Institute of Acoustics

acoustics BULLETIN

Volume 22 No 4
July – August 1997

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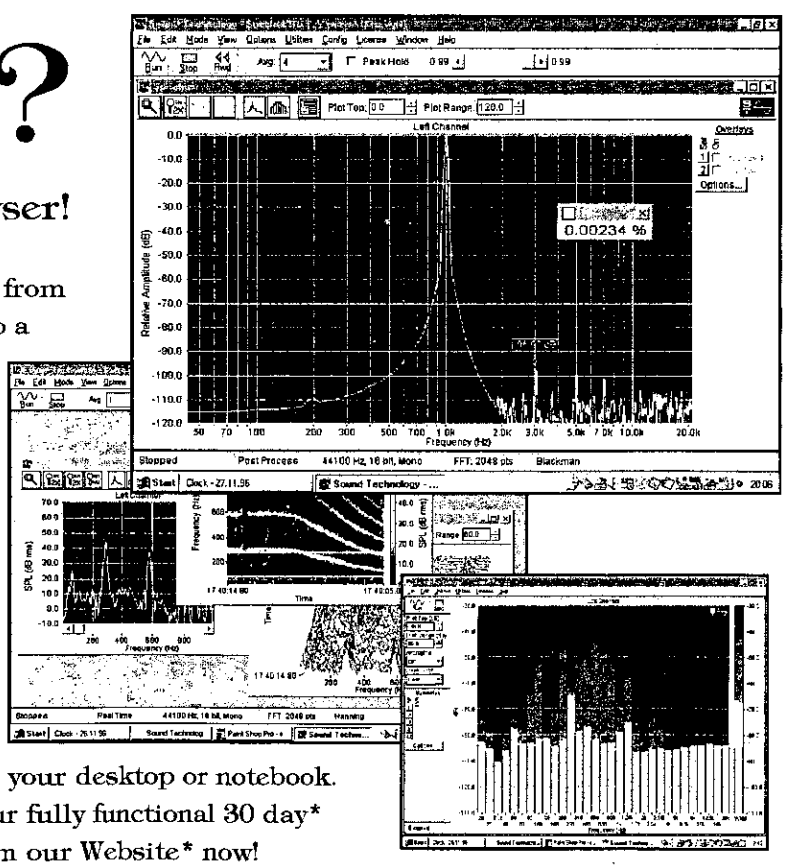

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contents

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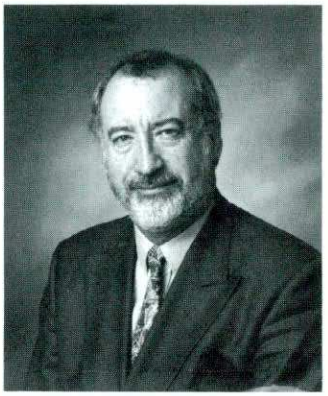

Dear Fellow Member

Some months ago the Institute began the process of finding and appointing a new Deputy Chief Executive. I am delighted to report that the process was completed in the middle of May and that Mr Roy Bratby joined the staff on June 23. I feel confident that he will be able to meet the many challenges ahead and make a significant contribution to the future success of the Institute.

Since the formalities of the Annual General Meeting were completed in May, I am also able to welcome three new members of Council – Professor Bob Craik of Heriot-Watt University, Mr Colin English of Arup Acoustics, and Mr Colin Grimwood of the Building Research Establishment. Each of them is, I know, looking forward to bringing their own brand of fresh enthusiasm to Council, and I look forward to working with them when Council re-convenes after the summer break.

As ever, the summer looks like being far from a quiet time. In August, I was pleased to participate in another of the many and varied aspects of the life of the Institute when I attended the International Symposium on Musical Acoustics in Edinburgh. A fascinating technical and social programme was arranged. It is hoped that a full report of this well-supported meeting will be published in the next issue of Acoustics Bulletin.

Just prior to the start of Internoise 97 in Budapest, there are the annual meetings of the General Assembly of the European Acoustics Association and of the Executive Board of the International Institute of Noise Control Engineering (I/INCE). The IOA is of course a Member Society of both organisations. At both meetings, and in particular at the EAA Assembly, issues are to be discussed and decisions taken which are of importance to the future of our own Institute. For example, a proposal is to be discussed by the EAA for a scheme to set up a Europe-wide sponsor membership scheme for the EAA with the intention of eliciting support from companies and research organisations. The Executive Committee of the IOA will be meeting to prepare for the EAA Assembly and will as ever endeavour to ensure that the correct balance is maintained between the interests of the EAA and those of our own Institute. Members will be kept informed of developments arising from these international meetings through the Bulletin.

Sincerely yours

Bernard Berry

Bernard Berry

ACOUSTIC MODELLING – A PERSONAL VIEW

Colin McCulloch MIOA

Introduction

In this article, I shall attempt to give something of an overview of the different methods available for acoustic modelling, and to make some remarks about their applications, advantages and disadvantages, with some typical examples. Computers are ever-present in today's world, and provide the tools for doing many things, much faster, than has ever before been possible. Compared to measurement methods, computer-based prediction and analysis enables the acoustician or engineer to assess many possible scenarios, before they are even built, and to minimise any late testing, trouble-shooting, or prototype revisions. Measurements tell us a lot about what is, predictions tell us what could be.

However, it is also true that computer modelling can be a dangerous thing: it can 'dress up' the results of a completely inadequate analysis and present them in a way that makes them very believable – beautiful colour plots, huge tables of data, even animations or auralizations. How can we avoid such situations of 'garbage in, garbage out'? We should consider the possible causes of wrong results: incorrect input data (like incorrect source sound power) wrong assumptions about the phenomena being modelled (like ignoring fluid-structure interaction and the effect of a flexible structure, or 3-dimensional sound dispersion) or the application of the wrong algorithm (like trying to use a formula for exterior traffic noise in a reverberant space). Note that I assume that the obvious causes of error – like typing wrong data – should be prevented by any reasonable quality control procedure.

So how can one make good use of computer modelling? The key is to take a step back from the excitement (and possibly significant workload) of making a model and entering data, and consider the fundamentals of what it is that is being modelled – what frequency ranges are we looking at, what physics is involved (sound propagation, fluid-structure interaction, diffraction, reflection etc) – and what modelling methods are best for this?

The rest of this article is intended to provide some signposts along this road.

Types of Modelling Method

We can divide modelling techniques into three broad classes:

- (semi) empirical methods,
- geometrical or energy-distribution-based methods, such as ray tracing,
- numerical methods (based on equations for the physics of vibro-acoustics), such as finite elements and boundary elements.

The category in which to place some techniques, particularly for specialised applications like some underwater propagation models, may be open to debate, but these broad classes generally indicate the nature of each approach.

Empirical Methods

There are many rules and formulæ in use in classical acoustics, from Sabine's and Eyring's room reverberation formulæ, to the formulæ for exterior noise propagation from road and rail traffic, aircraft, fixed or moving plant, and so on. These rules and formulæ are generally well-tested, in the sense that they have been developed over many years and are usually being refined and adjusted when measurements and practical experience demands it. The main feature of such formulæ is that they are almost always devised so as to be practical for 'hand' calculation. Typically, they are published in literature, national or international standards and the like. These formulæ can be programmed into computer codes, in some cases as simple as a spreadsheet, in other cases with advanced interactive graphics and colour contour plot outputs. The great advantage of this is that input data for complex or voluminous calculations is much more convenient and many calculations can be performed in a short time. Results may also be presented in a very attractive way. The great weakness of this, as suggested in the Introduction, is that a great many errors, uncertainties or assumptions may be obscured by the speed of the calculation or the attractiveness of the presentation. To give one instance: a three-dimensional dispersion of sound from a traffic noise source, with many multiple reflections from high-sided buildings, and diffraction of the reflected sound over barriers, cannot be properly represented by a calculation based on an array of receiver points each of which is calculated using the CRTN formulæ based on cross-sections and view-angles (which is at best 'two dimensional').

Geometrical or Energy Methods

This class of modelling methods relies on some geometrical description of the field(s) within which noise or vibration is propagating, together with formulæ which describe the physics of that propagation. Typically, there is a distinction between purely acoustic methods ('ray tracing') and vibro-acoustic methods (such as statistical energy analysis) where the latter can include acoustic regions, but is usually mainly concerned with structural vibration.

Ray tracing (or 'beam tracing') calculates the propagation of sound assuming that it can be considered as a ray or beam of acoustic energy, which suffers reflection at any surface it meets. Normally, the reflection is specular (hence the surface is a plane mirror) but diffuse reflections may also be included. Absorption takes place at surfaces, and in the air along the path if required. Sound energy arriving at some receiver location is added in a standard energy ('dB') sense to arrive at steady-state behaviour, or the impulse response can be derived from the path lengths (and hence travel time) of

the rays to arrive at acoustic quality parameters (RT, clarity etc). Wave effects may be accounted for by simple or complex formulæ for diffraction, or by considering phase content (based on ray path length) as well as energy level in each ray, and adding-up energy in a complex (amplitude and phase) sense. Advanced models may include transmission as well as absorption, reflection and diffusion at surfaces.

Statistical energy analysis (SEA) is more useful for structural than acoustic calculations, although it can include acoustic 'sub-systems' in the model. SEA requires input describing the vibration characteristics of the different parts of the structure, arbitrarily divided by the user. Often these characteristics can be picked from libraries of standard parts (which in turn use classical formulæ of structural mechanics) or they may be derived from measurements. Anyone involved in structural vibrations will know that damping (or energy loss) factors are often difficult to determine, and it is because of this that SEA is often regarded as either an approximate design tool, for use early in the analysis of a structure, or a diagnostic tool (with a large amount of measured data) for use in trouble-shooting. A major benefit of SEA is that the calculations themselves are usually very fast, so many alternatives can be analysed very quickly – but on the other hand, that can be very necessary in order to determine the sensitivity of the results to the many uncertainties in the input data!

Numerical Methods

The general class of numerical methods includes any modelling approach in which the physics of vibro-acoustics or sound propagation is modelled by equations describing the fundamental phenomena, essentially wave propagation. The equations are solved in numerical form, typically by some sort of discretisation of the geometry into elements and the assembly of a matrix equation system using numerical integration. The two most common approaches are the finite element and the boundary element methods. Finite difference methods are mostly defunct, since they generally involved more awkward data preparation and are less flexible and robust in use.

The finite element (FE) method divides the acoustic medium into volume elements (for a 3-d problem) which are typically bricks, prisms or tetrahedra. The boundary element (BE) method divides the medium in a two-step approach: the wave behaviour in the (3-d) fluid is first condensed to a (2-d) surface integral problem and the surface is divided into elements, which are typically quadrilaterals or triangles. The BE method can therefore directly handle exterior, open, field problems, whereas FE cannot (or can only do so by introducing approximations at some finite boundary).

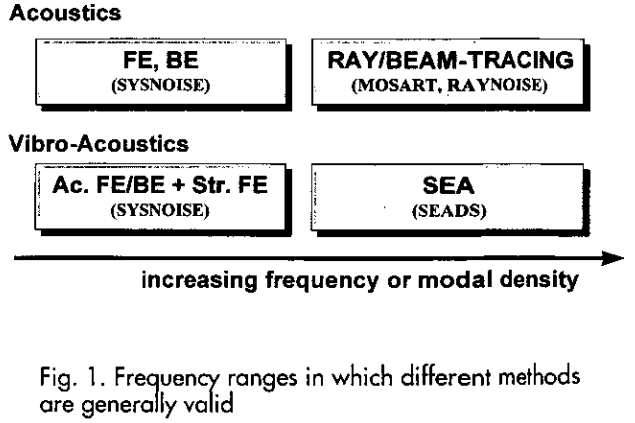

Fig. 1. Frequency ranges in which different methods are generally valid

The different methods are applicable at different frequencies, as shown in Figure 1. What constitutes a 'low' or 'high' frequency, however, depends on the application, as explained later. The following sections give some more details of the application of geometrical acoustics and numerical methods.

Geometrical Acoustics – Ray/Beam Tracing

Basic Principles

Sound propagation around the modelled region is calculated by tracing rays or beams. In effect, the trace of the ray (or beam centre-line) finds the mirror images of the sources, to some user-controlled order of reflections, taking into account the visibility of each surface from the previous image source (see Figure 2). Beam tracing differs from ray tracing in that the beam has a finite cross-

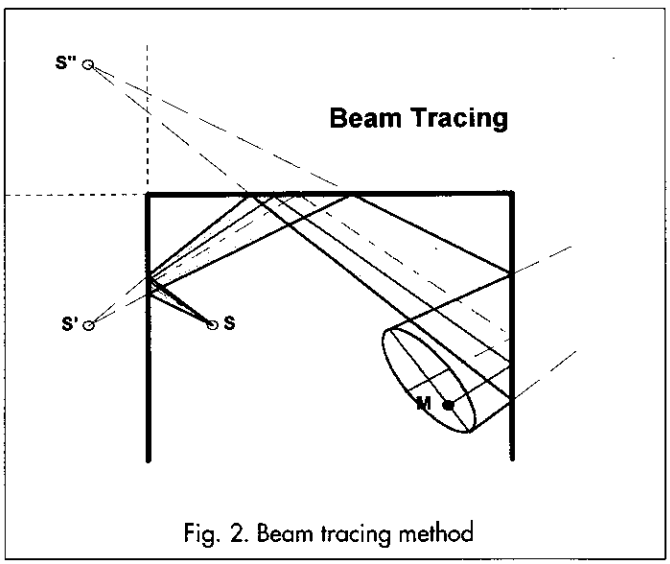

Fig. 2. Beam tracing method

section (eg a circle or triangle, forming a conical or pyramid beam) and intersects with a point receiver, whereas a ray is infinitessimal, but intersects with a finite receiver volume. This gives beam tracing the advantage that the impulse response conforms to the physical behaviour, in that the numbers of echoes arriving per unit time increases with time. Spherical dispersion of sound along the path is also automatic. The basic result of the beam trace is an impulse response, from which both steady-state sound level and acoustic quality parameters based on energy integrals can be derived, such as SPL, Early Decay Time, Clarity and Definition. All results can vary through the frequency range. Using the angle of arrival of beams at the receiver, lateral energy measures (Lateral Efficiency) can be calculated. The ray trace will also find the mean free path and its variance, and with an analytical formula this gives a very rapid calculation of room volume and position-independent reverberation time.

Applicability

The limitation of ray/beam tracing is mainly due to the assumption that the sound can be considered as energy being distributed as a result of reflections. In other words, major wave phenomena such as diffraction, refraction and interference are not taken into account. This limits the applicability to the mid- and high-frequency ranges (more precisely, above the Schroeder cut-off frequency, or where there are many, overlapping, room modes). However, for a typical interior space such as an auditorium or industrial building, this is not a serious limitation. Recently, more advanced features have even removed this limitation through the use of phase ray tracing (see below). Diffraction can be handled by simplified algorithms based on the path-length difference between the direct path from a (mirror image) source to the receiver and the path which just grazes a diffraction edge on a barrier. The shortest length of such a grazing path can be found by a rapid geometrical scan.

The other limitation of ray/beam tracing is that it is essentially a purely acoustic calculation, without any influence from fluid-structure interaction. It is possible to have sound sources which are derived from panel (wall) vibrations, but any flexible response of panels can only be taken into account by an adjustment to their absorption properties ('panel absorbers'). In future, more automated ways of transferring vibration data (for example from structural SEA models) into ray tracing acoustic models may be developed.

Calculation times for ray/beam tracing models are not trivial, but are usually acceptable (from a few minutes to a few hours, even on modest PC hardware) depending mainly on the number of sources. There is usually a direct trade-off between accuracy (for example, the number of beams into which a spherical source is divided, and the order of reflections at which the calculation of a ray is abandoned) and calculation time. 'Tail corrections' greatly reduce the inaccuracy caused by a low order of reflections. By storing model and results data in an intelligent way (in a database) the time to re-calculate new scenarios (changed source powers, new combinations of sources, altered delay time/phase for loudspeakers etc) can be made quite short.

Some More Advanced Features

Diffusion coefficients can be applied to selected surfaces. Essentially, these create new rays, in random directions, which are then traced in the same way as the primary rays. Clearly, the main disadvantage is an increase in calculation time. The diffuse energy fraction can be made dependent on angle of incidence of the arriving ray and can have its own directivity (eg diffuse energy is radiated preferentially in directions near the normal to the surface). Properties can always be frequency-dependent.

Sources may be coherent or incoherent. If they are coherent, the relative phase information, depending on the path lengths of all reflections arriving at a receiver, are taken into account when summing-up the impulse response or doing other calculations on it. This is the method known as *Phase Ray Tracing*. It means that the wave phenomenon (interference) in the sound propagation is taken into account, removing the low-frequency limit on the ray tracing approach. This results in remarkably close correlations between phase ray tracing results and numerical models such as BEM (see Figure 3) and even enables results such as room modes to be derived from the ray tracing model! A particularly interesting calculation is the derivation of *Speech Transmission Index (STI)* contours using modulation transfer functions. This allows the assessment of speech intelligibility of PA systems, for example, in the presence of background noise, with multiple, coherent sources representing the loudspeakers (with directivities, relative delays, etc).

Transmission through surfaces can also be considered. In a simple approach to this, the sound level on one side of a panel can be used to automatically generate a reradiating source on the other side, using some frequency-dependent transmission properties. In a more complex approach, the incident rays on the panel are allowed to pass through – so that the incident energy is partly reflected, partly absorbed and partly transmitted, with the reflected and transmitted fractions each also divided into specular and diffuse parts. The reflection, transmission and diffusion data can, of course, be dependent on frequency and angle of incidence. Such a calculation enables multiple acoustic regions to be linked and the acoustic energy distribution within and between them to be calculated by an iterative procedure in the software.

Stereo auralizations of results can be created using anechoic signals, convolved with the impulse response for a single receiver point combined with head-related transfer functions to produce

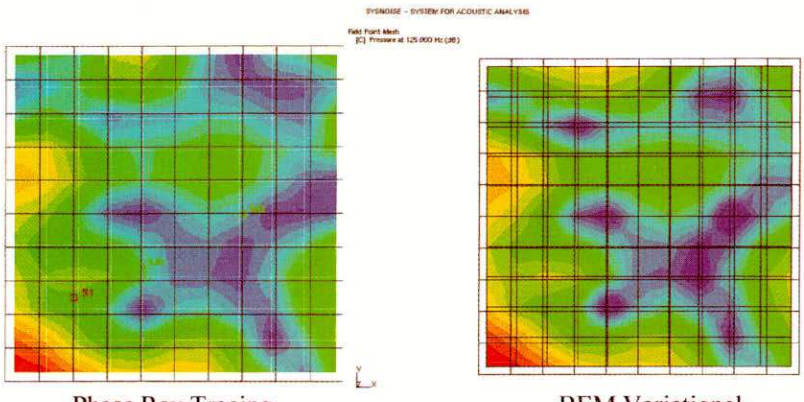

Fig. 3. Room response at 125 Hz, phase ray tracing vs BE method

the binaural signal. The arrival directions of all the echoes are used, as well as their amplitudes and phases, to give a true stereo image.

Some Typical Applications of Ray/Beam Tracing

In *auditorium design*, these methods are used to analyse sound distribution, reverberation time, and quality measures such as clarity, definition and lateral efficiency (Figure 4) as well as sound reinforcement systems.

In *public buildings*, the design of public address and voice evacuation systems can be assessed, as well as background noise and music reproduction. For transportation sites like railway and underground stations, vehicle noise may also be a major issue. (Figure 5). Speech intelligibility combined with sound transmission models also provides a measure of privacy between rooms and the possible need for (incoherent) sound to provide masking.

In *industrial noise control*, both interior (worker health and safety, PA etc) and exterior (environmental impact) analyses can be made. The possibilities for noise break-in/out analyses using transmission properties may be of particular interest, as well as diffraction algorithms over barriers, buildings etc (Figure 6).

In *vehicle design*, advanced ray tracing is used to analyse audio systems (for in-car entertainment, PA etc) and to assess speech intelligibility in the presence of relatively high background noise, as regards acoustic treatment of the vehicle interior (Figure 7). Multi-domain methods can be useful to assess mid- to high-frequency noise transmission from engine compartments, sound breakthrough and speech intelligibility from one region to another (eg in rail passenger vehicles). Exterior vehicle pass-by noise can also be modelled.

Numerical Methods – Finite Elements and Boundary Elements

Basic Principles

The approach adopted in numerical acoustics is to model the propagation of acoustic waves by an equation, typically the Helmholtz form of the wave equation which involves functions of frequency rather than time. By dividing-up the medium (air, water etc) into elements, the equation in the continuum is broken-down into a matrix equation, which can be solved numerically rather than analytically. Finite elements divide the medium directly into elements. Boundary elements divide the boundary surfaces into elements and use further mathematics (based on, for example, Green's theorem) to condense the 3-d field problem to a 2-d surface integral problem.

Since FE is by definition finite, it is limited to interior, closed regions. BE can handle interior, closed, regions, or exterior, open, regions – or, using the 'indirect, variational' form of the BE equations, it can also handle mixed regions, where the interior is linked to the exterior through relatively small openings, or through the walls of a flexible structure. This latter approach is much superior to the approach which links an interior FE model to an exterior BE ('direct') model, because linked FE-BE acoustic equations give much larger volumes of matrix data to handle in the solution procedure, with increased calculation times and reduced accuracy. The indirect variational BE method also allows a mathematically-robust handling of models with thin appendages like exterior ribs or fins, and it is the most general method for handling virtually all geometrical forms.

The effect of a flexible structure can be taken into account by coupling the FE or BE acoustic model to a structural FE model (which may use a different mesh of elements, depending on the nature of the structural details which ought to be taken into account). An efficient procedure for fluid-structure coupling uses the (uncoupled) modes of the structure to define the structural behaviour, rather than the complete mass and stiffness matrices, since this leads to a much smaller size of the coupled equation system. Structural damping can be included, as well as acoustic absorbers.

The excitation of the acoustic or vibro-acoustic system can be defined as vibrations of a boundary structure, or applied forces on a flexible structure, or acoustic wave sources. Normally, all excitations are coherent, since we are solving a deterministic set of equations.

The results consist of acoustic pressures and velocities on the boundary surfaces and at all points in the field. These data are complex and frequency-dependent. (All calculations are carried out at discrete, narrow-band, frequencies). Since the results are complex values with amplitude and phase, acoustic intensities can also be computed, together with radiated sound power, through a defined surface or from the object as a whole. Diagrams of directivity, and Nyquist and other frequency plots showing the contributions to the radiated energy from different parts of the object can also be produced.

Applicability

FE and BE can be used for any acoustic models where wave phenomena predominate. The field is being divided into elements, or in other words the waves are 'sampled' in space, hence there must be sufficient sampling points (nodes of the element mesh) to avoid 'spatial aliasing'. This normally implies a minimum of about 6 linear elements per wavelength (or 3 second-order elements, with mid-side nodes). Thus for any particular fineness of mesh, there is a nominal maximum frequency for which the results have acceptable accuracy. (This simple rule ignores any further refinement which may be needed due to small gaps between parts, getting a correct representation of a structural vibration shape, and other aspects). The maximum frequency is, of course, a limit at which accuracy starts to deteriorate significantly, not a fixed limit. Consequently, to model any particular frequency range, the mesh density can be established, and hence the numbers of nodes and elements for an object of a given size. As mesh density increases, so does disc space and computer time (often at the 2nd or 3rd power) so there is a practical limit to the frequencies which can be considered. In addition, the assumptions of coherent, interacting waves, begin to break down as the acoustic modal density or modal overlap increases, giving another upper frequency limit, based on what is the correct approach to model the physics of the behaviour. At this limit, the use of ray/beam tracing and/or SEA should be

considered. The surface properties (phase shifts in absorbers, vibration phase etc) may also not be properly known in a deterministic way at higher frequencies.

Some More Advanced Features

FE acoustic models can have some special features which give them advantages over BE models in specialised applications: Individual elements can have different properties (sound speed, density) so refraction effects can be considered; they can also be given *volume absorbent* properties (porosity, resistivity, tortuosity) to represent localised, thick absorbent, whereas BE models can only have surface absorbers (or distributed volume absorption by using a complex speed of sound); this can be useful, for example, in modelling seats in cars or absorbent chambers or blocks in mufflers and duct silencers.

A development of these volume absorbent properties allows the structural flexibility and damping in the skeleton of the porous material to be included (using Biot's theory). This provides a specialised tool for the modelling of the vibro-acoustic damping, absorption and transmission behaviour of *multi-layered poro-elastic materials*, such as the acoustic panels built into road and rail vehicles and aircraft. Results showing energy dissipation enable the effectiveness of the different damping layers to be assessed and alternative thicknesses, lay-ups, materials etc, can be considered.

In some applications, the acoustic medium may be moving at a significant fraction of the sound speed, producing a distortion of the wave behaviour. (For example, in the flow down a duct). In some cases, this can be taken into account by using a convected form of the wave equation (in three dimensions: a 1-d model of a duct is much easier).

Until recently, only BE models could handle reliably the case of exterior radiation to an infinite or semi-infinite field, but now wave envelope elements (or *Infinite FEM*) can be added to acoustic FE to model this. This method may partly replace the use of BE for exterior fields in the future, particularly in cases with inhomogeneous media, such as noise around jet engines and other cases with strong temperature gradients in the air, or with more than one fluid.

Contribution analysis, as a diagnostic tool to determine which surfaces are contributing to the radiated sound, has already been mentioned. It should be noted that some contributions can be negative (so for instance, if the panel vibration is reduced, the noise level will go up!). *Sensitivity analysis* takes the process a step further and provides information on what changes should be made in order to change the acoustic behaviour in the desired direction. By coupling acoustic and structural sensitivities (from the structural FE model) the structural changes needed to produce a certain acoustic change can be found. A further development of this procedure is to incorporate it into an *optimisation* process, in which the best combination of different possible design changes is found. Not only acoustic performance, but also other effects such as weight, cost etc, can be included in such a procedure.

Although the BE method is primarily deterministic, it is possible to analyse *random excitations*, either mechanical or acoustic. Examples are: random mechanical forces on a structure, coupled to an acoustic field; a diffuse acoustic field (cf precisely known waves) incident on a structure; and a turbulent boundary layer around a structure. The random inputs are usually defined by power spectral densities (PSDs) and correlation functions. By finding as results the PSDs of stresses or strains in the structure, *acoustic fatigue* can be calculated.

Some Typical Applications

Acoustic FE and BE models are widely used wherever structural FE models are common, and/or noise is an issue, for example:

- In the automotive industry – for car interiors: boom modes, low frequency response, panel contributions etc (Figure 8); for noise radiation from engines, tyres and other components (Figure 9); for intake and exhaust components.
- In aerospace – for interior noise in commercial and military aircraft (especially turboprops and helicopters); for space-craft integrity during launch (vibration amplitudes and fatigue).
- In marine and defence applications – for sonar device design, including deriving cross-impedances of arrays (Figure 10); for hull-water interaction and noise radiation from ships, submarines, torpedoes and so forth.
- In audio device design, loudspeakers, headphones and other items are modelled in detail to optimise their performance; the influence of the loudspeaker enclosure can be of particular interest, and possibly the effect of local features of its placement (eg adjacent to a wall). However, for

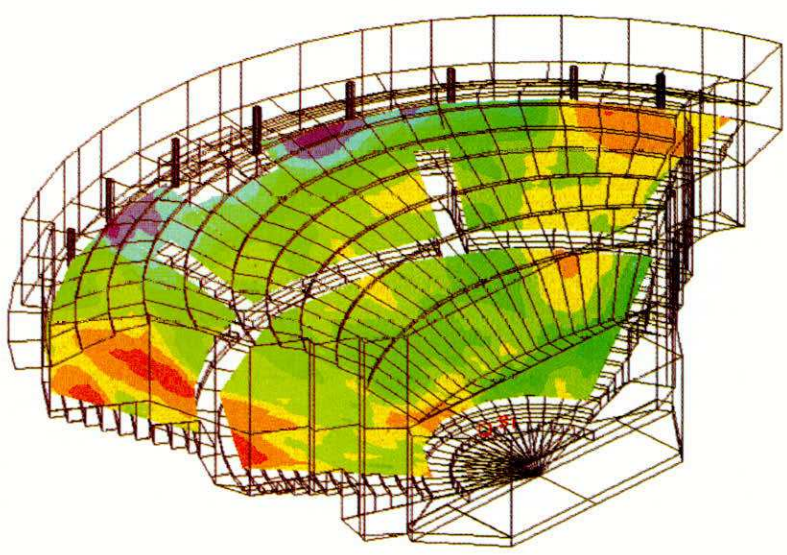

Fig. 4. Auditorium acoustic quality contours (Definition)

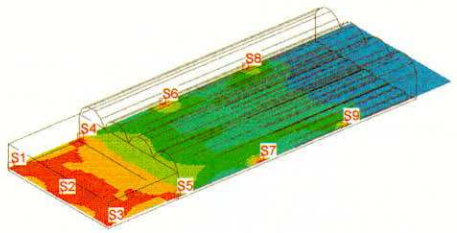

Fig. 5. Speech intelligibility calculation in railway station

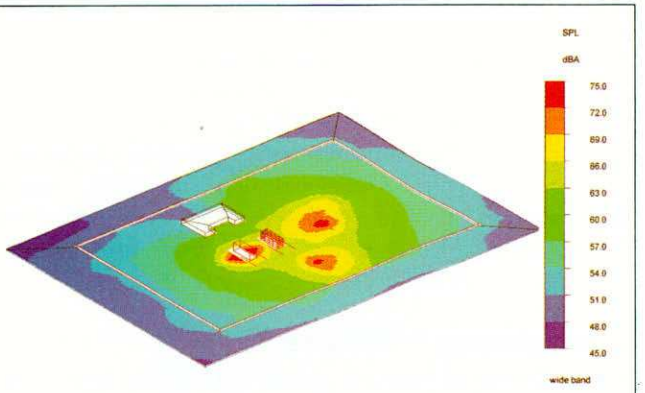

Fig. 6. Industrial plant noise including diffraction over a barrier

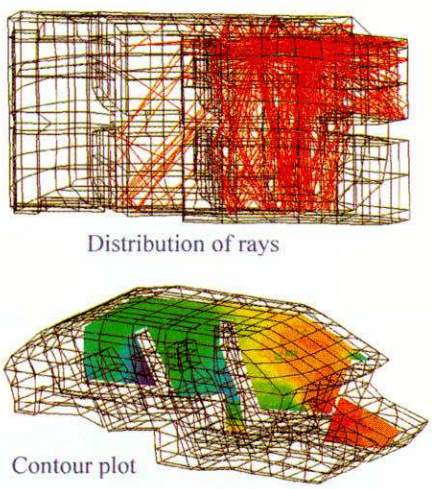

Fig. 7. Vehicle interior noise at mid-/high-frequencies by advanced ray tracing

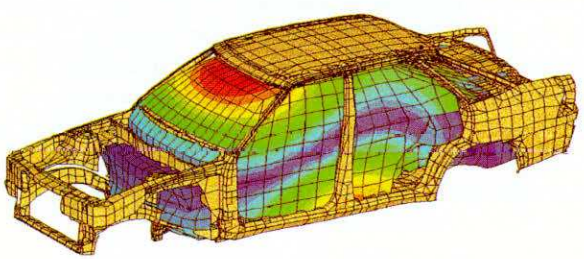

Fig. 8. Vehicle interior noise at low frequencies by FE and BE

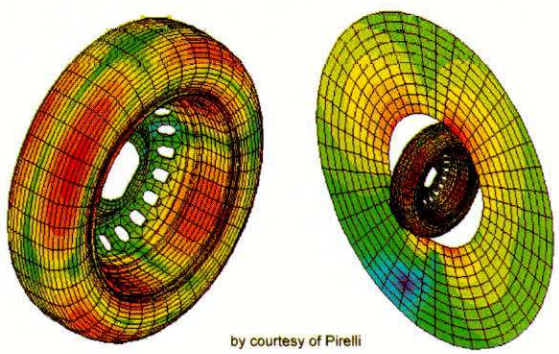

Fig. 9. Noise radiation on and around a tyre by BE

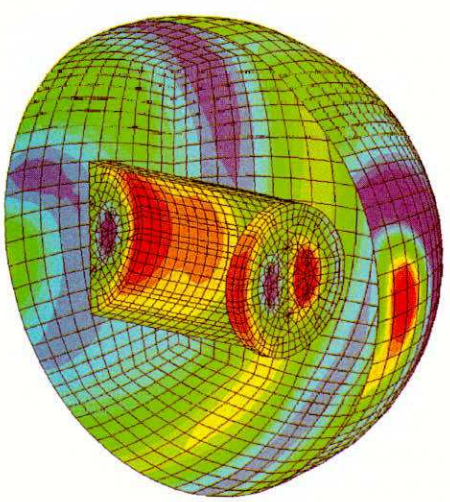

Fig. 10. Beam pattern and mutual impedances of a 6-element sonar array

modelling a complete audio system in a room, FE or BE methods are not appropriate (because of the mesh size/frequency limit described above) and a ray/beam tracing model, with phase effects, is required.
- Noise radiation from domestic appliance components, fridge pumps, motors etc, is modelled; special techniques for random excitations and non-linear sources can be used for the interaction of a pulsating flame and its enclosure in a boiler or chimney.

Conclusions – Where Now ?

In this review of acoustic modelling, limited space inevitably means that this article provides little more than an overview of the vast range of possibilities now available. Several major applications have probably been ignored completely, so those who have devoted their energies to any such must accept my apologies, in what cannot be a totally comprehensive article.

What can be said, is that acoustic modelling clearly is here to stay. It is being used by increasing numbers of practitioners, in many industries. The range and scope of applications is ever-increasing. However, the warning at the beginning of this article bears repeating: a model is only as good as the modeller who made it, however powerful the program used to make and analyse it. Anyone making a model must be confident not only of the quality and ease-of-use of the software they have, and the validity of their input data, but also the applicability of the simulation methods used in the program.
- Do they represent reality?
- Do they really model the physical situation?
- Do they carry in-built assumptions or limitations (frequency range, in/coherence of sources, flexible or rigid structure etc)?
- Is the model accurate but the input data unreliable (material properties, sources etc)?
- Given the known limitations, are the results worth having?

As computers become ever more powerful, and software incorporates yet more complex solutions, modellers will be able to assess more complex models, more rapidly, in many more alternative configurations, to arrive at more optimal design solutions. If they do this with a realistic understanding of what their models do, using robust and well-supported software, we can all hope to benefit from a world with better acoustics designed into it.

Acknowledgements

I would like to acknowledge the support of many colleagues during the years in which I have been involved in acoustics in general and modelling in particular, and especially to thank colleagues at LMS Numerical Technologies in Leuven, Belgium, developers of the programs SYSNOISE, RAYNOISE, MOSART, VIOLINS and SEADS, who have provided invaluable assistance and advice. The illustrations have been produced with their software.
This article is based on material presented at the Institute of Acoustics London Branch meeting on 18 June 1997.

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A STRATEGIC APPROACH TO PROBLEM ACOUSTICS FOR PIPELESS ORGANS

Lucy Comerford, Peter Comerford & Nick Briggs

Introduction

At the Institute of Acoustics' Reproduced Sound 12 conference in 1996, a paper [1] was presented by two of the present authors, discussing loudspeakers for pipeless organs. As a result, a number of those present commented that they had seldom before considered the particular acoustic problems associated with permanently installing a large classical electronic instrument in a building not designed to incorporate it. Against this background it has been suggested that the current paper would be of interest to readers of Acoustics Bulletin; it is a summary of some strategies evolved to tackle such problems by a multi-disciplinary team at the University of Bradford, who have been involved in the design and development of an innovative synthesis technology (Bradford Enhanced Synthesis Technology – BEST) [2], the principal commercial application of which is in the pipeless classical organ field.

Acoustic Problems for Pipeless Organs

Organs are instruments producing banks of sound, which are made up of individual stops of a very wide range of pitch, tone and loudness. In traditional instruments, this sound is produced from pipes, generally one pipe (or more) for each note of each stop. The pipes therefore occupy an appreciable space, mostly bounded by a 'case' of wooden frame and pipes, and sometimes sited in a corner. This means that the pipes generally speak in a 'chamber-like' local acoustic, in the presence of other hard curved surfaces off which their sound will be dispersed, and which may produce sympathetic resonances. Each pipe radiates sound in a number of directions, and the ensemble sound comes from a widely dispersed set of sound sources and includes a high degree of indirection.

The pipeless organ has none of these inbuilt acoustic advantages. The speakers from which its sound emanates are seldom placed in an acoustic 'chamber', and often speak with no indirection, a problem made worse by the limited angle of sound diffusion from the speaker itself. Loudspeaker placement for a pipeless organ is in general subject to a number of non-acoustic constraints. Architects are, rightly, concerned for the appearance of an ancient building or for the integrity of a new design; this means that speakers may be planned to go in the least visible position (such as behind pillars or down tunnels), which unfortunately can be one from which there is no direct egress of sound with the effect that many high frequencies are lost. Small speaker size obviously allows more flexibility in positioning. If loudspeakers are so placed as to be close to the congregation but far from the organist, there is danger of 'blast-out' if the speakers are not far enough above congregational head-height. The carpets, curtains and padded chairs of a 'refurbishment', of which the installation of a pipeless organ is often seen as a part, are extremely detrimental to organ sound, of which an essential part is chorus made up of a wide range of different frequencies.

Some Strategies to Tackle These Problems

In practice, these problems are best tackled by using high-quality loudspeakers with characteristics selected for this application, suitably positioned, to produce a carefully chosen stops list, the sounds of which can be adjusted in situ.

Loudspeaker Characteristics

A list of (non-technical) characteristics required of loudspeakers for pipeless organ applications was suggested in [1]. These were summarised as:

- wide frequency range
- good transient response
- high power handling and high efficiency
- wide dispersion
- low colouration
- restricted size
- moderate cost

Since that time, the authors have specified design requirements for the development of a loudspeaker for this purpose to Richard Allan International Ltd, at the behest of the Bradford Computing Organ Company Ltd. The resulting loudspeaker, the RA16M, has evolved from the RA8 studio monitor speaker originally designed by Richard Allan for the BBC.

For the pipeless organ application, the priority has been to allow the reproduction of the generated signal accurately with tonal neutrality and negligible colouration, with wide dispersion over an extended frequency range. The RA16M has two parts, a main unit and a tweeter array.

- The main unit measures approximately 240 mm x 240 mm x 75 mm, and can be disposed horizontally or vertically. It uses two 200 mm drive units with doped Cobex cones, mounted side by side in a 33 litre infinite baffle enclosure, with a system Q of approx. 0.7 to maintain transient response and maximally flat frequency response. No frequencies lower than 63 Hz are sent to the speakers, which reduces problems of colouration from intermodulation distortion.
- The tweeter array has four high-frequency wide dispersion horns, giving a coverage of 190 degrees hor-

izontal and 190 degrees vertical.

- A second-order (12 dB per octave) hardwired crossover at 2.5 kHz creates a seamless transition from the main unit to the tweeter array; this gives a substantially flat frequency response from 63 Hz to 20 kHz when measured both on-axis and also 45 degrees off axis (above, below, left and right).

To date, these speakers have been assessed for pipeless organ use in two laboratory situations (one of them acoustically very dry) and in two field installations – for the occasional installation of a chamber organ in the Council Chamber at Bradford City Hall, and for the new 3 manual organ at Pershore Abbey. This latter is a large reverberant building, where some of the high frequency tweeters were partially obscured by thin pillars. In all these usages the loudspeakers performed well, with good dispersion over a wide frequency range, excellent transient response and low colouration. They are smaller in size than any other speakers tested with similar performance and are considered by the authors to be a useful development in the field of loudspeaker design for pipeless organs, going a long way to meeting the criteria defined as necessary for this application [1]. Assessment of these speakers is continuing, as also of speakers dedicated to frequencies from 16 Hz to 64 Hz.

Placement of Loudspeakers

As has been noted elsewhere [1] [3], a 'chamber' of hard parallel walls and floor, or bounded by hard dispersing pipes, can have the effect of creating a high degree of indirection and dispersion over a wide frequency range for the sound from speakers placed within it. Given such a lively local 'buffer', the sound either of pipes or of a pipeless organ can withstand the muffling effects of a less resonant acoustic in the building as a whole; this is particularly important if some of the floor is to be covered in carpet.

The authors are to undertake a study of pipe organ chamber effects and positionings within different types of building, and their applicability to pipeless organs, the results of which are to be reported elsewhere.

Given an attitude by the local church that the pipeless organ is a musical instrument to be used to the full as part of the music tradition of the Church (rather than that it is

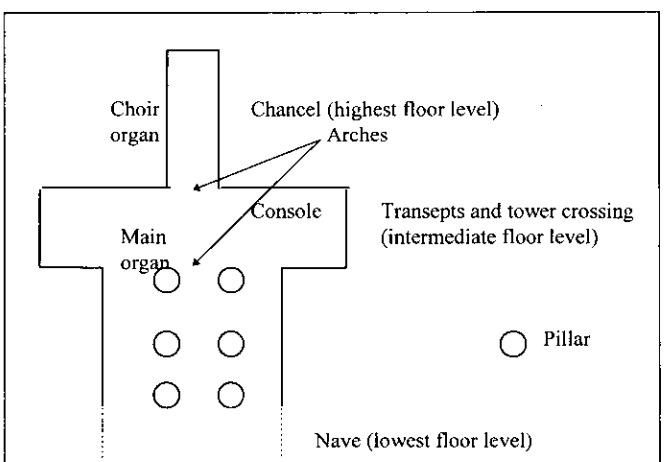

Fig. 1. Sketch plan of trial pipeless organ installation

a space-saving expedient to be installed as inconspicuously as possible for use at weddings and funerals), then pipeless organs can offer acoustic possibilities which could be more difficult with pipes. In a recent trial installation (see Figure 1), the organ console stood in one transept, and the main departments of the organ at a height of about 5 metres in the other, speaking mostly down the church with some surreptitious re-enforcement directed over the crossing under the tower to allow the organist to gauge his playing. The church choir sang from a narrow tall chancel with a higher floor level, obscured around the corner from the console and shielded from the nave by two arches either side of the tower. In consequence they heard the organ at a different time from any of the congregation, when singing hymns, and were 'drowned out' by the organ in anthems when heard from the nave. The solution was to site the Choir division of the organ in the chancel itself, invisibly, using relatively light voicing. This enabled the choir to sing in time with the organ, and solved the problem of intervening organ sound masking the choir from the congregation.

Selection of Stops List and Voicing Style

The choice of a suitable stops list to create the right spectral balance for the acoustic applies equally to pipes and to pipeless organs. In large resonant buildings, the middle and lower frequencies will be accentuated because, as a result of the dampening affect of air, the higher frequencies will not be resonant for so long; this means that a stops list can safely include more high-frequency stops, and the voicing can include higher partials, without the result sounding over-shrill. If a building is small and dry the balance between high and low frequencies is quite different and a different spectral balance is needed.

Commercial companies often face pressure to supply an instrument with a large stops list, regardless of whether this is the most suitable either for the technical resources of the instrument or for the acoustic in which it is to be sited. This can afflict the pipe organ builder as well as his pipeless counterpart.

Voicing Tools

The pipe organ builder decides the basic voicing or sound-style of a new instrument before it is installed, on the basis of a range of factors including the size of building, the use to which the instrument is to be put, and his own and his clients' preferences. The basic tone of the instrument will be determined in the factory; on-site tonal finishing adjustments to the pipes to take account of building acoustic are likely to be less radical.

In custom pipeless organs, the stops list and basic voicing style will be considered in a similar way, as outlined above. Nowadays, the sound of most pipeless organs can be also adjusted in some way on site. On many sampled (recorded) instruments, it is possible to apply filters to recorded sound, so that the spectral balance of each stop can be altered by a 'brightness' control; often this is accomplished by a 'remote-control' type device, which also adjusts such features as tuning and volume.

All these adjustments are an improvement over the 'wheel it up and plug it in' approach of the pipeless organs of yesteryear, but are in the opinion of the

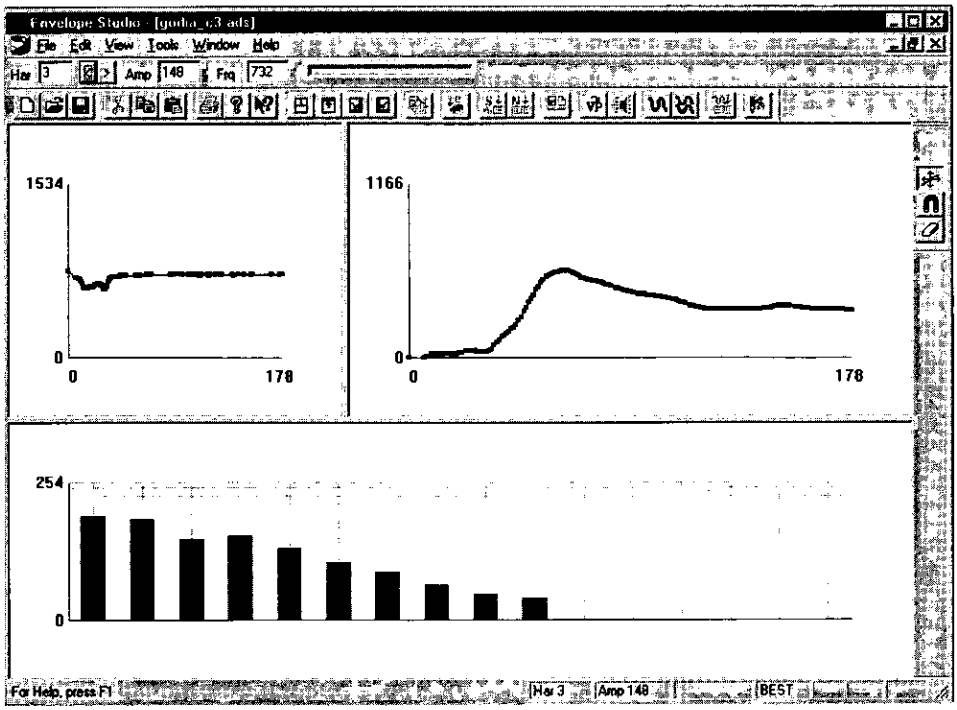

Fig. 2. Envelope Studio screen: showing sustain profile of Great Open Diapason 8' middle C, with frequency and amplitude attack profiles for the third partial

authors still a far cry from the degree of control needed to craft the sound of the organ to the acoustic of the building within which it is placed, to get optimal results. For example, although the differences between sound heard in small non-reverberant surroundings and large resonant buildings are obvious, one might anticipate that a pipeless organ voiced for one large Cathedral would sound much the same when heard in another. The authors were able to show that this is not the case in a series of assessments in Worcester Cathedral and York Minster; in essence, the sound at York had a much higher spectral balance and a quite different effect upon transients, necessitating a different style of voicing. As the building cannot be altered, there must be control over the elements of the sound which create the effect perceived by the auditioner.

For such reasons, the Microcomputer Music Research Unit at the University of Bradford has designed and developed a synthesis system specialising in 'voicability', to allow the sort of fine control required. Historically this was a purely additive synthesis system; recently, a new generation of synthesis technology has been launched called 'Bradford Enhanced Synthesis Technology' (BEST) which uses not only primary sine-waves for additive synthesis but complex waveforms for the perceptually sensitive attack transient period. A graphical voicing system has been developed for BEST additive synthesis features, and for the complex waveforms a completely new control tool (Envelope Studio) has been written. These control systems are Windows-based and interact as a (more or less) seamless single control mechanism.

Envelope Studio allows the individual control of both frequency and amplitude profiles for each partial of each waveform (see Figure 2), as well as overall controls for volume adjustment and copy/paste, and so on. The speed, flexibility and precision of the new control tools mean that the quality of the new synthesis technology can be exploited to the full because its sounds can be altered to suit each different acoustic environment.

This paper has briefly summarised some of the strategies used in the field of pipeless organs to overcome some of the problems presented by building acoustics. Much of the success or otherwise of the finished installation depends on the use of a first-class synthesis system, fully adjustable on site, and heard through widely dispersing non-coloured loudspeakers in a setting providing indirect as well as direct sound. Given these circumstances, the skill of the voicer can hopefully produce an instrument worthy for use in worship.

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Acknowledgements

Thanks to Phil Hansen of Richard Allan for collaboration on speaker development, to The Bradford Computing Organ Company for the opportunity to experiment on site, to Wyvern Classical Organs for collaboration on the additive synthesis graphics, and to our colleague Dr Miles Marks.

Dr Peter Comerford, Dr Lucy Comerford and Dr Nick Briggs work in the Microcomputer Music Research Unit of the Department of Computing at the University of Bradford, Yorkshire BD7 1DP. The MMRU has designed and developed Bradford Enhanced Synthesis Technology and Envelope Studio, and has considerable experience of pipeless organ voicing in a variety of acoustic environments, including five cathedral installations. ❖

THE EFFECT OF DISCO NOISE ON SHARKS

Philip R Dunbavin MIOA

Introduction

'We want to build a nightclub next to the Sea Life Centre in Blackpool and wondered if you could predict the likely effect of the noise and vibration on the sharks?'

This must surely be one of the strangest requests I have ever received as an acoustic consultant. After the initial shock had worn off and I realised that my potential client was serious, it was time to scratch the grey cells. The obvious first question was how sensitive are sharks to vibration and noise?

A litbrary search proved to offer no assistance as did my children's encyclopædias and this included the CD ROM versions. It was time to go surfing the Web to look for information on sharks. In the MBL/WHOI library I found references to a number of books by Dr A. A. Myrberg [1 & 2]. These texts yielded the following pearls of wisdom:

"Most of the studies have shown that rapid, irregularly pulsed, broad-band sounds with spectral frequencies below 600 Hz can attract sharks. An important point in all studies was that sharks rapidly habituated to such sounds so long as they received no rewards, eg food; attraction ceased after 5 to 10 repetitions".

Disappointingly the research did not yield any threshold limit values or sensitivity figures. Our client wisely consulted James Ellis BSc PhD, a marine biologist, who referred not only to Dr Myrberg's papers but to three further texts [3, 4 & 5].

Dr Ellis' view was summarised as: "If there is no increase in the ambient airborne sound and water-borne vibration levels, then there should be no adverse affect on maintained sharks. Sounds produced by the aquarium systems will be a major sound source in the tank, as will daytime visitors tapping on the glass." This simple statement then became our guidelines by default..

The Site

The proposed discotheque was to be situated on the ground floor of a building which is an independent three storey steel-framed building with infill masonry walls and reinforced concrete floors. The building does not share foundations with any other structure.

Our visual inspection revealed that the Sea Life Centre also appeared to be an independent three storey steel framed structure. Both buildings have separate party walls each constructed using a cavity and two layers of blockwork.

The shark tank, together with the majority of the Sea Life Centre's facilities, is located at first floor level. Between the shark tank and the party walls of interest lie a large restaurant, shop, walk-through exhibition and exit stair well. This stairwell leads down to ground level.

Airborne Sound Insulation

Our first attempt to measure the airborne sound using a B&K 4224 sound source not surprisingly failed for lack of available sound power. Consequently a large disco rig was hired [6] to produce typical disco levels at the party wall. The sound produced was still inaudible in the Sea Life Centre.

We eventually produced a sound level at the wall that we could hear and measure in the Sea Life Centre stairwell. This was achieved by filtering the sound system to produce the following levels at the party wall:

Freq, Hz	31	63	125	250	500
SPL, dB	93 0	120.1	96.8	84.0	81.0

In the stairwell the break-in noise was both audible and measurable; unfortunately at the shark tank it was neither. At the shark tank the following levels were measured:

Freq, Hz	31	63	125	
SPL, dB	55.0	57 0	58 0	Disco 'On'
SPL, dB	55.0	57.0	58.0	Disco 'Off'

Despite being unable to actually measure the sound insulation we could at least deduce a sensible upper limit by using the fact that all the energy is being produced principally at 63 Hz. The disco noise level was 120.1 dB and since no increase in noise level could be measured at the shark tank it was reasonable to conclude that the break-in noise was less than 47.0 dB at 63 Hz. Consequently

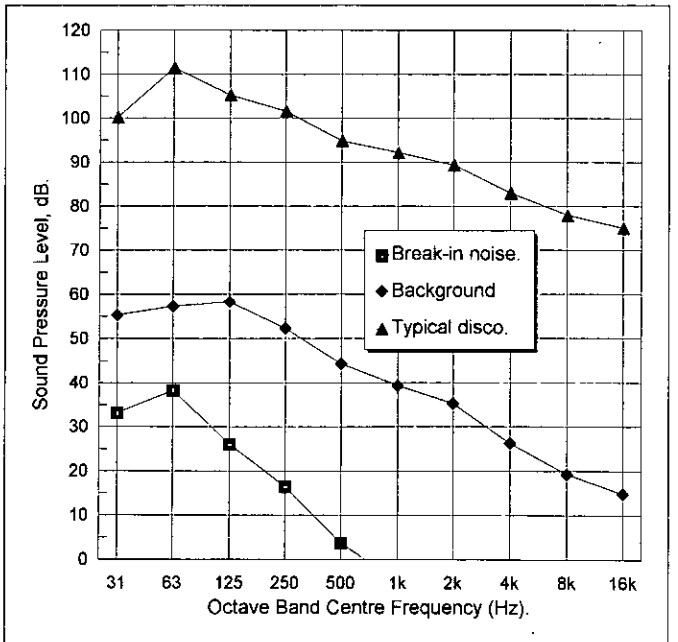

Fig. 1. Disco noise and the predicted noise levels within the Sea Life Centre

Fig. 2. A Blacktip Reef Shark at the Centre

the sound insulation was better than 73.1 dB at 63 Hz. Using mass law this could be extrapolated to other frequencies.

The graph shows the typical disco levels at a wall of 98.7 dB(A), the maximum possible break-in noise of 15.2 dB(A) and the background noise level of 48.0 dB(A). Clearly the airborne noise limit of zero increase was met.

Vibration

The next problem was to measure the vibrational coupling between the buildings. Clearly from the structure a conventional tapping machine would be of little use, but we knew that the vibration from a pneumatic drill could be felt in the Sea Life Centre when road-works took place outside. Regrettably we could not use a pneumatic drill as we could not justify to our client breaking up the ground floor level slab. We eventually settled for a dose of brute force and used a heavy paving mallet to inject a vibration impulse into the floor while simultaneous measurements were made in both buildings.

Even this failed to produce any detectable vibration transfer. The vibration level in the various structures in the Sea Life Centre was absolutely constant. We could not detect the vibration of vehicles passing on the road only metres away; the reason being that the air conditioning system and the aquarium systems were themselves generating vast levels of vibration and no vibration insulation precautions appear to have been taken.

Notwithstanding the fact that, logically, absence of evidence is not evidence of absence, we still felt reasonably secure in our assessment that vibration from the footfalls of dancers would not cause any measurable increase in vibration in the shark tank.

Conclusion

We concluded that the disco noise and vibration would not have a detrimental effect on the sharks and thought that our casebook was closed. This was not true; the incredulity the case caused in court was a new revelation.

Noise evidence in court is usually fraught with danger and with a staggering potential for obfuscation. Well we moved into a different league in trying to explain why the sharks were not going to be disturbed. Eventually we managed to convince the judge that there would be no problem on the grounds of noise and vibration.

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23rd ANNUAL REPORT OF THE COUNCIL 1996

Summary

The Institute is the professional body representing acoustics in the UK. A range of services is provided for members. This includes publishing six editions per year of Acoustics Bulletin and an annual Register, organising meetings and conferences, and providing courses for the Diploma in Acoustics and Noise Control, the Certificate of Competence in Workplace Noise Assessment and the Certificate of Competence in Environmental Noise Assessment. International activities include the organisation of conferences and participation in the European Acoustics Association. Many members have registered as Chartered or Incorporated Engineers via the Institute, which is an affiliated/nominated body of the Engineering Council, and a Continuing Professional Development (CPD) Scheme began operating at the start of the year. A major feature of the meetings programme was Inter-Noise '96 which the Institute organised, being one of the largest and the most successful ever of this series of international conferences. A debt of gratitude is due to the Secretary, Cathy Mackenzie, and her staff at the Headquarters in St Albans for their commitment and enthusiasm which ensured the efficient organisation of Institute activities despite bearing the brunt of organising Inter-Noise '96.

Standing Committees

The operation of the Institute is guided by Council through Standing Committees concerned with Membership, Meetings, Publications, Education, and Medals & Awards. There is also a Committee of the Engineering Division. A Business Review Committee has been formed in order to carry out a strategic and operational review of Institute activities.

Membership Committee

Over the year the Institute's numbers have slightly increased in total, the current membership statistics being shown in Table 1. In December we regretfully took the decision to remove from our register those members who had not paid their subscriptions nor replied to several communications. A sample survey, carried out earlier in the year on behalf of the Business Review Committee, showed that career changes and financial considerations featured in several cases of resignation. The Business Review Comittee Report on membership matters provided grounds for optimism in the future. A renewed bid for additional Sponsor Members, together with the introduction of a new grade of Institutional Subscriber has been started. As part of a general review of Institute activities, the Committee has updated its Terms of Reference and The Institute Code of Conduct. In consideration of professional qualifications and course syllabuses, we have renewed our approval of the Open University leaflet regarding professional recognition of OU qualifications following slight changes to certain modules. Course syllabuses from most Universities are being searched for acoustic content and a preliminary presentation of the results to education-based members is being prepared for comment.

Grade	1995	1996	Applied	Elected
Hon Fellow	14	16	—	2
Fellow	224	232	9	9
Member	1225	1239	70	61
Associate Member	546	577	101	100
Associate	177	165	34	34
Student	54	45	3	3
Totals	**2240**	**2274**	**217**	**209**
Key Sponsor	3	3	0	0
Sponsor	20	18	1	1

Table 1. Institute Membership

Employment Category	1995	1996
Architectural Practice	18	18
Consultancy	528	569
Industry/Commerce	314	309
Education	224	222
Public Authority	477	491
Research & Development	214	200
Other	72	59
Retired	66	84

Table 2. Details of Employment

Meetings Committee

During the year, fourteen meetings were held, one jointly with the British Society of Audiology. The main event was the Inter-Noise '96 Congress organised by the Institute in Liverpool. The meeting was very well attended and has earned a reputation as one of the best Inter-Noise meetings ever. The Meetings Committee expressed their thanks for the terrific effort made by many members and the St Albans' staff. In light of the effort to organise Inter-Noise, no Spring Conference was held. However, several other smaller meetings were organised for members and, after Inter-Noise, the two annual conferences at Windermere, Reproduced Sound 12 and the Autumn Conference, were held successfully. The workshop form of meeting has also continued to be successful.

Publications Committee

Acoustics Bulletin has continued to be published as a bi-monthly journal containing a balance of news, technical contributions and regular features. The special 96 page edition published for Inter-Noise '96 contained eight technical contributions as well as the regular features. Because of the workload involved in running Inter-Noise, the Institute Register was published and circulated to members later in the year than is our normal practice. For 1997 the Institute has signed an agreement with Cathy Mackenzie Management Services to execute the editorial and production of the Bulletin and Register. A Management Board appointed by the Publications Committee will meet regularly to monitor and control these publications.

Topic, Date & Venue	Attendance
Roughly How Loud is That? Current Issues in Measurement *14 February, The Royal Society, London*	47
Audiology and Industry* *29 February, The Royal Society, London*	*
Pubs & Clubs – Nuisance from Amplified Music *27 March, Aston Science Park, Birmingham*	51
Planning Policy and Noise *17 April, Church House, London*	85
Noise Criteria and Control in Buildings *27 May, Building Research Establishment*	130
Low Frequency Noise *4 June, The Royal Society, London*	26
Environmental Noise from Pubs & Clubs *11 June, Basingstoke and Deane BC*	57
Arrays & Beamforming in Underwater Acoustics *23–26 July, University of Bristol*	54
Inter-Noise '96 **30 July – 2 August , Liverpool**	**915**
WHO Guidelines Workshop *25 September, NESCOT*	50
How Sound Are Your Measurements? *9 October, University of Strathclyde*	24
The Assessment of Workplace Noise Exposure *21 October, St Albans*	40
Reproduced Sound 12 **24 – 27 October, Windermere**	**100**
Autumn Conference – Speech & Hearing **21 – 24 November, Windermere**	**70**
Numerical/Analytical Methods for Fluid-Structure Interaction Problems *16 – 17 December, Strelley Hall, Nottingham*	40

** Joint with British Society for Audiology – no attendance record*

Table 3. Meetings and Attendance in 1996

The reference library for use by members is now well established. The books are catalogued on a computer data-base, as are the authors and titles of papers in the Institute's Proceedings. In future the authors of papers presented at Institute meetings will be asked to provide keywords which will be included on the data-base.

Education Committee

In 1996 candidates studied at 11 centres for the award of the Institute's Diploma in Acoustics and Noise Control, including students for the Institute's Tutored Distance Learning Programme, and 125 Diplomas were awarded. At the three examinations held in February, May and October, 104 candidates were awarded the Certificate of Competence in Workplace Noise Assessment; this makes the total awarded so far 1225. Following examinations in March, June and November, 126 candidates were awarded the Certificate of Competence in Environmental Noise Measurement. This makes 372 in total.

Medals and Awards Committee

Professor Keith Attenborough presented his Rayleigh Medal Lecture 'Natural Noise Control' at Inter-Noise '96 in Liverpool. The 1996 Tyndall Medal was awarded to Dr Simon Chandler-Wilde for his work on numerical modelling of sound propagation. Dr N C Makris of the US Naval Research Laboratory in Washington DC, was presented with the A B Wood Medal for 1995 at the Underwater Acoustics Group Conference in December. Honorary Fellowships were awarded to Professor Bill Lang, President of International INCE, and to Professor Derek Sugden. The Best Diploma Student Prize for 1996 was won by Clare Wildfire who gained the Diploma by Distance Learning. The prize for the Best Diploma Project for 1995, awarded by the Association of Noise Consultants, was won by Elizabeth Ingle. Terms of reference have been agreed by Council for a new R W B Stephens Medal, and the Stephens family have agreed to fund the award. The first award is expected to be made in 1997. Discussions are in progress between the Institute and the ISVR at Southampton University on a new prize in memory of Professor E J Richards. Following the withdrawal of the Simon Alport Prize we are pleased to say that a new annual prize for the best paper published in the Institute Proceedings will be given by the Association of Noise Consultants.

Engineering Division

During 1996 members of the Engineering Division and Officers of the Institute actively participated in the development of the newly formed Engineering Council and are at present very involved in the new draft proposals by the Engineering Council for Standards and Routes to Registration (SARTOR parts 1 & 2) which incorporate qualifications, continued professional development, and registration of Incorporated and Chartered Engineers. Dr Susan Boyle CEng MIOA is still our elected member on the Senate. Two candidates have been granted Incorporated Engineer and six have been registered at Stage 1, twenty-three have been granted Chartered Engineer (two by the Mature Candidate Route) and thirty-two graduates have been registered at Stage 1 for Chartered Engineer. This year we have been successful in having four members accepted as European Engineers (Eur Ing).

Business Review Committee

The Committee was brought into being following the Council resolution at the end of 1995 to investigate the various options open to the Institute to put its affairs onto a sound basis to allow further expansion of the services available to the members. It comprises representatives of the Standing Committees of the Institute. A plan for a strategic and operation review was prepared and presented to the Council. This envisaged a two year programme that included a diagnostic phase that would lead to a definition of objectives and conclude with the design of the various structures that would be needed. The initial work packages covering the investigation of the Institute's records, to establish the trends in membership and the activity drivers within the organisation, have been completed. As a result, meetings and membership trend plans have been prepared and presented to the responsible Committees and acceptance obtained. Investigation of the accounts has progressed but all the information necessary to form opinions on the longer term financial plan is not

yet available. At the year end the Committee commenced a review of the terms of reference of all the Institute's Committees.

Specialist Groups

The Institute reflects the broad spectrum of the science and application of acoustics. Several Groups have been formed to foster closer contacts between members of the various specialisms.

Building Acoustics Group

The Building Acoustics Group has had a successful year with a number of activities around the country. The largest event was a conference held at the Building Research Establishment in May and attended by 125 delegates. This conference was entitled 'Sound insulation - the law, the science and the practice' and dealt with a range of topical problems and issues. Building acoustics was also well represented at Inter-Noise '96 in Liverpool where there were many sessions on building acoustics, attracting many national and international delegates. This provided a useful informal forum where many problems were discussed and acquaintances renewed. The Group's Secretary, Nick Antonio, left to go to Hong Kong; he co-ordinated many of the activities of the Group and will be missed.

Electroacoustics Group

The Group has not been active, though it is hoped that it will be re-energised by the committee organising the annual Reproduced Sound Conferences. Anyone interested in participating in a re-formed Electroacoustics Group should contact the Institute's headquarters.

Environmental Noise Group

1996 was another busy year for the Group. Workshops were held in Birmingham and Basingstoke on the subject of noise from pubs and clubs, and at NESCOT on the use of the World Health Organisation Criteria. All three workshops attracted the maximum attendance of about 50. Following the pubs and clubs workshops, the Group set up a working party with the brief of putting together a code of practice on tackling the noise issues related to such venues. The committee also co-ordinated responses on behalf of the Institute to the consultation on PPG24 and the implementation of the Noise Act 1996.

Industrial Noise Group

There were no meetings during 1996. Suggestions for future activities and meetings of the Group, and for volunteers for the Committee would be welcomed and should be directed to Dr Bob Peters via IOA Headquarters.

Measurement and Instrumentation Group

The Group held its first one-day meeting on 14 February 1996 at the Royal Society in London entitled 'Roughly how loud is that?'. It was attended by 47 people and consisted of presentations from seven speakers in the morning and two practical workshop sessions in the afternoon covering a range of measurement and calibration issues, many related to sound level meters and acoustic calibrators. Following the original suggestion of holding meetings around the country, the Group held a similar meeting on 9 October at Strathclyde University entitled 'How sound are your measurements?' Six speakers in the morning and two workshops in the afternoon attracted 24 attendees; this number was undoubtedly affected by late publicity. From these two sessions, several useful suggestions have been advanced for future meetings, as a result of which the next one-day meeting covers the Noise Act 1996 to be held at the Commonwealth Institute in London in February 1997.

Musical Acoustics Group

The Musical Acoustics Group has experienced a mild revival this year. This has been brought about by our involvement in ISMA '97 – the International Symposium on Musical Acoustics. ISMA is a major annual event which in 1997 will be held in Edinburgh during the Festival and is organised by the University of Edinburgh in association with the Institute of Acoustics, the Catgut Acoustical Society and the European Acoustics Association. It is hoped that the Musical Acoustics Group's involvement will encourage further new activity in the future.

Physical Acoustics Group

The AGM was held on 17 April. A meeting on Acoustics of Complex Fluids was held in September at the University of Glasgow. A meeting on Ultrasound in Food Processing was also held in September at the University of Leeds. David Cartwright undertook to edit the next issue of the Group's newsletter, to appear by the end of January 1997. The committee agreed that a questionnaire on the interests of the Group members should be included in the next newsletter, to be used as a guide for choosing relevant topics for future meetings.

Speech Group

The main pre-occupation of the Speech Group and its committee this year has been to revive the Group's fortunes after a period of decline and to re-define its role in a world where increasing demands are being made upon the time and energy of its members. This review is continuing, but the change has already been marked by the re-appearance of the Speakeasy magazine, now edited by Martin Russell and Andy Breen, and by a new-style, joint meeting with the IEE on audio-visual speech processing, held in London during November. Speech Group members also met during the Autumn Meeting at Windermere to discuss the Group's way forward and the current position is described by the chairman in the January 1997 edition of Speakeasy.

Underwater Acoustics Group

Two major conferences were organised by the Group in 1996. In July, a new venue was tried for a meeting on Arrays and Beamforming in Sonar at Bristol University. This was a truly international event and attracted support from industry for some speakers from Russia. The conference on Numerical/Analytical Methods for Fluid-Structure Interaction Problems was held at Strelley Hall, Nottingham, and was the venue for Dr Nicholas Makris' 1995 A B Wood Medal presentation. The Group continues to thrive, and has plans for several important conferences in the near future.

ANNOUNCEMENT & CALL FOR PAPERS

Measurement and Instrumentation Group

One Day Meeting

Sound Intensity - Theory and Practice

Tuesday 11 November 1997

Building Research Establishment, Watford, Herts

It is hoped that the meeting will be equally relevant to practitioners already familiar with the technique and to those considering the technique for the first time. A number of formal presentations have already been offered and the purpose of this first call is to seek additional contributions from as wide an audience as possible. Further contributions are invited on all topics including :

- Sound intensity theory
- Calibration
- Probes and microphones
- PC based acquisition and analysis systems
- Sound power determination
- ISO 9614
  Intensity mapping

There will also be the opportunity for some 'hands on' experience workshop sessions in the afternoon to include :

- Calibration
- Probes
- Sound power determination
  Mapping

Early indications are that at least two specialist representatives from manufacturers will be contributing so this should be an excellent opportunity to hear at first hand the latest developments and current thinking. Certificates of attendance for CPD purposes will be available to delegates. All expressions of interest in submitting an appropriate paper should be sent to the meeting organiser :

Alistair Mackinnon MIOA, National Engineering Laboratory, East Kilbride, Glasgow, G75 0QU
Tel: 01355 272531 Fax: 01355 272999 email: amackinnon@nel.uk

Sound Intensity - Theory and Practice, BRE, 11 November 1997

Name:

Organisation:

Address:

Tel: Fax: email:

☐ Please register me as a delegate to the one-day technical meeting and invoice me for the meeting fee which includes lunch & proceedings ☐ Members £95.00 + £16.63 VAT = £111.63 ☐ Others £125.00 +

Institute of Acoustics, 5 Holywell Hill, St Albans, Herts AL1 1EU
Tel 01727 848195 Fax 01727 850553 email Acoustics@clus1.ulcc.ac.uk Registered Charity No 267026

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5 Holywell Hill, St Albans AL1 1EU
Tel: (0)1727 848195 Fax: (0)1727 850553 email Acoustics@clus1.ulcc.ac.uk
Registered Charity 267026.

Weekend Course

ACOUSTICS FOR SOUND SYSTEM ENGINEERS

3pm Friday 3rd October to 5pm Sunday 5th October 1997

Institute Offices, St Albans and Building Research Establishment, Watford

This course is based on the courses of the same name that have been run until last year as part of the Reproduced Sound series of conferences. The Tutors will again be

Dr Paul Darlington (University of Salford), Peter Barnett (AMS Acoustics), Dr Roy Lawrence

Full course notes will be provided and the subject areas covered will include

- *The structure of sound waves*
- *How sound is quantified*
- *Aspects of hearing*
- *Sources of sound*
- *Direct and reverberant sound levels*
- *The behaviour of sound in large spaces*
- *The behaviour of sound in small spaces*
- *Room defects*
- *Use of physical and computer models*
- *Microphones*
- *Loudspeakers*
- *Interaction of loudspeakers with spaces*
- *Sound system design*
- *Speech intelligibility*
- *Standards*
- *Aspects of the law*

To derive maximum benefit from the time available, (no prior knowledge will be assumed), course delegates assemble at between 3.00 and 3.30 pm at the Building Research Establishment, Watford (five miles from the Institute offices at St Albans) for loudspeaker measurements in their large chambers. A discussion of the results follows from 6.00 to 9.00pm the same day at St Albans. On the Saturday teaching is from 09.00 to 20.00 with the evening taken up with measurements at the former Court House in St Albans. The course concludes at 17.00 on the Sunday. Course fees include the cost of all written materials and meals. Course numbers will be limited to a maximum of ten to permit demonstrations. Hotel accommodation for the Friday and Saturday nights can be arranged if required. Attendance Certificates will be issued for CPD purposes.

Attendance on this course satisfies the tuition requirement for the Acoustics Module of the new Diploma of the Institute of Sound and Communications Engineers.

ACOUSTICS FOR SOUND SYSTEM ENGINEERS (No 97/3)
Friday 3rd to Sunday 5 October 1997, Institute of Acoustics Offices, St Albans and BRE, Watford

Course Fees: Members of the Institute of Acoustics, the Institute of Sound and Communications Engineers, APRS and employees of PLASA companies £340 + £59.50 VAT = £399.50
Non-members £440 + £77.00 VAT = £517.00

Name: **Qualifying Membership:**

Organisation:

Address:

☐ Please register me for the course, I understand that space on the course is limited
☐ Cheque enclosed for the course fees
☐ Please invoice me for the course fees at the above address
☐ I am unable to attend this course, please inform me when it is to be run again.

EDUCATION

Certificate of Competence in Workplace Noise Assessment

The following were successful in the May 1997 examination

Amber
Dunkley, P B
Dye, B
Greatorex, I D
Lloyd, K J
Miles, D G

Colchester
Aitken, D M
Baldwin, M
Cooper, L H
Harbron, J
Moat, A
Morrice, J
Nicholls, D H
Small, A J
Small, J
Tilcock, R

EEF Sheffield
Heseltine, S

Glasgow
Blair, D E
Britton, A J
Corlett, R
Durrant, J H
Meechan, S G
Stewart, K J

Leeds
Finch, P L

Liverpool
Fane de Salis, M H
Howell, J A
Hunsperger, H F
Maluski, S
Powell, T V
Traynor, J
Whithead, S
Wilson, C J
Wilson, G
Yap, S H

Certificate of Competence in Environmental Noise Measurement

The following were successful in the June 1997 examination

Bell College
Davidson, W
Drinkwater, L J
Green, B C
Higgins, A
Hunt,C L
Mackenzie, S D
McCover, R J
Ratter, C
Steele, E
Stewart, A B
Vogwell, L E
Wilson, J C

Birmingham
Clarke, G
Corry, D J
Iceton, C E
Tabibzadeh, H
Yates, P T

Bristol
James, D H
Keyford, A
Kimber, M
Lightfoot, M E
Pilliner, N J
Skipp, M
Vujanic, P

Colchester
De Cruz, J
Epps, T J
Heaton, D R
Hems, S J
Lawson, J
Lee, S J
Spence, W D
Stanley, N E
Wellaway, H

Derby
Burns ,P J
Cannings, S M
Fulcher, K
Peel, G T
Wardle, W C
Warman, B C

Liverpool
Ansell, H E
Armstrong, H C
Byrnes, D
Hughes, N C
Ibrahim, H
Lewis, D M
Maluski, S
Yap, S H

NESCOT
Chauhan, P
Hoyland, R
Hunter, S L
Masters, R W
Seviour, A
Shipton, A B
Staker, S M

Staffs
Stringer, R P

Engineering Council Announcement

Young Engineers Exuberant Summer Ball 1997

Saturday 27 September

A secret location within London. Black tie or lounge suit

To offer help in organising the event or to order tickets at the bargain price of £25.00 each, contact Peter Greaves on Tel: 0171 557 6425

INSTITUTE DIARY 1997/8

1997

10 SEP
Building Acoustics Group Workshop - Sound Insulation
Salford

18 SEP
IOA Publications, Meetings Committee
St Albans

24 SEP
Instrumentation & Measurement Group Committee Mtg
St Albans

24 SEP
North West Branch AGM and Evening Mtg Application of PPG24
Manchester

25 SEP
IOA Membership, Education Committee
St Albans

26 SEP
CPD Committee & Branch Representatives Mtg
St Albans

2 OCT
IOA Medals & Awards, Council
St Albans

3-5 OCT
Acoustics for Sound System Engineers Course
St Albans

10 OCT
IOA CofC in W'place Noise Exam
Accredited Centres

20 OCT
Acoustics Buletin Management Board
St Albans

23-26 OCT
Conference: Reproduced Sound 13
Windermere

29 OCT
Chartered Engineer Interviews
St Albans

31 OCT
IOA CofC in Env Noise M'ment exam
Accredited Centres

OCT
IOA CofC in W'place Noise (Refresher Workshop)
Birmingham

OCT
Instrumentation & Measurement Group Workshop- Hand/Arm and Whole Body Vibration
TBA

1 NOV
Acoustics Bulletin Copy Date (Nov/December)

4 NOV
Environmental Assessment Code of Practice Working Party
St Albans

7 NOV
IOA CofC in W'place Noise Ass't Advisory Committee
St Albans

7-9 NOV
IOA Diploma Distance Learning Laboratory Weekend
St Albans

11 NOV
Instrumentation & Measurement Group One-day Mtg Sound Intensity - Theory and Practice
BRE Watford

12 NOV
Midlands Branch Evening Mtg
TBA

13 NOV
IOA Publications, Meetings Committee
St Albans

14-16 NOV
IOA Diploma Distance Learning Laboratory Weekend
St Albans

19 NOV
North West Branch Technical Visit to Salford University and Presentation on MIDI.
Salford

19 NOV
Engineering Council Conference and Exhibition
London

27-30 NOV
Autumn Conference: Codes of Practice
Windermere

4 DEC
IOA Membership, Education Committee
St Albans

5 DEC
IOA CofC in Environmental Noise M'ment Advisory Committee
St Albans

5-7 DEC
IOA Diploma Distance Learning Laboratory Weekend
St Albans

11 DEC
IOA Medals & Awards, Council
St Albans

16-17 DEC
Underwater Acoustics Group Conference: Underwater Bio-Sonar Systems and Bioacoustics
Loughborough

1998

JAN
North West Branch Evening Mtg - Sound Insulation Around Manchester Airport.
Manchester

5 FEB
IOA Publications, Meetings Committee
St Albans

6 FEB
IOA CofC in W'place Noise Exam
Accredited Centres

12 FEB
IOA Membership, Education Committee
St Albans

26 FEB
IOA Medals & Awards, Council
St Albans

6 MAR
IOA CofC in W'place Noise Ass't Advisory Committee
St Albans

31 MAR - 2 APR
Acoustics 98. IOA Spring Conference
Cranfield University

23 APR
IOA Publications, Meetings Committee
St Albans

30 APR
IOA Membership, Education Committee
St Albans

14 MAY
IOA Medals & Awards, Council
St Albans

15 MAY
IOA CofC in W'place Noise Exam
Accredited Centres

5 JUN
IOA CofC in Env Noise M'ment exam
Accredited Centres

12 JUN
IOA CofC in W'place Noise Ass't Advisory Committee
St Albans

18-19 JUN
Diploma examinations
Accredited Centres

9 JUL
IOA CofC in Environmental Noise M'ment Advisory Committee
St Albans

17 SEP
IOA Publications, Meetings Committee
St Albans

24 SEP
IOA Membership, Education Committee
St Albans

1 OCT
IOA Medals & Awards, Council
St Albans

9 OCT
IOA CofC in W'place Noise Exam
Accredited Centres

30 OCT
IOA CofC in Env Noise M'ment exam
Accredited Centres

6 NOV
IOA CofC in W'place Noise Ass't Advisory Committee
St Albans

12 NOV
IOA Publications, Meetings Committee
St Albans

3 DEC
IOA Membership, Education Committee
St Albans

4 DEC
IOA CofC in Environmental Noise M'ment Advisory Committee
St Albans

10 DEC
IOA Medals & Awards, Council
St Albans

Group	1995	1996
Building Acoustics	499	515
Electroacoustics	134	125
Environmental Noise	653	704
Industrial Noise	531	481
Measurement & Instrumentation	new group	69
Musical Acoustics	123	110
Physical Acoustics	86	76
Speech	111	103
Underwater Acoustics	143	136

Table 4. Group Membership

Regional Branches

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

Eastern Branch

Once again the Eastern Branch was very active, holding eight meetings including the annual dinner and four committee meetings. As usual, the topics for the meetings and the venues were chosen to give a good balance to suit as many members as possible. Most meetings were well attended, although the highly specialised subject of gear noise proved too much for most!! All the speakers gave excellent presentations to their very mixed audiences. The meetings were Anti Sound and Stereo Sound by Prof Philip Nelson, 3rd Annual Dinner at Essex University with Ian Sharland as guest speaker, Environmental Noise Barriers* by Dr David Hothersall, Virtual Instrumentation by John Shelton, Stansted Airport Tour (a summer evening family trip), Vibration and People by Mike Hewitt, Gear Noise by Dr J D Smith and 30 Years of Tunnel Ventilation by Woods of Colchester. (* Held in conjunction with Chartered Institute of Environmental Health)

London Branch

The London Branch held seven evening meetings, a visit to the Channel Tunnel and a one day conference on the subject of Planning Policy Guidance and Noise. Average attendance at the evening meetings was 22 which was not as high as might have been expected given the added incentive of CPD. The subjects at the meetings were wide ranging and included Concert Hall Acoustics, Noise on the Internet, The Noise Act and Long Distance Noise Propagation amongst others. Unfortunately the annual dinner was cancelled this year but this was compensated for by the superb meal by courtesy of W S Atkins in a French chateau as part of the Channel Tunnel visit.

Midlands Branch

The Midlands Branch had another successful year holding three evening meetings and arranging a half day visit. The presentations given at the meetings were, 'Active Noise Control' by Geoff Leventhall of Digisonix Inc, 'A Survey of Concert Hall Acoustics' by Bridget Shield of University of the South Bank, and 'A Review of BS5228' by Paul Freeborn of Stanger Science and Environment. The average attendance at these meetings was 25. The half day visit was a technical tour of the Birmingham Symphony Hall. The Branch intend to hold four evening meetings in 1997 and are planning a one day visit.

North West Branch

The year started with a talk in January by Nick Antonio, then at BRE, and Paul Freeborn, TBV Science, on the proposed revisions to BSS 5228 'Noise and Vibration Control on Construction and Open Sites'. In April a visit to Bridgwater Hall in Manchester took place led by David Anderson of Arup Acoustics. In July a workshop led by John Hinton, Birmingham City Council, and Ken Dibble, Ken Dibble Acoustics, was held to discuss noise breakout from pubs and clubs and the potential for a Code of Practice. The AGM was held in September when John Seller of BRE gave a presentation on 'Short L_{eq} – its use in noise measurement'. In October a talk was given on 'Hearing Threshold Levels in People Exposed to Noise' by Professor Mark Lutman of ISVR. The year ended in November with a presentation by Jim Griffiths, Symonds Travers Morgan, on 'Rock Concert Noise'. All meetings were well attended and the Branch wish to thank BDP for providing excellent facilities for the majority of the meetings. We are looking forward to a successful 1997.

Scottish Branch

The AGM this year was held on 24 April at Heriot-Watt University. Prior to the AGM the proposed arrangements for CPD monitoring were outlined by Sue Bird. It was also agreed that Patrick Corbishley would act as Scottish liaison person for CPD. Ricky Burnett retired from office due to his transferring to the newly formed Scottish Environmental Protection Agency. David Barbour was duly elected to the committee. Bernadette McKell remains as Branch Chairperson, John Nicol took over from Ron McLauchlin as Branch Secretary and Andy Watson remained as Treasurer. On 22 October an evening meeting was held in the Glasgow Caledonian University when a paper was presented by David Barbour on, 'The Sound Insulation of Separating Floors – An Analysis of Cost and Quality'. In the run up to the festive season, a combined 'Demonstration of Acoustic Software & Christmas Get Together' was held. The software included programmes for use in Building Acoustics, Automotive Industry, Transport and Environmental Acoustics. The meeting was followed by an informal get-together complete with mulled wine and mince pies.

Southern Branch

The 1996 AGM was held at NESCOT in Ewell, Surrey on 23 October 1996, when Graham Parry retired as Chairman. Ian Flindell was elected as the new Chairman, having previously served as Secretary, and Dawn Connor was elected as Secretary. Liz Williams (Arup Acoustics), Patrick Williams (Southdowns Environmental Consultants Ltd), and Mike Breslin (ANV), joined the committee as new members.

The AGM was immediately followed by a very successful technical meeting with four speakers on Railway Noise and Vibration. The speakers were Brian Hemsworth (BR Research), Ken Collins (AEL), Graham Parry (RPS) and David Trevor-Jones (Consultant). The meeting was well attended and there was a wide ranging discussion. A full meetings programme for 1997 was agreed at a committee meeting held at Basingstoke on 12 November 1996.

South West Branch
The third AGM of the South West Branch was held at UWE, Bristol on 21 March with an attendance of around 30. The informal management structure was agreed once again with the re-election of Norman Pittams, Stan Simpson, Steve Peliza, Mike Squires, and Peter Dobbins. The theme of the meeting was Environmental Noise with contributions from Peter Dobbins (Noise in the sea), Steve Peliza (Noise from pubs and clubs), Tim Clarke (The Noise Bill) and Ian Campbell (Common errors in noise measurements). Stan Simpson gave a report on the Institute's CPD scheme and was formally appointed as the CPD co-ordinator for the SW Branch. One of the more important events later in the year was the retirement of the Branch Chairman Norman Pittams, who was instrumental in re-starting the SW Branch in 1994. Norman and his wife Brenda are now actively pursuing their long standing interest in breeding Aberdeen Angus cattle on their farm, which is idyllically situated in a very 'quiet' spot between the Black Mountains and the Brecon Beacons in South Wales.

Yorkshire and Humberside Branch
The Branch held three meetings in 1996. The AGM was in April when all officers were re-elected. Following this, Bernard Berry gave a presentation on the new revision of BS4142. In June a meeting was held at Leeds and Bradford airport; Chris Elliot gave a presentation on his experiences of monitoring and controlling airport noise followed by a tour of the airport. In November a meeting was held at York University followed by a presentation on aircraft noise monitoring instrumentation by Cirrus Research. Five members of the branch have submitted CPD summaries at the end of the first year of the scheme. The proposed programme for 1997 includes meetings in Rotherham, Leeds (AGM) and a half day session at Bradford University.

Branch	1995	1996
Eastern	177	205
London	464	513
Midlands	217	267
North East	48	49
North West	231	258
Scottish	86	85
South West	148	164
Southern	316	365
Yorks/Humberside	103	123
Hong Kong	146	-
Overseas	138	205

Table 5. Branch Membership

COUNCIL
Officers
President: Mr B F Berry FIOA
President Elect: Mr I J Campbell MIOA
Immediate Past President: Mr A N Burd FIOA
Honorary Secretary: Dr A J Jones FIOA
Honorary Treasurer: Mr G Kerry FIOA
Vice President (Groups & Branches): Dr R J Peters FIOA
Vice President (Engineering Division): Prof P D Wheeler FIOA
Vice President (International Liaison): Prof M A A Tatham FIOA

Ordinary Members
Mr K Broughton MIOA
Mr J G Charles FIOA
Prof R J M Craik FIOA
Dr P F Dobbins FIOA
Dr C A Hill FIOA
Prof P A Nelson MIOA
Dr B M Shield MIOA
Mr S W Turner FIOA

Chairmen of Standing Committees of Council and Sub-committees
EDUCATION: Dr R J Peters FIOA
Diploma in Acoustics and Noise Control, Board of Examiners: Dr J M Bowsher HonFIOA,
Certificate of Competence in Environmental Noise Measurement Advisory Board: Dr M E Fillery MIOA
Certificate of Competence in Workplace Noise Assessment Advisory Board: Dr R J Peters FIOA
Continuing Professional Development: Ms S M Bird MIOA
ENGINEERING DIVISION: Prof P D Wheeler FIOA
MEDALS & AWARDS: Mr B F Berry FIOA
MEETINGS: Mr J G Charles FIOA
MEMBERSHIP: Mr A N Burd FIOA
PUBLICATIONS: Mr J W Sargent MIOA

Specialist Groups
BUILDING ACOUSTICS: Chairman Prof R J M Craik FIOA
ELECTROACOUSTICS: Hon Secretary Dr J A S Angus FIOA
ENVIRONMENTAL NOISE: Chairman Mr S W Turner FIOA, Hon Secretary Ms D G Connor MIOA
INDUSTRIAL NOISE: Chairman Dr R J Peters FIOA, Hon Secretary Mr D G Bull FIOA
MEASUREMENT & INSTRUMENTATION: Chairman Mr R G Tyler FIOA, Hon Secretary Mr P Hanes MIOA
MUSICAL ACOUSTICS: Chairman Dr P F Dobbins FIOA
PHYSICAL ACOUSTICS (Joint with the Institute of Physics): Chairman Prof V V Krylov FIOA
SPEECH: Chairman Dr M Brooke FIOA, Hon Sec Mr S J Cox MIOA
UNDERWATER ACOUSTICS: Chairman Dr P F Dobbins FIOA, Hon Secretary Dr P D Thorne FIOA

Regional Branches
EASTERN: Chairman Mr D G Bull FIOA, Hon Secretary Mr J M Hustwick MIOA
MIDLANDS: Chairman Mr J F Hinton MIOA, Hon Secretary Dr M E Fillery MIOA
LONDON: Chairman Mr J Simson MIOA, Hon Secretary Mr A J Garton MIOA
NORTH WEST: Chairman Mr P E Sacre MIOA, Hon Secretary Ms N Alexander MIOA
SCOTTISH: Chairman Dr B McKell MIOA, Hon Secretary Mr J Nicol MIOA
SOUTHERN: Chairman Dr I H Flindell MIOA, Hon Secretary Mrs D G Connor MIOA
SOUTH WEST: Secretary: Mr S Simpson MIOA
YORKSHIRE & HUMBERSIDE: Chairman Mr R F Scott MIOA, Hon Secretary Mr J Bickerdike FIOA

Table 6. Institute Personnel at 31 December 1996

AUDITORIUM DESIGN AT THE MILLENNIUM

Wellington Park Hotel, Belfast, 22 – 24 May 1997

Small is beautiful but a little larger is best! The Belfast conference 'Auditorium Design at the Millennium' was the third of a very successful series of Institute meetings associated with new auditoria, organised by Mike Barron and Raf Orlowski. The first, held in 1992, was linked to Birmingham Symphony Hall, while the second, in 1995, centred around the new Glyndebourne Opera House. The focus of this meeting was the new Waterfront Hall in Belfast, which opened in January this year. There was some concern about how many delegates would be willing to come to Belfast but we were delighted to have as many authors as at the previous meetings, with 28 papers and a total attendance of 61. With the meeting spread over three days, this allowed time for a friendly atmosphere to develop.

The meeting was held in the Wellington Park Hotel, a large but by no means overpowering hotel which looked after us admirably. As is typical for Belfast, the bars became particularly lively come the weekend. Our meeting had attracted the attention of our President, Bernard Berry, and we were delighted that he could welcome everyone to the meeting. The first session contained papers which all related to computer modelling of auditoria. Adrian James, of Adrian James Acoustics, discussed the relative merits of computer and physical scale modelling. His preference is obviously towards computer models though he stressed there are both good and poor software packages. Henrik Moller of Akukon in Helsinki then presented a paper about an exciting 400-seat glass auditorium in Turku, which was designed with the aid of a computer model. Though this is the first in Finland, three glass auditoria now exist in Holland apparently. Computer modelling has highlighted the need for quantification of the diffusion characteristics of room surfaces. Tristran Hargreaves from Salford University elegantly reviewed the various methods available to characterise diffusion from surfaces, concluding that a new parameter based on the autocorrelation function might be the most suitable.

After lunch, Catherine Semidor from the University of Bordeaux reported on objective and subjective measurements in the Four Seasons Theatre near Bordeaux, which has multi-purpose facilities. Of particular interest were the survey techniques with non-specialist members of the audience, a topic also considered later in the meeting by Bridget Shield. We then moved from the small to the large scale, an enclosed sports arena in Pesaro, Italy, with 12,000 seats and an enclosed volume of 200,000 m^3! Patrizio Fausti of the University of Ferrara presented a paper, jointly authored by Professor Cocchi and G Raffellini, on the acoustic design of this arena whose success was confirmed at the opening concert by the voice of Luciano Pavarotti. Duncan Templeton, BDP Acoustics, brought us back to the small scale again with a description of the meticulous reconstruction of the chapel of Tonbridge School, which had been completely destroyed by fire in 1988.

Robert Metkemeijer of Adviesbureau Peutz in the Netherlands described how, with the help of a 1:12 scale model, he is aiming to improve the acoustics of the Royal Albert Hall. Rob admitted that Ken Shearer did remarkably well with his acoustic mushrooms but stated that current proposals to introduce a reflective velarium at high level would give the Hall a better appearance with equally good, if not better, acoustics. Mike Barron, of Fleming and Barron in Bath, then presented a fascinating account of his 21 year involvement with acoustic scale modelling of auditoria. Early work on large 1:8 scale models led to his development of the more flexible technique of testing at 1:50 scale and he has investigated the acoustics of numerous auditoria using this method. Although acknowledging improvements in computer modelling, Mike confirmed that acoustic scale modelling has a secure future.

The last paper of the day, prior to the evening concert, was appropriately about the Waterfront Hall. Laurence Haslam of Sandy Brown Associates described the design aims of the hall, the principal one being appropriate acoustics for symphonic music, and how these led to a geometry based on St David's Hall, Cardiff. Laurence's colleague, Steven Stringer summarised building services noise control and how the target of NR20 in the auditorium was met.

The Waterfront Hall is a circular building overlooking the River Lagan. Any self-respecting arts complex these days has substantial glass walls to allow views both into and out of the foyer areas. This building is no exception, offering glorious views of the river and beyond towards Belfast Lough. The auditorium seating with a capacity of 2250 is split up into tiers in a manner very similar to that used in the Cardiff hall already mentioned. Sandy Brown Associates had distributed listeners' questionnaires for those happy to complete them. Tickets for the concert had been bought in two different parts of the hall to allow swapping at the interval.

The highlights of the concert were Sibelius' Violin Concerto and Respighi's Pines of Rome; the orchestra was the Moscow State Symphony Orchestra. For reasons unknown, the first half of the concert was rather lacklustre whereas in the second half the musicians really came to life. Such are the hazards of doing subjective studies since this may well have influenced the responses!

On the Friday morning we returned to the Waterfront

Hall to hear an account of the design of the hall and to see more of the building. Martin Carr of theatre consultants Carr & Angier began by recalling the history of the project; he had titled his paper 'War and peace over 18 years'. Progress had been extremely protracted partly due to resistance from the local Northern Ireland Office and government in Westminster. At one stage the latter proposed confiscating the site to use it for more Law Courts!

Peter McGuckin of the Belfast architects Robinson-McIlwaine discussed the project from their perspective. Their willingness to listen to the advice of their consultants and develop the design as a team was clearly a major contribution to its success. Martin Carr returned to explained some design details including the many variable elements in the hall, which includes provision for a simple proscenium.

We next had the privilege of hearing a group of six brass players from the Music Department of the University of Ulster directed by Graham Nelson, while delegates were able to wander around the auditorium. The choice of instruments was a brave one as they can expose troublesome echoes. We then left the auditorium itself for some of the nether regions, such as part of the plant room over 100 m long round the perimeter of the building at high level and the space under the 56 m diameter domed roof of the building.

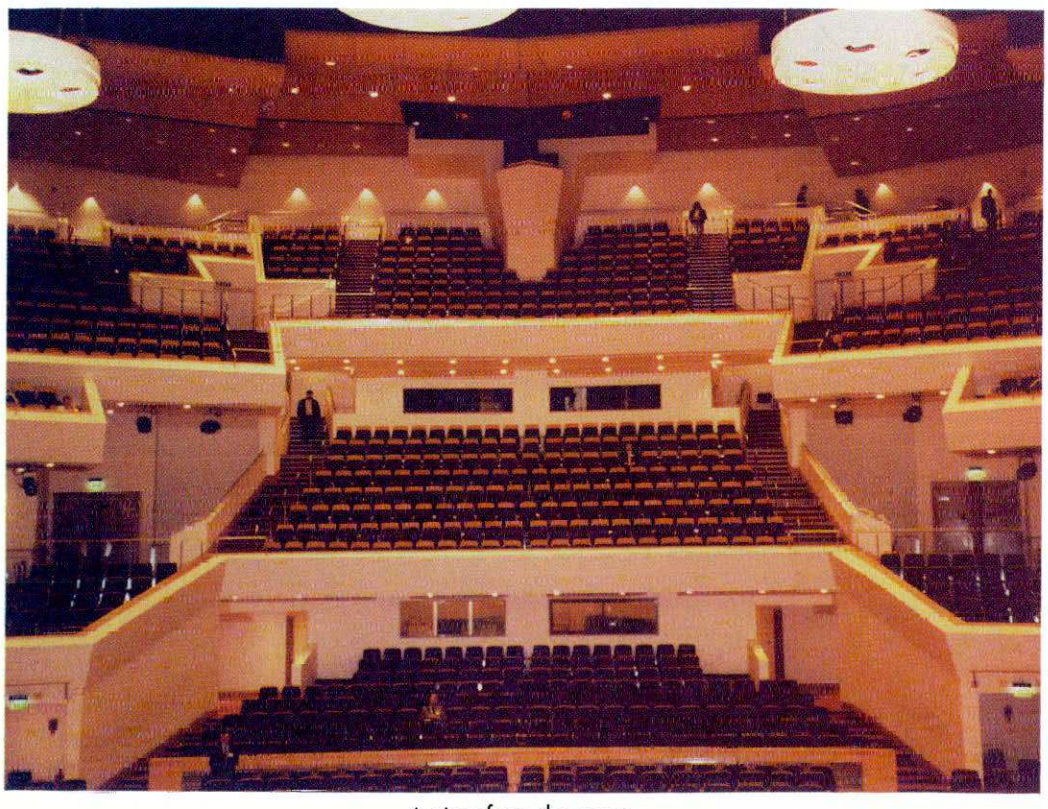
Back in the hotel refreshed by lunch, the afternoon session was started by Anders Christian Gade from the Technical University of Denmark, who reported on correlation analyses of objective data measured in 53 halls, with findings for instance that objective clarity (Cxo) is higher in wider halls. We then heard Bridget Shield of South Bank University who has with Trevor Cox been bravely conducting questionnaire surveys of normal concert goers at live concerts; her account of preliminary results whetted our appetite for more.

It is always nice to welcome speakers from related disciplines: Anne Minors, an independent theatre consultant, began her talk on 'Live performance' with a series of photographs of impromptu street performances at Covent Garden. The answers to many of her questions about appropriate design of arts complexes contained the word flexibility, that future requirements are unknown and removable partitions as opposed to concrete might be more appropriate in back-stage areas for instance. Bodil Vaupel from Denmark had also been studying people's behaviour in public with a camera; her paper 'The best remaining seat' was concerned with what one could learn from people's selection of a seat when a free choice is available and what that tells us about optimum arrangements of seating – a novel and intriguing study.

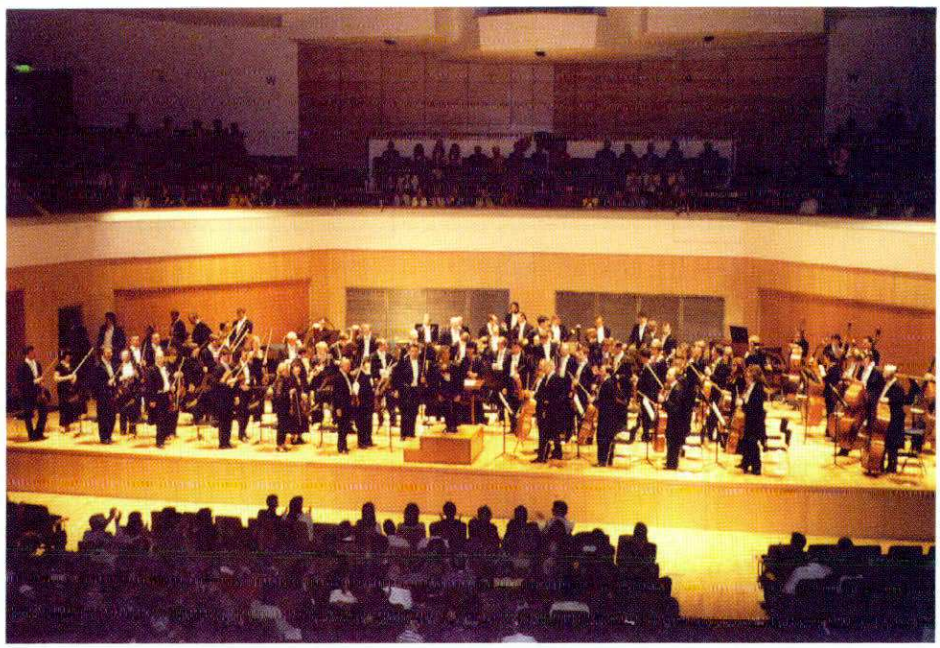
The other major auditorium to open in Britain in the last 12 months is the 2400 seat Bridgewater Hall, Manchester. Rob Harris of Arup Acoustics gave an extensive account of its design, including the internal acoustics, sound insulation design, ventilation noise and vibration isolation from the nearby Metrolink light railway system. The hall appears to have met nearly all the criteria set for it but Rob Harris wondered whether more diffusing surfaces might improve the sound further.

Adrian James (Adrian James Acoustics) then gave a paper about the fraught subject of orchestra pit acoustics; of particular interest were the evidence of risk of hearing loss among players and the question of appropriate configurations for performance of Baroque and earlier operas. Staying in opera houses, John O'Keefe of Aercoustics, Toronto, Canada, reported on-going studies of balance between stage and pit. He considers it important to look at the balance at different frequency bands; one surprising result is that modifying the depth of the pit has only a minor effect on balance.

Patrizio Fausti from the University of Ferrara gave a joint paper (co-authored by Angelo Farina and Professor Pompoli) on the use of orchestra shells in Italian opera houses. The orchestra shells con-



A view from the stage



The evening concert by the Moscow State Symphony Orchestra

sidered varied with regard to their degree of enclosure and hence the acoustic effects produced. The day's proceedings were rounded off by Trevor Cox (Salford University) who has been applying a Kirchoff prediction technique to optimise the design of stage canopies. We had thus covered related issues from the consultant's, the engineer's and the scientist's perspective.

Saturday's proceedings started early. Bob Essert of Arup Acoustics talked about developing awareness and control of spatial sound, with some interesting proposals for achieving spatial impression with 2nd or higher order reflections rather than simply first order ones. Leonie Couthon from Bordeaux University then described measurements on musical instruments, particularly of directivity, for use in simulations and auralisation. This was followed by Rendell Torres in a joint paper with colleagues at Chalmers University of Technology discussing subjective tests on the audibility of the frequency characteristics of reflections. We then heard from Kyri Kyriakides about the Edinburgh International Conference Centre. The novel feature of the Centre is the first turntable divisible auditorium in the UK, which allows one large auditorium to be converted into three smaller ones. And if we needed further convincing we were shown the publicity video for the Centre (perhaps a bit grand for the Institute?).

And so to the last, but by no means least, session of the conference. Gimenez, Marin, Sanchis and Romero from the University of Valencia described how the currently popular parameters in auditorium acoustics (Clarity, Lateral Energy Fraction etc) can be used in a new simple evaluation scale for auditoria which also accounts for different musical styles. Mario Rossi, from the Federal Institute of Technology in Lausanne, presented the acoustical design of the Auditorium Stravinsky in Montreux which opened in 1992. The principal aim was to build a concert hall for 2000 but it also became necessary to cater for the famous jazz festival which meant the provision of 1000 m² of temporary absorbent panels.

Andy Moorhouse, of the University of Liverpool, discussed the acoustics of the 25 year-old Guildhall at Preston. Current conditions are barely adequate and, with the help of Lottery funding, an upgrade is proposed which will provide a degree of variability in the acoustics. The final paper by Daniel Commins of the Commins Acoustic Workshop in Suffolk described how the Art Nouveau architect, Victor Horta, successfully carried out in the 1920's the acoustical design of the Palais des Beaux-Arts Concert Hall in Brussels. Unfortunately, insensitive modifications over the years have led to deterioration of its once excellent acoustic quality.

The conference was closed with sincere thanks to the organisers and especially to Sandy Brown Associates for arranging the visit to Waterfront Hall and organising the brass ensemble – a particularly bold choice of test signal! The proposal to hold another UK conference on auditorium acoustics in a couple of years or so was warmly welcomed by the delegates.

Mike Barron MIOA & Raf Orlowski MIOA

IEC 1672: THE NEW INTERNATIONAL STANDARD FOR SOUND LEVEL METERS

The Royal Society, London, 25 June 1997

The Measurement and Instrumentation Group returned to the prestigious surroundings of The Royal Society in London for its latest one-day Meeting, held on 25 June 1997. Working Group 4 of IEC/TC29 is preparing a new International Standard for sound level meters, and a new Committee Draft had recently been circulated. This meeting was arranged to allow discussion of the specifications within the new Standard and the implications for all users of sound level meters.

An authoritative and international group of speakers, many of whom had contributed directly to the new Standard, were welcomed by Bernard Berry, President of the Institute. The Convenor of the Working Group, Alan Marsh (DyTec Engineering, USA), opened by describing the shortcomings of the existing Standards, IEC 651 and IEC 804, and the investment of effort in producing a new Standard; since May 1990, an estimated 20,000 hours have been spent by the various contributors. The scope for the Standard and principal performance specifications were also introduced.

The invited speakers each described a particular aspect of the new Standard. Gunnar Rasmussen (GRAS Sound & Vibration, Denmark) discussed the requirements of IEC 1672 for microphones, pointing out the special needs of systems that use outdoor microphones, and made some general comments about progress in microphone technology that relates to noise measurements.

The specification and testing of frequency weightings were covered by Peter Hedegaard (Brüel & Kjær, Denmark), from the basis of the weightings in equal loudness contours to the proposed method for testing the weighting networks both acoustically and electrically. Peter also detailed the requirements for steady level linearity and measurement of peak sound pressure level.

Ole-Herman Bjor (Norsonic, Norway) introduced the specifications for steady and transient measurement capabilities, including toneburst response and fast and slow time-weightings. The tests of these capabilities, along with the requirements for signal level display and ac electrical output, were also described.

To conclude the morning session, Meeting Organiser Richard Tyler (CEL Instruments, UK) pointed out that IEC 1672 will introduce requirements for the electromagnetic compatibility of sound level meters. These are required because of the numerous sources of radio frequency fields that a meter may encounter. The Standard takes account of the requirements for CE marking, and provides detailed requirements and test procedures for emissions from meters and their susceptibility.

After lunch, Gaston Banget Mossaz (Laboratoire National d'Essais, France) described the new specifications for the effect of environmental conditions (static pressure, temperature and relative humidity) on sound level meters. Gaston showed some results of tests performed at LNE to the specifications of IEC 651 and IEC 804.

The conformance of an instrument to its specification cannot strictly be confirmed without knowing the uncertainties associated with the measurements. Susan Dowson (National Physical Laboratory, UK) described the evaluation of measurement uncertainties in general and the approach to uncertainties within IEC 1672. Examples were provided of the distinction between manufacturing tolerance and the laboratory measurement uncertainty, and of the importance of small measurement uncertainties in reliably confirming the conformance of a sound level meter.

John Kuehn (IEC/TC29/WG17) emphasised the importance of the sound calibrator used to adjust the sensitivity of the sound level meter and gave some practical advice for correct use of calibrators with meters. WG17 is revising the current IEC 942 for sound calibrators, and John set out the changes that are required in that Standard and the progress towards a revised version.

The presentations closed with Alan Marsh describing the stages in producing an IEC Standard, estimating that the completed Standard will probably be published in either December 1998 or December 1999. The new Standard is intended to make sound level meters more accurate, easier to test and easier to use.

An open discussion session enabled the 35 delegates to supplement questions to individual speakers with wider debate on issues including the scope of the Standard and the validity of declarations of conformance. The meeting concluded with Richard Tyler's thanks to the international cast of speakers for making the meeting so comprehensive and successful in its coverage of the topic.

Peter Hanes MIOA ❖

Information Requested

If you have any information on work concerning the interaction of sound or vibration with human cells or animals or if you are interested in the therapeutic use of sound (this could be music, but not necessarily so), please contact:

Gordon Dalgarno MIOA

70 Seward Close, Cowl Street, Evesham, Worcs WR11 4PN

Tel: 01386 423842 email: dalgarno.btinternet.com

Hansard

25 June 1997

M20

Sir John Stanley: To ask the Secretary of State for the Environment, Transport and the Regions if he will use the M20 between junctions 3 and 5 to test the new quieter road surfaces developed by his Department.

Ms Glenda Jackson: When the M20 between junctions 3 and 5 needs attention as part of planned maintenance, the possibility of using it to test novel forms of quieter road surface developed by the industry will be considered.

Sir John Stanley: To ask the Secretary of State for the Environment, Transport and the Regions if he will provide noise barriers on the M20 between junctions 3 and 5.

Ms Jackson: It is not possible to justify the expenditure of public funds on providing noise barriers along this section of the M20. As this would mainly be of benefit to people who either bought property in the vicinity of the M20 in full knowledge of the noise from traffic, or were compensated for the loss of value of their property when the road was first built, in anticipation of the growth of traffic on it.

Noise Barriers

Sir John Stanley: To ask the Secretary of State for the Environment, Transport and the Regions if he will adopt a discretionary policy of providing noise barriers on motorways that were opened to traffic after 17 October 1969.

Ms Glenda Jackson: The current policy is aimed at reducing the adverse effects that road construction or improvement would have on the surrounding area and applying similar principles to those roads which were built before the operative date specified in the Land Compensation Act.

2 July 1997

M20 (Noise Reduction)

Sir John Stanley (Tonbridge and Malling): On 12 December last year, I initiated an Adjournment debate about the problem of the ever-mounting noise on the M20 between junctions 3 and 5. I make no apology for returning to the subject six months later. I do so because we have a new Government, and whether they choose to follow or to change the policies adopted by their predecessor is a matter of profound importance to my constituents. The Minister will note that I have broadened the ambit of the debate to cover the area between junctions 2 and 5; I will explain why later.

No doubt the Minister will have familiarised herself with the background of the issues that I shall raise. As she will know, the M20 is the primary route through Kent to the continent, and, by virtue of its geographical position, the primary route from the whole of Britain to the continent. At junction 3, which is in my constituency, two branches of the national motorway system meet. The branch from the north, the M20, carries traffic from London, traffic through the Dartford tunnel and traffic from the north and east of London to the channel tunnel. The other branch, represented by the M26 spur of the M25, carries traffic from the south and west of the country to the continent.

It was inescapable that that section of the motorway would be densely used, especially after the opening of the channel tunnel. Those living along the section of the M20 between Wrotham and Aylesford – following the boundary changes, Aylesford is now in the constituency of the hon. Member for Chatham and Aylesford – are suffering from the noise and environmental disruption.

Inevitably, the initial projections of the volume of traffic that would be carried on that section of the M20 were substantial underestimates. The section between junctions 3 and 5 was opened to traffic in December 1971, having been built with three lanes in each direction. Less than 20 years later, in 1989, the then Secretary of State for Transport, Mr Paul Channon, announced in his White Paper 'Roads for Prosperity' that the section would be widened to four lanes in each direction. That announcement set in train what I can only describe as probably the single most botched piece of motorway planning since the start of the motorway programme.

First, the announcement was made with no indication of how the widening would be carried out and what new land would or would not be required. As a result, the homes of 2,000 or 3,000 people living near that section of the motorway were blighted, which made them either unsaleable or saleable only at sacrificial prices.

Secondly, the Department of Transport had to spend some £30 million of taxpayers' money on the purchase of some 300 houses under statutory blight procedures. It transpired, however, that the purchase of virtually all those houses had been unnecessary, as the most desirable way of widening the section involved using the existing curtilage of the motorway, and no additional land would be required. Effectively, £30 million of taxpayers' money had gone down the drain. I made a formal complaint about the waste of money to the then Comptroller and Auditor General, who strongly criticised the Department of Transport's handling of the scheme.

The final instalment of this sorry saga came just seven and a half years after the original announcement of the widening scheme. In November last year, the then Secretary of State for Transport, my right hon. Friend the Member for North-West Hampshire (Sir G Young), announced that the scheme was to be abandoned. Quite apart from the fact that further millions of pounds that had been spent on design, consultation and planning went down the drain, the announcement was another sad example of the extraordinary mishandling of the scheme.

For my constituents, the widening arrangements had had one potentially redeeming feature. Built into them was the adoption of substantial noise abatement measures, such as noise barriers and new earth contours. Under the last Government's policy, however, because the road had been opened after 17 October 1969, the abandoning of the widening scheme meant the automatic abandoning of all the noise mitigation measures. My constituents are living alongside the main road artery between Britain and the continent, and the Highways Agency forecasts that,

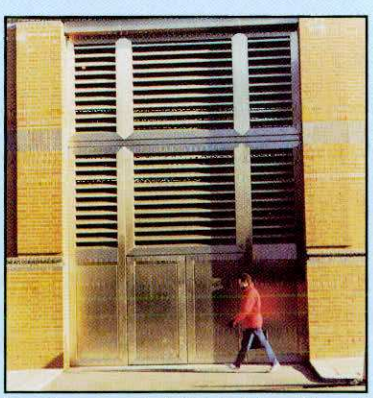
Industrial Noise Control

Safeguard people's hearing levels

Busy Works Office

Process and Production Areas

Heavy Industry



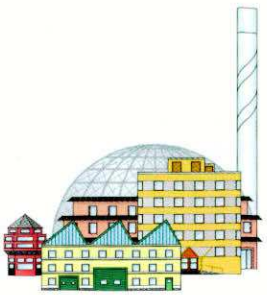
Environmental/Neighbourhood Noise Control

For further information contact:

ECOMAX ACOUSTICS

Ecomax Acoustics Limited (Head Office)
Gomm Road, High Wycombe. Bucks HP13 7DJ
Fax: 01494 465274 Telephone: 01494 436345

Consult the Professionals for Noise Control Solutions



even without any widening, traffic on the road will at least double over the next 20 years.

Let me put two specific policy issues to the Minister. The first relates to the Government's policy on noise barriers, and the second to road surfaces. The last Government's policy on noise barriers was set out by the then Minister for Railways and Roads, John Watts, when he replied to my debate on 12 December. He said:

"the Department is required to provide noise mitigation in circumstances where we act as a developer by building a new road or substantially altering an existing one. We are not obliged to do so to deal with noise levels resulting from increased use of an existing unaltered road. I made it clear in answer to a parliamentary question earlier today that we have, in exceptional circumstances and where funds have been available, exercised a discretionary policy for providing noise barriers on roads last improved before 17 October 1969, but that policy is not applicable in respect of this section of road, which opened to traffic in 1971." – [Official Report, 12 December 1996; Vol 287, c 512.]

He went on to confirrn that the cut-off date was not statutory but a matter of policy, which means that if the Minister is so minded she can change it without further legislation.

I tabled a parliamentary question to the Secretary of State to find out whether the present policy would continue or whether he would provide noise barriers on the M20 between junctions 3 and 5. The Minister replied:

"It is not possible to justify the expenditure of public funds on providing noise barriers along this section of the M20, as this would mainly be of benefit to people who either bought property in the vicinity of the M20 in full knowledge of the noise from traffic, or were compensated for the loss of value of their property when the road was first built, in anticipation of the growth of traffic on it". – [Official Report, 25 June 1997; Vol 296, c S20.]

Will the Minister reconsider that policy, which appears to be – I hope that I am wrong – an endorsement of the previous Government's policy?

There is an extremely compelling case for reviewing the policy. The Minister's statement that the expenditure could not be justified is strange, in that only a few months previously, until November last year, the Department of Transport found no difficulty in justifying the use of public funds for the construction of noise barriers and other noise abatement measures along that section of the motorway. I accept that that was done in the context of the widening scheme, but I do not believe that the Minister would argue that, merely because the widening scheme has been abandoned, there will be a considerable reduction in the noise disturbance.

The Highways Agency's figures show that, even without the widening scheme, the traffic on that section of the M20 will double. There is no evidence to suggest that there will be any material diminution of the volume of traffic using it simply because the widening will not proceed. The cut-off date of 17 October 1969 for the discretionary policy of constructing barriers on existing roads looks increasingly anachronistic. Surely policy should be determined not by some past cut-off date, almost 30 years distant, but by the present environmental realities.

The present policy is based on the Department effectively disowning any environmental responsibility for what happens on existing roads. The Department is effectively saying that any intensification of existing use, creating increased noise and environmental disturbance, is not its responsibility and that it washes its hands of it. That position is not taken by those who operate airports in this country, and it would certainly not be allowed to be taken by companies in the private sector.

I recently had complaints about a company operating a sawmill in my constituency and I regularly get complaints about quarries. We do not allow private sector companies to say that, because they have planning consent, they can carry on intensifying use and creating more and more noise disturbance at ever-higher decibel levels for any number of hours in the day. We bring to bear on them the planning authority, public health legislation and the Health and Safety Executive. The Department cannot continue to operate a policy under which it simply walks away from the environmental consequences flowing from intensification of use of existing roads.

In the previous debate that I secured, I asked the then Minister for Railways and Roads, Mr John Watts, whether he could consider whether the new road surfaces being tested by his Department could be applied to the section of the M20 about which I am concerned. I have deliberately extended the geographical ambit of this debate to cover the area from junctions 2 to 5, because on the section between junctions 2 and 3, heavy lorry traffic makes considerable noise as it goes past the village of Wrotham and up the steep gradient of the north downs to the top of Wrotham hill.

As recorded at column 514 on 12 December 1996, the then Minister replied relatively positively to my request for the motorway to be used for testing new road surfaces. When I tabled a question to the present Secretary of State asking him whether that section of the M20 could be used to test the quieter road surfaces being developed by the Department, the Minister replied:

"when the M20 between junctions 3 and 5 needs attention as part of planned maintenance, the possibility of using it to test novel forms of quieter road surface developed by the industry will be considered"(Official Report, 25 June 1997: Vol. 296, c. 520)

Will the Minister extend her consideration of using the quieter road surfaces to junctions 2 to 5, for the reasons that I have explained? Will she, either in her reply or by letter, as the matter may require some research, give me the fullest possible information about when the Department plans to carry out resurfacing on that section of the M20? Perhaps she may say more firmly than in her written answer that the Department intends to make every possible effort to use quieter surfaces.

The issue is deeply significant for my constituents and those of the hon. Member for Chatham and Aylesford. I strongly believe that it will not be sustainable for the Department simply to walk away from the environmental

consequences of the intensification of use of existing motorways. I am told that the Department of Transport in the Netherlands has as a policy objective the planned resurfacing of main roads, specifically to try to reduce noise disturbance, and that it applies that policy on existing roads. I earnestly hope that a similar policy objective will be adopted by the Department in this country.

The Parliamentary Under-Secretary of State for the Environment, Transport and the Regions (Ms Glenda Jackson): I congratulate the right hon. Member for Tonbridge and Malling (Sir J Stanley) on securing this debate so early in the life of this Parliament. He has been a tireless advocate for his constituents in the matter and I welcome his raising it in the House, because it gives me the opportunity to explain more fully how the legislation dealing with the adverse effects of roads on the environment works.

There is no doubt that traffic noise is an exceedingly contentious issue, not least when defining what is a serious nuisance, because the perception of noise may vary from person to person and from place to place.

I recognise that people living near the M20 feel that they suffer the adverse effects of the traffic without receiving much benefit from the motorway. I must point out, however, that it plays a vital role in giving access to the single European market. The right hon. Gentleman detailed the precise importance of that stretch of our national road network; I believe that the effect of that access on our trade has benefited the nation. The efficient distribution of goods and other services brought about by that direct link to the continental motorway network has had a dramatic effect on society. Although we have had arguments to the contrary from the right hon. Gentleman, most of those effects have been essentially beneficial.

The right hon. Gentleman argued that the discretionary powers provided by the Highways Act 1980 to mitigate the adverse effect of roads on their surroundings have not been used to their fullest extent. It is important to understand the basis of the legislation and the principles of equity and consistency which underpin the way in which discretion has been exercised.

The fundamental principle originally established under the Land Compensation Act 1973 is that a public body that carries out development under statutory powers should provide compensation for the indirect effects of that development on adjacent land interests.

In addition to providing for financial compensation, that Act also gave the Secretary of State for Transport the power to make regulations imposing a duty or conferring a power on responsible authorities to insulate buildings against noise caused, or expected to be caused, by the works associated with road construction or improvement. That power was implemented in the Noise Insulation Regulations 1973. Further provisions contained in the Land Compensation Act included the power for responsible authorities to carry out additional measures to mitigate against the adverse effects of the construction, improvement, existence or use of the public works.

The provision for compensation was limited to public works completed on or after 17 October 1969. The same operative date was contained in the Noise Insulation Regulations 1973. It was not considered appropriate to specify a retrospective date limiting the power to provide other mitigation measures, because it was intended to cover deserving cases in which properties were affected by roads that had been completed before the specified date, which limited the exercise of the other powers.

It took several years for retrospective cases to be dealt with under the Noise Insulation Regulations. It was not until 1979, under the previous Labour Government, that the power to provide other forms of mitigation was activated. It was made clear at that time that the policy of providing noise barriers alongside existing highways was restricted to roads opened prior to 17 October 1969.

In each case, the decision to provide a noise barrier was subject to the requirement that that would provide a significant degree of relief to a substantial number of properties. It also had to be feasible to erect a barrier within the existing highway boundary as there was no provision for acquiring extra land.

Subsequently, the power to provide measures to mitigate the adverse effects of highway construction was included in the Highways Act 1980. In applying that power to new road construction, it was extended to include a power to acquire additional land on which to construct such measures. That has allowed a much wider view to be taken of mitigating environmental impacts, but the effectiveness of mitigation has always been measured against the number of properties that would otherwise need to be insulated under the Noise Insulation Regulations.

That power has been exercised only in very particular circumstances to provide an additional noise barrier alongside roads built since 17 October 1969. For example, additional noise barriers were placed on the A27 Havant-Chichester route, which was opened in 1988. That was possible because the Noise Insulation Regulations had been revised in that year and specifically provided an allowance for differences between road surfaces. The change meant that a significant number of properties became eligible for statutory noise insulation and it was considered appropriate to provide additional noise barriers instead.

In other cases, barriers have been erected after the road was opened only when the cost has been met by a third party. That has usually been as a consequence of a planning condition attached to residential development. Noise barriers have been provided at the expense of the developer to protect properties, which would otherwise not have been permitted.

This is quite a complicated matter and I have described the provisions of the legislation at some length. In summary, the exercise of discretion to provide noise barriers relates to roads built or improved after October 1969 – where a developer or other interested party is prepared to cover all costs – and roads that have not been improved since October 1969 where it can be shown that barriers would provide a significant benefit to a sufficient number of properties suffering unduly from traffic noise.

I understand the argument presented by the right hon. Gentleman that the effects of increased traffic on the sec-

tion of the M20 to which he referred make his constituents a special case. I am sure that he would acknowledge, however, that there are many sites around the country that are similarly affected by increased traffic noise, both from motorways and within towns.

To consider all those deserving cases equitably would involve substantial costs, even within the existing legislation. There is the issue of whether the public purse should provide benefits in kind to owners of property who either bought at a price reflecting its location relative to the motorway or received compensation when the motorway was first built, to offset the anticipated effect on the value of the property.

When a trunk road is planned to be constructed or improved, an assessment of its environmental impacts and the potential benefits of various types of mitigation takes into account the volume of traffic expected to be using it 15 years after the scheme is first open to the public. I acknowledge that one of the most important concerns discussed at the public inquiry into the proposals to widen the M20 between junctions 3 and 5 was the impact of traffic noise on the surrounding area.

I am aware that the inspector strongly supported the use of porous asphalt, as well as the proposed noise barriers, to reduce the adverse effects. But those measures were discussed in relation to the longer-term effect of the widening proposals.

The right hon. Gentleman was scathing in his criticism of the proposals to widen the M20 and their subsequent withdrawal. However, the draft statutory orders for the acquisition of a small amount of land, mainly needed to provide for additional mitigation measures, were not confirmed. That allowed the local planning authority the freedom to permit development on the land, and released previously blighted properties back on to the market.

I understand the intense disappointment that the right hon. Gentleman's constituents must have felt having been offered some prospect of relief by those widening proposals from the apparently inexorable increase in noise from traffic on the section of the M20 between junctions 3 and 5.

I have to say that the purpose of the mitigation then on offer was essentially to offset the anticipated effect of the widening. However, the assessment of noise impacts arising from the proposals used the updated method of assessing noise levels, which takes account of the type of road surface. It is likely that the original concrete surface and the subsequent surface dressing would probably not have been as quiet as they now can be with the use of modern construction methods.

The right hon. Gentleman referred to the seemingly inexorable increase in road traffic. The Government are committed to developing an integrated transport policy, and the upward trend in traffic growth will be re-examined. For the moment, I must ask the right hon. Gentleman to be patient until the appropriate maintenance programme for that section of the M20 is decided. I have taken careful note of his question and I will certainly ask my officials to respond to it as speedily as possible.

I can assure the right hon. Gentleman that due consideration will be given to noise when the time comes to renew the surface. The technology involved is moving very rapidly and, when the time comes, whatever form of surfacing is provided should noticeably reduce traffic noise. The resurfacing of the M20 will be determined when an engineering assessment of the existing surface has been done. It is planned for this year and I repeat that I will ask my officials to respond as quickly as possible to the matter.

I referred earlier to the inspector's belief that porous asphalt could have helped in resurfacing. However, the extra costs for that are no more justifiable than those of noise barriers. It is many times more expensive to put down than other forms of surface and involves extra costs if used on existing roads because drainage arrangements have to be modified. It is more expensive to maintain the surface free of ice in winter.

11 July 1997

Traffic Noise

Mr Hunter: To ask the Secretary of State for the Environment, Transport and the Regions what is his policy for reducing the noise of traffic on motorways and trunk roads which pass through residential areas; and if he will make funds available for noise-reducing programmes.

Ms Glenda Jackson: The policy towards the mitigation of the noise of traffic on motorways and trunk roads near to residential properties derives from the Land Compensation Act 1973 and the associated Noise Insulation Regulations. On roads or motorways constructed or improved since 17 October 1969, appropriate measures to mitigate the impact of traffic noise have been provided and owners of affected properties have been able to claim additional compensation for the consequential lowering of the value of their property. It is not our policy to provide further measures to reduce the noise of traffic on trunk roads and motorways after the works have been completed and there are no plans to allocate funds for this purpose. In exceptional cases, where a trunk road was built before 17 October 1969 and not subsequently improved, noise barriers have been provided where it could be shown that these would be a feasible and cost-effective alternative to noise insulation of a significant number of affected properties, had that option been available.

18 July 1997

Soundproofing

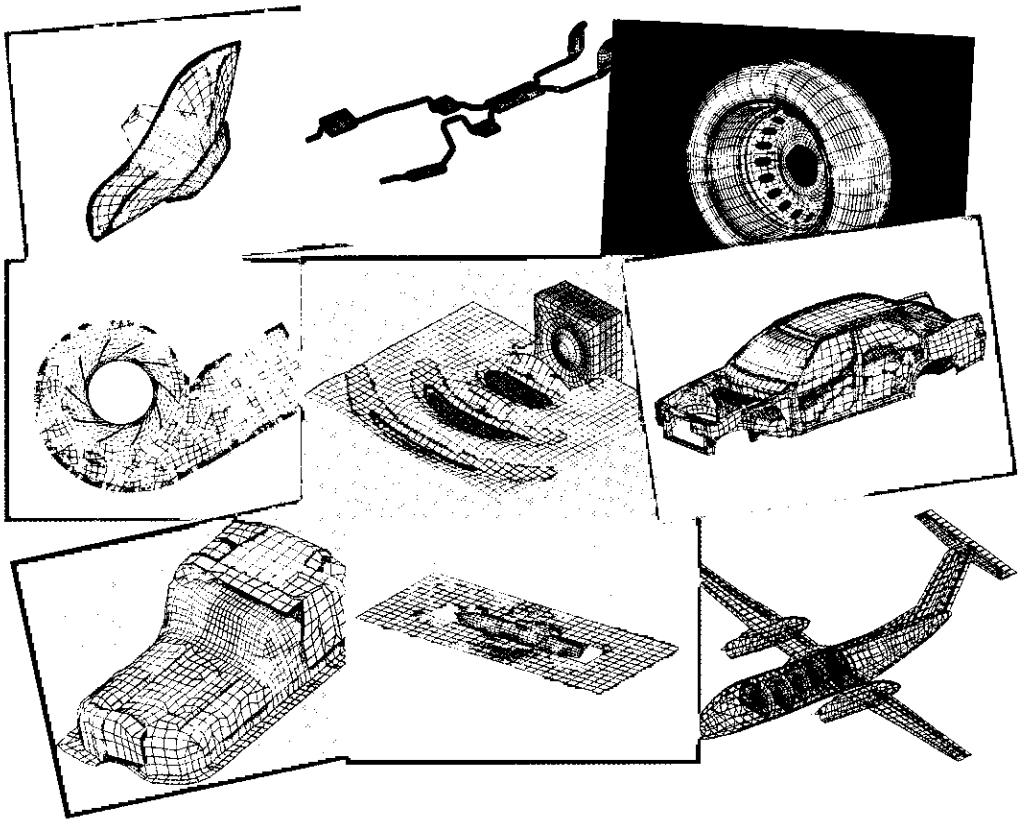
Mr Sanders: To ask the Secretary of State for the Environment, Transport and the Regions if he will review the building regulations in order to improve soundproofing; and if he will make a statement.

Mr Raynsford: Each part of the Building Regulations is kept under review and revised when the need is identified and adequate technical solutions are available. The Building Regulations Advisory Committee has advised the Department that there is a need to revise and strengthen Part E – Resistance to the passage of sound, and my officials have begun a review of the options available. Any changes made will draw on the results of research when this is completed.

Extracts provided by Rupert Taylor FIOA.

From Structural Response to Acoustic Control

5.3



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- Interior cabin noise modeling
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- Passenger comfort during long-duration space flights
- Airport noise mapping

Underwater acousticians

- Submarine and ship hull radiation
- Propeller noise modeling
- Interaction of sound waves with structures
- Sonar design and transducer modeling

Electrical engineers

- Transformer noise modeling
- Environmental impact of powerplants
- Turbine hall layout

Audio designers

- Loudspeaker radiation pattern
- Concert hall and sound studio acoustic modeling
- Design of electro-acoustic enclosures

Appliance manufacturers

- Modeling of compressor and blower noise
- Case radiation analysis
- Positioning of sound absorption material

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LMS NUMERICAL TECHNOLOGIES

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BSI News

New and Revised British Standards

BS 6955: Methods for calibration of vibration and shock pick-ups.

BS 6955: Part 20: 1997 Primary vibration calibration by the reciprocity method. Specifies the instrumentation and procedure to be used for the primary calibration of accelerometers using the reciprocity method. No current standard is superseded.

BS 6955: Part 22: 1997 Acceleration resonance testing – General methods. Lays down detailed specifications for the instrumentation and procedures to be used for accelerometer resonance testing. Applies to rectilinear accelerometers of the piezoresistive, piezoelectric and variable capacitance types in the frequency range 50 Hz to 200 Hz. No current standard is superseded.

Draft British Standards for public comment (for information only)

97/207294 DC (IEC 61669) Equipment for the measurement of real-ear characteristics of hearing aids (Possible new British Standard) (IEC 29/368/CD)

97/709056 DC (ISO 14509) Small craft – Measurement of sound pressure level of airborne sound emitted by motor craft (ISO/DIS 14509)

BS EN Publications

The following are British Standard implementations of the English language versions of European Standards (ENs). BSI has an obligation to publish all ENs and withdraw any conflicting British Standards (BSs) or parts of BSs. This has led to a series of standards (BS ENs) using the EN number.

BS EN 352: Hearing protectors: Safety requirements and testing

BS EN 352-3: 1997 Ear-muffs attached to an industrial safety helmet. Specifies constructional, design and performance requirements, test methods, marking requirements and user information for ear-muffs when fitted to an industrial safety helmet. No current standard is superseded.

BS EN 61240: Piezoelectric devices – Preparation of outline drawings of surface mounted devices (SMD) for frequency control and selection – General rules. Sets out general rules for drawing all dimensional and geometrical characteristics of a surface mounted piezoelectric device package. No current standard is superseded.

EN ISOs

The following International standards have been adopted as ENs.

EN ISO 266: 1997 Acoustics – Preferred frequencies (ISO 266: 1997).

EN ISO 11200: Acoustics – Noise emitted by machinery and equipment – Guidelines for the use of basic standards for the determination of emission sound pressure levels at a work station and at other specified positions. Corrigendum: April 1997 to EN ISO 11200: 1995

EN ISO 11201: Acoustics – Noise emitted by machinery and equipment – Measurement of emission sound pressure levels at a work station and at other specified positions – Engineering method in an essentially free field over a reflecting plane (ISO 11201: 1995) Corrigendum: April 1997 to EN ISO 11201: 1995

EN ISO 11202: Acoustics – Noise emitted by machinery and equipment – Measurement of emission sound pressure levels at a work station and at other specified positions – Survey method in situ (ISO 11201: 1995) Corrigendum: April 1997 to EN ISO 11202: 1996

EN ISO 11204: Acoustics – Noise emitted by machinery and equipment – Measurement of emission sound pressure levels at a work station and at other specified positions – Method requiring environmental corrections. Corrigendum: April 1997 to EN ISO 11204: 1995 (ISO 112904: 1995)

EN ISO 354: Acoustics – Measurement of sound absorption in a reverberation room Amendment A1: 1997 to EN ISO 354: 1993. Test specimen mountings for sound absorption tests (ISO 354: 1985/AMD 1: 1997)

EN ISO 12001: Acoustics – Noise emitted by machinery and equipment – Rules for the drafting and presentation of a noise test code. Corrigendum: May 1997 to EN ISO 12001: 1996.

CEN European Standards

The document listed below is now available as an advanced warning copy of the BE EN implementation.

EN 12001: Acoustics – Noise emitted by machinery and equipment. Rules for the drafting and presentation of a noise test code. Corrigendum: May 1997 to EN ISO 12001: 1996.

ISO Standards

ISO 2631-1: 1997 Mechanical vibration and shock – Evaluation of human exposure to whole-body vibration – Part 1: General requirements. Implementation as a British Standard under consideration.

ISO 5805: 1997 (edition 2) Mechanical vibration and shock – Human exposure – Vocabulary. Implementation as a British standard under consideration.

ISO 354: Acoustics – Measurement of sound absorption in a reverberation room. Amendment 1: 1997 to ISO 354: 1985. Test specimen mountings for sound absorption tests. Will be implemented as an amendment to BS EN 20354: 1993 in the form of BS EN ISO 354.

ISO 9612: 1997 Acoustics – Guidelines for the measurement and assessment of exposure to noise in a working environment. Will not be implemented as a British Standard as the UK does not agree with the technical content.

International New Work Started

ISO 226-2 Acoustics – Equal loudness level contours for otologically normal listeners – Part 2: Equal-loudness level contours at higher levels. Will revise ISO 226-2

ISO 7029 Acoustics – Statistical distribution for threshold of hearing by air conduction as a function of age and sex for otologically normal populations. Will revise ISO 7029.

ISO 389-5 Acoustics – Reference zero for the calibration of audiometric equipment – Part 5: Reference equivalent

threshold sound pressure levels for pure tones in the frequency range 8 kHz to 16 kHz
ISO 2041 Vibration and shock – Vocabulary – Bilingual edition. Will amend ISO 2041.
ISO 2631-2 Vibration and shock – Evaluation of human exposure to whole-body vibration – Part 2: Continuous and shock induced vibrations in buildings (1-80 Hz). Will revise ISO2631-2.
ISO 5347 Methods for the calibration of vibration and shock pick-ups: Part 3: Secondary vibration calibration. Part 23: Primary shock calibration using laser interferometry.
ISO 8041 Characteristics of instrumentation for measurement of whole-body vibration. Will revise ISO 8041.
ISO 8568 Mechanical vibration and shock – Shock testing machines – Characteristics and performance. Will revise ISO 8568.
ISO 13090-2 Mechanical vibration and shock – Guidance on safety aspects of tests and experiments with people – Part 2: Exposure to impact.
ISO 11549 Technical aids for blind and visually impaired persons – Acoustic signals for traffic lights.
IEC 60704-2 (IEC 704-2) Test code for the determination of airborne acoustical noise emitted by household and similar electrical appliances – Part 2: Particular requirements: Section 2-2: Forced draught convection heaters. Will revise IEC 704-2-2. Section 2-5: Room heaters of the storage type. Will revise IEC 704-2-5.
ISO 11688-2 Acoustics – Recommended practice for the design of low noise machinery and equipment – Part 2: Introduction into physics of low noise design.
ISO 11690-3 Acoustics – Recommended practice for the design of low-noise work places containing machinery – Part 3: Sound propagation and noise prediction in workrooms.
ISO 13474 Impulse sound propagation for environmental noise assessment.
ISO 14257 Acoustical performance of workrooms – Measurements of spatial sound distribution curves and related descriptors.
ISO 15667 Acoustics – Guidelines for noise control by enclosures and cabins.
ISO 9052-2 Acoustics – Determination of dynamic stiffness – Part 2: Materials used for vibration and sound insulation of equipment in buildings.
ISO 10048 Measurement of flanking transmission in the laboratory and the field.
ISO 14837 Mechanical vibration – Prediction of vibration from underground railways.
ISO 15229 Mechanical vibration and shock – Evaluation of repetitive shocks affecting the whole body.
ISO 8525 Measurement of noise of metal cutting machines.
ISO 10791 Test conditions of machining centres: Part 11: Evaluation of noise emission. Part 12: Evaluation of vibration severity.
ISO 13045 Machine tools – Airborne noise of high speed mechanical and hydraulic presses.

Additional Item

DISC PD 2000-1 A Definition of Year 2000 Conformity Requirements

Introduction
This document addresses what is commonly known as Year 2000 conformity (also sometimes known as century or millenium compliance). It provides a definition of this expression and requirements that must be satisfied in equipment and products which use dates and times.
It has been prepared by British Standards Institution committee BDD/1/-/3 in response to demand from UK industry, commerce and the public sector.
The Definition
Year 2000 conformity shall mean that neither performance nor functionality is affected by dates prior to, during and after the year 2000.
In particular:
Rule 1. No value for currant date will cause any interruption in operation.
Rule 2. Date-based functionality must behave consistently for dates prior to, during and after year 2000.
Rule 3. In all interfaces and data storage, the century in any date must be specified either explicitly or by unambiguous algorithms or inferencing rules.
Rule 4. Year 2000 must be recognised as a leap year.

A full copy of this document can be downloaded from the DISC web site at: http://www.brainstorm.co.uk/reg/DISC or for further information telephone BSI Information on 0181 996 7111 or Fax DISC on 0181 996 7448.

This information, provided by John W Tyler FIOA was announced in the June & July issues of BSI News. ❖

YOUR PROFESSION NEEDS YOU

Mike Heath, Director General, the Engineering Council

The new network of 15 Professional Engineering Institutions (PEIs) throughout the UK presents individual engineers with a golden opportunity to have a direct influence on how the public, particularly schoolchildren and students, perceive engineering.

The profession needs more role models and ambassadors to promote its successes and engineers are the most valuable asset we have in this respect.

Although the public may not be considered a key point of contact in everyday work, all engineers have 'customers' and, in many cases, the client is an organisation or individual outside the profession.

Proportionally fewer engineers now work in what was generally perceived as 'industry,' but are often now in jobs giving greater contact with a wider public. This, of course, presents more opportunities to deal with people of influence in the community, within trade sectors or other professions.

A major concern for engineers is the status of the profession in the eyes of the public and how its image can be transformed. This is a challenge not only for the Engineering Council, the Institutions and the wider engineering community but, primarily, for individuals. The personal commitment of engineers themselves can do a lot to reinforce the effort being directed into successful headline campaigns such as the current 'Year of Engineering Success.'

I hope you would agree that it is a mistake to 'talk down' the profession. Potentially the best ambassadors for engineering are, naturally, engineers themselves, so I suggest that enthusiasm for your work and pride in achievement should be a stimulus to promote exciting achievements at every opportunity.

This means exploring all outlets for increasing awareness of the profession. Many thousands of registered professional engineers work voluntarily with programmes and campaigns involving children and young people. This is excellent work, which humanises engineering and gives a 'face' to members of a profession which, through occupational circumstances, tends to operate out of the spotlight.

An involvement in community affairs as, for example, a school governor or residents' association leader, can be an ideal opportunity to demonstrate that the thought processes we use in solving engineering problems can be applied to other issues. I hope that all of you who carry out voluntary work of any kind ensure that everybody you work with knows your profession – and that you are proud to be part of it.

The newly established PEI network is the perfect route through which the enthusiasm and commitment of all engineers can be channelled in the joint venture projects of the Institutions.

This new regional structure for the profession will eliminate the duplication of effort and waste of resource which previously hindered implementation of a cohesive strategy for the promotion of engineering. The PEIs should not become just 'talking shops' or bureaucracies with few visible signs of achievement. They must be outward looking and dynamic organisations working towards cultural change through inspired leadership and enthusiastic support.

The effectiveness of that support is very much down to the motivation of the individual engineer. It is essential that a climate is created in which both established activities and new initiatives can benefit from the contributions of people with fresh ideas. We want to see more young engineers and more women reinforcing the sterling work of the current activists.

Engineers have the power to influence a host of issues – from local services infrastructure to matters of national concern, such as the environment. It is crucial that the views of engineers, through the PEIs, should be heard by as wide an audience as possible. The Council is providing professional public relations support to the regions in order to ensure that this happens.

Activity in the English regions and Scotland, Wales and Northern Ireland, is an essential reinforcement for national initiatives and programmes. The profession's aims and objectives have powerful support nationally in Government, industry and academia but the public's perception of these initiatives depends to a great degree on the success of the regional organisation. To a large extent the PEIs are the front line in the battle to change the national culture.

Clearly, the message is – your profession needs you!

New Products

ALLAWAY ACOUSTICS LTD

Steel Spring Mounts

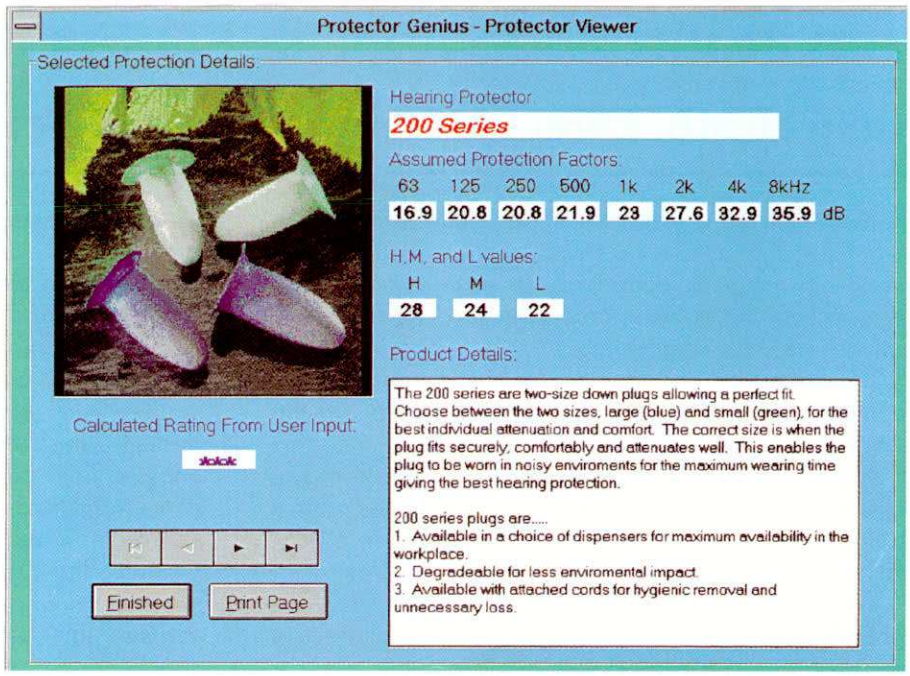
Allaway Acoustics has introduced an extended range of spring mounts, designed to prevent vibration from equipment being transmitted to buildings and structures. Unlike traditional rubber blocks and mounts, the new products incorporate high deflection steel springs and high-frequency isolation pads and grommets to deliver significantly improved vibration isolation.

The new range encompasses a total of 48 different mounts, from light duty models to double-spring units capable of supporting and damping over two tonnes apiece. Typical applications include the isolation of pumps, air handling units, generators, cooling systems and industrial machinery. Equipment can either be fitted to inertia bases supported by spring mounts, or attached direct.

The springs are colour-coded in stoved polyester and fittings are cadmium plated. Vertical natural frequencies of the mounts lie between 1.5 Hz and 5 Hz under all recommended loads. Options available include base plates for floor fixing and studs for bolting to steelwork.

Manufactured at the company's advanced facilities in Thetford, expert advice on optimum application of the new products is available via a team of qualified, industry-experienced engineers.

Enquiries to Jim Grieves, Allaway Acoustics, The Old Police Station, 1 Queens Road, Hertford SG14 1EN Tel: 01992 550825 Fax: 01992 554982.



PC Screen from SJK Scientifics' Hearing Protector Suitability Software

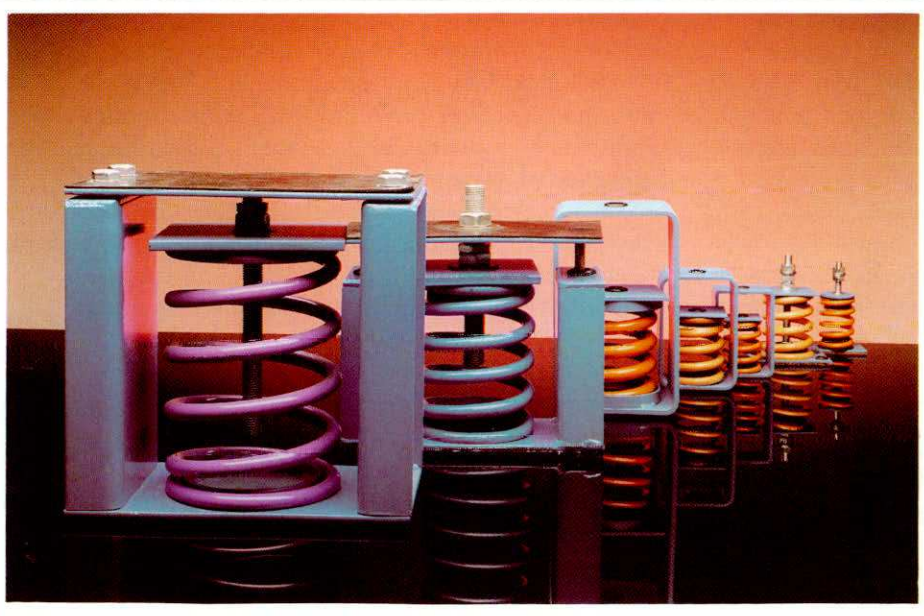
SJK SCIENTIFICS LTD

Simple Hearing Protector Suitability Check

SJK Scientifics is now offering software which allows the user to calculate the effectiveness of hearing protection in a given noise environment. It is simple to run under Windows. The user can enter noise data either as traditional Octave Bands, or as 'A-' or 'C-' weighted values for the new, easy-to-use and effective HML method. Both techniques are approved under current European and British Standards.

The program runs on any PC and uses noise data to rate a data bank of approximately 30 hearing protector specifications. It tells which are acoustically acceptable and which are unacceptable. It also gives details about the selected protector, including pictures.

For further information contact: Dr Stephen Karmy, SJK Scientifics, Epsilon House, University Research Park, Chilworth, Southampton SO1 7NS Tel: 01703 767954 Fax: 01703 767293



Allaway Acoustics' Steel Spring Mounts

CIRRUS RESEARCH plc

Precision Sound Level Meter for Environmental and Industrial Noise

The CR:703B is a Dual Range Type 1 Sound Level Meter to BS EN 60651 and BS EN 60804, with data logging capability, designed to meet the requirements of most Industrial and Environmental measurement standards.

The instrument can store up to

2,500 Events, and up to 100,000 Time History elements. Each Event measured has associated with it different measurement parameters, and the default functions include L_{eq}, Peak, L_{max}, L_{min}, SEL and 3 user defined L_ns. The duration of the time history elements can be adjusted to give different resolutions and measurement durations.

The 700Setup for Windows download and configuration software is supplied as standard, allowing the instrument to be programmed to store different parameters, as well as defining automatic Event measurements. Additional software is available for detailed analysis of download time history data, as well as special software packages for different applications. The 700Setup for Windows is also available for existing users of the CR:700 Instruments.

For further details, contact James Tingay, Cirrus Research plc, Acoustic House, Bridlington Road, Hunmanby, North Yorkshire YO14 0PH Tel: 01723 891655 Fax: 01723 891742

Cirrus Research is a Key Sponsor of the Institute.

GRACEY & ASSOCIATES

New Norsonic software suite for acoustics applications

A new range of acoustic software has been announced by Norsonic to complement their instrumentation. It comprises a number of independent windows 95 programmes designed to provide both control and post processing environments for the most popular acoustic applications.

WIN-SIC: Provides a comprehensive post processing environment for building acoustics measurements. It will produce the full range of sound insulation calculations to all the frequently used National and International Standards. From the input data the necessary spatial averaging is undertaken on the source and receive room spectra as well as the RT_{60} data and the information processed through to the final calculation of single number ratings such as the D_{nTw}. The report generator provides a print out that is in the exact format recommended in the Standards with the ability to paste in the logo and other information relating to the test house etc.

CONTROL-SIC: A companion programme for use with NOR-SIC that will control a NOR-840 Real Time Analyser to form a fully automated building acoustics measurement and analysis system.

NOR-RAC: The full range of subjective rating parameters such as clarity index, early energy fraction etc set out in ISO-3382 are produced by the Room Acoustics Calculation package.

NOR-POWER: This package guides the user through the complex procedures involved in the calculation of sound power levels based on sound level measurements. From the input of the levels in each third octave band, along with the dimensions of the source and measurement surface all the calculations are performed to the selected standard and the report printed.

NOR-MONIT: Allows a number of standard sound level meters to be controlled over modem links to form an area noise monitoring system. The concept allows for a high degree of flexibility in the configuration to allow applications as diverse as airport and construction sites to be monitored. In addition to noise levels, meteorological stations may also be linked into the system and the weather data incorporated into the reports. Reports may be generated at any time and include both time and event based information, it is also possible to put the system into a sound level mode to allow the SPL at any of the remote stations to be logged.

NOR-LOUD: Loudness ratings in both Sones and Phons are computed from the input data.

NOR-ISO:3882: Evaluates the noise levels from water and sanitary installations in accordance with British Standard 6864.

Demonstration copies of a number of these programmes are available on request from Gracey & Associates or Norsonic.

New sound intensity probes from GRAS

The GRAS-50AI probe is well established as one of the leading p-p devices for the measurement of sound intensity levels. The technology that allows the very accurate phase matching to be achieved has now been developed further to allow sets of four and six microphones to be produced. As a result broad band and vector probes have now been introduced.

Broad band probe GRAS-50Vic: This is based on a set of four phase and sensitivity matched microphones that are assembled in a linear array with 50, 25 and 12 mm spacers and as such can cover the complete audio band width in one measurement.

Vector probe GRAS-50Vic: Within this probe there are three pairs of phase matched microphones assembled at 90° to each other. This allows the x, y and z components of a sound field to be measured at the same time.

Both of these probes have been commissioned for specific research projects and represent the advanced transducer engineering that is available from GRAS.

For further details on these products contact Gracey & Associates, High Street, Chelveston, Northants NN9 6AS Tel: 01933 624212 Fax: 01933 624608.

Gracey & Associates is a Sponsoring Organisation of the Institute.

CEL INSTRUMENTS LTD

Hand Arm Vibration Meter

Compensation claims for vibration white finger and other ailments from long-term exposure to vibration are rising.

The new CEL 90259 hand arm vibration meter from CEL Instruments enables assessments to be made of the potential hazard of vibration and to take pre-emptive action to head off litigation.

This new addition to the CEL range, conforming to ISO 8041 and ISO 5349, is a lightweight handheld instrument offering both instantaneous vibration levels and the equivalent 8-hour exposure. It allows 7 separate vibration measurements to be collected in each run then gives the user options to enter exposure time for all relevant measurements to give an overall daily

(8hr) dose level. Graphic profiling of measurement runs is also possible.

Automatic data storage is provided to the meter's on-board memory which is capable of saving up to 99 measurement runs and this data can be output to printers or PC's.

For further details: CEL Instruments Limited, 35-37 Bury Mead Road, Hitchin, Herts SG5 1RT Tel: 01462 422411 Fax: 01462 422511 Email: sales@cel.ltd.uk

CEL Instruments is a Key Sponsor of the Institute.

ACSOFT LTD

Spectra SOFtest

AcSoft has concluded a distribution agreement with Sound Technology of California. As a result, AcSoft introduces into the UK Sound Technology's Spectra SOFtest Series of powerful sound and vibration analysis products.

Spectra SOFtest keeps the costs down by running with any Windows sound card to transform the PC into a high-performance analysis system. All versions of Spectra SOFtest include versatile signal generator capabilities.

Spectra SOFtest packages are designed to take advantage of 32-bit Windows 95 and NT, and to make full use of multimedia. They will also work with other Windows versions with extension software.

The four packages offered by Acsoft span a wide range of applications. SpectraRTA is a good starting point for studio and pro-audio applications, and for electro-acoustic applications with distortion measurements available as an add-on.

SpectraPLUS, SpectraPRO and SpectraLAB packages offer progressively more sophisticated facilities for industrial applications. Ultimately the software provides all the features of a high end analyser, such as fast high-res FFT, phase, spectrogram and waterfall plots, and so on. Calibration for engineering transducers is built in.

The systems are easy to use and upgrade. Naturally performance depends on the quality of the hardware. AcSoft can help by offering total solutions, with support for a wide range of analogue and digital interfaces.

For further information contact: John Shelton, AcSoft Ltd, 6 Church Lane, Cheddington, Leighton Buzzard LU7 0RU Tel: 01296 662852 Fax: 01296 661400

AcSoft is a Sponsoring Organisation of the Institute.

LMS NUMERICAL TECHNOLOGIES

RAYNOISE Revision 3.0

LMS Numerical Technologies has announced the release of RAYNOISE Revision 3.0, the program for acoustic modelling of interior and exterior sound using ray/beam tracing methods.

The program adds many new features to the existing, well-proven methods of previous versions, including:

- a fully-inter-active, menu-driven system, with automatic updating, of the model display
- advanced, interactive graphics (derived from LMS's SYSNOISE program)
- phase ray tracing, with multiple coherent and incoherent sources
- panel sources for easy definition of noise radiation from structures
- variable, frequency-dependent, source directivities
- panel transmission properties, enabling calculation of noise break-in/-out in one single model, with multiple acoustic domains (exterior, one or more interior)
- wall diffusion using multiple-order combined reflection and diffusion enhanced frequency-dependent diffraction algorithms
- general frequency selection, with results presented in $^1/_1$ or $^1/_3$ octave or narrow bands
- results for SPLs, acoustic quality (clarity, definition, lateral efficiency) and RT (with very rapid statistical calculation of position-independent RT)
- latest methods for speech inteference (STI)
- desk-top auralisation, with binaural stereo signals synthesised using room impulse responses and head-related transfer functions

The new features are implemented in a multi-model environment for data and results management, making RAYNOISE an even more powerful acoustic modelling system.

Contact the following for more information: Dynamic Structures & Systems Ltd, Aizlewood's Mill, Nursery Street, Sheffield S3 8GG Tel: 0114 282 3141 Fax: 0114 282 3150 email: DSSL@aol.com

News

KEMO LTD

Internet filter selection guide

Kemo Ltd, the Beckenham-based manufacturer of electronic filters and signal-conditioning systems, has opened a web site containing a complete filter selection guide.

In addition to giving information on all the various filters produced by Kemo, the site will contain full application guidelines, covering the need for filters and how to choose the best filter for a particular task.

Products listed, with full technical specifications and applications data, include benchtop filters, manually adjustable and computer-controlled multi-channel variable filters, OEM filter modules, board-level products, and computer chassis mounted systems.

A glossary of filter terms and definitions is also provided.

Filter reference guide can be found at http://www.kemo.com

ECOMAX ACOUSTICS

Tufsound acoustic panelling

Tufsound acoustic panelling, supplied and installed by Ecomax Acoustics Limited, has been used as a roof lining to solve severe noise problems caused by traffic using the busy Beech Street road tunnel in Central London.

Located near the Barbican Centre, the tunnel carries a heavy flow of traffic 24 hours a day. The structure's original sound reflective walls and roof created a build up of reverberant noise which caused considerable problems to nearby residents. In 1996, plans to refurbish the tunnel were formed. The refurbishment project aimed to improve not only the general appearance

and lighting of the tunnel but also to reduce these excessive noise levels. As a result, engineering consultants to the City of London, W S Atkins Consultants Ltd, awarded a £237,000 contract to noise control specialist, Ecomax Acoustics.

The specific requirements of this application were met by Ecomax Acoustics' Tufsound acoustic panelling. Comprising a mineral wool sound absorbent core and perforated steel outer facing, robust Tufsound panelling has been designed to provide high acoustic performance in harsh conditions. Tufsound is unaffected by rapid air movement and its heavy duty surface allows regular steam cleaning thereby making it ideal for specification in polluted environments such as the road tunnel. As a sound absorbing lining for the soffit, Tufsound panels also proved æsthetically suitable and were compatible with a new lighting system being installed.

With the tunnel situated on a busy main road, the installation had to be completed quickly to minimise disruption to traffic. Close liaison between Ecomax Acoustics and other contractors involved in the refurbishment project ensured that the entire operation was completed efficiently and without severe inconvenience to road users.

For further information contact Ecomax Acoustics Ltd, Gomm Road, High Wycombe, Bucks HP13 7DJ Tel: 01494 436345 Fax: 01494 465274

Tufsound Acoustic panelling used at Beech Street road tunnel

SOUND ATTENUATORS LTD

Sound Tuning Equipment for Jordan Television

The Jordan Radio and Television facilities at Amman, Jordan, which are now being completed, represent a major step forward for this country and its broadcast medium. Sound Attenuators have supplied approximately £250,000 worth of equipment to this site.

Some years ago Sound Attenuators developed a complete range of Studio Tuners, each with a different acoustic response which could be used in a 'mix and match' situation to give precisely the studio reverberation time required. These Studio Tuners are used on the walls and ceilings of studios and control rooms in which specific reverberation times are required in each of the octave bands.

Of particular interest was the very large Music Studio where the designer wanted to optimise the reverberation times to cater for different music styles. This was achieved by using the Studio Tuners to cover a large proportion of the wall and ceiling areas but with the addition of a variable response system which can modify the reverberation time to suit the different music being played.

Sound Attenuators also supplied timber acoustic doors for the Studio and Control areas. The Plant Rooms had the Kinetic floating floor system located beneath them and all access was via steel acoustic doors.

For further information, contact: Sound Attenuators Ltd, Eastgates, Colchester, Essex CO1 2TW Tel: 01206 866911 Fax: 01206 865987

Sound Attenuators are part of the Salex Group which is a sponsoring organisation of the Institute.

ALLAWAY ACOUSTICS

Acoustics and the Crown Jewels

Noise and vibration control specialist Allaway Acoustics has helped to create a suitable environment for the Crown Jewels, by supplying a large number of noise attenuators for the refurbished Jewel House at the Tower of London. To overcome space restrictions the company had to manufacture the attenuators, which minimise noise from conditioned air systems that supply exhibition areas, sealed jewel display cases and a theatre, in multiple sections. M & E contractor SES was then able to assemble the units within the roof space, on-site. Consulting engineer for the project was Oscar Faber.

Enquiries to: Jim Grieves, Allaway Acoustics, The Old Police Station, 1 Queens Road, Hertford SG14 1EN Tel: 01992 550825, Fax: 01992 554982

INDUSTRIAL ACOUSTICS COMPANY

Rooms For Listening

Pictured here are two listening rooms, constructed by Industrial Acoustics Company (IAC) for Addison Wesley Longman at Harlow in Essex. Designed by Sam Wise, these special soundproof rooms are used in the preparation and review of audio material produced for worldwide sale on audio cassette and CD by this international educational publisher. Objective checks of all recordings can only be undertaken effectively in the very quiet, acoustically controlled conditions provided by such rooms.

The rooms are of identical size, measuring 5.5 m x 4.8 m x 2.5 m high internally. The walls and ceilings were built from modular prefabricated 100 mm thick acoustic panels from IAC's Noishield range, which simply and rapidly join together to create complete acoustic structures. Isolation from structure-borne noise and vibration was achieved using concrete floating floors.

Both rooms have purpose-designed magnetic-seal acoustic doors which have 'porthole' style circular windows to match those found elsewhere in the building. Visual contact between the rooms is provided by a large quadruple-glazed acoustic window which has angled faces to cut down on acoustic reflections. Decorative wall finishes in sound-absorbing fabrics and fitted carpets further help to reduce reverberation

Further information from IAC Ltd, IAC House, Moorside Road, Winchester SO23 7US Tel: 01962 873000 Fax: 01962 873111.

BTR SILVERTOWN LTD

Bearings for new Seattle concert hall

BTR Silvertown has won a prestigious $500,000 contract to supply Andre elastomeric bearings for the vibration isolation of Seattle's new Benaroya Hall, due to open in September 1998.

The 310 Andre bearings will play a key role in the quest for optimal conditions for music performance and digital recording in the new concert hall. They consist of a sandwich of specially formulated natural rubber reinforced with bonded internal steel plates.

The bearings are installed above the below-ground parking garage situated beneath the building and the auditorium structure in order to reduce any external vibration that could be transmitted so as noise into the auditorium. In addition, as Seattle is situated in an earthquake zone, 240 similarly manufactured lateral bearings are required to anchor the building against lateral movement.

To achieve the exceptionally high standards of vibration isolation essential for this application, the load deflection characteristics of each bearing were individually specified by acoustic consultants Wilson Ihrig & Associates Inc, of California. This enabled BTR Silvertown's Andre division to formulate the composition of the rubber compound to have a specific isolation frequency band while maintaining a design life in excess of 100 years.

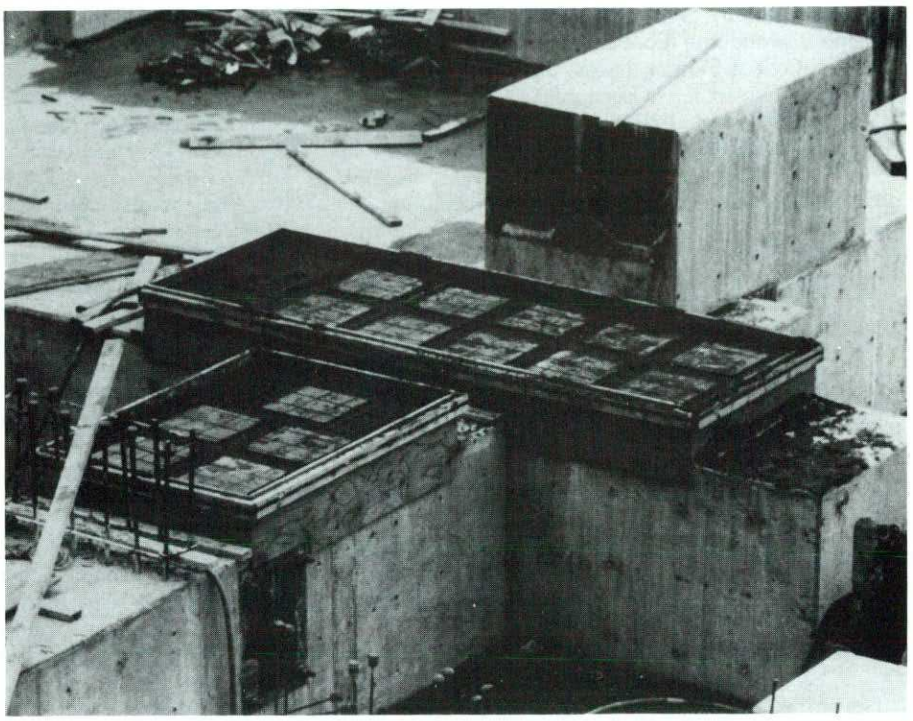
Benaroya Hall will provide the city and Seattle Symphony with two music performance venues with top quality acoustics. The project includes a main auditorium seating 2,500 people that is vibration isolated and a smaller Recital Hall seating 540. These will also be available for use by other groups for a variety of civic and musically based events.

The acoustics in the hall's rectangular main auditorium have been configured according to the same principles as the great traditional concert halls, such as the Boston Symphony's hall and the Grosser Musikvereinsaal in Vienna. The stage is set in an acoustic shell, reflecting sound both to the audience and the performers. The room's inner walls and ceiling are covered with complex plaster and wood panels to form multiple reflecting surfaces that diffuse sound throughout the space.

The Benaroya Hall was designed by architects Loschky, Marquardt & Nesholm of Seattle with Dr Cyril Harris of New York as the acoustical consultant.

BTR has supplied Andre bearings for several similar vibration isolation applications, including the Glasgow

One of the IAC listening rooms at Addison Wesley Longman



Andre elastomeric bearings at Seattle's new concert hall

Concert Hall and and the Birmingham International Convention Centre, both of which are built over railway tunnels as well as the recently completed Belfast Concert Hall.

Based in Burton on Trent, BTR Silvertown is part of the international BTR group and its Andre Division is approved to ISO 9002.

Further information from BTR Silvertown Ltd, Horninglow Road, Burton on Trent, Staffs DE13 0SN. Tel: 01283 510510 Fax: 01283 510052.

HEALTH AND SAFETY EXECUTIVE (HSE)

Quality Approval For Laboratory

The Health and Safety Laboratory (HSL) has been awarded the international quality standard ISO 9001.

An agency of the Health and Safety Executive (HSE), HSL adopted ISO 9001 to demonstrate the consistent quality of its work which includes investigating accidents and researching safer working practices.

Further information from: HSE Information Centre, Broad Lane, Sheffield, S3 7HQ Tel: 0541 545500.

BUILDING TEST CENTRE

New filing of laboratory reports

The Building Test Centre is installing a Canofile System, specifically designed for library reports and additional material of both a written or photographical nature.

For the last twenty years all Building Test Centre reports have been filed in hard copy, which provides a logistical nightmare to testing consultants when they have to find results in room upon room of filing cabinets (some reports can run to more than 80 pages).

The value of this investment is in terms of the hours that the new system will save the institution. The NAMAS accredited facility is in such demand from the construction industry that it has a long waiting list for testing space. By saving time on logistics, this will free man hours to meet demand.

The investment signals the start of a three month project to input all the hard copy clata, which can be easily scanned in. When test data is required it will then be able to be down loaded on to a PC or onto optical disk.

The Building Test Centre, a NAMAS/UKAS approved facility is located at British Gypsum's headquarters in East Leake, Loughborough and is one of Europe's most advanced testing centres for fire, structural and acoustic performance.

Further information from British Gypsum Ltd, East Leake, Loughborough LE12 6HX Tel: 0115 945 1000 Fax: 0115 945 1901.

People

SALFORD UNIVERSITY BUSINESS SERVICES LTD

Salford University Business Services Ltd (SUBS), the commercial arm of the University of Salford, has strengthened its thriving acoustics consultancy division with two key appointments, following Andy Turnbull's move to the University's NAMAS accredited acoustics laboratory as deputy manager.

Andrew Asbury and James Smith have joined SUBS as consultants, thus expanding the extent of SUBS' Health and Safety and Environmental work.

They will be directly involved in assisting businesses to achieve noise and emission control objectives to meet current and forthcoming legislation. Both Andrew Asbury and James Smith have a BEng in Electroacoustics from the University of Salford, together with a wide range of professional experience.

Items for inclusion in this section should be sent to John Sargent MIOA, Oak Tree House, 26 Stratford Way, Watford WD1 3DJ. ❖

Non-Institute Meetings

September 21–23, 1997: Product Sound Quality '97 (PSQ '97), Cape Cod, Massachusetts, USA
Contact: Richard H Lyon, R H Lyon Corp, 691 Concord Avenue, Cambridge, MA 02138, USA, Tel: 617 864 7260 Fax: 617 864 0779 e-mail: rhlyon@mit.edu

September 22–25, 1997: 5th European Conference on Speech Communication and Technology, EUROSPEECH 97, Patras, Greece
Contact: G Kokkinakis, Dept of Electrical and Computer Engineering, Univ of Patras, 26110 Rion-Patras, Greece Fax: +30 61 991 855, email: Eurospeech97 @wcl.ee.upatras.gr

September 23–26, 1997: Fluid-Structure Interaction in Acoustics, Delft, The Netherlands
Contact: Euromech Colloquium 369, A H P van der Gurgh, Faculty of Technical Mathematics and Informatics, University of Technology, PO Box 5031, NL-2600 GA Delft, The Netherlands e-mail: burgh@dv.twi.tudelft.nl

October 14–18, 1997: XVI Symposium of the International BioAcoustics Council (IBAC), College Station, Texas, USA
Contact: Center for Bioacoustics, Mail Stop 3367, Texas A&M Univ, College Station, TX 77843 Tel: 409 862 4254 Fax: 409847 9396 http://entcweb.tamu.edu/cfba/cfbahome.htm

October 19–22, 1997: IEEE 1997 Workshop on Applications of Signal Processing to Audio and Acoustics, New York, USA
Contact: Eric Lindemann, AudioLogic Inc, 6655 Lookout Road, Suite 200, Boulder, CO 80301, USA Tel: 303 581 9556 e-mail: eric@audiologic. com

November 5–7, 1997: XXIII Meeting of the Spanish Acoustical Society, TECNIACUSTICA '97, Oviedo, Spain
Contact: Spanish Acoustical Society, c/ Serrano 144, 28006 Madrid, Spain Tel: 341 561 88 06 Fax: 341 411 76 51 e-mail: ssantiago@ fresno.csic.es

November 19–21, 1997: WESTPRAC '97, (Western Pacific Region Acoustics Congress), Hong Kong
Contact: S K Tang, WESTPRAC Secretary, Department of Building Services Engineering, The Hong Kong Polytechnic University, Hong Kong Fax: +852 277 461 46 e-mail: besktang@polyu.edu.hk

December 1–5, 1997: 134th Meeting of the Acoustical Society of America, San Diego, CA, USA
Contact: M Pierucci, Dept of Aerospace Engineering and Engineering Mechanics, San Diego State Univ, San Diego, CA, USA Fax: +1 619 594 6005 e-mail: mpierucci @sciences.sdsu.edu

December 15–18, 1997: 5th International Congress on Sound and Vibration, Adelaide, Australia
Contact: ICSV5 Secretariat, Department of Mechanical Engineering, University of Adelaide, South Australia 5005, Australia Fax: +61 8 8303 4367 e-mail: icsv5@ mecheng.adelaide.edu.au

March 4–5, 1998: 4th Annual Conference of the Society of Acoustics (Singapore), Singapore
Contact: Dr W S Gan, Acoustical Services (1989) Pte Ltd, 209–212 Innovation Centre, NTU, Manyang Avenue, Singapore 639798, Republic of Singapore Tel: +65 7913242, Fax: +65 7913665 email: wsgan@singnet.com.sg

March 23–26, 1998: DAGA 98, Meeting of the German Acoustical Society, Zurich, Switzerland
Contact: German Acoustical Society DEGA Univ Oldenburg, Dept Physics/ Acoustics D-26111 Oldenburg Tel: +49 441 798 3572 Fax: +49 441 798 3698

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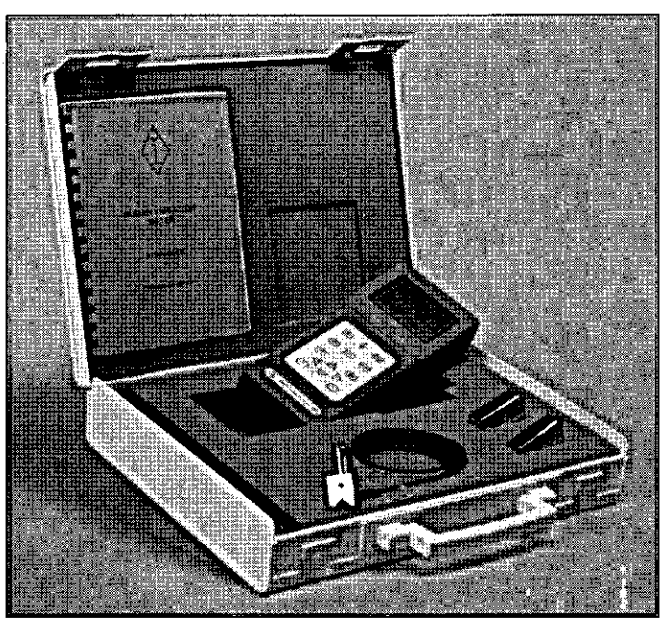

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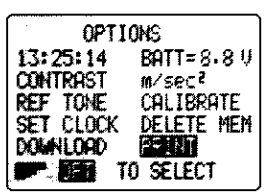

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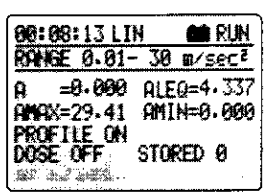

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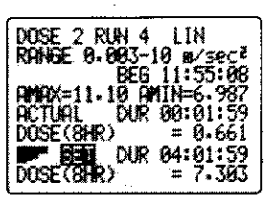

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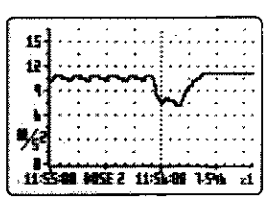

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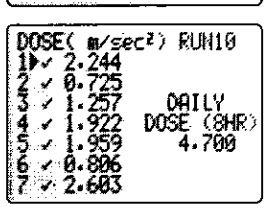

The result 'A 8' daily dose displayed on screen.

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