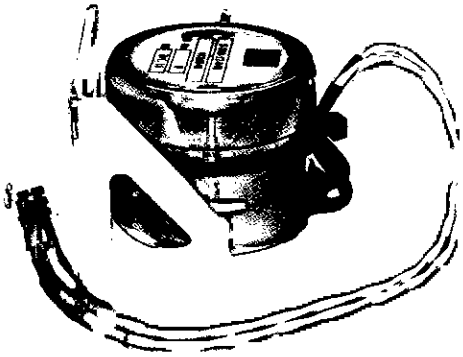
Positioning of the miniature inertial shakers (*Figure 3* and *Figure 4*) was a critical element of the installation. The sound field must be even and realistic throughout the simulator. In actual flight, the majority of the noise in the cabin is radiated from the structure, therefore the best way to simulate it is to replicate real life by injecting vibration into the structure and performing closed loop control based on the acoustic noise produced. Many of the miniature inertial shakers are fixed in a radial direction on brackets attached to the structural frames of the aircraft, close to the windows. Exciters are also positioned on the supports of the overhead luggage bins and in the fore and aft galley areas, cockpit and toilet. Three large (200 newton) inertial shakers are attached to the floor panel supports beneath the main cabin to simulate floor vibration. Two sub-woofers enhance the effect of the low frequency noise.

2. Import of digital data recorded in the real environment into the control system

Noise and vibration data is recorded in various passenger aircraft during typical flights on a portable digital tape recorder at an initial sampling frequency of 48KHz. Selected sections of this data are then exported either as WAV files or text files as required.

3. Reference signal preparation

The recorded airborne noise and floor vibration time histories are calibrated and edited before they are ready to be replicated by the *SignalStar* Matrix control software. This process also ensures that unwanted sections such as speech are removed. *SignalStar* pre-processing and post-processing software is used in conjunction with a proprietary music editing package to cut the time series into segments, and to filter the data to prevent the signal exceeding the displacement and frequency limits of the shakers. Since the frequency bandwidth of the mini-shakers is 4kHz, the volume of data can be reduced by re-sampling from 48kHz down to 12kHz. Sequences are created for different parts of the flight, such as take-off, cruise and landing. A sequence can be played just once or repeated many times by the Matrix software; so, for example, a few minutes of steady-state cruise data can be played hundreds of times to recreate a full flight profile of several hours. Different sequences are cross-faded and mixed together smoothly by the control software in real-time as they are played out.



Above: Fig 3 miniature shaker fixed to inner fuselage

Left: Fig 4 miniature inertial shaker in close-up

4. Pre-test and transfer function matrix calculation

The speed of equalisation and accuracy of the simulation is dependent in the first instance upon the quality of the transfer function matrix measured during a multi-shaker pre-test. The pre-test is run at a low level using bursts of random noise.

To assure the feasibility of the $[G_{xx}]$ matrix inversion in any situation, the drive signals are uncorrelated random signals. The power spectral density of this data can be adjusted depending on the test conditions. Several bursts are output to allow averaging.

5: Initial drive signal calculation

Drive signals are derived initially using the transfer function matrix and the references prepared in steps *2* and *3*. The drive signals are calculated block by block. The size of the block is a power of 2 to allow Fast Fourier Transform processing.

Drive signal preparation is stopped when the control signals are close enough to the required references. Accuracy criteria are specified to estimate the quality of the fits.

6: Feasibility checking

Before running the full test a feasibility check may be done to verify that the exciter limits will not be exceeded and that the equipment parameters will meet the demands of the test specification.

7: Run the test

After the preparation stages, the test is run at full level. Full tolerance and abort limits can be defined

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A new application of closed-loop time history simulation

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to protect and monitor the test progress, aborting if the maximum preset limits are exceeded. During the simulation further refinement continues to achieve the best possible control and equalisation. Drive signals, control and channels of measured time history data are continuously stored for recall and post-process.

Correction algorithms

Two different methods are used to adjust the drive signals in order that the control responses are a 'best fit' with the required references.

Method 1: Transfer function matrix correction

This technique involves modification of the current [H] matrix from the new set of responses of the control channels compared with the new set of drive signals: $[H]_{nxn} = [G_{xy}]_{nxn}.[G_{xx}]^{-1}{}_{nxn}$. Checks are made on the $[G_{xx}]$ matrix to verify that it may be inverted. The advantage of this method is that it provides a continuously updated function, but sometimes problems of control divergence occur when the reference signals contain areas of zero response in the frequency bandwidth resulting in excessive noise in the transfer function at those frequencies. If the transfer function matrix correction method is not feasible, the correction can be executed with a different method, time domain error correction.

Method 2 : Time domain error correction

Error is calculated from the difference in time domain between the references r(t) and the control responses c(t). This method does not suffer from the problems caused by areas of zero response in frequency domain, since it operates entirely in the time domain.

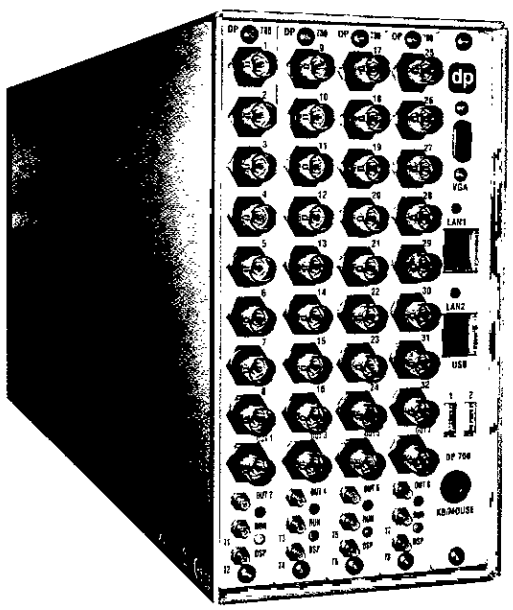

Fig 6: ABACUS DSPcentric data aquisition system used in SignalStar Matrix controllers

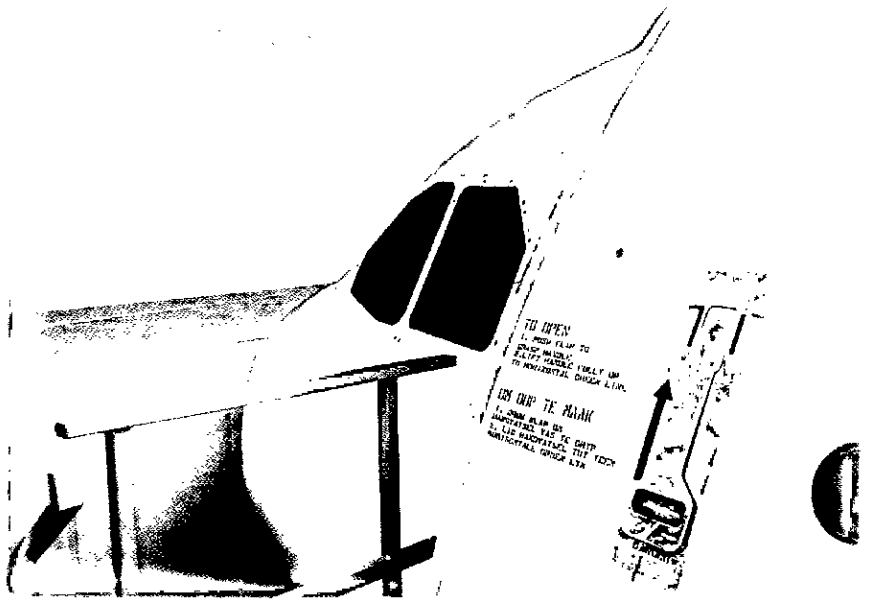

Fig 5: A300 cockpit

The advantage of time domain error correction is it permits zeroes in the frequency bandwidth of the references and does not require a new inversion of the matrix. In other words, the [H] matrix which is used is the one obtained after the pretest without any updating. This method requires a good estimation of the initial [H] matrix. Methods *1* and *2* described above are combined to provide an optimum result.

Convergence criteria

The user decides when to stop the correction of the drive signals using one or all of the following error criteria: RMS value, average value, variance, minimum value and maximum value.

SignalStar time history simulation control

Many vibration tests use general vibration control techniques such as random or swept sine excitation. Certain types of testing demand precise creation and control of specific time histories to truly characterise the operational environment. Replication uses field measured time history signals as a reference for the vibration test. Typical uses are to perform controlled investigations of automotive vehicle durability and dynamics, or simulation of earthquake vibration on multi-axis hydraulic test rigs. In the application described here, replication software is being applied to the problem of reproducing both the vibration and noise profile inside an aircraft cabin. The *SignalStar* system provides multi-shaker excitation and control of both amplitude and phase, including compensation for cross coupling between the different exciters.

Steve Coe *and* **Geoff Murphy** *are with Data Physics (UK) Ltd and* **John Seller** MIOA *is with the Building Research Establishment Acoustics Centre*

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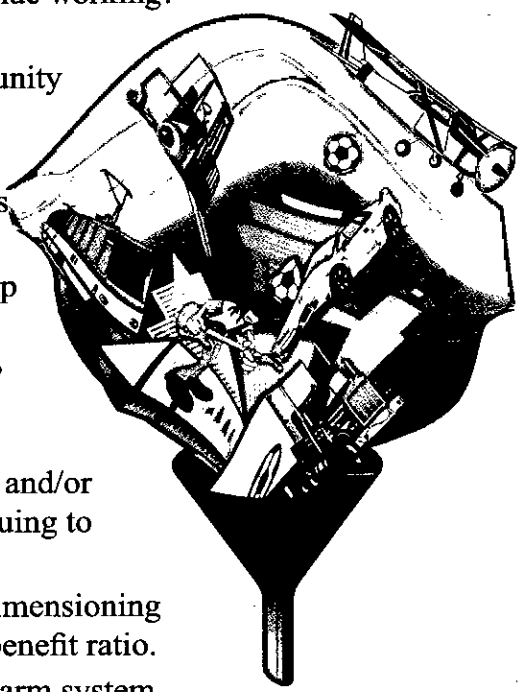

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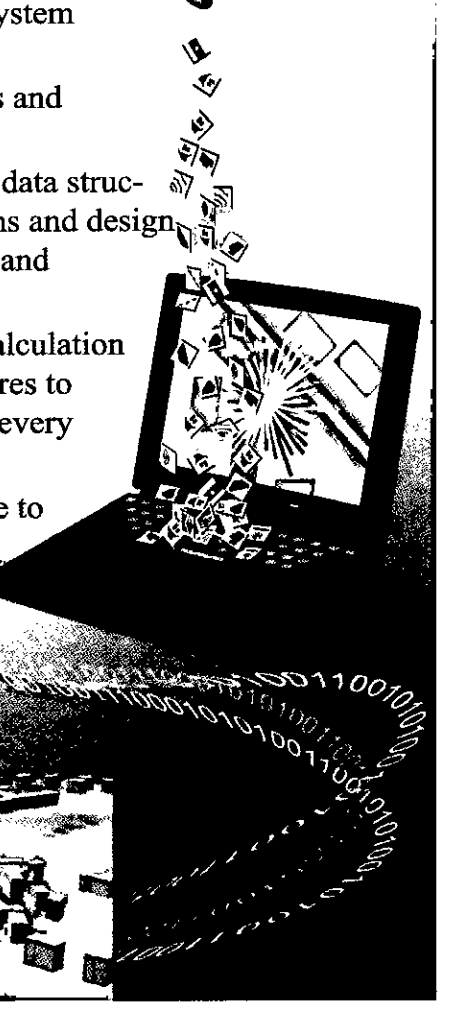

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Wall vibrations in musical wind instruments

J W Whitehouse, D B Sharp and T J W Hill

When a musical wind instrument is blown, its air column begins to vibrate. The air particles within the instrument oscillate backwards and forwards and a note sounds. It is generally accepted that the pitch and timbre of the note produced are largely dependent on the relative strengths and frequencies of the air column resonances. However, blowing a wind instrument also causes the walls of the instrument to vibrate. Whether or not such wall vibrations perceptibly affect the tonal quality of the instrument remains a subject of debate.

This article describes experiments designed to study the wall vibrations of a simple brass instrument. This simplified experimental instrument consists of a Denis Wick trombone mouthpiece coupled to a 70cm long section of brass pipe, with a 14mm external diameter and 0.5mm wall thickness. To begin with, by using a mechanical source to excite the instrument through a range of frequencies and by measuring the velocities induced in the walls, the instrument's structural modes are identified. The instrument is then blown and the vibrational response measured and compared with the instrument's structural mode shapes and frequencies. Finally, the mechanism by which blowing the instrument excites wall vibrations is investigated.

Structural modes of a simple brass instrument

To determine its structural modes, the simple brass instrument was rigidly clamped at each end around its circumference and fixed horizontally on an anti-vibration table housed in an anechoic chamber. It was mechanically driven at a position close to the mouthpiece using a shaker with a needle attachment at discrete frequencies over a range of 10 Hz - 1 kHz. At each frequency, the velocity amplitudes at 3cm intervals along the instrument were measured using a laser doppler vibrometer *(Figure 1)*.

Figure 2 shows a two-dimensional contour plot of the variation in velocity amplitude with frequency along the length of the instrument. The first four structural modes of vibration, located at 90Hz, 255Hz, 520Hz and 835Hz, can be clearly distinguished.

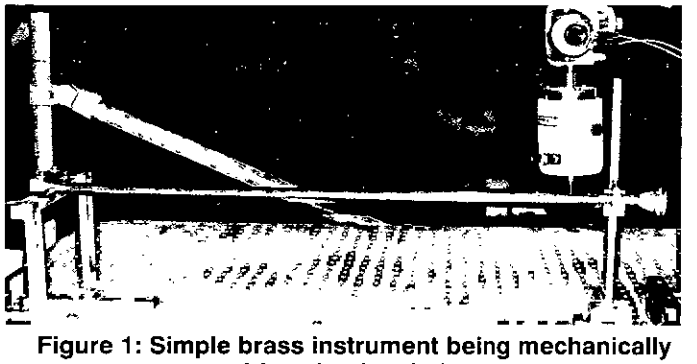

Figure 1: Simple brass instrument being mechanically driven by the shaker

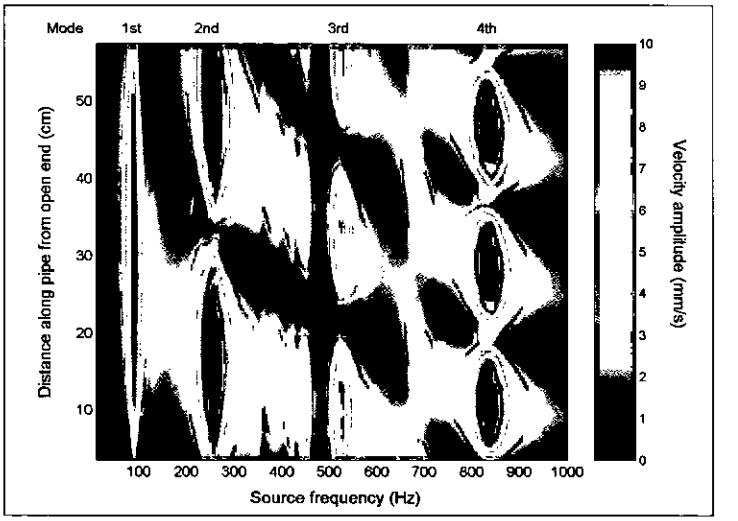

Figure 2: Velocity amplitude variation as function of frequency along the simple brass instrument when driven by a mechanical shaker

Measuring the wall vibrations induced by blowing the instrument

To measure the vibrations induced in the walls of the instrument when blown, the shaker was removed

Figure 3: Simple brass instrument being blown by artificial mouth

and the simple brass instrument was attached to an artificial mouth *(Figure 3)*. This is a mechanical device that comprises a pair of water-filled latex rubber lips through which air is blown. It is designed to mimic the playing action of a human musician but has the advantage of being able to sustain notes for long periods.

When the air supply to the artificial mouth was activated, the instrument produced a stable note which spectral analysis revealed had a strong fundamental at 365Hz and a weak second harmonic at 730Hz. The laser doppler vibrometer was used to measure the velocity amplitudes at 3cm intervals along the instrument whilst it was being artificially blown. These measurements revealed that the walls also vibrated strongly at a frequency of 365Hz and weakly at a frequency of 730Hz. *Figure 4* shows the velocity amplitude variation along the length of the instrument induced by the artificial mouth at these two frequencies.

To check whether these velocities are comparable with those induced by a musician, a human player

attempted to attain a note of similar frequency and loudness. Wall velocity measurements were then carried out as described previously. Again, the walls were found to vibrate strongly at a frequency of 365Hz and to a lesser extent at 730Hz. *Figure 5* shows the velocity amplitude variation along the instrument induced by a human player at these two frequencies.

Comparison of *Figures 4* and *5* reveals a good agreement in the shapes and amplitudes of the velocity variations, especially at 365Hz. This would appear to confirm the acceptability of using the artificial mouth when measuring the wall vibrations induced when an instrument is blown. The difficulty that the human player had in producing notes of similar loudness and quality is evident when the two graphs are compared. The constant output of the artificial mouth results in the much smoother variation in velocity amplitude along the instrument. The artificial mouth removes the problems encountered when using a human player, such as

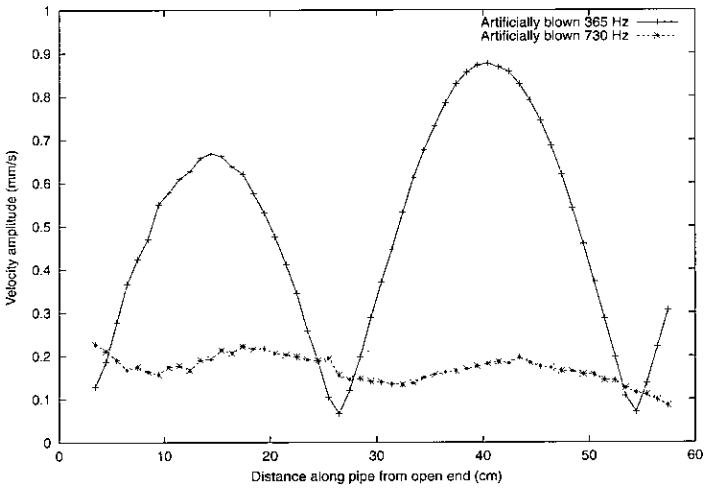

Figure 4: Velocity amplitude variation along the simple brass instrument when blown by artificial mouth. Measured at 365Hz and 730Hz

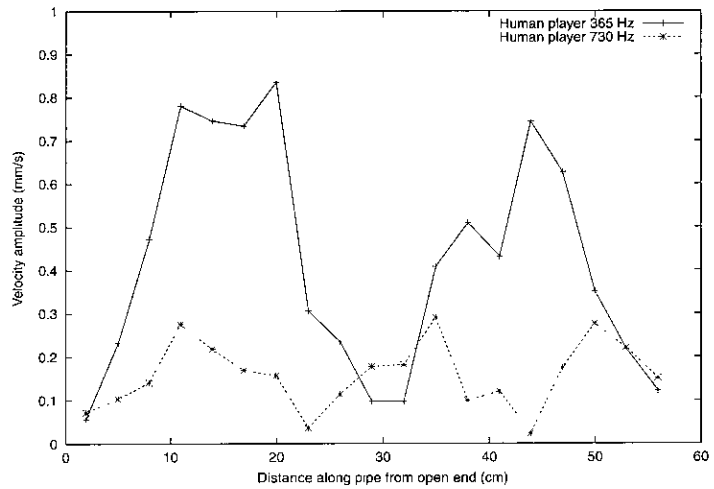

Figure 5: Velocity amplitude variation along the simple brass instrument when blown by a human player. Measured at 365Hz and 730Hz

the introduction of unavoidable movement into the system and the inability to repeat and sustain notes over long periods.

By comparing *Figures 4* and *5* with *Figure 2*, the velocity amplitude variation at 365Hz induced when

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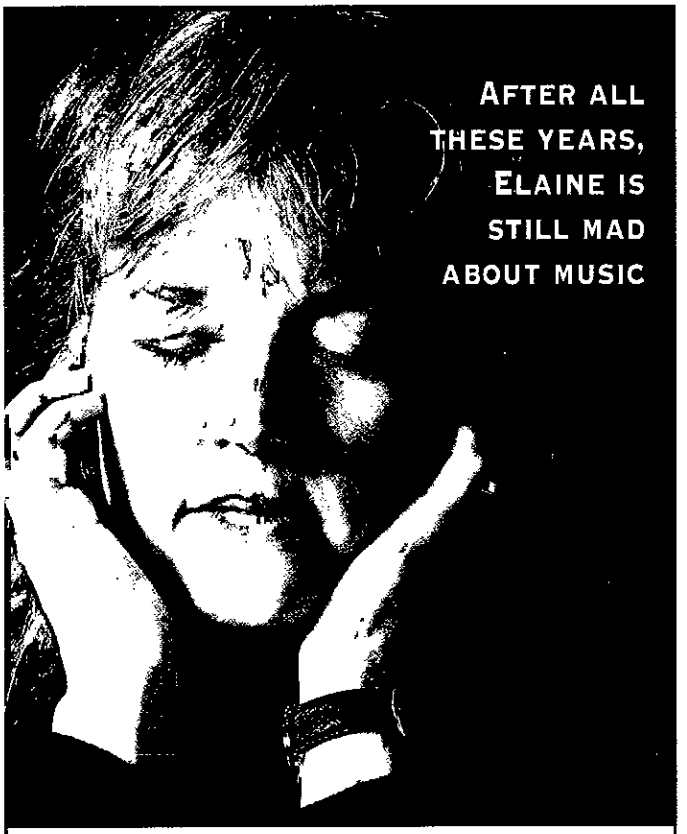

Elaine loves listening to music, sometimes she even likes to watch TOTP with her kids, but what she doesn't like, is having music forced on her at two in the morning while her children are trying to sleep.

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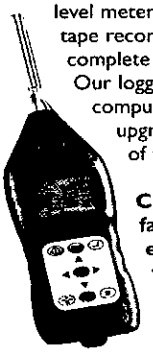

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Wall vibrations in musical wind instruments

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the instrument is blown can be seen to match the shape of the structural response of the instrument at the same frequency. At 730Hz, the velocity amplitudes induced when the instrument is blown are smaller. This is mainly because the structural response at this frequency is quite weak.

Excitation mechanism for wall vibrations

The experimental results presented so far in this article show that when a wind instrument is blown, the walls are excited at frequencies that match those of the air column resonances. This excitation could be a result of direct coupling between the air column and the walls of the instrument. That is, air pressure changes within the instrument could be providing a driving force to excite the walls into vibration. However, the excitation could also be caused by the motion of the lips, which are in contact with the pipe through the mouthpiece. Certainly the strong coupling between the air column and the lips does mean that the lips end up oscillating at, or close to, the resonance frequencies of the air column.

In order to determine the dominant excitation mechanism, two experiments were carried out. The first was designed to decouple the air column from the walls of the instrument. The second was designed to decouple the lips from the walls of the instrument.

Decoupling the air column from the instrument's walls

To decouple the air column from the walls of the instrument, an aluminium pipe (again 70cm long but with an external diameter of 9.5mm) was inserted

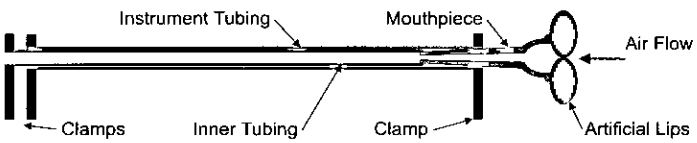

Figure 6: Schematic diagram of the simple brass instrument with an inner tube to decouple the air column from the instrument's walls

inside the brass pipe. This inner pipe was connected to the mouthpiece so that it behaved as the acoustic resonator *(Figure 6)*. This ensured that pressure changes within the air column were prevented from acting on the outer pipe. In this new configuration, the instrument was artificially blown and the velocity amplitude variation along the instrument was measured as before.

Figure 7 shows the velocity amplitude variations along the instrument induced by the artificial mouth at 365Hz and 730Hz. The plot shows velocity amplitudes similar to those measured when the brass pipe is normally coupled to the mouthpiece *(Figure 2)*, despite there being no interaction with the air column. This indicates that it is not pressure changes within the air column that excite the wall vibrations.

Decoupling the lips from the instrument's walls

To decouple the lips from the walls of the

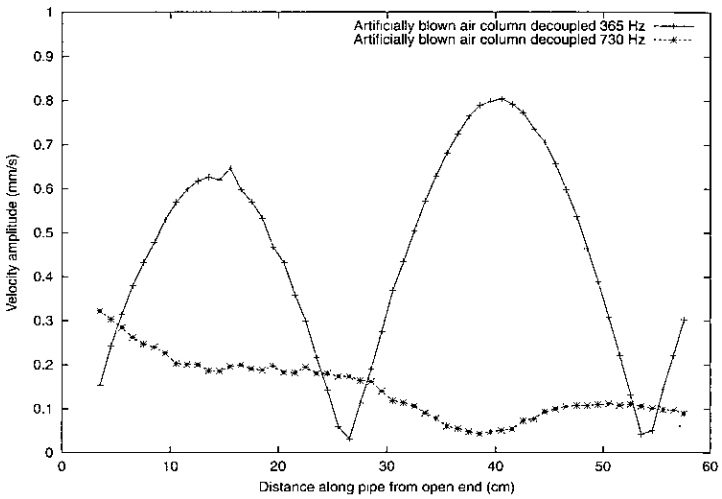

Figure 7: Velocity amplitude variation along the simple brass instrument when artificially blown with the air column decoupled. Measured at 365Hz and 730Hz

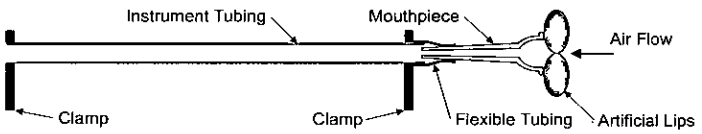

Figure 8: Schematic diagram of the simple brass instrument with flexible tubing to decouple the lips from the instrument's walls

instrument, a short length of flexible tubing was inserted between the brass pipe and the mouthpiece *(Figure 8)*. This reduced any vibration transmitted from the lips to the instrument walls without significantly altering the strengths and frequencies of the air column resonances. The instrument was again artificially blown and the velocity amplitude

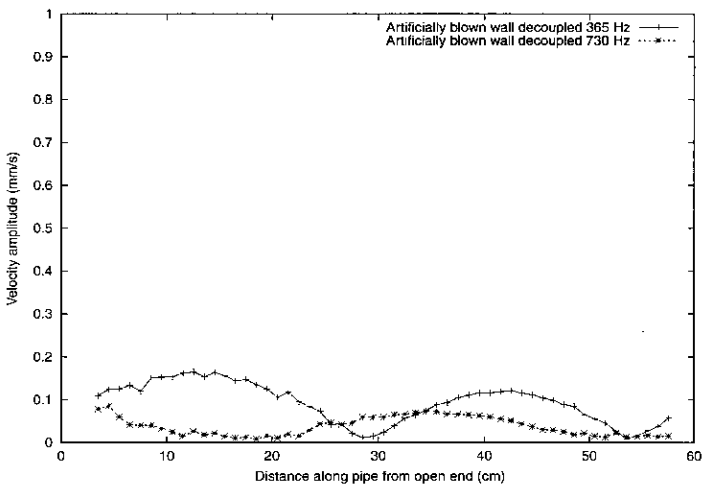

Figure 9: Velocity amplitude variation along the simple brass instrument when artificially blown with the lips decoupled. Measured at 365Hz and 730Hz

variation along the instrument was re-measured.

Figure 9 shows the velocity amplitude variations along the instrument induced by the artificial mouth at 365Hz and 730Hz. The plots show a reduction in the induced velocity amplitudes compared with those measured when the brass pipe is normally coupled to the mouthpiece *(Figure 2)*. The effect

is most dramatic at 365Hz, indicating that at this frequency especially, the motion of the lips against the mouthpiece is the dominant mechanism by which wall vibrations are excited.

Concluding remarks

This line of research has so far provided useful insight into the size of the wall vibrations induced when musical wind instruments, in particular lip-reed (brass) instruments, are blown and the mechanisms by which these vibrations are excited. It is not yet clear whether the wall vibrations are of large enough magnitude significantly to affect the sound produced, either by direct radiation or by perturbation of the sound field within the instrument. If they are, this may go some way towards explaining why some musicians and instrument makers claim that particular materials give rise to particular timbres and playing qualities.

Work is currently being carried out to determine how the magnitude of the wall vibrations depends on the material from which the instrument is manufactured. Psychoacoustical tests are then planned to ascertain the extent, if any, to which listeners can discern differences between notes produced by instruments of different materials. It is hoped that by combining the results of these tests and the acoustical measurements described in this article, we will be in a position to unravel and dispel some of the problems and misconceptions that are quite often found surrounding musical instrument construction and performance.

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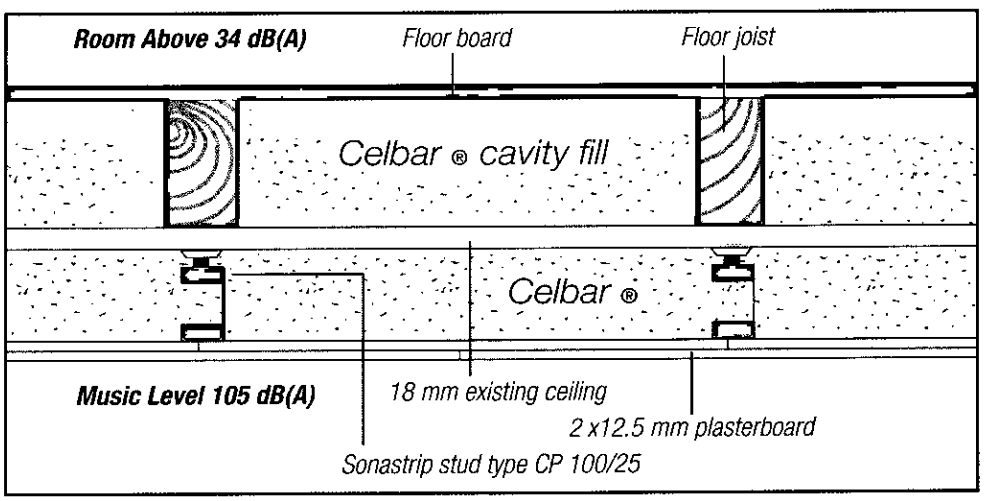

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techniques and applications

J M Bell, G R Elston and S Reed

Modelling is widely regarded as playing a critical role in enhancing understanding of underwater acoustics. It can aid in the development and testing of new processing techniques and algorithms by providing fully 'ground truthed' data sets, as well as assisting in the planning of experiments, the design of new equipment and the training of operators. This broad range of potential applications has differing requirements on the modelling, including the accuracy required, ease of use, flexibility and computation time.

To fulfil these wide ranging roles two complementary methods of simulating and visualising the sonar process have been developed. The first approach concentrates on developing the most accurate model possible which includes all the deterministic aspects of the sonar process. It is based on finite difference time domain modelling, which offers the advantage of treating the whole problem inherently. The technique, known as pseudospectral time-domain modelling (PSTD), is an accurate and efficient scheme for solving the acoustic wave equation numerically. It is capable of modelling highly complex environments, producing very accurate synthetic signals directly in the time domain.

The second approach, based on ray tracing, provides a more operationally-based approach but can provide realistic simulated sonar images and signals. This model has the flexibility to introduce a number of approximations thus decreasing the computational demands whilst attempting to maintain reasonable levels of accuracy. An overview of these two approaches is presented, illustrating their complementary nature and indicating the future for a hybrid approach combining the advantages of each technique.

Both models have a broad range of potential applications and have already found widespread application in the development and testing of novel image processing algorithms for improved interpretation of sonar images. Examples of these applications are presented to illustrate the significance of the models on future research in underwater acoustics.

Model requirements

The modelling aimed to simulate the entire sonar process through modelling the underlying physical processes. The main interest was in high frequency imaging sonars and in particular the production of synthetic data in the form of signals and images, which are directly comparable with the output of the real sonar. To provide the most general structure for the model, it was desired to model the element level data. This could then be beamformed to represent any active sonar including sidescan, forward looking, bathymetric and synthetic aperture.

The models must be capable of representing the principle deterministic and stochastic aspects of the sonar process. In particular, the models must calculate the propagation through a refractive water column with a user-specified sound velocity profile and the scattering at complex rough boundaries (both seabed and sea surface). The transducer characteristics should also be specified, including the number and dimensions of each element, the pulse shape and frequency and the motion of the transducer with six degrees of freedom. In addition, the ability to include objects on the seabed or in the water column further extends potential applications of the models.

Modelling techniques

Given these requirements, there are several possible techniques which could be employed to create a general coherent sonar model. Central to any approach is the wave equation and the choice of solution to it. The two most appropriate approximations to permit its solution are based on finite difference techniques and ray tracing.

Pseudospectral Time Domain (PSTD) modelling

The PSTD model is strongly related to finite-difference time-domain (FDTD) techniques. FDTD methods discretise the wave equation by replacing the exact differential operators with local difference approximations over a discrete space-time grid. This leads to a recurrence relation which relates the pressure at any point within the grid to the pressures at neighbouring points in both space and time. Iteration of this recurrence relation yields a numerical solution to the full spatial and temporal evolution of the acoustic field.

'Both models have a broad range of potential applications'

The most significant advantage of this technique is its inherent capability to calculate all aspects of the sonar process such as propagation, losses, refraction and other wave effects (including diffraction), and reflections and scattering at surfaces with appropriate boundary conditions. In addition, realistic source and receiver elements can be positioned anywhere within the scene and the time series obtained. This permits the calculation of a received signal across a distributed array.

The main disadvantage of the FDTD method is the huge computational effort involved in its calculation. Sub-wavelength/period discretisation is necessary (in both space and time) in order for the solution to remain stable. Typically, a minimum of 10 grid points per wavelength is required for a second-order scheme, although practically a much higher discretisation is required to minimise the numerical dispersion. The number of points per wavelength can be reduced by deriving a recurrence relation from a higher-order discretisation of the wave equation.

The PSTD method essentially represents

the 'infinite-order' limit of FDTD schemes. It remains stable and accurate up to the Nyquist limit of two points per wavelength. Simulations of larger environments and higher frequencies are therefore possible for the same computational load. The PSTD method also virtually eliminates the numerical dispersion associated with FDTD schemes. The major difference between the FDTD and PSTD techniques lies in the calculation of the spatial derivatives of the wave equation. Instead of approximating the spatial derivatives by local differences as for FDTD methods, the PSTD technique calculates them exactly using the global Fourier transform, since differentiation in the time domain can be replaced by multiplication by ik in the frequency domain, where k is the wavenumber; and i is the imaginary number.

In order to prevent the solution from wrapping around the boundaries due to the periodic nature of the FFT, the perfectly matched layer (PML) absorbing boundary condition (1) is employed at the exterior boundaries of the numerical domain. This PML also permits the termination of the calculations at the boundaries of the region of interest by preventing spurious reflections from the exterior edges of the numerical domain.

The PSTD scheme implemented solves a coupled first-order wave equation using a two-step recurrence relation (1, 2). To provide the required generality the user can specify fully all inputs to the model, including both the environmental and sonar operating characteristics. The input scene is a discretised version of the environment, where the material parameters (sound speed, density and absorption) are defined for all points in the grid representing the artificial world. Since the method is a direct numerical solution of the wave equation, an impedance contrast between materials causes reflection from and transmission through the boundary. It also causes scattering if this boundary is rough, thus calculating the total acoustic field within complex scenes including boundaries between regions with differing properties.

Ray tracing

The second model that meets the requirements described in section 2 is a ray tracing solution to the wave equation. This approach is analogous to ray tracing in computer graphics and permits the simulation of the sonar through modelling the acoustic pulse as a sequence of rays perpendicular to the expanding wavefronts. These rays are traced from the transmitter through the scene to their subsequent intersection with any objects or boundaries. At each intersection the back-scatter is represented by a ray returning to the transducer and the forward scattered energy is represented by a ray in the specular direction. This specular ray is traced on to any further intersections. The time taken for each ray and the pressure returned, taking into account refraction, propagation losses, scattering and the transducer directivity, is processed to form the returned signal for one ping. This processing is required to produce a time series with equally spaced samples (required for the generation of an output image). It takes into account rays with the same return time, periods of no returned rays as a result of shadow zones, and convolution of the resulting impulse responses with the transmitted pulse.

Since the transducer is assumed to be composed of an array of elements, rays must be traced to and from every element of the array. In addition, the transducer is in motion between the transmission and reception, so the returning ray trajectory for the back-scattered ray is not identical to the outward trajectory. The model therefore uses a novel vector approximation technique (3), which permits the approximation of the back-scatter ray trajectory from knowledge of the outward ray. The returning ray to the same element (and every other element) of the array can be calculated from tracing one ray accurately from the transmitter. The technique takes into account the motion of the transducer in all six degrees of freedom between the emission of the pulse (ray) and the reception of the returning signal.

'Contrasting approaches have led to the development of two very different simulation methods'

The accuracy of the model can be varied through altering the level of approximations present, mainly through variation of the number of rays to trace. If the total number of rays is simply reduced, the ray coverage of the scene may not be adequate and regions may falsely appear as shadows. However, the number of rays can be reduced in the case of a distributed array of several elements by tracing the rays from only a few elements and approximating the others. Typically rays from each corner element and the central element are traced. The back-scattered ray returning to every other element of the array can also be approximated from the trajectory of an outward ray from one element. At each reflection the specular ray is traced on through the scene, and the number of subsequent intersections to consider can be controlled.

The flexibility of the model permits the evaluation of each of these approximations for the scene in question and the set up of the model can be altered to meet the requirements of the simulation. If accurate element level signals are required, no approximations are used, but if a representative image is the desired output, the accuracy can be reduced without producing spurious effects detrimental to the quality of the output image. This greatly increases the scope of application of the model.

Comparison of techniques

These two contrasting approaches have led to the development of two very different simulation methods, each of which offers a range of advantages and disadvantages that arise directly as a result of the approximations inherent in its derivation.

The main advantage of the PSTD technique is its inherent ability to model all aspects of the problem and produce the output acoustic signal in the time domain as an integral part of its solution. This includes the representation of complex wave effects such as diffraction which cannot be modelled by ray tracing. The PSTD technique calculates the acoustic

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field over the entire scene at every time step. This permits the visualisation of the time-varying field and complex wave effects such as diffraction, scattering, transmission at boundaries and the effects of changes in sound speed.

In addition, since the acoustic field is calculated for the entire grid (scene), any point on the grid can be considered as a receiver and the field at this point recorded. This means that any number of receivers (with any number of elements) can be included with no computational overhead. Signals can also be injected into the field from any number of transmitters, with no restriction on their location. This flexibility permits the modelling of bistatic sonars or complex acoustic experiments, such as those to monitor seabed scattering and penetration.

The material properties can be varied for any point on the grid enabling the effects of inhomogeneities on the acoustic field to be investigated. This cannot be simply introduced into the ray tracing model as such an inherent part of the solution. Unlike the ray model, the PSTD model considers both the transmission and the scattering at any boundary. It also calculates the entire scattered field in all directions and not just the energy in the specular and back-scatter directions.

The primary disadvantage of the PSTD is its computational complexity. The grid sizes are dictated by the frequency of the acoustic source. Although the minimum requirement is a grid spacing of two points per wavelength, typically a finer discretisation is required depending on the complexity of the scene. Time discretisation is also related to the frequency, with an upper limit dictated by stability conditions. Rays can overcome many of the computational limitations by incorporating techniques such as the vector approximation. This permits the ray method to simulate larger operating scenes or higher frequency sonars.

The ray tracing technique is a simple intuitive method of modelling the sonar process but at the cost of reduced accuracy. The principle disadvantage of the ray-based technique arises from the representation of a continuous process with a discrete set of rays. Each ray trajectory is calculated in space and then complex post processing of the computed values for the set of rays representing each transmitted pulse is required to produce the received signal in the time domain. The ray trajectories cannot be predicted *a priori*. Only by trial and error is it possible to trace rays which will result in either constant increments of time between returning rays, or a constant density of ray intersections at the seabed. Hence the requirement for complex post-processing of the time and intensity values for each ray to produce a time series signal which has not distorted the highlights and shadows of the image.

The benefits of each technique mean that they are liable to fulfil complementary roles: PSTD provides accurate benchmark calculations, and the ray method a more operational approach. The PSTD method can also be used as a means of verifying the simplifying assumptions employed within the ray tracing method.

Simulation results

Regardless of the technique, the principal aim is to produce synthetic data of the form normally produced by the actual sonar system. Before considering current applications of each model, the simulation of a simple scenario illustrates the principle advantages of each technique.

Operating scenario

Both techniques were used to simulate a sidescan sonar imaging a region of sand ripples on the seabed. This seabed was chosen since it provides features for straightforward visual comparison with the resulting synthetic sidescan sonar image.

As a result of the computer power available and the computational complexity of the PSTD method, the scene was scaled to model the operation over a limited range with a lower frequency transducer. No limitations on the operating frequency or range are imposed by the ray method.

The scene is summarised in *Figure 1*. The height field represents a region of seabed 10m by 5m to be imaged by the sidescan. It is composed of sand ripples with a trough to peak height range of 25 to 45cm. The red line marks the path of the sidescan sonar, at a height of 1.4m above the mean seabed level, and 0.7m from the left-hand edge of the seabed. One hundred A-scans are simulated at 5cm intervals down this path, which corresponds to every tenth row of the height-map. The central A-scan is highlighted in green and provides the example A-scan for discussion later.

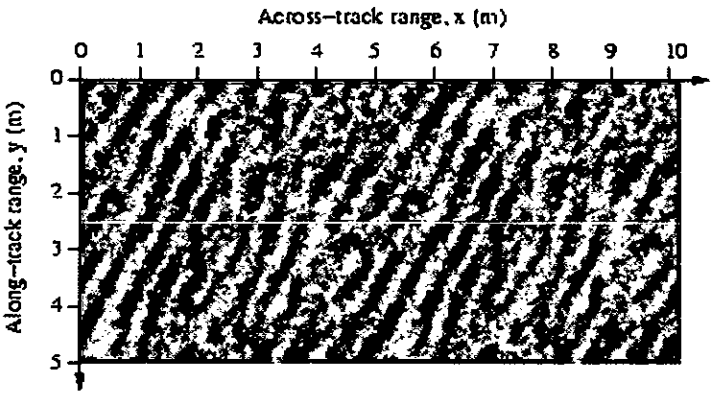

Figure 1: (a) Input seabed height field

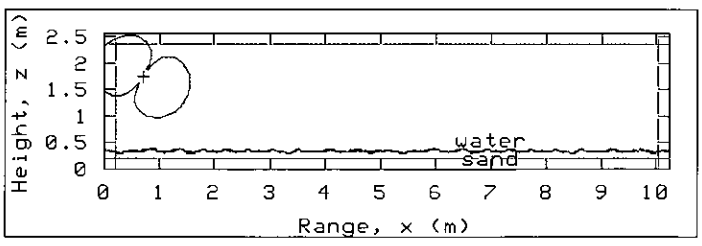

Figure 1: (b) Cross section of scene

For each ping, a broad beam pattern is projected from a two-element source array, which has a depression angle of 31°. The elements are separated by half a wavelength, and each emits a 25.7kHz Gaussian enveloped pulse of 0.5ms duration. The resulting beam pattern is plotted as the blue line on the simulation scene of *Figure 1(b)* and the red cross marks the position of the sonar. A single hydrophone at the centre of the array records the back-scattered energy from the seabed. The dashed line in this figure illustrates the position of the PML region that is required for the termination of the PSTD method.

In order to apply the 2-D PSTD model to the 3-D environment, certain simplifying assumptions are made. The simulation is a so-called 2½D simulation, in which successive adjacent 2-D simulations are assembled into the whole. This produces discrete incremental motion of the vehicle, rather than the smooth and continuous motion of a real tow-fish. The artificial tow-fish is assumed to be stationary during each transmit-receive cycle, before stepping directly to the next position. The ray tracing model however assumes that the transducer is in constant motion throughout the entire process and produces a full 3D simulation. Ideal, straight line motion is assumed in both cases, with no variation in speed or angular position of the sonar transducer.

Converting the recorded signals into a sidescan sonar image, both for real sonar systems and for either model, requires envelope detection and quantisation as well as the optional pre-amplification with time varying gain (tvg). The recorded signal level diminishes with time because of spreading and absorption losses, and the time varying gain is designed to compensate for this. Envelope detection removes the carrier frequency of the sonar pulse to leave the amplitude variations which encode the shape of the seabed. The envelope of each A-scan is finally quantised to give the pixel values for one line of the sidescan image.

PSTD Results

Figure 2 shows the received signal after envelope detection for the central A-scan calculated using the PSTD technique. The highlights generated by the ripples and the associated shadows can be clearly seen.

The signals for all 100 pings were processed to produce the simulated image shown in *Figure 3*. The image was stretched by a factor of ten in the y-direction to give it a similar aspect ratio to the seabed height-map in *Figure 1*. The sidescan image displays many of the prominent ripple features of the seabed, particularly after about 4ms, which corresponds to 3m across-track range.

Prior to 4ms there is a noticeable discrepancy between the image and the seabed height-map as a result of the lack of definition. The lack of definition

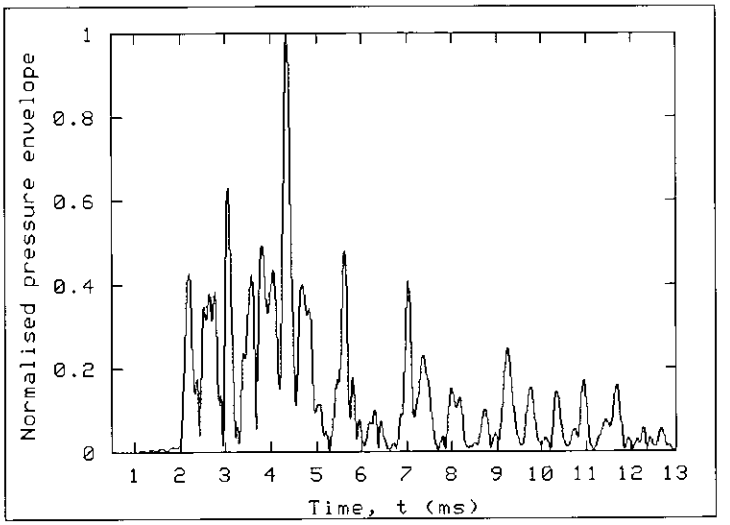

Figure 2 : Envelope of received signal

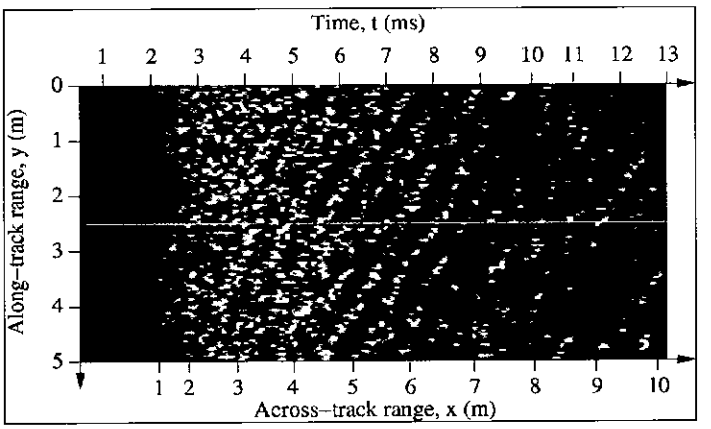

Figure 3: Sidescan sonar image simulated using PSTD technique

has two main causes. First, when viewed from high grazing angles, sand ripples do not cast the acoustic shadows responsible for much of the texture in a sidescan sonar image. Without the contrast between the highlighted ripple faces and the shadow regions, the features of the seabed are much less obvious. Second, in the band between the first return and approximately 3ms, there are contributions from the region of seabed behind the sonar because of the broad transmit beam pattern. These contributions overlap with the energy scattered from in front of the sonar and smear out the detail of the ripples.

One major advantage of the PSTD technique is that it can also provide images of the pressure field throughout the entire scene. *Figure 4* shows the acoustic field for the central A-scan 6ms after transmission of the pulse. Energy scattered from the

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seabed fills most of the water column. The brightest (green) sections of the back-scattered field can be traced back to the faces of the larger sand ripples, while the darker (blue) sections are scattered from the flatter regions of the seabed. The dark (black) sections are due to shading of the ripple troughs by the preceding crests. This is the mechanism responsible for the characteristic texture of sidescan sonar images. The more complex part of the scattered field, towards the right of the image, is characteristic of interference between earlier forward scattered energy and the more recently scattered energy. The pressure field also illustrates the penetration of the acoustic field into the sediment.

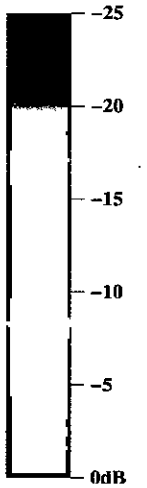

Figure 4: PSTD simulation of acoustic pressure field after 6ms

Ray tracing results

Figure 5 provides the simulated sidescan sonar image generated for the same scene and sonar operating parameters using the ray tracing technique. In comparison with *Figure 3*, the simulated image created by ray tracing appears to have clearer definition since the ray tracing technique is a high frequency approximation and cannot include wave effects. Within the region prior to 4ms, the definition appears markedly clearer. This suggests that it is energy received from the region behind the transducer which is contributing to the smearing in this region of the PSTD image, as only energy propagated in front of the transducer is considered in the ray tracing method.

The simulated images from both techniques exhibit the same characteristics. Comparison of the simulated images to the input seabed of *Figure 1* confirms that the principal ripples are correctly located. Statistical and spectral techniques have also been employed for verification of the output images **(4, 5)**.

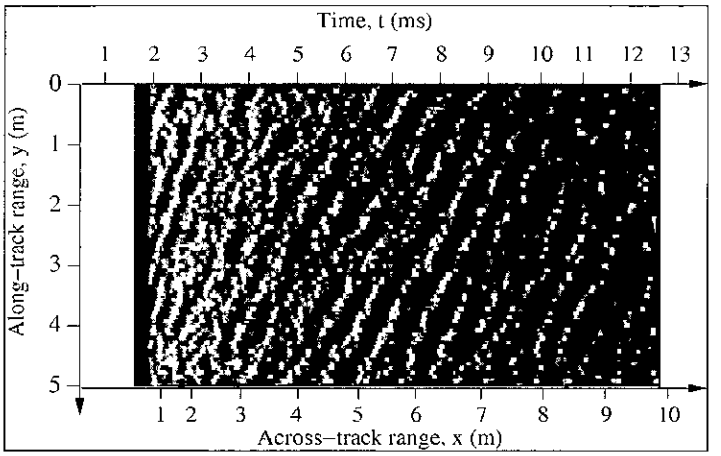

Figure 5: Sidescan sonar image simulated using ray technique

Application of models

One of the primary applications of the models is to provide fully ground truthed data sets for the development and analysis of algorithms for the processing of sonar data. Without these models it can be difficult to obtain details of the input scene, the environmental conditions and the transducer characteristics to accompany the sonar images. The simulators also permit the isolation of individual features of the sonar process and allow the effects of these features on the subsequent images to be considered in isolation.

Several applications of the models have already arisen. These included their use for the analysis of orientation effects on sidescan sonar classification **(5)**, object detection and classification **(6)** and techniques for the reconstruction of scene data from sonar images **(7)**. Two specific uses are highlighted below.

Object identification in sonar images

The detection and identification of objects in sonar images is of importance for defence applications and for terrain-based navigation algorithms. One problem in developing such algorithms is the availability of data sets where all objects and clutter are clearly identified. The simulation models therefore allow testing of algorithms for a wide range of sonar types, operating scenarios and objects.

Figure 6(a) illustrates a simulated sidescan sonar image developed using the ray tracing technique. This contains four different objects lying on two different regions of seabed: one isotropic silty region and one region of sand ripples. Markov Random Field techniques were used to detect the objects and segment the scene into object (white), shadow (black) and background (grey) as shown in *Figure 6(b)*. This information was then fed to feature extraction algorithms based on Co-operating Statistic Snakes **(6)** to extract features of the shadows following each object which were then used to classify the object.

The classification is based on Monte Carlo Markov Chain techniques, which compare iteratively the extracted data with simulated images of objects until the most likely set of object parameters are identified. This process requires a very fast simulation model, as thousands of iterations may be necessary. A ray based model with the maximum number of approximations was therefore employed to provide a quick estimate rather than a very detailed simulation. This application is thus reliant on the ray based approach, with extensive use of approximations, rather than the PSTD technique.

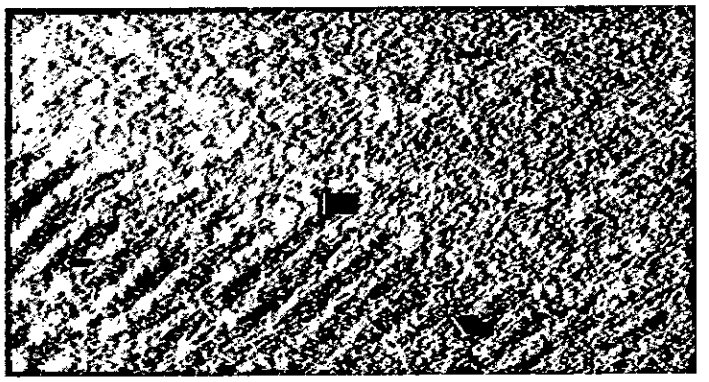

Figure 6: (a) Simulated sonar image

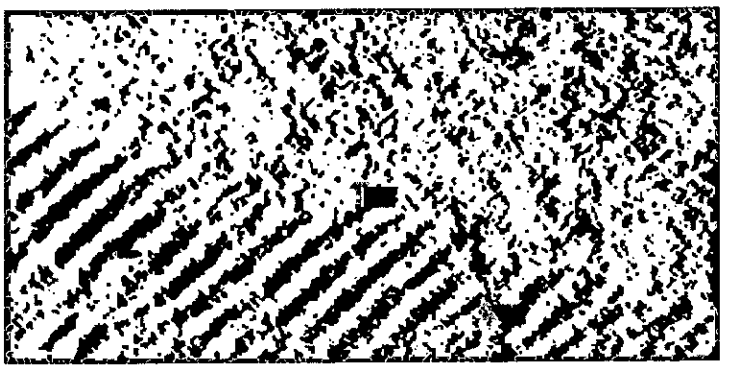

Figure 6: (b) Segmentation into object highlight (white) shadow (black) and background (grey)

Analysis of seabed scattering

The ray tracing approach is ideal for creating simulated sonar images where the effects of the approximations are not apparent to the human eye. However the ability of the PSTD model to provide details of the acoustic field across the whole grid and to include any number of receivers further increases its range of potential applications. For example it has been used for investigation of the effects of inhomogeneities in the seabed and to monitor the relative contributions of interface and volume scattering (2). Within these investigations it was possible to position receivers in a wide arc around the region of interest (and within the sediment) and to calculate the bistatic scattering strength as a function of angle.

Conclusions

PSTD is highly accurate but limited to only short range lower frequency applications. This is due to the large computational load resulting from the restrictions imposed on the grid discretisation to maintain the stability of the solution. The ray tracing method is less accurate in the details of the signals it produces, but these small variations are not apparent once the returned signals for each ping have been processed to form an image. The ability to produce such images within reasonable time frames has led to widespread application for the development and verification of processing algorithms for sonar images. It is foreseen than the two approaches can fulfil complementary roles for the design, testing and visualisation of sonar systems, the PSTD approach providing accurate research benchmarking, and the ray tracing method providing a faster operational style model.

The integration of the two techniques into a hybrid model was also considered (8), where the PSTD technique was used to model accurately the acoustic field in the region (and within) objects of interest, and ray theory used to make a rapid calculation of the field arriving in this region. This approach combines the advantages of both techniques. There are, however, issues with the transfer of data from one method to the other as a result of the differing natures of each solution.

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Applying phase conjugate arrays to sonar

R J Brind, M K Prior, B S Cazzolato, P A Nelson and P F Joseph

Abstract

A phase conjugate array (time reversal mirror) is a method of focusing acoustic energy spatially and temporally in a complex ocean propagation environment. Signals from a probe source are received on an array, time-reversed and re-transmitted. Multipath components are directed back along the paths over which they arrived, in the reverse order they were received. Numerical models have been developed to predict the focusing achievable with different array configurations in different types of environment. The effect of a time dependent rough surface has also been calculated. The models are described and examples of results obtained presented. An alternative focusing method based on inverse filters has been developed which may be an important enhancement to the basic reversal method. The relationship between the two methods and the advantages of each are explained. The models of focusing performance need validation using data taken in real environments. The type of experimental system required to provide this validation is described. The focusing techniques can be used in a number of ways to improve the performance of sonar and underwater communication systems. Examples of new types of sonar that exploit the focusing techniques to deliver improved performance are described.

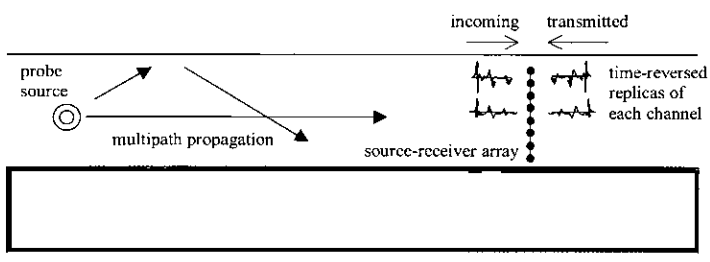

Fig.1: Multipath propagation and time-reversal at a source receiver array

A number of our potential adversaries already operate extremely capable modern conventional submarines which could be a significant threat to allied shipping in a future military conflict. Acoustic systems are likely to remain the principal surveillance method for detecting such threats on account of the relatively good propagation characteristics of acoustic signals in the underwater environment (compared to other signals). Nevertheless, the shallow and littoral water environments in which future conflicts are likely to occur are extremely challenging environments for acoustic systems. Passive sonars are faced with high levels of ambient noise against which the low signatures of threat submarines have to be detected. Active sonars are affected by high levels of reverberation and high numbers of false alarms, which makes the detection of clad slow-moving submarines extremely difficult. There is a need for research on new types of sonar and new methods of processing which have the potential to lead to major improvements in performance.

A phase conjugate array (time-reversal mirror) is a concept that may deliver the needed improvements in performance. The idea behind the technique is that an acoustic transmission can be focused in range and depth, and temporal dispersion reversed, if a probe signal received on an array is time-reversed and retransmitted. Probe signals received on the array consist of multipath, components arriving by different paths, perhaps involving different numbers of reflections from the surface and the seabed *(see Figure 1)*.

Time-reversal at the array effectively directs the multipath components back along the paths over which they arrived, in the reverse order they were received. The signals recombine at the focus, the point the probe signal was generated. The probe signal received on the array contains exactly the information required to achieve the focusing. There are a number of ways (discussed later) in which the technique could be used in an acoustic detection system. Environments that are difficult for conventional acoustic systems (those where there is a significant multipath structure) are precisely those where the technique has the potential for producing the largest gains.

As well as the underwater surveillance requirement, acoustic communication systems have an increasingly important role in both military and civil applications. In military systems, acoustic communication is required, for example, to enable a surface force to communicate with a submarine operating in conjunction with it. In the offshore industry, acoustic communication systems are used for transmitting data to - and from - deployed systems on the seabed or in the water. Inter-symbol interference caused by dispersive multipath encountered in shallow water environments limits the capacity of these systems. There is a need for systems to be higher data rate (with the same or lower error rate), and for power consumption to be reduced. For the military requirement, low probability of intercept is often also desired.

The idea of obtaining spatial and temporal focusing using phase conjugation is not new. It was first demonstrated in optics where the non-linear

properties of the medium were used to produce a time-reversed, retro-directed replica of an incident field. In acoustics, frequencies are considerably lower and the time-reversal (or phase conjugation) can be accomplished directly (electronically). The first experimental study dates back to the 1960s when Parvulescu and Clay used a time-reversed transmission to compensate for multi-path effects (1). They used an omnidirectional transmitter and they were consequently able to produce temporal but not spatial focusing. There has been renewed interest in the phase conjugate technique in recent years. Theoretical analysis of the phenomenon has been developed (2). An experimental demonstration of focusing in an ocean environment has been successfully achieved by the Marine Physics Laboratory (MPL) and the SACLANT Undersea Research Centre (SACLANTCEN) (3). Experimental and theoretical work on focusing in inhomogeneous media at ultrasonic frequencies in the laboratory has also been undertaken (4).

The work on focusing in the ocean environment has concentrated on the focusing achievable over a two-way transmission path (*ie* the generation of a probe signal and then the return transmission from the array). This is important for both the underwater surveillance and communication applications. However, focusing over a four-way path, *ie* the use of an initial insonification of a volume of water to produce an echo which can be used as the input to the process, has received less attention. Here, we have set out to develop a modelling capability that will enable an assessment of the gains likely to be obtained in both the two-way and four-way path cases. Variability of the environment, particularly of the sea surface, is expected to lead to a degradation of the focusing. The numerical models have been extended to allow these effects to be assessed.

Methods based on inverse filters for generating a desired field at a certain point, or over a given volume, have been developed in room acoustics (5). Here, the application of these techniques to underwater acoustics has been considered. This has resulted in a new focusing method that may prove to be an important enhancement of the basic time-reversal technique. The performance of the new method has been modelled and comparisons made to the performance of time-reversal.

The models enable the focusing obtainable from an array to be predicted. However, focusing depends on a number of subtle environmental effects. The models need validation using data taken in real environments in order to confirm that the important effects have been represented accurately. The design issues that need to be considered in an experimental system to provide that validation are discussed. Finally, a number of possible new concepts for sonars that exploit the focusing technique to deliver improved performance are described.

Modelling

A primary objective of the work reported here was the development of a simulation capability so that new concepts exploiting focusing techniques could be studied and the performance of different array options in these concepts evaluated. To simulate

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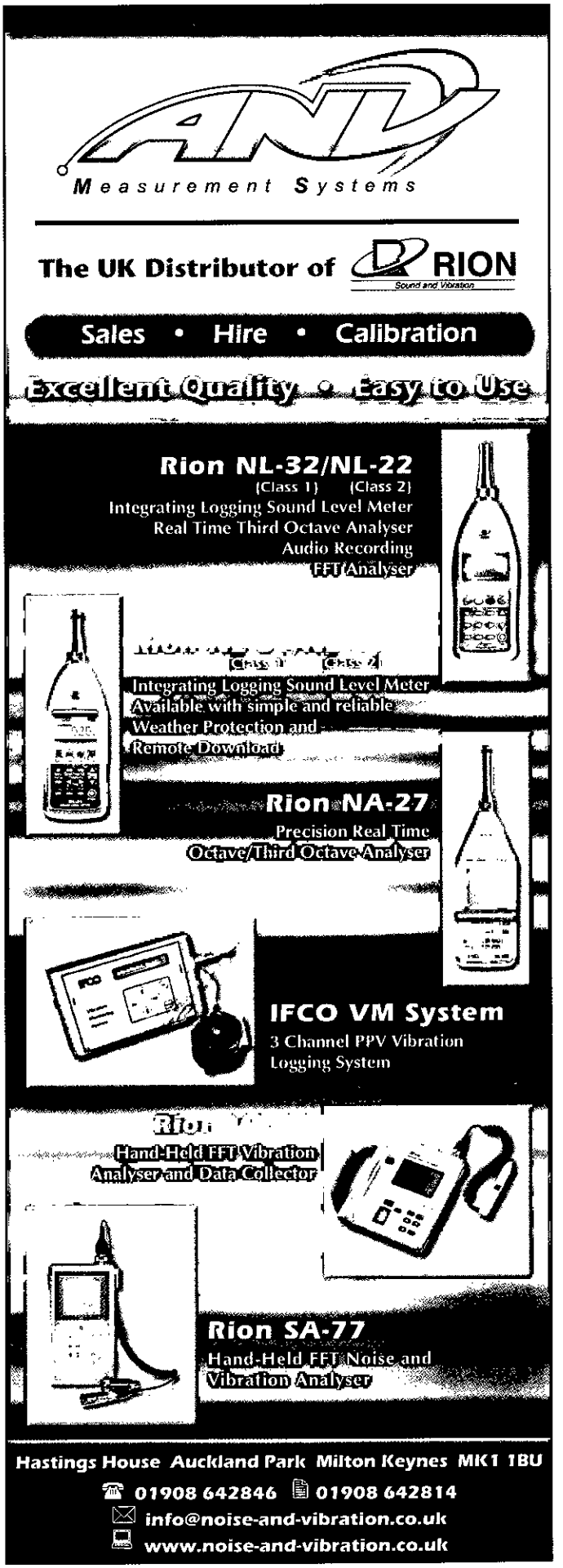

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the performance of a phase conjugate array in a realistic environment, a high fidelity model of the propagation of acoustic pulses was required. The model used was the SPUR model which was developed as part of a MoD programme on Synthetic Acoustic Environments. SPUR uses as its kernel a wide-angle parabolic equation solver, RAM. The dispersion of each spectral component of a pulse over a propagation path is calculated and the final pulse evaluated by transforming back into the time domain. Time-reversal at the array in the model is achieved by taking the complex conjugate of each spectral component.

Performance was studied in a number of shallow water environments, with different sound speed profiles and bottom reflectivities. Calculations were carried out for systems with a two-way and a four-way transmission path. The configuration used for each was the same but the sequence in which the sources and receivers were operated was different. The configuration is shown in *Figure 2*.

The phase conjugate array is a source/receiver array, a line of equally spaced sources and coincident receivers. For the two-way path case, a pulse is generated at an omnidirectional probe source (at the right of the figure). The signals received at each of the elements of the array are time-reversed, amplified and retransmitted. In the simulations a normalisation was applied so that the total energy transmitted by the array was the same as that transmitted by the point source. The field in the focal region is of interest hence a receiver is shown coincident with the probe source. The field near the surface and at the bottom (at the points shown) is also calculated to assess the extent to which the field is focused away from the boundaries.

For the four-way path case, a pulse is generated at the centre element of the array. The echo from the target is received on the array, time-reversed and retransmitted. In practice the energy from the target is received within the reverberation field from surface, seabed and volume scatterers in the environment. It was not practical in the present study to undertake a full simulation of reverberation.

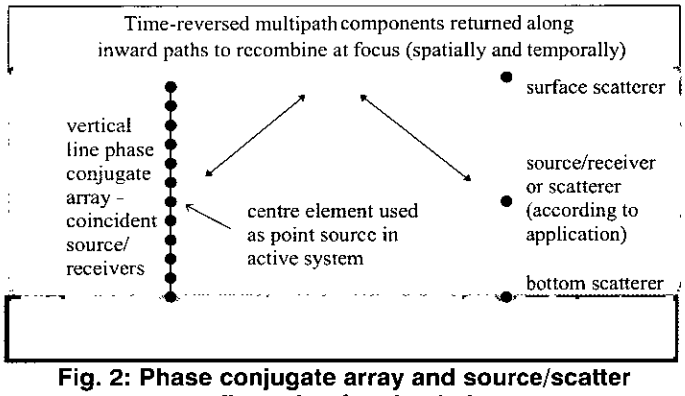

Fig. 2: Phase conjugate array and source/scatter configuration for simulations

Instead, discrete scatterers at the target range were modelled. The energy from the phase conjugate transmission at the three scatterers (the target and the scatterers at the boundaries), and the echoes from these at the centre element of the array, was calculated.

Array performance was studied in a number of shallow water environments. The depth assumed was 91m and the range of the source from the array was 10km. The array is shown in *Figure 2* as vertical and extending over the full water column, but various lengths of array, various numbers of elements, and various orientations (vertical and horizontal with the probe source or the scatterer at either broadside or endfire) were considered. Simulations were performed for an initial 2kHz CW pulse with a 0.1s Hanning window.

Focusing is expected to produce benefits via three routes: to increase the energy at the focus (for a given power output); to increase the ratio of energy at the focus to that at other points (particularly the ocean boundaries which are sources of reverberation in

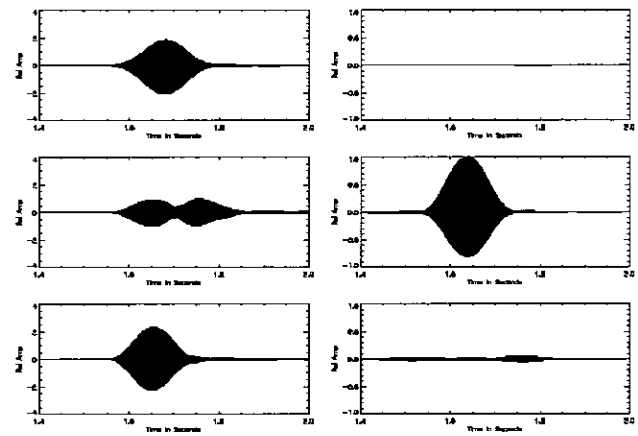

Fig. 3: Pulses in a two-way transmission path case: at the top, middle and bottom of the array (left) and at the source/receiver range after time-reversal and return propagation (right)

an active system); and to produce signals at the final receiver which are less dispersed in time. Measures of performance in each of these areas have been developed to allow the benefit of different array configurations to be quantified.

Time series of the pressure generated in the two-way transmission path case with a 31 element vertical array are shown in *Figure 3*. On the left are the time series of the probe transmission at the top, middle and bottom of the array. On the right are the time series of the time-reversed transmission at the range of the focus, at the surface, mid water and seabed. The plots are normalised by the peak amplitude at the mid water depth. The probe transmission is severely distorted by multipath, particularly at the middle of the array, and there is not much variation in energy at different depths. The temporal dispersion is reversed in the time-reversed transmission, and the energy concentrated at the focus and away from the boundaries. Dramatic focusing gains are predicted (greater than 20dB). In an ocean environment there are several factors that will mean that gains will not be as high as this. Time compression is modest; higher time compressions would be observed if shorter pulses could have been modelled.

Calculations of focusing four-way path cases have been performed. Gains were less than in the two-way path case, although performance generally increases with number of elements, as the array is

better able to resolve the multipath. Since the signal which is time-reversed includes energy that has been scattered by the surface and bottom scatterers, a portion of the energy in the time-reversed transmission would be expected to focus on these. Details of the numerical simulations are given in **(6)** and **(7)**.

A method of representing the effect of a non-stationary rough surface in the model was developed. This was achieved by modelling the fields in both the water and the air, and the reflection at the boundary between them, for snapshots of an evolving surface profile (fixed for each propagation leg). Calculations were performed for two-way and four-way path systems. When the time-reversed transmission was made immediately after reception, the effect of a slightly rough surface was in fact to improve focusing gains relative to the flat surface case: levels away from the focus relative to the focus were lower (although absolute levels were reduced). This is because the roughness scattered energy into higher angle modes, leading to a wider range of angles of arrival at the array.

The focusing performance of a phase conjugate array, at moderate range when there was a delay before retransmission, was found to be reasonably unaffected by surface motion except at high sea states. This is because sound propagates to these range at low angles which are relatively unaffected by the sea surface spectrum.

Inverse filter methods

Time-reversal techniques have been shown to be effective in enabling a desired signal to be transmitted to the focus point. To do this, however, it is necessary to characterise the environment using a transmission from the focal point. There can be problems with time-reversal with broadband signals when there is significant variation in the magnitude of the transfer function of the waveguide across the band.

Inverse filtering (or equalisation) is a common technique used in room acoustics **(5)**. Pre-filters are applied to the input(s) to compensate for the transfer function of the system, with the intention that the signal at the receiver is equal to the desired signal. In a non-square system, the pre-filter is calculated using a least squares approximation. In general, the simple least squares solution does not lead to a useable time domain form of the filter as it is non-causal and has long duration in forward time. These properties lead to temporal aliasing if a practical filter length is adopted.

Here, inverse filter techniques have been applied to focusing in the ocean environment and have been shown to overcome some of the limitations of time-reversal when applied to broadband signals. Tikhonov regularisation and cyclic shifting has been used to achieve a stable and causal inverse filter. The presence of low levels of noise has been shown to have little impact, indeed noise acts to regularise the matrix. The inverse filter is

$$H(\omega)=\left[C^{H}(\omega)C(\omega)+E\left[N^{H}N\right]+\beta(\omega)I\right]^{-1}C^{H}(\omega)$$

where C is the matrix of transfer functions of the channel, N the noise matrix and I a regularisation coefficient.

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The effectiveness of the inverse filter method with a vertical array has been assessed using transfer functions calculated using the OASES propagation model for the site off Italy where experiments on phase conjugate focusing have been conducted by MPL and SACLANTCEN **(3)**.

An example of the temporal shape of the pulse, from an impulse signal from a conventional transmission (a broadside-steered array), from inverse filters, and from phase conjugation, for a two element array, is shown in *Figure 4*. Also shown is the spectrum of the received signal. The conventional transmission is significantly distorted as evidenced by the reduced amplitude and extended duration.

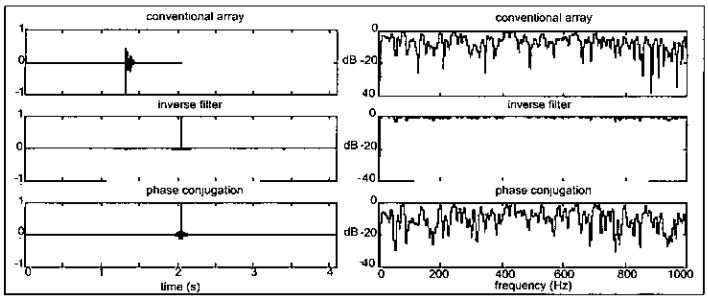

Fig. 4: Time series and spectrum of received pulse from conventional, inverse filter and phase conjugate transmissions

In the model here, the inverse filter gives a near perfect impulse and a uniform spectrum. The phase conjugate transmission has low level sidelobes before and after the main impulse, and an uneven response in the frequency domain. The benefit of inverse filters is most marked when the number of elements in the array is small (as in the example here).

Experiments

The relative performance of inverse filter and time-reversal focusing in the ocean has been investigated in numerical simulations and the inverse filter method has been shown to have important potential advantages. Focusing depends on a number of subtle environmental effects and several important simplifications have been made in the modelling. The results therefore need validation with data taken in a real environment.

Both focusing methods will be degraded by changes to the environment and to the array during the period between the transmission of the probe signal and the final reception of the focused transmission. Noise at the array will also degrade focusing, although low levels of noise can have benefits in the calculation of the inverse filter. Flow noise, which is incoherent at the elements of the array, and coherent noise from ships in the vicinity are components of the noise field. Slight changes to the environment can be thought of as noise, provided they do not change the transfer function of the channel significantly. The susceptibility of a practical system to the changes to the environment and to noise needs to be assessed.

At the same time as demonstrating the focusing obtainable in a real environment, any experiment must be sufficiently controlled so that the impact of the different effects can be separated and identified. For example, steps must be taken to ensure the array is completely stable in order that the focusing achievable with a stationary array can be determined. The effect of a moving or deforming array can then be determined. Modelling has shown that the type of environment, particularly the nature of the sea-bed, will have an important effect. This should be borne in mind when interpreting results and ideally measurements in several different types of environment should be undertaken.

Any operational system using the focusing concept will need to minimise the number of sources and receivers employed in order to minimise costs and the effort required to deploy the system. An experimental system must therefore be flexible to allow different number of elements to be tested. The focusing methods are unusual in that the performance can only be determined by playing back the transmissions through the environment itself, at the time in question. Post-trial analysis of data is limited to displaying the field in the region of interest measured at the time.

The MPL/SACLANTCEN experiments have been extremely successful in demonstrating the phenomenon of phase conjugate focusing in an ocean environment **(3)**. Vertical strings of sources and receivers spanning a large fraction of the water column were used. Experiments at both 445Hz and 3.5kHz have been performed. Extensive environmental measurements were taken to assist in the interpretation of the results. Inverse filters were not tested in these experiments.

The arrays used were autonomous and were moored vertically up from anchors on the seabed. This ensured the arrays were decoupled from motions of the surface. Projectors were located at different depths in the array and the transmitting response of these had to be accurately characterised. The arrays communicated with the trials ship through a RF data link from a buoy on the surface. The signal controllers, power amplifiers and batteries for the transmit system were located in the surface buoy. The arrays were controlled from the trials ship. Data received on the receiver channels will be transmitted to the trials ship, where time-reversed replicas were prepared. These were then passed to the arrays for transmission. It is evident from this description that the experimental system used by MPL/SACLANTCEN was a considerable engineering feat.

Applications to sonar

Focusing techniques have obvious applications to underwater communication. As multipath dispersion is reversed, inter-symbol interference will be reduced and achievable data rates increased. Since energy is focused at the receiver, power consumption will be reduced. The transmitter and receiver need to be fixed in the period between the probe signal and the transmission of data, and this may be a constraint in some applications.

The application of focusing techniques to sonar is less straightforward. Several possible concepts for a submarine detection system that uses focusing to obtain improved performance have been examined. First is the use of previously acquired data, or data obtained in situ, to determine the transmissions required to focus at a particular range and depth. A source deployed from a helicopter or an autonomous underwater vehicle (AUV) could be used as a probe source to acquire this data. The system would then scan a volume of water by making transmissions directed to a sequence of search cells. This is the two-way path case considered in the modelling. The echo from a submarine in the focal region would be stronger as more energy would be directed there, and reverberation would be lower because less energy would be directed at the surface and the seabed.

Because of the difficulty collecting and processing the focusing information for a large number of search cells, this type of system is likely to be of most use in a scenario where the submarine is likely to be in a fairly restricted area, for example in a choke point. Another factor is the time validity of the focusing information. This would depend on the stability of the environment but in most environments it is likely to be limited. The requirement for a large number of transmissions on a continuing basis and the fact that the array making the focused transmissions needs to be stable, mean that this concept is most likely to be suitable for a fixed installation with a link to an external power supply.

A second concept is the use of an echo of an initial transmission from a submarine to determine the transmission required to focus on it. This is an acoustics version of the technique used successfully in laser-based directed energy weapons to overcome imperfections in the optical components and distortions and divergence of transmitted pulses due to atmospheric turbulence. The initial transmission in an acoustics system could be from the array that will make the focused transmission or from a separate array. If the initial transmission is from the array that will make the final reception, the situation is the four-way transmission path case. The modelling predicted more modest (but still valuable) gains than for a two-way path system.

An advantage of this system is that the transmission does not need to be scanned over a set of search cells covering a volume of water: the system will focus on any echo that is present. The signal to noise of the echo from the submarine however needs to be positive initially. The focused transmission should therefore be seen as a means of raising an echo which is on the limits of detectability, above the threshold. The process can be repeated and further gains obtained **(8)**. The system will only focus on the strongest scatterer, although recent work has proposed a new method that could enable focusing on a weaker scatterer in the presence of a stronger one to be achieved **(9)**.

Conclusions

A numerical model for predicting the focusing obtainable from a phase conjugate array (time-reversal mirror) has been developed. Measures of performance have been defined to quantify the advantages of different array configurations. Calculations have been made for systems that work over a two-way and a four-way transmission path. Gains in systems working over a two-way path are substantial while those in systems working over a four-way path are more modest. A method of modelling the effect of a time varying rough surface has been developed. Focusing performance at moderate range was found to be reasonably unaffected by surface motion.

The application of inverse filters to focusing in the underwater environment has been investigated. It has been shown that inverse filters overcome some of the limitations of time-reversal when applied to broadband signals.

Focusing depends on a number of subtle environmental effects. The modelling needs to be validated with data taken in real environments. Experiments have been conducted by MPL and SACLANTCEN in which focusing in an ocean environment has been successfully demonstrated. The provision of an experimental system to provide this validation, however, represented a considerable engineering feat. To date inverse filters have not been tested in an ocean environment.

A number of possible concepts for using focusing in a submarine detection system have been identified. Systems could use focusing information obtained with a deployed source, or the echo from an initial insonification of an area.

Acknowledgement

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John Tyndall FRS DCL LLD (1820-1893)

Ian Bennett BSc CEng MIOA

John Tyndall, a name perpetuated in a medal awarded by the Institute of Acoustics, was born in Ireland on 2 August 1820. His was not a wealthy family: his father was in the local constabulary, which given contemporary views of the 'occupying' British powers may not have made him the height of popularity! John's formal education ended at the age of 17, so he did not attend university, although his basic schooling seems to have given him a good grounding in mathematics and English.

He was soon to join the Ordnance Survey as a draughtsman and practical surveyor, a function he continued to fulfil in England in 1842, when the Irish survey was completed. However, he was dismissed for his political views - seemingly his protests about the treatment of the Irish - and returned to Ireland until he became caught up in 'railway mania' in 1844. Skilled surveyors and railway engineers were at something of a premium in Britain during that decade, although the boom began to subside about three years later.

Tyndall then decided to look for employment as a teacher: he became mathematics master at Queenwood College in Hampshire, where he befriended Edward Frankland, the young chemistry teacher and a keen chemist.

The pair decided to travel to Germany to further their scientific education, and were taken under the wing of Robert Bunsen at his laboratory in Marburg. Despite a limited knowledge of the German language, and of most formal science, Tyndall managed to complete his doctorate in just two years. By then he had decided that his main interest was in physics, and had begun to study the magnetic and optical properties of crystals. This proved to be the first area of research to gain him a wider reputation, and it continued at Magnus's Berlin laboratory and later back in England at Queenwood College. Through a lack of financial support, he undertook translations and reviews for the *Philosophical Magazine*, and became better known to the likes of Faraday and Huxley.

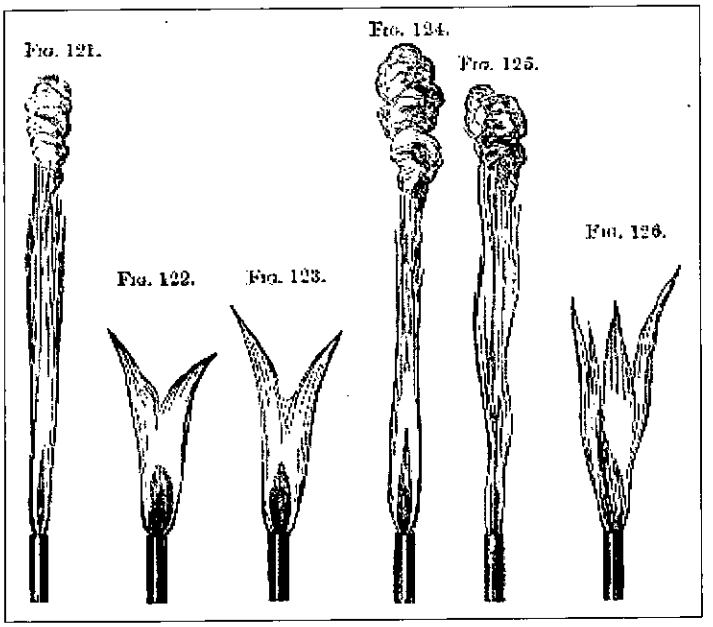
He gave a presentation or 'discourse' at the Royal Society in 1853, which was highly successful and led to another, then a full series of lectures. This gave him the opportunity to work with Faraday, and at the age of 33 recognition came when he was made Professor of Natural Philosophy. Tyndall was one of those gifted individuals who are capable of making scientific concepts accessible to his audience, and this was demonstrated not only by his regular lecture tours for the Royal Institution, but also in the series of working men's lectures he gave at the Royal School of Mines with Thomas Huxley. These were followed by similar programmes for other organisations. He constantly strove to increase scientific knowledge, and the quality of scientific education, being convinced that British education was having the opposite effect because of its outdated philosophy and methods. The idea that there could be a popular awareness of science and how it affects everyday life had not really existed before Tyndall and his contemporaries.

He was to continue at the Royal Institution for many years, not least because it gave him the opportunity to continue working with Faraday, but he was also active in many other scientific fields. Among his achievements - he published 145 papers and nearly 20 books altogether - he researched radiant heat, the germ theory of disease, glacial motion, light diffusion in the atmosphere, and the acoustic properties of the atmosphere. This last area of research, which is, of course, of particular interest to readers of the *Bulletin*, enabled him to invent a better foghorn. The safety of mariners was of great concern to him, since for 14 years he was a member of the Board of Trade which had, among many other responsibilities, the care of lighthouses and coastal navigation. Tyndall's work enabled him to discover how the atmosphere affects sounds of different frequencies to different degrees, and develop a foghorn that exploited these effects.

'Knowledge once gained casts a light beyond its own immediate boundaries' - *John Tyndall*

Tyndall's publications on sound were noteworthy for their insight, and the clarity with which ideas were worked out and explained. He developed an observation of Le Conte, who had noticed that naked flames 'danced' under the influence of the sounds present in the room. At that time, of course, lighting was often by gas jet so the presence of a flame was not very unusual. Tyndall took the idea of sensitive naked flames and used them to measure the pitch and tone quality of sounds. He did this by reading poetry aloud in a still room, and noted how the flame reacted to different vowel sounds. Contemporary accounts describe how he was able to affect the flame of a Bunsen burner from a distance by clapping loudly or making other sounds. He also observed the way tuning forks vibrate, by reflecting light from them onto a moving strip of paper. His researches included the way in which sound affects a shallow layer of sand, or a water jet.

Some of those working with him attempted to link the phenomenon to telepathic or psychic activity,



Tyndall took the idea of sensitive naked flames and used them to measure the pitch and tone quality of sounds

although this was never seriously entertained by Tyndall. In fact, despite (or perhaps because of) his early interest in theology, he began to turn against what he saw as the anti-intellectual Christian hierarchy, which was in general opposed to developments in scientific fields. He was an early supporter of Darwin, and was described as a materialist and atheist by the orthodox powers. After his British Association presidential address in Belfast, in 1874, he was denounced from church pulpits across the country, and adversely critical pamphlets continued to appear for several years afterwards.

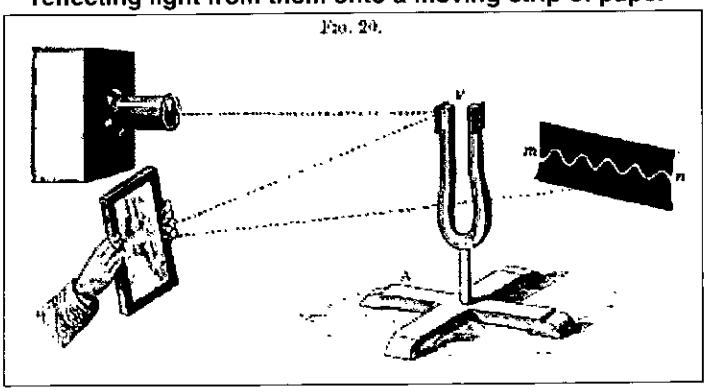
A number of other inventions are credited to Tyndall, including the fireman's breathing apparatus and the light pipe (which was ultimately to lead to the development of fibre optics for medical purposes). He investigated accidents in coal mines and the causes of steam engine boiler explosions, and in the course of his investigations into how light beams behave, he postulated that large molecules and dust scattered the light of the sun, making the sky appear blue. The phenomenon was later explained theoretically by Rayleigh (*Acoustics Bulletin* vol.27 no.3) but is nevertheless called the Tyndall effect.

It was his interest in glaciation that took him on many occasions to the Alps, having visited them for the first time in 1849. He grew to be an excellent mountaineer in the process, becoming the first to scale the Weisshorn (in 1860). He is also credited with making the first measurements of atmospheric pollution, when he used scattering phenomena and infrared to investigate the atmosphere in London.

In 1876, at the comparatively late age of 56, John Tyndall married Louisa Hamilton. They had no children, but the marriage appears to have been a contented one and although most of his major work had already been completed, he continued to give lecture tours and to investigate germ theory. By 1881 he was finally able to lay to rest the long-upheld idea that foodstuffs kept in germ-free air did not decay. He was a passionate supporter of the work of Louis Pasteur and, besides discrediting the views of Pasteur's opponents, he was able to take the work further himself.

Ever since his time in Germany Tyndall had been a poor sleeper, and as he grew older his health began to deteriorate. He retired to Hampshire, although he remained politically active, in particular campaigning against Gladstone's Home Rule Bill for Ireland. By 1891 he was too ill to go to the Alps, the first summer for three decades he had not done so. He had been experimenting with drugs to cure his sleeplessness for some time, and tragically was given an accidental overdose by Louisa in 1893.

Tyndall also observed the way tuning forks vibrate, by reflecting light from them onto a moving strip of paper



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FROM HANSARD

10 April

Aircraft Noise (Gatwick)

Virginia Bottomley (South-West Surrey): I very much appreciate the Under-Secretary of State for Transport, Local Government and the Regions, the hon. Member for Plymouth, Devonport (Mr Jamieson), being present to discuss issues of serious concern to my constituents. It is two years since I raised the issue of aircraft noise in the Dunsfold area. The hon. Member for Sunderland, South (Mr Mullin), who was the Minister at the time, was extremely helpful, and I am sure that he still remembers in detail the important points that were made. I hope that the present Minister has been able to consider some of the issues that I raised on behalf of my constituents.

People live in south-west Surrey because it is a particularly beautiful part of the country. There is real concern about development pressures and quality of life. There is anxiety that the government may impose entirely unrealistic and appalling housing quotas on the area. There is pressure from traffic congestion, although it is hoped that improvements on the A3 at Hindhead will relieve some of the problems.

Over recent years, the number of serious concerns about aircraft noise has grown. When I raised the issue in the previous debate, I talked about noise preferential routes (NPRs) and the importance of raising the minimum vectoring level to 5000ft. I also talked about the speed of arriving and departing aircraft, the importance of enforcement and encouraging aircraft to adhere to the 250 knot limit below 10,000 feet.

My third point concerned altitude levels and particularly those of arriving aircraft. I said that continuous descent procedures could be modified and that there should be greater enforcement. Finally, I mentioned the disturbance caused by night flying, which is identified time and again in government reports about noise.

I am pleased to say that the then Minister responded helpfully to the debate and that the airlines, the British Airports Authority and others were extremely helpful.

Lord Marshall made it clear that British Airways would be happy to comply with any restriction that required aircraft to fly at 250 knots until below 10,000 feet. As regards night noise, British Airways said that it would introduce a voluntary ban on departures scheduled after 11.30 pm and arrivals scheduled before 4.45 am.

Enthused by such activities, Bridget Bloom, John Burgess and many others from the Quieter Skies Campaign for which I have the highest regard organised a meeting of the most phenomenal proportions in Dunsfold in March 2001. At a time when fewer and fewer people seem enthusiastic about political gatherings, people from all over the south-east attended a spectacular meeting at Dunsfold village hall, which was the happy recipient of a lottery award for improvements.

Points were made about increasing passenger numbers, the growing disturbance, the difficulties of non-adherence to NPRs, departure height issues, landing approaches and heights, and the problem of old aircraft. I am pleased to say that, once again, there were encouraging responses all round.

'The number of serious concerns about aircraft noise has grown'

Aircraft noise has been deeply affected by the serious situation following 11 September. It would not be right or proper for me to speak today without referring to that. The Select Committee on Transport, Local Government and the Regions held hearings on the issues. Roger Wiltshire, the secretary general of the British Air Transport Association, said:

"Air space was closed affecting roughly 20 % of the aviation businesses coming out of the UK and even after all the events were over and the airlines returned to normal operationally there was a major impact on demand for air travel ... soon after that return to normal operations an insurance change ... threatened all airlines, not just those flying to space closed after 11 September."

Virgin and British Airways gave evidence that their losses had been around 20%, and that British Airways had relinquished 300 slots at Gatwick. Inevitably, there has been encouragingly less noise. That is partly a temporary phenomenon, due to the effect of 11 September on the airline industry, but it is also a result of a more profound difference. Following the detailed lobbying and representations to the Minister's predecessors, as well as work with BAA and the airlines, I am pleased to report significant improvements.

The *Quieter Skies Campaign* has assiduously documented the changes. For example, a document produced by it records: 'In a four-day weekend in January 2001 there were 179 westerly take-offs over the Dunsfold/Hascombe area compared with only 77 in the same period in January 2002'. It also states that there is less perceived noise because of the continuing move to modern aircraft. I am pleased that Virgin has now eliminated all its old 747-200s.

The document also records that 'two years ago 23% of all Gatwick outward flights passed over the Hascombe-Dunsfold area below 5000ft.' Westerly take-offs were particularly bad, with 33% below 5000ft.' Recent figures for 2002 show a dramatic improvement, with 'only 12% below 5000ft, with 70% above 7000ft.' Those changes are encouraging.

Easterly take-offs, which are normally higher, show a marginal improvement in the period. Only 13% of flights were under 5000ft, compared with a previous figure of 16%, and the average overhead height was slightly below 7000ft. I give enormous credit to the group. Its vigilance in monitoring the situation, taking matters up with the authorities and clearly stating that all breaches should be properly identified and chased up has made a significant impact.

I am pleased that several people contacted me before the debate. British Airways has been in touch about its continuing commitment to the code of practice for continuous descent approach, the stringent departure noise limits and other such measures. Alison Addy of BAA has been enormously helpful, and has talked about BAA's work for and commitment to further improvements. Those include ongoing work to reduce noise, the imposition of higher landing charges on noisier aircraft, the fining of aircraft that exceed noise limits, and the supplementing of restrictions on which aircraft can operate at night through a further voluntary ban. Also relevant are the establishment of the flight operations performance committee and the publication of a continuous descent approach code of practice.

The Minister may say that it is unusual for Opposition Members to raise subjects for debate, in Committee Room 10 or in Westminster Hall, in the light of so much encouraging good news. However, the real anxiety in the area concerns the future of aviation in the south-east, the future of Gatwick and the string of leaked documents, comments and reports. I pay tribute to the *Gatwick Area Conservation Campaign* and Brendan Sewill, who has been most assiduous in documenting the issue and alerting councillors, Members of Parliament and others.

A new runway at Gatwick would be the most deplorable event. Such a runway would be designed to increase the airport's capacity from the present 30 million

passengers to 80 million or 100 million around three times its present size. There would be three times as many aircraft in the sky and three times as much noise, three times as much pollution and three times as much airport-related traffic. It would mean more houses, more congestion and more air pollution. I ask the Minister to be aware of the mounting concern over air pollution.

I am sure that the Minister and others will be aware of the Gatwick legal agreement. Some leaks have suggested that Ministers have found a way around the agreement. I would like the Minister to clarify the situation and how he envisages the future of Gatwick. When will there be further announcements and further consultation? People in the south-east not only mind about the quality of life and the local environment but are deeply concerned about opportunities in more economically disadvantaged parts of the country. One way to compound the difficulties of the south-east and exaggerate the problems elsewhere would be to impose willy-nilly a new terminal at Gatwick, with all the ensuing difficulties. The expressions of worry throughout my constituency about aircraft noise, not only in Dunsfold but in Farnham concerning Farnborough airport and the complaints about noise from Chinook helicopters would be as nothing compared to the outrage and problems that would emerge.

'A new runway at Gatwick would be the most deplorable event'

As well as being concerned about the series of leaks on the future of Gatwick, the Minister should know that a growing number of voices in my constituency are deeply worried about the threatened erosion of local democratic accountability for planning decisions. Dr Jenny Masding, chairman of Alfold parish council, has written to me about the planning Green Paper *Delivering a Fundamental Change*. There is great anxiety that there is no mention of parish or town councils in the Green Paper and concern that their role is being undermined and threatened. No one disputes the need for reducing the time taken to conduct planning inquiries, but there is real anxiety about the erosion of local accountability. In particular, there is concern about the future of the work of the county council, which in my constituency has been very effective.

I refer also to the comments made by Mr Thwaites of Waverley Borough Council about the development of further air traffic and the importance of the planning procedures and local accountability. There is a real sense that this government has been characterised by centralising and imposing their will willy-nilly on local bodies and agencies. The effects of such an imposition on this area would be devastating beyond all belief and entirely irreparable.

I thank the Minister for being present today to answer some of those points. There are many welcome changes such as the reduction in aircraft noise, which has occurred partly as a result of the tragic and regrettable events in the United States but also because of changing practices and a co-operative approach. How does he clarify his own responsibilities in the area? Good practice is all very well, but the Minister has responsibilities. I thank him and the government for recognising the importance of tranquillity measures in the rural White Paper; he will know the link with the ambient noise strategy.

However, aircraft noise issues pale into insignificance in comparison with what is now the real anxiety about the future at Gatwick. The Minister is aware of the issues and of my appreciation of the *Quieter Skies Campaign* and of his predecessor's contribution. However, deep and widespread anxiety now exists and I hope that he will take note of my points and offer some clarification and answers to my constituents.

The Parliamentary Under-Secretary of State for Transport, Local Government and the Regions (Mr David Jamieson):

I congratulate the right hon. Member for South-west Surrey (Virginia Bottomley) on having secured the debate. I understand that she secured a similar debate in January 2000, to which my hon. Friend the Member for Sunderland, South (Mr Mullin) responded. She is, rightly, concerned about aircraft noise, which concerns many people who live near airports around the country. I am pleased that she has raised the subject again and given the government another opportunity to respond.

The right hon. Lady will not be surprised to hear again some of the points that were made last time. However, there have been many positive developments, some of which she alluded to. I hope that I can reassure her on the points that she raised; all reasonable efforts are made to keep the disturbance from aircraft to a minimum and we continue to seek ways to improve the noise climate even more.

We need to minimise the impact of airports on the environment. At the same time, we must ensure that land use planning and conservation policies take account of the economic benefits of maintaining a strong, competitive airline industry and providing sufficient airport capacity where it is economically and environmentally justified. That involves striking a fine balance between aviation needs, providing jobs - Gatwick generates a substantial number of jobs in and around the right hon. Lady's constituency and serves the local, regional and national economy - and the need to minimise the impact on communities around airports.

'Noise is the most prominent environment impact of aviation locally'

The right hon. Lady is aware of my Department's broad role in respect of aircraft noise policy. Gatwick, along with Heathrow and Stansted, is designated under section 80 for the purposes of section 78 of the Civil Aviation Act 1982. That empowers the Secretary of State to impose requirements on the operators of the airport, and of aircraft using it, in order to mitigate the effects of noise. The requirements that we impose include departure noise limits, noise preferential routes to which the right hon. Lady referred for departures, night restrictions and certain regulations pertaining to the management of arriving aircraft.

A noise and track monitoring advisory group oversees the operation of the noise and track keeping system. The core of that system was updated a few years ago with a more modern computer system. The group includes representatives from the Department, the airport, consultative committee members, local authority officers representing the local community, National Air Traffic Services and the airlines. The group examines ways of improving the noise climate around the airport, and of monitoring and reporting. Gatwick also convenes a flight operations performance committee in which airline representatives and air traffic controllers examine technical issues and seek ways of improving performance.

Noise is the most prominent environmental impact of aviation locally. At Gatwick, the general trend in the daytime noise climate has perhaps surprisingly, although I think the right hon. Lady concedes it, seen a diminution of noise over the years as older, noisier aircraft have been replaced by quieter ones. That is despite a large increase in the volume of aircraft movements. It is best illustrated by the annual noise contour reports, produced on behalf of the Department.

Those noise exposure contours show the equivalent continuous sound level experienced on the ground between 7am and 11pm during the busiest summer months. In the past 12 years, the area of the 57dB Gatwick contour has more than halved. The right hon. Lady's constituency of South-West Surrey now lies outside that contour, and I am sure that she welcomes that reduction in the noise.

The right hon. Lady referred to noise preferential routes. It has long been recognised that the balance of environmental advantage lies in concentrating departing aircraft along the least practicable number of specified routes. Since 1968, the Department and its predecessor Departments have stipulated noise preferential routes for aircraft departing from Gatwick. As far as possible, those routes are designed to avoid built-up areas and so minimise disturbance to those on the ground. However, it must be accepted that some dispersion from flight paths is inevitable because of navigational tolerance, aircraft characteristics and, not least, the weather, especially the wind, which can be particularly significant.

In practice, that means that there can be a swathe of tracks up to 1.5km on either side of the nominal centre line of a route, with the greatest likelihood of dispersion when aircraft are turning. However, the right hon. Lady will be pleased to hear that compliance with the swathes has improved from more than 95% of departures in 1998-99 to more than 99% today. There is

continued on page 40

FROM HANSARD

continued from page 39

no financial sanction for deviations, but causes of and trends in significant track deviation are thoroughly investigated. Once aircraft departing Gatwick have reached 4000ft on westerly departures, air traffic control may, if traffic conditions permit, assign them a more direct course to their destinations. The release height for those departures was raised to 4000ft two years ago, and that may benefit the right hon. Lady's constituents. That practice, known as vectoring, is intended to speed up the flow of traffic, which has the benefit that aircraft are able to clear an area more quickly and at higher altitude. That may result in more track dispersion once the required altitude has been achieved, but the amount of noise experienced by people on the ground will of course be relatively less than at lower altitudes closer to the airport.

The vectoring height for easterly departures remains at 3000ft, and I assure the right hon. Lady that the possibility of raising the height to 4000ft is kept under review. The right hon. Lady mentioned her contact with the *Quieter Skies Campaign.* It has requested that the vectoring height be raised to 5000ft. That remains a difficult proposition and it is unlikely to happen in the near future.

It is inevitable that areas so close to the airport will experience overflight. The right hon. Lady's constituency is situated between 15 and 25 miles west of Gatwick airport. Two departure routes over-fly the area when the airport is operating towards the west, as it does for about 75% of the time. Departures from Heathrow and elsewhere, for example those navigating via the Midhurst beacon, will also over-fly the area on both easterly and westerly departures, usually at higher altitude, but they will not climb above 6000ft until cleared to do so by air traffic control. That is to avoid conflict with Gatwick air traffic. It is a fact of modern life that the airspace over the south-east of England is very congested. Over-flight at altitudes of 4000ft and more over a large proportion of the region is inevitable. We are not complacent, however, and we actively seek improvements when possible, but the noise heard on the ground must be taken in perspective with that from other sources endemic in modern life.

'Noise heard on the ground must be taken in perspective'

Maximising the use of continuous-descent approach is of prime importance in reducing the noise impact of arrivals. Pilots at Gatwick are requested to use continuous descent as best they can, but air traffic control constraints - particularly the need to maintain clearance from Heathrow departures - mean that 100% adherence is not possible. At night, there is an additional requirement not to join the extended runway centre line below 3000ft closer than ten nautical miles from touchdown. I accept that that may bring more traffic over the Dunsfold area, but that rule benefits other areas that would otherwise be over-flown more noisily and at lower altitude.

The right hon. Lady also mentioned night restrictions. The Department appreciates that aircraft noise can be particularly disturbing at night and we operate a night restriction regime limiting the number and sort of aircraft that can take off and land. That regime is reviewed every five years or so through public consultation. There is a movement limit between 11.30pm and 6am, backed by a quota system in which noisier aircraft score more than quieter ones against the overall total. The system is designed to ensure that the overall level of noise from aircraft using the airport at night will not worsen, although the total number of night flights may increase as airlines substitute quieter aircraft for noisier ones, but only up to the movement limit set for Gatwick airport for night flights per season.

I turn to the national airports policy. The right hon. Lady is concerned, naturally, that in addition to noise disturbance on communities, the expansion of airports will have an impact on air traffic management and local infrastructure such as housing. I can assure her that any increase in traffic will be met with improvements and increases in air traffic control. There would be no increase in movements without the necessary air traffic control to cope with it. I assure her that safety is always the prime concern. That is fundamental to our planning and any changes in the use of airports and airlines in the south-east. If there is more

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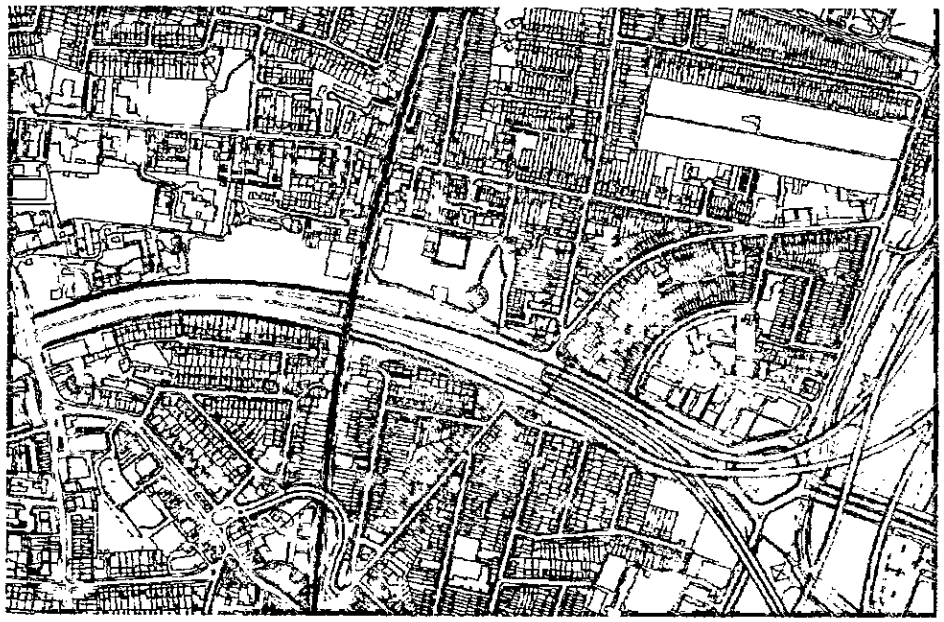

development, there will also be more environmental measures to ameliorate or control that development.
My Department's work on a new air transport White Paper is well under way. Major infrastructure projects take a long time to come to fruition, so we must look a long way forward. Our aim is to provide a better framework to assist planning by all those concerned, including airports, airlines, local authorities and local residents, and to ensure that all relevant factors are taken into account.
I do not pretend to know precisely what the aviation industry or even Gatwick airport will look like in a decade or more, but I do not share the right hon. Lady's vision of environmental measures being abandoned. I assure her that appropriate measures will be in place.
The right hon. Lady is aware of the *South East and East of England Air Services* study of airports in the south-east and east of England, which will inform the new policy. The study will take full account of the potential for airports in other parts of the country to attract a greater proportion of demand than at present. I am sure that the right hon. Lady will welcome that.
Projects for which planning applications have been made, or are expected to be made shortly, are not within the scope of the study because that would lead to duplication and delay. The study examines a range of scenarios based on those projects either going ahead or not going ahead. Implications of possible developments for the planning of airspace capacity, air traffic control and surface access to the airports are included. The government has also consulted on proposals to reform the land use planning system and will announce its conclusions in due course. I assure the right hon. Lady that local people and local authorities have a say about any changes. She will agree that the procedures for terminal 5 did not reflect well on the planning system.
We want to avoid delay, which merely causes uncertainty and pours money into barristers' pockets without helping local people.
The right hon. Lady referred to leaks, but speculation might be a more appropriate definition of what she read in the newspapers. I ask her not to take that speculation too seriously. The SERAS study will be published shortly and at the end of the year it will be converted into a White Paper. The right hon. Lady's constituents and local authorities in the area will have an opportunity to contribute to both parts of the process.
Much work has been done to minimise the impact of noise on the communities around Gatwick airport. We shall continue to examine ways in which to improve the noise climate in the wider policy issues and in the details.
Question put and agreed to.

'Our aim is to provide a better framework to assist planning'

Commons Written Answers

14 April

Roads (noise reduction)

Mr Oaten: To ask the Secretary of State for Transport **(1)** pursuant to his written statement of 1 April 2003 on trunk roads, when he will announce the concrete roads due to be resurfaced from April 2007; **(2)** what budget has been allocated for noise reduction work on concrete roads and motorways for *(a)* 2003-04 and *(b)* 2004-05; **(3)** what percentage of the money allocated for noise reduction work on the motorway network for 2002-03 was spent; and **(4)** what criteria are used for selecting which roads should be resurfaced for noise reduction.

'Each airport is responsible for funding its own noise abatement measures'

Mr Jamieson: I have asked the Chief Executive of the Highways Agency, Tim Matthews, to write to the hon. Member.
Letter from Tim Matthews to Mr Oaten, dated 14 April 2003:
'David Jamieson has asked me to reply to your recent Parliamentary Questions about noise reduction measures on the trunk road and motorway network.
In 2002-03, the Agency spent £5.9 million on noise mitigation measures such as noise barriers on trunk roads and motorways, against a ring fenced annual budget of £5 million. In addition, it is our policy to use low-noise surfacing whenever a road surface needs renewing. In 2002-03, £235 million was spent on resurfacing trunk roads and motorways, two per cent above the budget for this work.
For 2003-04, the allocation for resurfacing concrete trunk roads and motorways is £52 million. The programme for 2004-05 is currently still under development. We shall be resurfacing the highest priority sections of concrete road ahead of maintenance need, in order to reduce traffic noise.
Following consultation with local highways authorities and others, the following criteria were announced on 17 October 2001 for prioritising the surfacing of concrete roads with quieter material: *(i)* that wherever possible the application of quieter surfaces will fit in with normal maintenance needs; *(ii)* that priority will be given to those sites where treatment would benefit the greatest number of people; *(iii)* that the works will be carried out in such a way to minimise disruption to the general public and users of the network; and *(iv)* that 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.
These criteria have been used to prioritise the list of schemes announced on 1 April. The main determinants of priority are the number of properties affected (proxy for criterion *ii*) and for newer roads, the increase in noise levels above those predicted at public inquiry (criterion *iv*). The high priority group is defined by sections of road which affect more than 100 properties per km or for which the current noise level is at least 3dB(A) greater than predicted at public inquiry (an increase of 3dB(A) is equivalent to the noise increase expected from a doubling of the volume of traffic on a road). The medium priority group is defined by sections of road which affect more than ten properties per km or for which the current noise level is 1dB(A) greater than predicted at public inquiry, which equates to a noticeable noise increase.
It is expected that the sections indicated as having a high priority will be completed by the end of March 2007, subject to funding being available. We expect to resurface sections of road in the medium or low priority groups between April 2007 and March 2011, subject to funding being available. Where there is an identified maintenance need, some of the medium or low priority sections may be resurfaced earlier, for road safety reasons.
If you need any further information, please contact Martin Steward at the Highways Agency, Broadway, Broad Street, Birmingham B15 1BL tel: 0121 678 8324.'

28 April

Airport noise

Mr George Osborne: To ask the Secretary of State for Transport how much has been provided by central government funds to *(a)* all UK airports and *(b)* each UK airport for noise abatement measures in each of the last ten years.
Mr Jamieson: Nil. Each airport is responsible for funding its own noise abatement measures, including noise insulation schemes. This applies irrespective of whether the noise abatement measures are specified by the Secretary of State (ie at airports designated under section 80 of the Civil Aviation Act 1982) or determined locally.

29 April

Wind turbines

Mr Lidington: To ask the Deputy Prime Minister if he plans to amend planning policy guidance so that the five kilometre distance recommended between offshore wind turbines and people's homes is applied to onshore turbines also.
Mr McNulty: The annex on Wind Energy in *Policy Planning Guidance Note 22* (PPG22) already contains guidelines about various factors which should be taken into consideration in relation to wind turbine location, including suggestions about turbine separation distances from residential dwellings, specifically in relation to noise. However, the Office of the Deputy Prime Minister intends to consult on a revision to the planning guidance later this year.
Mr Lidington: To ask the Deputy Prime Minister if he will make a statement on the method used by his Department to assess the likely noise impact on local residents of a planned onshore wind turbine.

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FROM HANSARD

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Mr McNulty: Paragraphs 39-47 within the annex on Wind Energy in *Policy Planning Guidance Note 22* contain guidelines about noise levels in relation to wind turbines. The guidelines include a table comparing the noise in decibels generated by a windfarm at 350 metres to that generated by other everyday activities.

30 April

Transport: Aeroplanes

Mr Colman: To ask the Secretary of State for Transport what plans he has to encourage aviation companies to replace older and noisier aeroplanes with aeroplanes with the latest technology low-noise engines through *(a)* financial incentives, *(b)* legislative measures and *(c)* other incentives.
Mr Jamieson: Government plans for the future of aviation in the UK are currently the subject of comprehensive review in preparation for a White Paper it is hoped to publish later this year. These plans will be decided in the light, *inter alia*, of the outcome of current discussions with stakeholder groups on the appropriate use of economic instruments for encouraging the aviation industry to limit aircraft noise and its other environmental impacts. Regulations to transpose EU Directive 2002/30/EC, which sets out rules and procedures for introducing noise-related operating restrictions at Community airports, are in preparation. It is hoped to lay them before the summer recess.

6 May

Aircraft noise

Alan Keen: To ask the Secretary of State for Transport if he will make a statement on the health risks associated with the impact of aircraft noise on people; and how many people he estimates have had their health affected by aircraft noise in the South East of England region.
Mr Jamieson: Available evidence suggests that aircraft noise, either at current levels or at the far higher levels experienced in the 1970s around Heathrow, has no detectable direct effect on the physical health of communities near airports. However, health may be interpreted more widely to encompass impacts upon quality of life, including sleep disturbance and serious annoyance otherwise caused. Some indication of the scale of annoyance is available from noise contours, which have substantially contracted at Heathrow and Gatwick over the past two decades or so (but have expanded at Stansted).
Daytime contours for Heathrow, Gatwick and Stansted airports in 2001 are available on the DfT website at www.aviation.dft.gov.iik/nec01/index.htm. Further information for these and other airports in the South East is available in the relevant consultation documents on the Future Development of Air Transport and supporting technical material.
The Government is signatory to the WHO Charter on Transport, the Environment and Health, and has regard to the guidelines referred to therein.

19 May

Buffer zones and wind farms

Mr Blizzard: To ask the Deputy Prime Minister **(1)** what guidance he will give local planning authorities on the creation of local buffer zones beyond the boundaries of national parks and areas of outstanding natural beauty; **(2)** if he will adopt the noise standards contained in the DTI document, *Assessment and Rating of Noise from Wind Farms*, as a standard planning guideline on wind farm applications; and **(3)** if he will encourage local planning authorities to identify landscape areas suitable for wind farm development in local land use plans.
Mr McNulty: Current government guidance on renewable energy is set out in *Planning Policy Guidance Note (PPG) 22* and its associated annexes. PPG22 is currently being revised and a draft for public consultation will be published later this year. Policy on the use of buffer zones, noise and the location of wind farm developments will be included in that draft.

3 June

A27 Lewes bypass

Norman Baker: To ask the Secretary of State for Transport if he will require an assessment to be made by the Highways Agency of noise pollution in Lewes emanating from the A27 Lewes bypass.
Mr Jamieson: A detailed noise study of the A27 Lewes bypass has been carried out and there is no need for a further noise study. The answers previously given on 20 June 2002 and 8 January 2003 still apply.

Control of Noise from Pubs and Clubs

The Institute's *Good Practice Guide on the Control of Noise from Pubs and Clubs* is now available from the Institute office. Priced at a very reasonable £20, the *Good Practice Guide* is selling very well already and is set to become the standard for dealing with noise problems in this tricky and highly subjective field.
Phone head office on 01727 848195 to order your copy: payment is accepted by credit or debit card, or by cheque (payable to the Institute of Acoustics).

Institute of Acoustics

Members Register 2003 - 2004

❑ Are you a consultancy looking to stand out from the rest ?
❑ Are you a consultancy with a specialised product/service to sell ?

Advertising in the Institute of Acoustics' annual ***Members Register*** gives you a higher profile than being one of the names in the general listing.

We are **now** accepting advertising for the 2003/2004 issue, which is due to be published in late September – the beginning of the budgeting and buying season for many of our members' organisations.

If you would like more information about advertising opportunities in the
Institute of Acoustics Members Register: 2003–2004
please contact: Dennis Baylis MIOA, Advertising Manager,
Peypouquet, 32320 Montesquiou, France
Tel/Fax: + 33 (0)5 62 70 99 25 e-mail: dbioa@hotmail.com
or: via the IOA Head Office at St. Albans Tel: + 44 (0)1727 848195

Engineering Council update

The Board Meeting was held electronically for the first time on 20 March 2003. The following issues arose.
Dr Sa'ad Medhat, the Engineering Technology Board's (ETB) director of education and professional development was welcomed to the Board. He replaces Professor Howard Barnes as one of seven ETB nominees.
A number of concerns were raised about misleading statements to the media by ETB regarding the ongoing review of registration standards. The consensus was that every effort should be made to achieve closer working between EC(UK) and ETB to prevent recurrences, with particular emphasis on improved communications co-ordination.
Agreement was reached on creation of three Panels to undertake work on behalf of the Board. These are: the Finance Audit and Remuneration Panel; the Communications Panel; and the Privy Council and Constitution Panel.
Consideration was given to ways in which the burden on companies of satisfying the requirements of more than one Institution for Initial Professional Development could be reduced. The issue was serious enough to form a major topic for the next meeting.
Draft accounts for 2002 were discussed, and reports received covering work of the Registration Standards Committee; the Quality Assurance Committee; the International Advisory Panel; and the Standards Working Group.

Marketing the new qualifications structure: links with ETB

At a recent meeting of ETB and EC(UK) Executives, plans were initiated for a campaign to market the value of registration to employers. It is proposed that the campaign should coincide with launch of the new registration standards expected in autumn 2003. Consultation on these continues (http://www.engc.org.uk/registration/standards_review.asp).
A previous attempt to raise employer awareness of registration was abandoned in late 2001, during reorganisation of the former Engineering Council structure.

ETB and EC(UK) plan debate on licensing

ETB and EC(UK) plan a public debate on the topic of Licensing. Many registrants believe that some form of statutory recognition for engineers in the UK would enhance the profession's status and perhaps increase its attraction as a career. There has been a number of studies over the years, most concluding that some form of licensing for specific tasks would be helpful. However there are considerable difficulties in achieving this and no consensus that it would be beneficial to UK industry, or to public safety. Further details of the arrangements for the debate will be published soon.

Report from the EC(UK) Board Meeting

Professional engineers: then and now

At an earlier ICE meeting, Andrew Ramsay presented the results of a unique survey. EMTA published the Report, by Professor Stephen Wearne of UMIST, of a survey into the management skills required and challenges faced by Chartered Engineers in 2002. The unique nature of the survey was that it paralleled a 1979 survey also conducted by Professor Wearne. Amongst key findings were the overwhelming need felt by practising engineers for training in presentation and meeting management skills.
The report was sponsored by EMTA and EC(UK), and was supported by several Institutions. EC(UK) said that it would provide a valuable contribution to the review of standards for registration currently taking place. Copies will shortly be available from EMTA and EC(UK).

Review of registration: press comment

The review of registration standards has already gained many column inches in one of the UK profession's best-read magazines. *Professional Engineer* stirred up interest with a double-page spread in its 27 November 2002 edition, entitled 'Routemaster' (http://www.engc.org.uk/news/responses.asp).
The letters pages subsequently carried a number of comments and statements on the issue. Comments by Engineering Professors Council Chairman, Professor Bill Banks, who is also a Vice-President of IMechE also featured prominently. More recently the magazine carried a further review of the consultation draft, stating that the ECUK's discussion document was being well received by the profession (Vol 16 No 5 12 March 2003).

New opportunity for international recognition for UK engineers

The Engineering Council (UK) has announced the official opening of the UK section of the International Register of Professional Engineers. The Register offers Chartered Engineers holding a recognised degree, and with at least seven years' experience, to join their peers from other signatory countries in gaining recognition in other jurisdictions. While not precluding recognition of other registered engineers, it takes advantage of the growing mutual confidence in registration systems in Washington Accord and allied countries, and responds to increasing demands from multinational companies for easier ways of recognising professionally qualified engineers.

Engineers discuss the importance of increasing international recognition

An EC(UK) organised seminar learned that a fifth of UK registered engineers live abroad and sales of engineering services net the UK an income of £1.9 billion a year. Engineers produce 17% of the UK's trade in services.
Some seventy delegates, mainly senior engineering institution staff and officers but also representatives from other professions, the Quality Assurance Agency, the Engineering Professors Council and Government Departments, met in February 2003 for a presentation on the international work of the Engineering Council (UK).
Feedback from delegates indicated that the seminar had been both useful and timely in updating them on the many interconnecting aspects of international recognition with which the EC(UK) is involved.
More information and details about International Register requirements can be

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Reconciling the Register to membership databases

The EC(UK) Register of Chartered Engineers, Incorporated Engineers and Engineering Technicians has over 400,000 records and ensuring that these mirror the data held in the membership databases of individual engineering Institutions is a significant task.
A web service is under test that will enable Institutions to interrogate the Register directly and thus verify information such as other memberships held and the EC(UK) fee payment route. Developing this technology would enable EC(UK) to receive information from Institutions about relevant changes to their databases in real time without affecting the security or integrity of those databases. Clearly, electronic data interchange is not new, but web services now provide a simple and efficient mechanism.
In the short term, some temporary assistance has been recruited to clear the backlog of reconciliations that have built up with some Institutions. The EC's automated systems cope with most of the work, but changes of surname, invalid postcodes and similar discrepancies need human intervention. Following initial trials, a report on how this work is developing will be made to the EC(UK) Board.

The DTI National Measurement System

Acoustical Metrology Programme 2004-2007

Work on developing the next *National Measurement System (NMS) Acoustical Metrology Programme* has now started. Funded by the DTI, the Programme aims to develop, maintain and disseminate measurement standards for sound, mainly but not exclusively covering airborne and waterborne sound. As well as research and development, there is also provision for 'knowledge transfer' activities to ensure the findings of the work are widely disseminated to UK practitioners.

NMS programmes are funded on a three-year cycle, with the present acoustics programme due to end in September 2004. In order to ensure that the work carried out is both excellent (in terms of measurement science) and relevant to the needs of the user community, consultation is a major feature of each programme's formulation.

A team from Scientific Generics, led by Antony Hurden, has been engaged by the DTI to assess the needs for acoustical measurement over the next 10-15 years, with particular emphasis on new areas of research. The team has consulted widely and many readers of *Acoustics Bulletin* will have been contacted as part of the study, the results of which will be made available for downloading from the NPL Acoustics web site.

Following a consultation meeting held at the end of June, more technically-focused meetings will be held in September, the venue not necessarily being NPL, with the possibility of regional meetings being considered. After the preparation in autumn 2003 of a draft programme which will be reviewed by the DTI-appointed Measurement Advisory Committee Working Group on Acoustics (an independent panel of experts who oversee the development and delivery of work in this area), it will be released for public comment at the end of this year.

In order to ensure the programme best matches the needs of the UK user community, our readers' help is sought in shaping its future direction and content. The NPL programme formulator and the DTI's National Measurement System Directorate (NMSD) would welcome individual comments or suggestions from anyone with an interest in acoustical measurement at any time during the formulation process.

Contact: (NPL) Roy Preston (0208 943 6154, roy.preston@npl.co.uk), and (NMSD) Norman Bolton (0207 215 1450, norman.bolton@gsi.dti.gov.uk)

To keep up to date with the Acoustics Programme formulation, visit the NPL Acoustics web site at http://www.npl.co.uk/npl/acoustics/research/

Tackling noise nuisance from alarms

London's new keyholder database could speed access to premises

In May this year a new database of keyholders across London went 'live': it will be used by EHOs to gain access to premises where alarms are causing noise nuisance. A company specialising in database strategies based on the internet, Dial Media Group, developed the keyholder database after the data held in local police stations was destroyed in February 2001. Richmond Council had just leafleted householders throughout the borough, and had brought its information right up to date, so was particularly upset by the destruction.

Apparently this was a cost-cutting measure by the Metropolitan Police, whose staff were spending unacceptable amounts of time responding to requests from councils for phone numbers and addresses. Noise teams across London had been using the data since 1991, and it had been an easy and quick way to deal with nuisance alarms, a major source of community annoyance. At the time, councils registered their objections to its discontinuance very strongly. Owners of properties equipped with intruder alarms have a duty to tell police the identities of keyholders who can gain access to premises.

The new system is being brought into operation by circulating a mailshot to all houses and businesses during the course of this year, inviting their registrations. Specific authorities are not being targeted, but the mailshot is being delivered in consultation with Royal Mail in order to make the best use of its capacity. The basic service is free of charge, with registration being made using a freephone number. However, there is also a 'premium' service (£15 for domestic properties, £35 for commercial premises) which allows registrants to update their data on-line, and make information available such as their preferred locksmith and glazier. Private householders are also able to record details of their GP, in case of emergency. It is hoped that all 1.4 million alarm systems in the capital will eventually be on record.

The Metropolitan Police says Data Protection Act restrictions will prevent details from the database being transferred onto its own files, but questions have been raised about how EHOs will gain access to the data from their offices or in the field. For example, it may be necessary for there to be named officers who can contact Dial Media Group directly, unless a secure internet connection can be guaranteed. Patrick Lacey, the company's financial director, has said that it would depend on what the local authorities wanted. However Valerie Solomon, the public protection officer for the Association of London Government, believes that in order to make sure the system is workable, a good deal more consultation with the authorities is necessary.

Engineering Council update

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viewed at www.engc.org.uk/international/irpe.asp. Application forms and guidance notes are also downloadable from this web page.

Professional Development Forum

A meeting of the Forum was held on 20 February, hosted by the IEE. In examining the draft specification members stressed the importance of professional development, especially of work based learning, in the requirements for registration. More information is needed on what is expected of engineers, and of employers, in the professional review process. An initial report was presented on a study of Institutions' policies and practices for mentoring. This showed that mentoring is recognised to be important in supporting engineers, both towards Registration and for ongoing CPD.

The meeting discussed the future of the Forum, noting the changing responsibilities of the EC(UK) and the ETB for Professional Development. Members believed strongly that the Forum should remain within the regulatory role of the EC(UK).

Newly registered engineers

The most recent list of engineers registered by EC(UK) is now available at http://www.engc.org.uk/registration/new_registered_eng.asp

The Annual Digest of Engineering Statistics (2002)

The Annual Digest of Engineering Statistics (2002), published by EC(UK) and ETB is now available as a download, via free registration with the ETB site, at: http://www.etechb.co.uk/archive/digest/index.asp A speedier download version is expected to be available soon.

Forum for the Future report

Forum for the Future has published a report of the Engineer for the 21st Century Inquiry, *Change Challenges for Sustainability*. The EC(UK) is seen as a possible partner, through its work on the revised Standards, at Recommendation 2: 'To build the capacity of teachers and trainers to integrate sustainability into courses'.

The report can be downloaded at: http://www.forumforthefuture.org.uk/publications/default.asp?pubid=29

Women and technology

In welcoming new government approach, IOP also urges further action

While the Institute of Physics has welcomed, in principle, a new approach from the government to increase funds for women in science and technology, it also calls for other forms of action to be taken.
Dr Wendy Kneissl, leader of the Institute's *Women In Physics* programme, describes the government's new integrated initiative to tackle the problem of the under-representation of women in science as 'a positive start'.
"In particular, in physics we are seeing fewer pupils taking the subject, and most who do are boys," she said. "Women represent only 20% of our community at best and this issue must be addressed. Planned action in this direction improves the chances of women being more evenly represented in science. We look forward to seeing the results of this approach to a global problem, but we feel there is more work that needs to be done."
Dr Kneissl welcomed the government's move towards bringing the gender issue into the mainstream, and the independent evaluation of the impact of initiatives, "which are both very much in line with our own approach. However", she added, "we feel that more needs to be done to engage the commercial sector, and to encourage the collection and sharing of up-to-date statistics that show the difference between the sexes in employment, so that we can better understand the position of women scientists and engineers in industry."
Business, she suggested, might reflect on the potential commercial impact of a workforce that represents only half the world's consumers in the context of their own position with respect to gender diversity. Best practice in industry needed to be identified and shared, as was already happening in higher education through the Athena initiative.
"We believe our new *Programme for Women in Physics*, formally launched at the Institute of Physics in May 2003, will be able to make a real contribution to the issues, particularly those faced by the physics community. We very much look forward to collaborating with other organisations, to gather momentum and to drive the solution forward," concluded Dr. Kneissl.

Understanding low frequency noise and its effects on health

A review of research into the perception of low frequency noise and its impact on health has recently been published by Defra. The publication, *A Review of Published Research on Low Frequency Noise and its Effects,* looks at research into the effects of low frequency noise on annoyance, sleep patterns, stress and other aspects of human behaviour.
According to the minister responsible, Alun Michael, the report offers an accessible and interesting overview of previously published material about a difficult problem which can be a cause of great distress for those it affects, and for which there are no easily identifiable remedies. However, there is still a great deal to be done to gain a fuller understanding of low level, low frequency noise, its effects, assessment and management.
Low frequency noise can cause extreme distress to some people who are sensitive to it. Sufferers most commonly hear a humming or deep drone that can severely affect their lives. There is relatively little information readily available regarding the impact, assessment or management of low frequency noise.
The report, commissioned by Defra, was written by Dr Geoff Leventhall, a Fellow of the Institute of Physics and the Institute of Acoustics, and an acknowledged expert in low frequency noise. A former President of the IOA, he was founder editor of the *Journal of Low Frequency Noise and Vibration* and is an organiser of the series of international conferences on Low Frequency Noise and Vibration. He has produced 40 publications about low frequency noise and its effects.
The report considers such key issues as the potential for 'learned' sensitivity and the phenomena of the 'hums' reported in towns and cities across the globe, including Bristol. In particular, it assesses the data available regarding the impact of low frequency noise on human behaviour, sleep periods, task performance and social attitudes. It has been written for low-frequency noise-sufferers, health professionals, environmental action groups, local authorities and acousticians.
Copies may be downloaded from Defra's website at:
http://www.defra.gov.uk/environment/noise/lowfrequency/index.htm
or can be requested by e-mail from noise@defra.gsi.gov.uk or in writing from: Noise and Nuisance Policy, Air and Environmental Quality Division, Department for Environment, Food and Rural Affairs, 4/H17 Ashdown House, 123 Victoria Street, London SW1E 6DE.

'Horse' sense

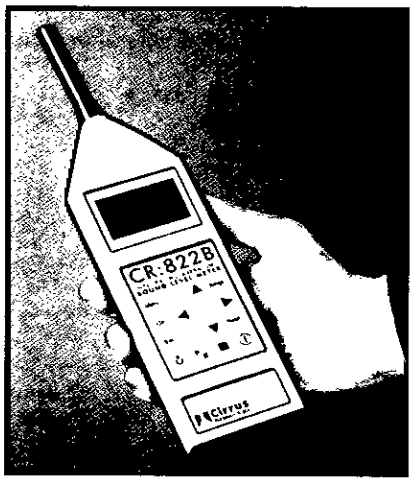
Apparently BHS is leading a campaign against the laying of a new road surface. This was the source of some little surprise, as after all, why would a retail store be interested in the materials used on the high street, unless the punters were treading the black stuff into the newly-polished floors? But no, the BHS in question was the British Horse Society, whose members are objecting to the new low-noise surface used on major roads, as mentioned in several recent issues of *Acoustics Bulletin* (Hansard reports). It seems that horses' hooves shod with traditional iron shoes skid all too easily on the modern road surface, because (surprise, surprise) the specification was not developed with quadrupeds in mind. Erm, what approximately is the ratio of horse traffic mileage to motor vehicle mileage these days ... about 1 in one million?
Watch this space: judging by the usual reaction of local highways authorities, the next stage will be to provide 'horse lanes' alongside the cycle lanes and bus lanes, surfaced with hoof-friendly material and painted blue (to go with the reds and greens we already have). Rest assured they will be in conveniently usable 8-metre lengths, with ordinary road surfacing used in between.

WISE LAUNCHES 'FUN' WEBSITE

The WISE (Women Into Science and Engineering) Campaign promotes science and engineering as a valuable and interesting career option to young women, and also encourages the retention of women engineers and scientists in the profession. Since its launch in 1984, the percentage of female engineering graduates has risen from 7% to 15%.
The WISE Campaign has re-launched its national website: www.wisecampaign.org.uk with role model profiles, answers to frequently-asked questions, help for women returning to science, engineering and technology (SET), fun sections for girls to explore, and information on ways to enthuse young people. The world we live in is run by SET, and these careers are an exciting and challenging path for girls as well as boys.
Web sites are the major source of information for young people, and WISE wants to make certain that girls surfing the net will be helped to see how exciting such careers are, by considering the impact SET has on their lives and society. It is hoped that they will then want to become the engineers and scientists of tomorrow.

Millionaire expert

The expert opinion of Dr John French FIOA was sought in the recent high-profile *Who Wants to be a Millionaire* trial at Southwark Crown Court. He said that the coughs claimed to have been signals to the contestant came from a row of five contestants which included the lecturer who was implicated.
Comparisons of the sound levels produced showed the quietest of the coughs was considerably louder (sometimes up to five times) than any of the genuine coughs from the studio audience.
Dr French said that he had also traced the origins of the word 'no' - which was uttered just as Major Charles Ingram seemed about to answer the half-million pound question incorrectly - to the same area of the studio. It was on microphone ... and apparently spoken by the same person who was producing the abnormally loud coughs.



Cirrus Research

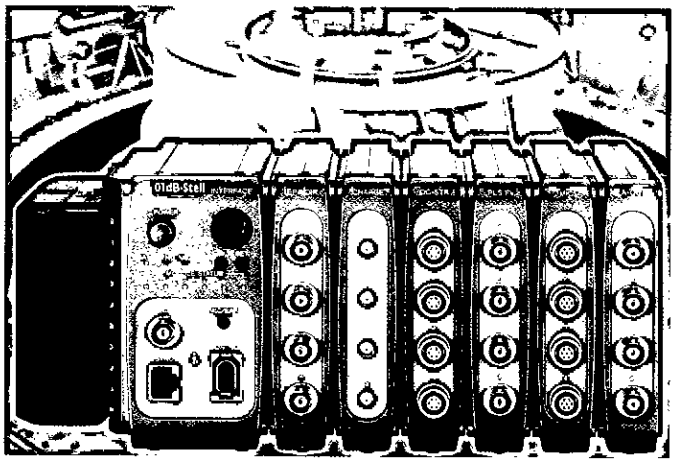
New instrument for workplace noise measurements

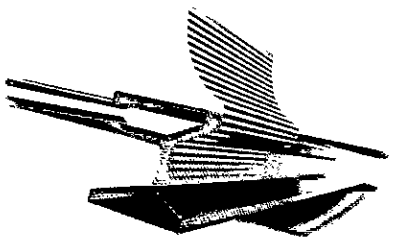
The *CR:822B*, part of the CR:800 family of sound level meters, has been launched by **Cirrus Research.** It provides all the functions needed to make an assessment of the risk, and where appropriate, to recommend suitable hearing protection.
The company says that with the imminent changes to the Noise at Work Regulations, accurate measurement of workplace noise is becoming increasingly important.
The new meter version - an update of the successful CR:800 series - brings new features and functions to the market whilst being easy to use. The instrument can be supplied as a complete measurement kit which includes accessories and software.
For more information: James Tingay,
tel: 01723 891655 fax: 01723 891742
e-mail: sales@cirrusresearch.co.uk
www.cirrusresearch.co.uk

AcSoft

Orchestra: small system with big bandwidth

Orchestra is 01dB-Stell's new multichannel front end for the DBFA analysis software, and is now available from **AcSoft** for large-scale or distributed acquisition and analysis projects.
It is based on two important developments which provide a combination of channel and bandwidth capability, scalability and ability to network. Firstly, it is built up from a system of bolt-together modules unique in the sound and vibration marketplace. With no need for a mainframe computer, it is exceptionally light and compact, and offers low-cost entry.
Secondly, *Orchestra* uses Firewire communications technology for networkable acquisition and fast data transfer to a PC. This means it handles data acquisition and real time analysis simultaneously, and can be built into a distributed system streaming data at 26Mbps from measurement blocks up to 100 metres apart.
The system consists of a Firewire communications module, a choice of input modules, and output/ functional modules.
Each input module has four channels and each Firewire interface connects up to six input modules to a PC, with a maximum system configuration of 192 channels. Input modules can provide signal conditioning for a wide variety of transducers including direct, IEPE, charge, microphone, strain gauge, thermocouple, tachometer pulse, FV converter and CAN, with flexible triggering options. Functional modules provide analogue outputs and a function generator.
Given the power of the DBFA suite, Orchestra handles real time FFT and *n*th-octave frequency analysis, with the latest version bringing acoustic intensity, sound power, structural analysis, materials testing, psychoacoustics and sound quality, time/ frequency analysis, order analysis, transient analysis and building acoustics within the scope of this cost-effective system. Data can also be exported to other industry-standard analysis packages for advanced post-processing.
For more information: John Shelton,
tel: 01296 682686 fax: 01296 682860





New AcouStud

British Gypsum

New AcouStud for commercial applications

New 70mm and 146mm versions of *Gypframe AcouStud* have been introduced by **British Gypsum.** They are specifically designed for use in hotels, hostels, student accommodation, nursing and residential homes, and other commercial buildings required to comply with the new Part E acoustic regulations.
Developed by British Gypsum in collaboration with its Swedish sister company, the new *AcouStud* features a unique, patented profile which absorbs sound energy as it passes through the wall.
The stud is claimed to improve system acoustic performance by up to 6dB, enabling more demanding applications to be satisfied without the need to upgrade board specification or add supplementary acoustic insulation quilt.
The latest launches follow the introduction last year of the 43mm *AcouStud* designed primarily for domestic applications, which is already proving very popular with house builders keen to comply with the new tougher Part E acoustic standards for dwellings.
Commercial specifiers will now be able to specify the new 70mm and 146mm *AcouStud* as an economic alternative to other upgrading measures, wherever the acoustic performance of wall systems needs to be enhanced, whilst retaining the company's usual performance warranty.
All relevant White Book sections have been updated to show the performance of existing systems with *AcouStud* in place of the traditional stud specification, and are available to download from the company's website www.british-gypsum.bpb.com

38th United Kingdom Conference on Human Response to Vibration

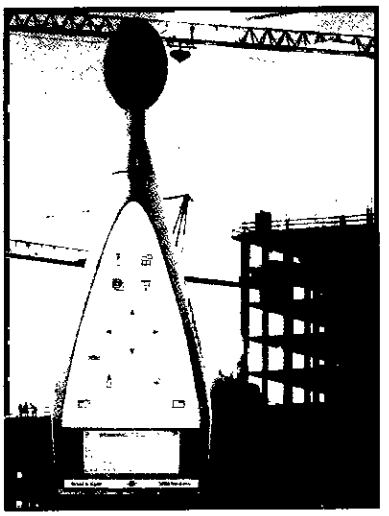
17-19 September 2003

This annual conference provides a forum for exchange of information, dissemination of research findings and an opportunity to be updated in current issues related to human response to vibration. Presented papers cover all aspects of hand-transmitted vibration, whole-body vibration and motion sickness.
The conference usually attracts a diverse mix of delegates from government, industry, academic, consultancy and military organisations with backgrounds in psychology, medicine, physiology, science, health and safety, ergonomics, design and engineering.
Titles and abstracts for papers are invited. Please use the 'offer to present a paper' template in the 'downloads' section of the website shown below. The full text of papers will be expected at least one month prior to the conference so that proceedings can be provided to delegates when they register.
For further information, please contact Dr G S Paddan on tel. 023 9276 8080, email hav@inm.mod.uk or visit the website at www.hrv.org.uk

Bruel & Kjaer

Noise measurement practicalities highlighted in new Building Acoustics course

A new one-day training course aimed at building designers, architects and engineers looking to improve their theoretical knowledge of building acoustics has been introduced by **Bruel & Kjaer.**
It offers delegates practical advice on optimising their use of building acoustics instrumentation to assess the impact of excessive noise levels in a building.
The *Building Acoustics* course explains the theory and measurement of parameters including reverberation time, airborne sound insulation and impact sound insulation.
Measurement of building acoustics is now a fairly quick procedure using real time frequency analysis, but the assessment needs to be carried out to recognised standards. The course reviews the relevant standards and features a practical session covering measurements relating to these standards.
Participants learn how to set instruments for fast measurement of parameters and assessment of results, while practical exercises reflect typical measurement situations. All participants will work through practical measurement exercises and the training is interactive with personal supervision.
The one-day course includes all training materials, lunch and coffee breaks.
The company has also announced details of its 17th consecutive *Noise Tours* seminar programme. This starts on 7 October 2003 in Cornwall, and will visit Bristol, Cardiff, Southampton, Hertfordshire, London, Edinburgh, East Kilbride, Haydock, Doncaster and Darlington during the following two months.
The *Noise Tours* are designed to increase knowledge, offer guidance on the fundamentals of noise instrumentation, and provide solutions for the effective monitoring of environmental and occupational noise. They aim to cater for newcomers to the subject as well as those in need of refresher. The main points of the day are illustrated throughout with current case studies.



The company is a leading supplier of sound and vibration products

A free *Course Planner* wall calendar highlighting all Bruel & Kjaer's training 2003 courses can be ordered from the company by calling 01438 739000 or e-mailing ukinfo@bksv.com

IAC Ltd

Acoustic partitions help to maximise revenue from function space

London's Hotel Antoinette has adjacent restaurant and conference rooms which frequently need to be opened up to create one large function space. Many years ago a movable wall system was installed to divide the area. This failed to provide an effective acoustic barrier so, to boost sound reduction, a secondary wall was erected. However, even this proved inadequate acoustically, when two separate events took place side by side. The 'double wall' arrangement was also difficult and time consuming to set up and dismantle.
With demand for the function rooms increasing, the hotel's manager, Peter Hartnell, could see that a proper and lasting solution to acceptable room division was essential. He contacted **IAC** who sent two engineers to undertake a free acoustic survey of the dining/function space. At best, existing walls were providing sound reduction amounting to 36dB. This was simply inadequate to contain the noise generated by music and amplified speech when two events ran concurrently.
The solution was found in a new type of IAC movable wall system which has a sound reduction rating of 54dB. *Trackwall 60* consists of 100mm thick individual panels suspended from a neatly concealed overhead track. When in position, a simple handle-driven scissor jack mechanism ensures that the top and bottom seals in each panel form a tight acoustic bond with floor and ceiling.
Panels can be manoeuvred easily in and out of position by one person in just a few minutes. They have a tough, washable, melamine finish matching different decorative schemes on either side. Peter Hartnell's verdict is that the system looks good and works extremely well, allowing the hotel to maximise revenue from its dining and function space.

Further details can be found in a datasheet (TDS/01.02), available by phoning 01962 873050. Data can also be viewed and downloaded from the website: www.iaci.co.uk.

Campbell Associates

Accolade for service standards

In April this year, **Campbell Associates** received an award for 'world-class service'. As Steinar Bohn, managing director of Norsonic AS commented: "The award recognises the excellent technical support Campbell Associates provides to its ever growing number of customers. The people within the team have helped us develop products successfully, to specifically meet needs of the sound and vibration professional in the UK market."
Campbell Associates continues to expand its all round service to customers with the introduction of an all-makes calibration service and full training programme for CADNA noise mapping software and Norsonic sound level meters.
For further information visit www.campbell-associates.co.uk or contact Joanna Hargrave on info@campbell-associates.co.uk or tel: 01279 718898.

Steinar Bohn presents the award to members of the Campbell Associates team

Ono Sokki CF-350 Signal Analyser

Is anyone willing to dispose of such an instrument to a good educational home, so that it will complement our 16-year-old model at the Colchester Institute?

We would also be interested in a large old sound level meter, B&K Type 2218, if anyone has one.

Please contact David Bull telephone 01206 241684, or E-mail david.db@ntlworld.com.

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Parson Brinckerhoff's Environment, Safety and Risk Management group operates as a specialist environmental consultancy with 120 staff located in Birmingham, Bristol, Chester, Cardiff Glasgow, Manchester and London.

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- Industrial noise
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Institute Diary 2003

17 July
Medals & Awards & Council,
St Albans

5 August
Diploma Moderators Meeting,
St Albans

16 September
Meetings,
St Albans

18 September
Membership,
St Albans

18 - 19 September
Research Symposium, Acoustic characteristics of surfaces: measurement, prediction and applications
University of Salford

23 September
Environmental Noise Group Wilson - 40 years on
Commonwealth Conference Centre, London

25 September
Executive,
St Albans

30 September
Diploma Tutors and Examiners & Education,
St Albans

30 September
Environmental Noise Group IPPC
Birmingham

7 October
Measurement & Instrumentation Group Its how loud .... Are you sure?
NPL

9 October
Medals & Awards & Council,
St Albans

14 October
Engineering Division,
St Albans

23 October
Publications,
St Albans

4 November
Research Co-ordination,
London

5 - 6 November
Building Acoustics Group Autumn Conference 2003, Sound-bite
The Oxford Hotel, Oxford

6 November
Membership,
St Albans

7 - 9 November
Electroacoustics Group Reproduced Sound 19
The Oxford Hotel, Oxford

18 November
CCENM Examiners & Committee,
St Albans

20 November
Executive
St Albans

25 November
Meetings,
St Albans

2 December
CCWPNA Examiners & Committee,
St Albans

4 December
Medals & Awards & Council,
St Albans

9 December
CMOHAV Examiners & Committee,
St Albans

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British Standards audit Gracey & Associates twice a year for the hire and calibration of sound and vibration instrumentation.

Campbell Associates

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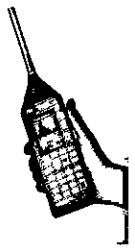
Sales Support and Calibration



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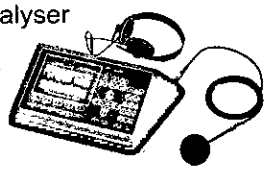

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