Institute of Acoustics

Contents

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Volume 24 No 5
September – October 1999

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Volume 24 No 5
September – October 1999

contents

Technical Contributions

Consultancy Spotlight

Acoustics of Yesteryear

Technical Note

The Acoustics World

Meetings and Conference Reports

Engineering Division

Obituaries

Publications

News from the Industry

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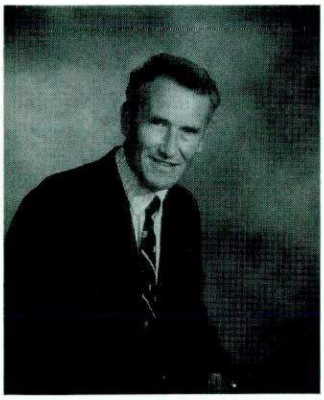


Dear Fellow Member

As we move into the Autumn, the life of the Institute starts to pick up a pace with new rounds of Committee sessions and of course our Meetings and Conference programme gets under way. This year we are moving to Stratford upon Avon as the venue for the Autumn Conference; with the new location we are developing the format by linking the Reproduced Sound and Environmental Conferences to allow more people to attend both. With the current interest in the environmental noise burden resulting from amplified music, there should be a strong cross interest in these conferences. Environmental Noise Issues for the New Millennium will run from Wednesday through to Friday with Reproduced Sound 15 picking up on Friday evening and running through to the Sunday; all the dates are in the blue pages. Specialist conferences are also being organised by the Building Acoustics and Underwater Acoustics Groups in the current season making it our most ambitious conference programme for a long time.

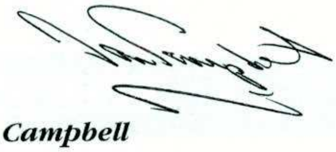
The one day meetings schedule is also continuing; there is a joint meeting of the Electroacoustics and Speech Groups dealing with speech intelligibility issues and the first meeting organised by the new Industrial Noise Group.

Our Certificate of Competence in Workplace Noise Assessment has been one of our most successful education programmes and is the route chosen by a majority of safety professionals to document their competence as required by the Noise at Work Regulations. We are building on this success with a meeting to review the working of UK legislation aimed at controlling noise in the workplace; if this is your area of specialisation we look forward to your contribution in Birmingham on the 13th November.

In addition to these national events it is encouraging to see that the branches have also full programmes of meetings. I have written before of my belief that it is the local branches that are the true roots of the Institute. I trust that you can continue to support your colleagues who are putting in the necessary effort to ensure that the IOA has a forum in all parts of the country.

I look forward to the prospect of seeing you at least at one of the events organised for this autumn and for now with kindest regards, I remain

Yours truly



Ian Campbell

PRESSURE TRANSIENTS GENERATED BY A HIGH-SPEED TRAIN

Michael Howe FIOA

Introduction

One of the most fascinating applications of classical acoustics is to the 'piston' problem of the generation of a compression wave when a high-speed train enters a tunnel. The train pushes aside the stationary air, most of which flows over the train and out of the tunnel portal, but the build-up of pressure just ahead of the train propagates into the tunnel as a compression wave at the speed of sound (Figure 1). The wave becomes of environmental concern at train speeds exceeding 200 kph, especially in tunnels longer than about 3 km with non-ballasted, modern concrete slab tracks, offering little dissipation to the wave, when nonlinear steepening can lead to a shock-like wavefront. The initial thickness of the wavefront ~ R/M where R is the tunnel entrance height and M is the train *Mach* number. The total pressure rise $\Delta p \sim \alpha \rho_0 U^2/(1 - M^2)$, where U is the train speed, ρ_0 is the mean air density, and α = train cross-section/tunnel cross-section is the *blockage*, which typically does not exceed about 0.2. At 200 kph the initial wave thickness is roughly 40 m and Δp is about 0.7% of atmospheric pressure, which is about six or seven times larger than the pressure jump at ground level across the sonic boom from *Concorde*. The new generation of 500 kph *Maglev* trains would generate wave amplitudes approaching 5% atmospheric pressure (5 kPa) with an initial wave thickness reduced to about 15 m if they were permitted to enter a tunnel at the maximum proposed operating speed.

Multiple reflections from the ends of the tunnel, from discontinuities such as changes in cross-sectional area, air shafts, side branches, etc, and from the nose and tail of the train can produce complicated interference patterns with locally intense pressure transients. The rapidly varying changes in pressure are frequently a source of serious discomfort to passengers in unsealed rail cars and to maintenance personnel in the tunnel. Nonlinear steepening not only increases the effective frequency of pressure fluctuations experienced during passage of the wave, but is also responsible for the emission from the tunnel of a strong pressure pulse, called the *micro-pressure wave* (see Figure 1), when the compression wave first arrives at the distant tunnel exit. Elementary acoustic theory shows that the amplitude of the pulse is approximately proportional to the maximum pressure gradient of the compression wavefront at the tunnel exit. Structural damage and severe personal annoyance were first attributed to strong micro-pressure waves in Japan in the 1970s with the introduction of high-speed trains. New high-speed routes typically require 30% or more of a journey to be within a tunnel, and considerable effort continues to be expended (especially in Japan, where long tunnels are common) to understand the mechanisms of wave formation, principally using scale model experiments and large scale numerical simulations of the tunnel entry problem.

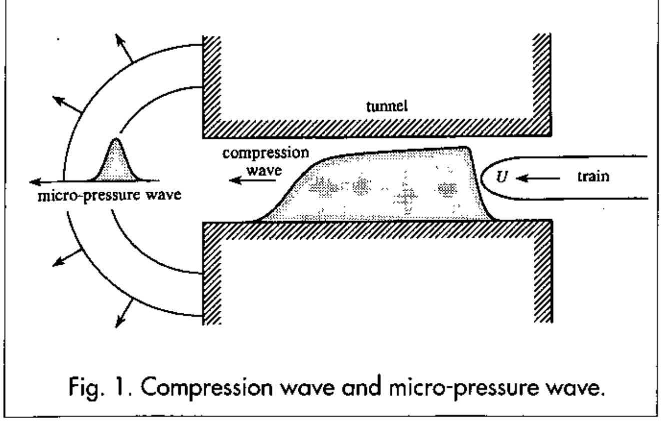


Fig. 1. Compression wave and micro-pressure wave.

Monopole Source Theory

However, the principal characteristics of the compression wave are easily derived by modelling the displacement of air by the advancing train by a set of constant strength, monopole sources distributed at ground level along a line in the plane of symmetry of the train and moving with the train at speed U. If x' denotes distance measured along the train from its nose, the source strength per unit length is just proportional to the rate of change of the fractional cross-sectional area of the train, ie to $(1/\mathcal{A}_0)\, d\mathcal{A}/dx'$, where $\mathcal{A}(x')$ = cross-sectional area at x' and $\mathcal{A}_0$ = cross-section of uniform part of the train. Then for a train entering from the right, as in Figure 1, the unsteady pressure p propagated into the tunnel ahead of the train is given by [1, 2].

$$p\left(t+\frac{x}{c}\right)=\frac{\alpha\rho_0 U^2}{\left(1-M^2\right)\mathcal{A}_0}\int_0^\infty \frac{d\mathcal{A}}{dx'}(x')\,\frac{\partial\varphi^*}{\partial x'}\left(x'-U\left[t+\frac{x}{c}\right]\right)dx' \quad (1)$$

where x denotes distance which increases *negatively* into the tunnel from the tunnel portal entrance plane, and c is the speed of sound. The compression wave is generated by the interaction of the sources with the portal, and according to this formula the influence of portal geometry is accounted for by the function $\varphi^*(x)$, which has the following very simple and appealing interpretation. Imagine a freely moving piston inside the tunnel whose face area is just equal to the cross-sectional area of the tunnel. Let the piston advance towards the tunnel portal at unit speed. Then φ^* is the *velocity potential* of the resulting flow from the portal when the fluid is assumed to be ideal and incompressible; in particular $\partial\varphi^*(x)/\partial x$ in equation (1) is the component of this velocity parallel to the tunnel axis evaluated on the line of travel of the train (the x-axis). The problem of calculating the compression wave pressure signature is therefore reduced to solving the conceptually much simpler problem of potential flow from the portal.

Of course, such a simple formula cannot be applicable in all circumstances. First it is limited to train Mach numbers less than 0.4 (~ 500 kph), and blockages, α, less than about 0.25; but these conditions are satisfied in practically all envisaged applications. Second, it ignores nonlinear steepening. It therefore determines only the *initial* form of the compression wave in a very long tunnel; if necessary, however, the solution can be extended further into the tunnel by using it to define the initial conditions for a nonlinear calculation based on the one-dimensional method of characteristics.

Figure 2 illustrates schematically an experimental arrangement used by Maeda *et al* [3] to investigate the compression wave. Wire-guided, axisymmetric model 'trains' are projected into and along the axis of a 'tunnel' consisting of a 7 m long circular cylinder of internal diameter 0.147 m. The nose 'aspect ratio' $h/L = 0.2$, the blockage $\alpha = 0.116$, and the projection speed $U \approx 230$ kph ($M \approx 0.188$). The data points in the Figure are measurements (made at the point labelled T) of the 'pressure gradient' dp/dt one metre from the entrance for three different train nose profiles (cone, paraboloid and ellipsoid). The solid curves are predictions of equation (1), which underpredicts the maximum pressure gradients by about 8%.

Suppression of the Micro-Pressure Wave

The amplitude of the micro-pressure wave that radiates from the far end of the tunnel is proportional to the compression wave pressure gradient dp/dt near the exit. The principal methods used to minimize its subjective and harmful environmental impact are based largely on reducing the initial value of dp/dt at the entrance portal, because wave steepening in a long tunnel tends to be suppressed by relaxation processes when the initial *rise time* of the wavefront is sufficiently large. The maximum pressure gradient varies approximately as U^3, but also depends critically on tunnel portal geometry and, to a lesser extent, on train nose profile. For a train of given cross-sectional area, nose profile modifications produce only modest increases in the initial rise time [3]. Much larger increases are possible by suitably modifying the tunnel portal geometry. Thus, for adjacent, parallel tunnels the initial wave thickness is increased when the high pressure air produced by an entering train is allowed to vent into the neighbouring tunnel through ducting close to the entrance. However, the most impressive increases have been realized by installing a duct-like 'hood' extending 30 – 50 m ahead of the tunnel entrance. The compression wave forms as the train enters the hood, and its rise time is increased by venting through judiciously positioned windows in the hood walls. For example, a fivefold increase in rise time is achieved by the 49 m long hood at the eastern entrance to the Ohirayama tunnel in Japan.

But, hoods tend to be unsightly, and a more elegant and æsthetically pleasing, although perhaps more expensive, method of increasing the rise time is to *flare* the entrance portal.

It turns out that the maximum thickness of the wavefront that can be achieved by flaring is about ℓ/M where ℓ is the length of the flared section of the tunnel (see Figure 3). The variation of p across the wavefront is governed by the potential function $\varphi^*(x)$ of equation (1), which in turn depends on the shape of the portal. In the optimal case the pressure rises smoothly and *linearly* across the wavefront, and equation (1) predicts that this will occur when $S(x)$, the cross-sectional area of the tunnel in the flared section, is given by [2]

$$\frac{S(x)}{\mathcal{A}_T} = \left[\frac{\mathcal{A}_T}{\mathcal{A}_E} - \frac{x}{\ell}\left(1 - \frac{\mathcal{A}_T}{\mathcal{A}_E}\right)\right]^{-1}, \quad -\ell < x < 0 \qquad (2)$$

where $\mathcal{A}_T$ is the cross-sectional area in the uniform section of the tunnel, and $\mathcal{A}_E$ is the area in the portal entrance plane. For a tunnel of semi-circular cross-section, $\mathcal{A}_E$ is given in terms of the prescribed value of ℓ/R ($R = \sqrt{\{2\mathcal{A}_T/\pi\}}$) by the formula

$$\frac{\mathcal{A}_E}{\mathcal{A}_T} = \left(\frac{\ell}{2R}\right)^{\frac{2}{3}} \left[\left(1 + \sqrt{1 - \left(\frac{2R}{3\sqrt{3}\ell}\right)^2}\right)^{\frac{1}{3}} + \left(1 - \sqrt{1 - \left(\frac{2R}{3\sqrt{3}\ell}\right)^2}\right)^{\frac{1}{3}}\right]^2 \qquad (3)$$

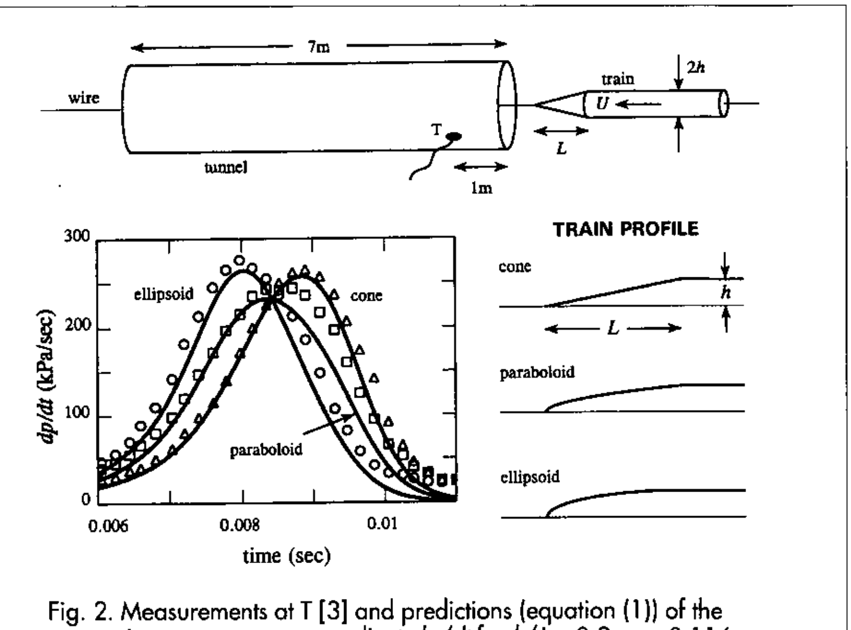


Fig. 2. Measurements at T [3] and predictions (equation (1)) of the compression wave pressure gradient dp/dt for $h/L = 0.2$, $\alpha = 0.116$, $U \approx 230$ kph ($M \approx 0.188$).

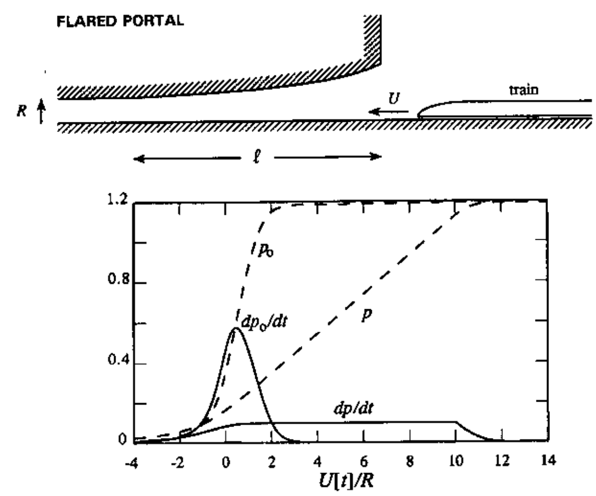


Fig. 3. Typical plots of $p/\alpha\rho_0 U^2$ and $(dp/dt)/(\alpha\rho_0 U^3/R)$ for a train with an elliptically profiled nose entering an optimally flared tunnel with $\ell/R = 10$, $h/L = 0.2$, $\alpha = 0.16$ and $M = 0.4$; $p_0/\alpha\rho_0 U^2$, $(dp_0/dt)/(\alpha\rho_0 U^3/R)$ are the corresponding predictions for an unflared portal.

The plots in Figure 3 compare calculated values of p and dp/dt for an optimally flared portal with corresponding values p_0, dp_0/dt for a uniform tunnel when the train has an elliptically profiled nose and enters along the axis of symmetry, and $\ell/R = 10$, $\alpha = 0.16$, $h/L = 0.2$, $M = 0.4$. The results are plotted against the non-dimensional *retarded time* $U[t]/R$, where $[t] = t + x/c$. The nose of the train crosses the portal entrance plane at $U[t]/R = 0$ and enters the uniform section of the tunnel when $U[t]/R = 10$. The amplitude of the pressure wave grows linearly during this time (with a constant and small value of the pressure gradient dp/dt) and the wave thickness ~ $12R/M = 30R$; for an unflared portal the wave thickness ~ $2R/M = 5R$. Thus, flaring yields a six-fold increase in the rise time of the compression wave, and the peak pressure gradient is reduced to about one sixth of its unflared value. According to equation (3), $\mathcal{A}_E \approx 5.35\mathcal{A}_T$, which requires the radius of the tunnel portal to be $\sqrt{5.35} \approx 2.3$ times the radius R of the uniform section of the tunnel. The validity of these predictions is currently being investigated experimentally by Dr M Iida of the Railway Technical Research Institute in Tokyo.

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THIN AND QUIET? AN UPDATE ON NEW QUIET ROAD SURFACE PRODUCTS

Mike Wright MIOA

Introduction

As road traffic continues to cram on to British Roads with ever-increasing levels of noise, it may seem hard to believe that there have been some recent developments that will bring some relief to us all. These have been most evident in new types of road surfaces. Firstly, we had porous asphalt which, a few years back was considered to be the way forward to noticeably reduce noise. However, trials have shown weaknesses and some premature failures have occurred notably on the recently opened A34 Newbury Bypass. There are now some new 'low noise thin surfacing' products, based on European experience that are rapidly gaining acceptance in the UK. This paper is a review of the current products and how they perform.

In an effort to reduce noise from major trunk road schemes designers became interested in the use of porous asphalt (PA) on major road schemes in the 1980s. Trials were undertaken and a number of important schemes were built with this material in the early 1990s.

Whilst the official guidance in *Calculation of Road Traffic Noise* (CRTN) [1] showed that PA would reduce levels by over 3 dBA, early trials boasted greater reductions [2,3]. The designer could be satisfied that with its use, a given noise level from road traffic would be reached at around half the distance from the road than would be the case if conventional hot rolled asphalt (HRA) were used. Whilst engineers steered a cautious line and were aware that this material had limitations there were quite a number of schemes that showed what could be done. The cost of this material, environmental implications together with the short life are now seen as significant disadvantages and cases of premature failures have now caused engineers to seek alternative solutions which are reviewed here.

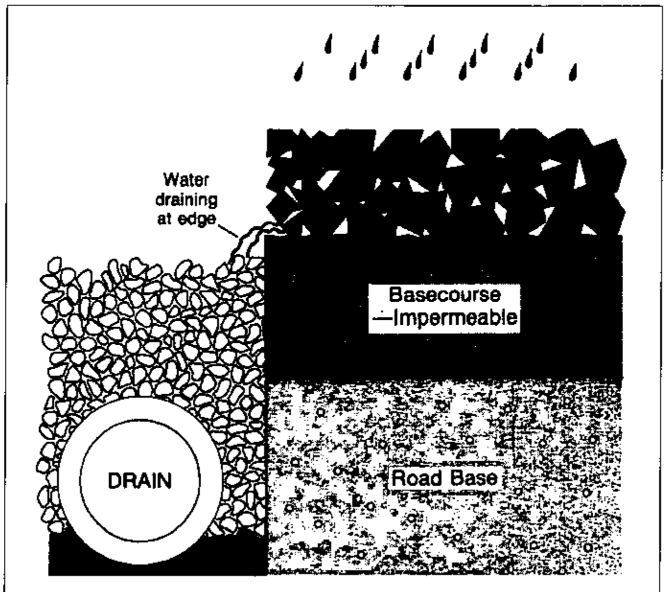

Fig. 1. Porous asphalt; what it is and how it works.

Why Use Porous Asphalt?

The 'negative texture' illustrated by the flat surface in Figure 1 is quieter – especially at first. It also reduces spray and reflected headlight glare at night in wet driving conditions. For comparison, conventional concrete and HRA road surfaces, with positive textures are illustrated in Figure 2.

What Is Wrong with Porous Asphalt?

Porous asphalt costs more than a conventional HRA road. It uses a thick layer (100 mm or more including the impermeable base course) of high quality *new* stone and *no* recycled material leading to environmental implications for the areas where this material is quarried.

PA has a shorter life than conventional material leading to greater costs and disruption. Even more disturbing has been the recent failures with the A34 Newbury Bypass as an example. This is currently being re-laid after only a year's use.

The surface of PA is more prone to freezing than normal roads. It is also difficult to 'patch up' because this often impairs the essential drainage through the material.

Because a thick layer of PA is needed on top of the structural base, there could be clearance problems with over-bridges when overlaying an existing road.

Because it has a very dark surface, there may be an increase in lighting requirements.

Experience has also shown that porous asphalt laid in the UK tends to 'clog' and compact, causing half its initial noise benefit to be lost over the design life.

What Are the Alternatives?

There is now a wide range of new products, many based on European developments. The following is only a brief description and further details are given in Transport Research Laboratory (TRL) reports [4,5] and manufacturers data [6].

(i) *Ultra Thin Hot Mixture Asphalt Layer* (UTHMAL) is a paver laid product, a well-known brand is 'Safepave' in the UK.

(ii) Thin Polymer-Modified Asphalt Concrete is classed in the UK as *Very Thin Surfacing Layer* (VTSL) – known brands include 'Brettpave', 'Millom Hitex', 'DA',

System	Manufacturer	Thickness/Type	Noise Benefit	Example	Data Source/Method
Safepave Thin Wearing Course System	Tarmac – Associated Asphalt	10mm aggregate (UTHMAL)	Light vehicles = 2.2dBA; Heavy vehicles = 0dBA [a]	A47 Thorney, Cambs, after 3 months use on Safepave. (d)	TRLData (Report314) ISO11819–1
			Light vehicles = 1.1 to 1.8dBA; Heavy vehicles = 1.7 to 2.8dBA [b]	A1 Eaton Socon, Cambs: 3 months use. (y)	
		14–mm aggregate (UTHMAL)	Light vehicles = 3dBA; Heavy vehicles = 1.7 to 2.5dBA [b]		
		Can be laid 10–25mm thick (UTHMAL) 10–25mm thick	40% (~2dB) claimed [b]	Dorset County Co	Manufacturers data, method not known
Masterpave	Tarmac – Associated Asphalt	35mm thick, 14mm PSV gritstone (SMA)	Cars at 110 km/h= 5.1dBA; Heavy vehicles at 90 km/h = 3.7dBA [c]	M40 J6/J8 Oxfordshire 'soon after opening' 1997	ISO 11819– 1*
Tuffgrip	Hanson Aggregate	25mm thick, 14mm open texture grade. (can be laid 20–40mm thick) (Hybrid)	Light vehicles at 90 km/h = 3.8dBA; vehicles at 110 km/h = 4.6dBA; Heavy vehicles at 90 km/h = 3.2dBA. [c]	M4, J23/J24 in S Wales: 5 weeks traffic – 1997	Manufacturers data, source not quoted; ISO 11819– 1*
			Light vehicles at 90 km/h = 2.9dBA; vehicles at 110 km/h = 3.7dBA; Heavy vehicles at 90 km/h = 2.8dBA [c]	M4, J23/J24 in S Wales: 10 months traffic – 1997	Manufacturers data, source not quoted; ISO11819– 1*
Megapave	Mid–Essex Gravel	25mm thick, 10mm granite with bituminous binder, 4% voids (SMA)	774 veh/hr, 9.3% heavy vehicles at 65 km/h – LA10 2.6dB; 706 veh/h, 8.7% heavy vehicles at 65 km/h– 3.8dB L_{A10}; [c]	B1018 at Latchington, Essex: after 1–2 months – 1996	WS Atkins data; CRTN – 88 Comparative Method'
Brettpave	Brett Asphalt	10mm VTSL	In-car levels – 68dB at 70 km/h; 72dB at 110 km/h	A274, Headcorn, March 1997	'Hand–held Noise Meter. In-Car Levels tested, Ford Mondeo'
Axofibre	Lafarge Redland Aggregates	14mm aggregate (SMA)	90 and 110 km/h Light Vehicles 3 to 4dB(A); heavy vehicles 3dBA lower than HRA of a similar age.**	A1/A428 junction (Black Cat Roundabout) near Wyboston, 'less than 12 months old'.	TRL Unpublished Report ISO 11819–1*
			Light vehicles = 6.8dBA; Heavy vehicles = 5.9dB(A) [a]	A10, Littleport, Cambs new SMA and HRA	TRL Data (Report 314) – ISO11819–1*
UL–M	White Mountain (Asphalt)	10mm VTSL, 20mm thick	Light vehicles = 4.4 to 5.3dBA; Heavy vehicles = 1.7 to 3.8dBA [b]	A1 Eaton Socon, Cambs: 5 months use. (y)	– Do –
Colrug	Colas Ltd	Hybrid complies with HA Clause 942 approved	1.8dBA compared to HRA at 80km/h and 4.5dBA compared to a surface dressing	A340, Pamber Green & Lower Beeding: report 1996	4 m from test lane and inside a test car
Colsoft		6mm VTSL, 20–30mm thick	4dBA improvement at 90km/h	Various, in France	Using the 'French-German controlled vehicle' method
		10mm VTSL, 20–30mm thick	5 or 6dBA improvement at 90km/h	Various, in France	– Do –
Hitex – Clause 942 Thin Wearing Course System	Bardon Aggregates	PSV > 65; Thin Polymer– Modified Asphalt HA Clause 942 approved	'3.7dB L_{A10} compared to HRA'	A635 Doncaster to Barnsley in 1995	Hetherington and Anderson; 'CRTN – 88 Comparative Method'
Thinpave high Textured Ultra-thin Surfacing		15 – 30mm thick, 10mm aggregate; Thin Polymer– Modified Asphalt HA 942 approved	'4dB compared to HRA'	Not known	Manufacturers data; understood to be 'CRTN – 88 Comparative method'
Smatex Range		10– 50mm thickness, 6 –20mm aggregate (SMA)	'3 or 4dB compared to HRA'	Not known	– Do –
		14mm aggregate	Light vehicles = 4.6dBA: Heavy vehicles = 2.7dBA. (b)	A1 Eaton Socon, Cambs: 5 months use. (e)	TRL Data (Report 314) – ISO11819–1

Table 1: Manufacturers and TRL Data compiled by W S Atkins Noise and Vibration

Notes: [a] = Comparison Against HRA at 90km/h: [b] Comparison against Brushed Concrete at 90 km/h: [c] Comparison against HRA: [d] = Age ofHRA unknown: [e] = Age of Brushed Concrete unknown: *=Statistical Pass-By Method ** = TRL also indicated that these were 2–3dB higher than results obtained for similar age porous asphalt. UTHMAL = Ultra-Thin Hot Mixture Asphalt Layer: SMA = Stone Mastic Asphalt: 'Hybrid' indicates UTHMAL combined with Thin Polymer-Modified Asphalt Concrete: HRA = Conventional Hot Rolled Asphalt: PSV = Polished Stone Value: VTSL = Thin Polymer-Modified Asphalt Concrete - Very Thin Surfacing Layer.

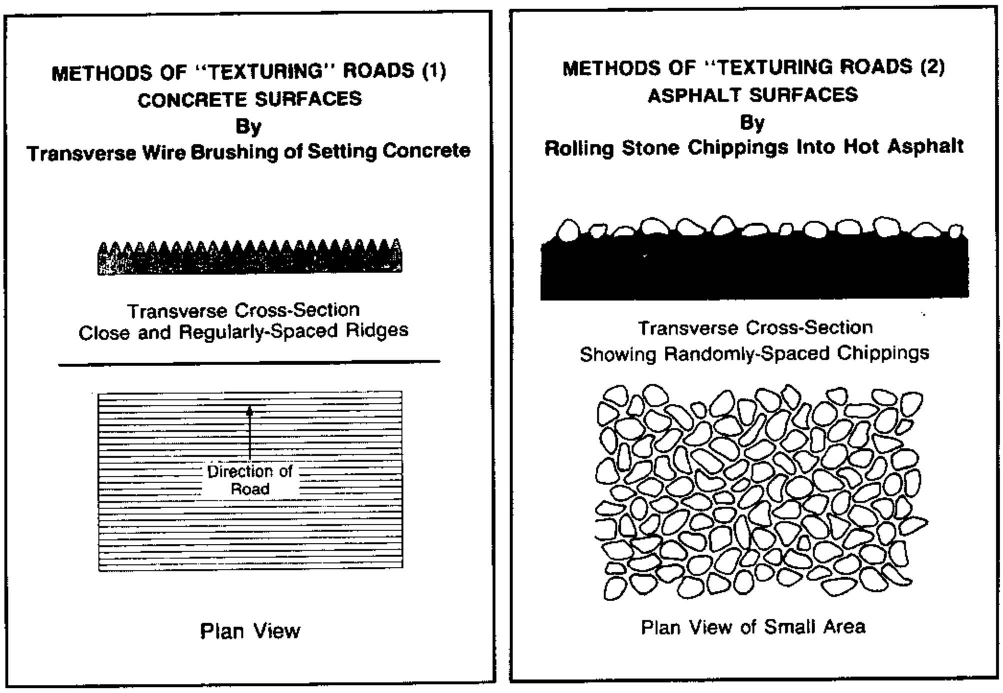

Fig.2. Conventional road surface

'Axoflex', Wimpey 'Thin Textured Asphalt' and UL-M. (Some of these meet Clause 942 in the current *Specification for Roads and Bridges* – see below.)
(iii) Hybrid versions of both the above with known brands such as 'Tuffgrip', 'Euro-Mac', and 'Colrug'.
(iv) Thin *Stone Mastic Asphalt* surface course (SMA) - known brands such as 'Masterpave', 'SMAtex', 'Brettmastic' and 'Megapave'.
(v) Thick slurry mixtures – under the generic heading of 'micro-surfacing'.

There are also *Multi-Layer Surface Dressings* that may use some elements of the above types. However, some products are better than others. The best have a 'negative texture' similar to PA. However some multi-layer surfaces are *no* quieter than hot rolled asphalt (HRA), there are a few ('positive texture') that are actually quite a bit noisier.

How Do They Perform?

The following shows some comparisons with other materials:

- UTHMAL – expect up to 2 dBA reduction compared to HRA.
- SMA is showing 3 to 4 dBA reduction compared to HRA and is generally best all round at all frequencies.
- Hybrid types can give 2 to 5 dBA improvements over HRA.
- VTSL (clause 942 approved) has shown a 2 to 6 dBA improvement over brushed concrete.

Table 1 is a list based upon a recent survey of manufacturers, including published and unpublished data. This includes the comparative tests given in TRL Report 314 [7].

After reviewing a considerable amount of test reports by manufacturers, consultants, TRL etc, it was clear that there were several approaches to testing. Inquiries to the Highways Agency confirmed that there is no 'standard prescribed method' of measuring road surface noise although 'TRL are trying to develop a better prediction method' [8]. It was also evident that insufficient testing had been done and no information is available on the continued acoustic performance.

European Data

Table 2 is based upon the data given in the 1996 Nordic Method [9]. All comparisons of noise performance are related to hot rolled asphalt.

It is understood that the versions of SMA used in Europe may be different from those found in the UK and this may affect the acoustic performance. These data must be used with some caution.

Other Benefits

There are some other important benefits associated with most thin quiet surfaces:

- They are cheaper than PA.
- Layers are typically 10 to 50 mm thick.
- Less high quality stone is used.
- They last longer.
- The acoustic performance does not deteriorate as quickly.
- They can be laid on existing roads in a similar way to a normal wearing course.

However there are some disadvantages compared to PA:

- The 'negative texture' is less pronounced than PA; spray problems in wet weather are less than HRA but worse than porous asphalt.
- No 'official' statement on how to calculate noise.

Test Methods

There are two reliable test methods to determine the source noise level of any road surface:

- ISO 11819-1 Statistical Pass-By Method (SPB) [10] assuming a 'road surface influence' (RSI) rating developed by TRL.
- The 'Shortened Procedure' described in Section III of CRTN.

TRL also have a mobile testing laboratory that can determine relative noise levels of road surfaces. This is known as the 'close proximity tyre/road vehicle' that is used in the 'close proximity tests' described in ISO 11819-2 [11] which are not described here.

This shows a section of the A46 Kennilworth Bypass before it was overlaid with 'Safepave'. Before this was done, traffic noise levels were some 5 dB higher that would be found if the road was a conventional HRA type. The random grooving in this example is more extreme than usually found. Immediately after overlaying with 'Safepave', noise levels were reduced by 9 dB, some 4 dB less than would be found with HRA.

ISO 11819-1

This method requires the following

- Direct measurements of vehicles at 7.5 m from each traffic lane.
- The test section covers 30–50 m each side of a road that should be straight and level with a constant speed traffic.
- Sufficient vehicles are required to allow reasonable measuring time and the L_{Amax} noise of these should be 10 dB above background. These should also be at least 6 dB above levels found between the passage of vehicles. 'Free field' conditions are specified with no large reflecting surfaces around the site. At least 50% of the ground surface between a test vehicle and the microphone should be hard.
- Three vehicle categories are tested, each must include samples containing at least 100 cars and 80 commercial vehicles. Paired noise measurements are recommended to reduce random errors.
- The procedure requires very close monitoring of traffic speed, air and road surface temperatures and strict ranges are specified.
- The analysis requires normalisation of the data to determine the Statistical Pass-by Index (SPBI) for a standard mix of light and heavy vehicles.
- There are strict requirements on systematic errors, variations in fleet composition, random errors. Repeatability should be better than 1 dB.

RSI Rating

The RSI rating method has been devised by TRL. This is

Road Surface			Correction term in dBA for a certain % of heavy vehicles (Relative to HRA)							
			0 – 60 km/h			61 – 80 km/h			81 – 100 km/h	
No	Type/Max chipping size (mm)	Age (years)	0 – 5%	6 – 19%	20 – 100%	0 – 5%	6 – 19%	20 – 100%	0 – 5%	6 – 100%
3a	SMA (12 – 16)	1 – 20	–1	0	0	–1	–1	0	–1	–1
3b	SMA (12 – 16)	<1	–1	0	0	–1	0	0	–1	0
4a	SMA (8 – 10)	1 – 20	–2	–1	0	–3	–2	–1	–3	–2
4b	SMA (8 – 10)	<1	–3	–1	0	–4	–3	–1	–4	–3
11a	PA (14 – 16mm, 20% voids)	3 – 7	–1	0	0	–3	–2	–1	–3	–2
11b	ditto	1 – 2	–2	–1	0	–3	–2	–1	–3	–3
11c	ditto	<1	–3	–2	–2	–4	–3	–3	–4	–4
12a	PA (8 – 12mm, 20% voids)	3 – 7	–1	0	0	–3	–2	–1	–3	–3
12b	ditto	1 – 2	–2	–1	–1	–4	–3	–2	–5	–4
12c	ditto	<1	–4	–3	–3	–6	–5	–5	–7	–6

Table 2 Data taken from the Nordic Method 1996

comparable with the CRTN surface correction for a typical motorway. This is the predicted difference between the $L_{Aeq,T}$ noise level arising from a given mix of traffic using the surface being rated against that from atypical HRA with a sand patch test texture depth of 2 mm. This is a surface that is assumed to have a zero correction in CRTN.

The calculation of RSI uses the method recommended by the Noise Advisory Council in 1978 [12].

The calculation of RSI from the SPB measurements is as follows:

RSI =

$10 \log_{10} [7.8^*f(light) + 0.568^*f(heavy2) + f(heavy3)] - 95.9$

Where cars (110 km/h) = f(light);

Lorries (90 km/h) are assumed based on the average flow for motorways (14%) and split into 2 axle = f (heavy2) and multi-axle = f(heavy3)

f (category) = $10^{L_{Amax}/10}$

L_{Amax} is the SPB for the f(category).

Work is still taking place at TRL to validate this and more information on SPBs is expected to be published by TRL shortly.

Calculation of Road Traffic Noise (CRTN)

This method determines L_{A10} directly from roadside measurements at 4 – 15 m from edge of carriageways. In order to make comparisons elsewhere and to compare measurements with theoretical values, light and heavy vehicles are counted and average speeds are taken at the same time. CRTN specifies measurement conditions that place limits on wind conditions, require dry roads, unobstructed views and no acoustic reflections. The minimum measurement period is related to traffic flow.

Comparison

During the course of the trials of porous asphalt, on the M4 near Cardiff [8], TRL carried out comparative measurements using the two methods described above. The following shows that there was very little between the two sets of results.

a) Using the ISO method gave:
Before resurfacing RSI = 2 dB; after, RSI = – 6.7 dB.
Improvement = 8.7 dB.

b) Using CRTN, the measured change in terms of L_{A10} was 8.5 dB.

Highways Agency Current Viewpoint

Highways Agency have recently confirmed that they recommend using the *pervious* surface correction in CRTN for quiet surfaces that meet Clause 942 in the current *Specification for Roads and Bridges* (DMRB Volume 1) [13]. They also consider that it would be appropriate to verify the actual performance of the surface when the road is open to refine the CRTN predictions.

Conclusions – More Testing Needed

Recent tests have shown that many of these 'thin noise reduced surfaces' can give significant acoustic benefits. These approach the benefits associated with PA. However, there is also some concern that measurement data on products is limited to new or fairly new surfaces and the long-term performance UK is not known.

Longer-term European data is available but must be used with caution as the materials may differ from UK practice.

There is no comprehensive 'manual' of noise data and none of the data given here can be regarded as definitive. More research is clearly needed. However, it is hoped that this survey will be of assistance to designers and others involved in planning and assessing noise impact from roads.

A TRL report giving average SPB results for different surfaces is understood to be in preparation.

Finally, it is evident that the development of new products is proceeding apace. This 'survey' should be taken as an indication of the situation up to Summer 1999.

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THE IMAX CINEMA, WATERLOO – ACOUSTIC DESIGN AND PRACTICAL CONSIDERATIONS

Peter Henson MIOA

The IMAX Cinema, Waterloo, London is located at the southern end of Waterloo Bridge, in the centre of a roundabout. Owned by the British Film Institute (BFI), it forms part of their expanding South Bank development which also includes, among others, the National Film Theatre, MOMI and the Royal Festival Hall. The IMAX Cinema opened to the public in May 1999.

The building is cylindrical in shape, with restaurant, ticketing and public areas at ground floor level. The auditorium makes up much of the remainder of the building from 1st floor to 6th floor, with a 500 seating capacity. It boasts 'the largest cinema screen in Europe', around 20 metres in height. IMAX cinemas specialise in large 2D and 3D format films although this cinema also houses 35 and 70 mm projection facilities.

From a commercial viewpoint, the BFI consider this location ideal for one of their flagship buildings. In contrast, acoustically, it would be hard to find a more demanding and less ideal site for a cinema. Located in the centre of one of London's busiest roundabouts, it lies less than 40 metres from an elevated railway carrying British Rail traffic over a series of steel bridges and brick viaducts. Below the site, only a few metres below ground level, there are two tunnels carrying London Underground's Waterloo and City Line trains. Aircraft bound for Heathrow and helicopters overfly the site.

Feasibility and Design Criteria

Bickerdike Allen Partners (BAP) were first approached by the architects, Avery Associates, about a decade ago to assist in studies to determine the feasibility of this project. The IMAX Corporation, who sell the IMAX system to operators around the world, set out standards of design on various issues including acoustics. The basic acoustic design aims for the auditorium are straight forward:

External Noise – shall be inaudible within the auditorium

Building Services Noise – shall not exceed NC 25 with all systems operating, and shall be free of tonal or impulsive components

Cinema Acoustic – reverberation time shall not exceed 0.7 seconds, with a 25% uplift allowable at low frequencies.

External view of the IMAX cinema showing adjacent road traffic

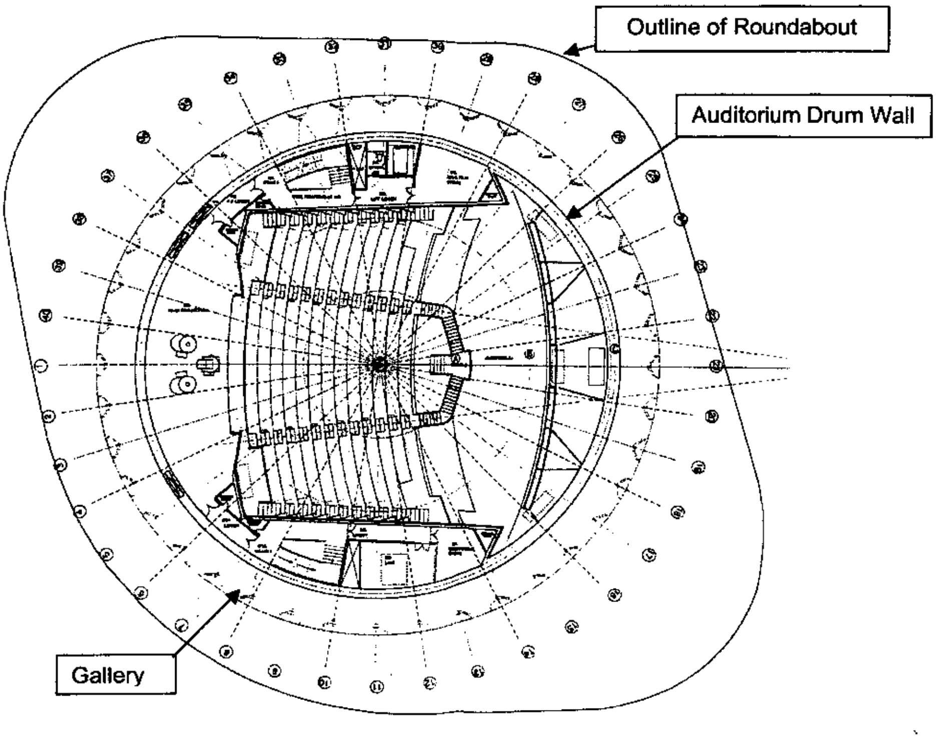


Fig. 1. Typical auditorium plan.

There was also considerable variation among measurements made on different flagstones, some of which were not correctly bedded.

Below the flagstones, a solid 300 mm thick layer of concrete extends over part of the roundabout zone. It was taken that vibration measurements made on this surface provided a reasonable indication of the magnitude of ground borne vibration in the vicinity of the tunnels. Figure 3 shows typical vibration levels in the ground above the tunnels based on measurements taken at the 31.5 Hz octave band, one of the principal frequencies of interest.

It was assessed that using conventional piles, as proposed, the noise levels resulting in the auditorium as a result of Underground trains passing beneath the building would be around NR45 unless acoustic measures were introduced. In addition, it was considered that conventional building isolation devices alone would struggle to achieve the 20 dB or so reduction sought in the design target.

Various methods of vibration control were considered including:

(i) Control at source, such as replacing local jointed track with welded track or installing track isolation using either base plate pads or a resilient layer beneath the whole track. This was found not to be currently possible.

(ii) Double sleeving of the piles. This was discounted in view of the relatively small reduction in vibration levels attainable and the cost and practicalities of piling much deeper.

(iii) Constructing trenches filled with sand, parallel to the tunnels. This was also discounted on the grounds of cost and practicality vs benefits.

(iv) Locating piles away from those tunnels where vibration levels were at their highest and maintaining an air gap between the building structure and local ground. This was implemented.

(v) Constructing the building on anti-vibration bearings. This was also implemented.

The cinema was to have piled foundations with a heavy concrete ground slab. For reasons of economy and speed of construction, however, the cinema shell was to be of lightweight construction, with a glass outer 'gallery' and an inner drum wall of plasterboard and steel construction, see Figures 1 & 2.

BAP's survey work, the results of which are described later, found that with regard to external noise control, the attainment of inaudibility was not possible with the proposed construction although noise from road and rail traffic could be controlled to around NC 25. With this standard, it was considered peak levels may therefore just be audible at times against a quiet background but would most likely go unnoticed by the audience.

To convince the client that this would be acceptable, a simulation was undertaken in the small IMAX cinema in the National Museum of Film & Photography in Bradford. The simulation involved replaying within the cinema the sounds that might arise from Underground trains below the proposed site, during film shows and between films. This confirmed that NC 25 was acceptable.

Control of Ground Borne Vibration: Design

Vibration levels on the pedestrianised area in the centre of the roundabout, prior to the development, were found to vary significantly during Underground train passbys in the vicinity of the tunnels. It is believed that variations arose in part, at least, due to the complexity of the site and the variety of underground structures that exist, including a large brick sewer passing over the tunnels, and the presence of a sizeable British Telecom Chamber.

Control of Ground Borne Vibration: Practice

The selected method of vibration control therefore was the adoption of (iv) and (v) above. The position chosen for the location of the anti-vibration bearings was beneath the first floor slab, on top of the columns. This had the advantage of elevating bearings away from

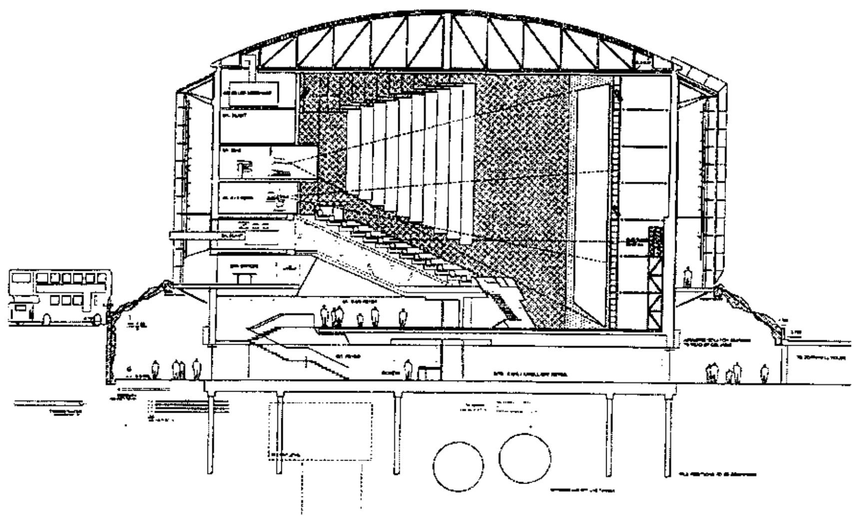


Fig. 2. Section through the auditorium.

ground water problems and introduced a large buffer zone between the vibrating ground surface and the isolated portion of the building. The upper isolated portion was however of a lightweight construction and due account had to be taken of its rather unevenly distributed load. This approach also introduced potential bridging routes via building services, stairs and lifts that were required to pass between the two zones. It also left the ground floor unisolated. This zone, however, contains less noise sensitive public circulation space, ticketing and catering facilities.

Another option, that of locating the bearings at the top of the piles and below the ground floor slab, was considered too costly, particularly in view of the need to maintain access to the bearings. It would also have had an impact on ground floor levels.

Various types of anti-vibration bearings were considered and some were tested with comparisons being made between elastomeric and steel spring types. The final choice was a pre-compressed steel spring arrangement, selected with a system natural frequency of 3.5 Hz. The bearings were manufactured by GERB and are retained in a damping fluid. In addition to good performance capabilities, the pre-compression feature meant that the springs were inserted in a rigid condition. The building was then built on top and the springs released towards the end of the contract when the design load had been achieved. This eliminated complicated construction sequencing to avoid differential settlement.

The creation of a 100 mm air gap beneath the slab which spans the tunnels, between pile lines set back 3 metres from the tunnels, proved a difficult task in practice. The slab over the tunnels was to be built as a series of 1.8 m deep beams and 0.3 m deep slab sections, with each 1 m wide beam cast on a polystyrene former. It was

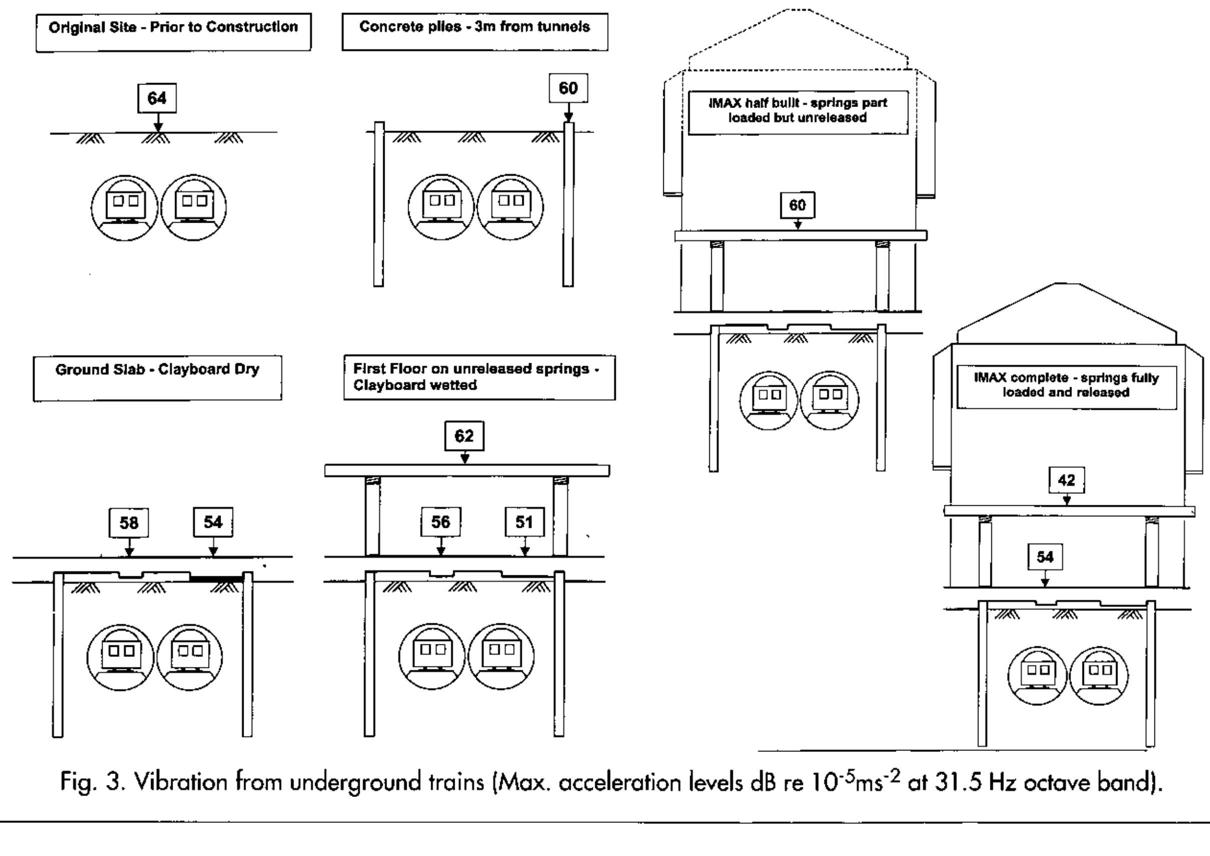


Fig. 3. Vibration from underground trains (Max. acceleration levels dB re $10^{-5}ms^{-2}$ at 31.5 Hz octave band).

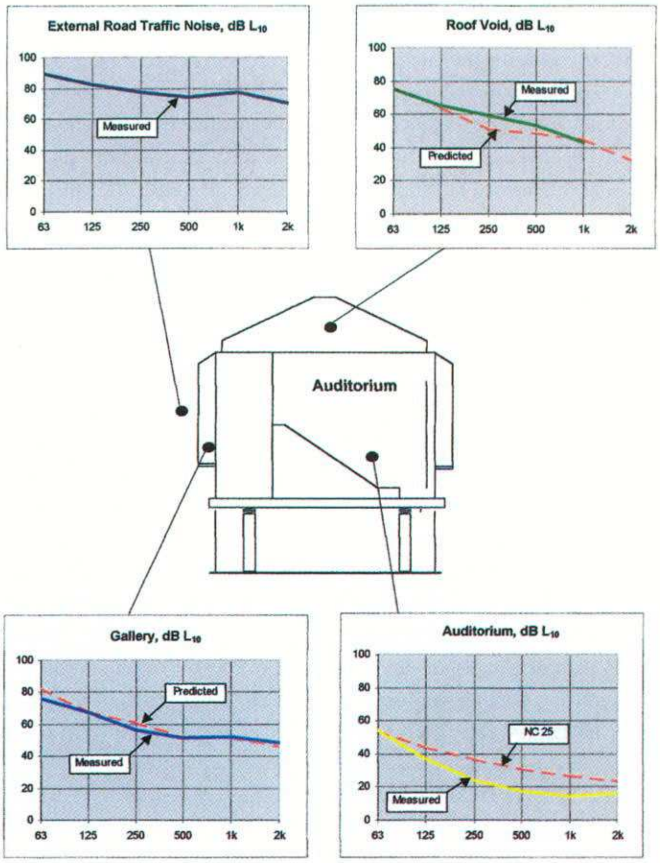


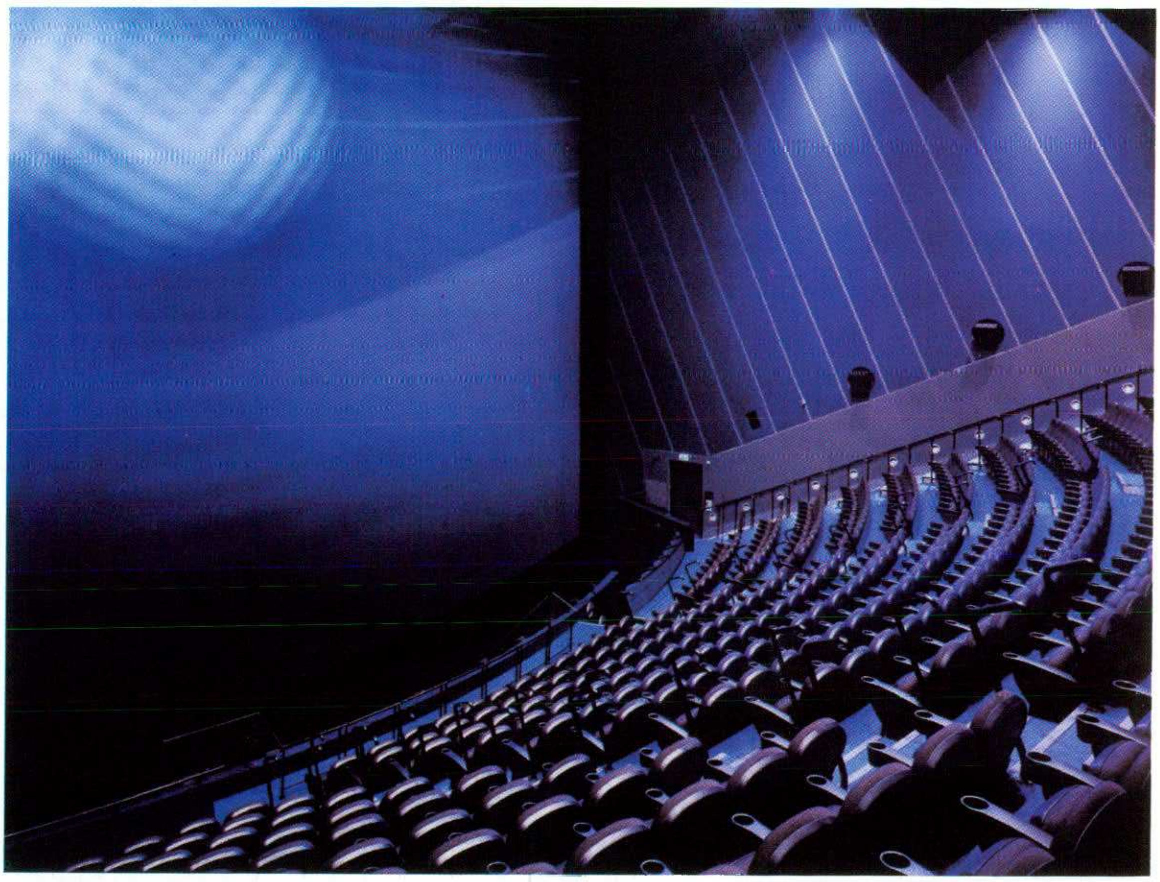
Fig. 4. Variation in noise levels around the IMAX building

intended that the slabs would be cast after the beams had set and the polystyrene removed. Unfortunately, some of the beams had to become sections of slab for structural reasons with a width in excess of 5 m in places. Removal of the polystyrene was not possible over this width. For these sections, a novel approach was introduced involving the use of clayboard as temporary formwork for these sections of the ground slab. Holes were introduced in the slab with pipes at around 2.5 m centres and after the concrete had set, water was introduced down each pipe to turn the clayboard into pulp, thereby maintaining the gap between ground and structure. Tests had been undertaken in the laboratory prior to this to ensure sufficient soaking time was allowed to fully pulp the board.

BAP inspected beneath the slab regularly to ensure that occasional sections of concrete overspill were removed. These regular inspections, in rat infested waters, were found to be a necessary function to ensure bridging between ground and slab was avoided wherever possible.

Above ground, various precautions were taken in the design process to minimise bridging across the bearings. These included:

(i) Careful building services detailing ensured as far as possible that the number of duct and pipe runs across the ground floor/first floor interface was kept to a minimum. All plant rooms were located above first floor level. Ducts and pipes serving the ground



View of the IMAX auditorium

floor were generally suspended from the underside of the isolated first floor slab, thereby avoiding the need to introduce vibration breaks. Where conduits pass across the interface, a structural break in the conduit was provided.
(ii) Stairs were built with a physical break between sections and all staircases spanning from ground floor to first floor levels were structurally broken at the mid-landing level, including the balustrades and handrails.
(iii) Lift shafts were broken at ground/first floor interface and discontinuities were built into the lift shaft structures just below the first floor slab. The lift itself had, however, to pass between the isolated and non-isolated areas and this was done by supporting the guide rails which carry the lift car on a steel cradle suspended from the first floor, independent of the lift shaft wall at ground level.
(iv) Internal masonry walls at ground floor level were provided with flexible fire resistant joints to the underside of the isolated first floor slab.

Control of External Noise Ingress: Design

The cinema wall is located less than 7 metres from the nearest point of the roundabout. Noise from road traffic, particularly lorries and buses accelerating up the incline toward Waterloo bridge, is therefore at times very high. A typical noise spectrum is set out in Figure 4 indicating road traffic levels incident on the outer wall of the IMAX building. Figure 4 also shows the spread of noise around other parts of the building.

Noise levels from overground British Rail trains were found to be similar to those for road traffic during the survey work at the existing site.

Walls

The first line of defence against external noise was provided by the 12 mm thick laminated glass wall formed by the Gallery which extends from the 2nd floor to the 6th floor of the IMAX building. The Gallery is around 3 metres in width and is penetrated at high level by a series of 40 Vent-axia type fans and by a similar number of slots in the floor to allow air circulation. No special acoustic measures were provided to these openings although floor slots were well screened from traffic noise by localised cladding.

The auditorium is well buffered on three sides by other accommodation within the building. However, the wall behind the screen forms the outer wall of the building.

The initial design concept for the auditorium drum wall was to use a twin construction of 146 mm metal stud partitions separated by a large cavity containing a 100 mm mineral fibre quilt. This was altered in the final design as discussed later.

The inner walls to the auditorium were to be of 146 mm metal stud partitions, boarded each side with two layers of plasterboard, with mineral wool infill. A high performance twin plasterboard wall construction was envisaged adjacent to noisy areas such as the projection room and plant rooms.

Roof

The roof was to be constructed of a lightweight material to achieve the curved shape required, eg GRG or similar. To achieve the acoustic requirements, a large void was to be provided between this layer and the auditorium ceiling, which was to comprise t&g boarding with a suspended M/F plasterboard ceiling beneath with mineral wool infill.

Control of External Noise Ingress: Practice

Walls

A small portion of the auditorium wall is not protected from noise by the glazed gallery. This is between the first and second floors. At this level, BAP insisted on the use of dense 215 mm blockwork in conjunction with an independent plasterboard inner lining to achieve the required acoustic performance.

For the main section of drum wall behind the screen, the design of the wall was arranged to maximise its low frequency performance. This was done by dispensing with the conventional 146 mm metal stud partition systems initially proposed and locating four layers of plasterboard on the outside of the wall, and four layers of plasterboard on the inner side of the wall. The inner laminate layer of plasterboard was isolated from the main steel frame of the building by neoprene acoustic isolation devices. The wall therefore was a very complex one comprising in sequence a plasterboard laminate layer of nominal 50 mm thickness, metal studwork, a large steel member, an acoustic isolation brace, more metal studwork and a plasterboard laminate layer. The gap between the plasterboard laminate layers was typically around one metre, with a 100 mm mineral fibre quilt in-between.

Roof

During construction, it was found, as expected, that noise levels from the overground railway were significantly higher at the top of the building than had been measured at ground level. It had previously not been possible to measure at this height prior to the construction of the IMAX building steel framework. Typical maximum levels of low frequency noise from trains at high level exceeded those from road traffic by around 5 dB at the same location.

The choice of roof was therefore influenced in part by acoustic considerations. The curved roof profile is formed by a lightweight metal, lined on the underside by close boarded timber and the eaves of the roof are used for ventilation purposes. These form chambers which serve various plant rooms at 3rd and 6th floor levels. The walls of the chambers are of studwork, double skinned with fire resistant boarding to control the acoustic conditions in the roof space.

The auditorium ceiling remains as a t&g timber boarding, with an M/F ceiling suspended beneath, comprising 2 x 12.5 mm plasterboard layers. A mineral wool quilt is located inside the void depth. This void varies in depth between 300 mm and 900 mm approximately.

Auditorium Acoustics: Design

Unlike a conventional auditorium, where the natural acoustics of the space influence the aural sensations, the IMAX experience relies on the sound system to provide all colouration and reverberation. The IMAX requirements relate therefore to the attainment of as low a reverberation time as possible but no higher than 0.7 seconds for a theatre of the size of the cinema at Waterloo. Some uplift at low frequencies is permitted, Figure 5.

An additional requirement, although not described by numerical specification, is that there shall be no acoustically reflecting surfaces that could cause sound reflections that could influence the sound heard by the listener. The aim is to ensure that the audience experience only direct sound from the loudspeaker system.

The auditorium has a volume of over 13,000 m^3. Calculations were therefore undertaken to ascertain the extent and type of materials required to achieve the IMAX specification. In view of the requirement to control the ingress of low frequency noise from passing cars and trains, it was also desirable to use a material with very good low frequency absorption properties.

The initial design concept was therefore based on a wall and ceiling treatment of a 100 mm thick mineral wool, located over a 100 mm deep airspace, covered in a fabric covering.

The architect was keen to include a large projection room window at the rear of the auditorium to allow the audience sight of the large IMAX projector and associated BFI 35 mm and 70 mm projectors. The IMAX Corporation were against this approach for two reasons; the possibility that projection room noise might reach the audience and secondly that acoustic reflections from the glass could be deleterious. BAP were asked to find a compromise to this situation.

Auditorium Design: Practice

The cost of adopting the mineral wool treatment to the wall as proposed was found to be high. Laboratory tests were therefore carried out to investigate alternative materials. The final selection was a 150 mm Melamine Foam, manufactured by The Noise Control Centre. This was found to have very good absorption properties at low frequencies when mounted solidly, namely around 0.9 at 125 Hz in laboratory conditions.

This material was used on all walls including the wall behind the screen. Only partial zones of the ceiling were treated with 100 mm thick foam, around the margins predominantly, to enhance low frequency absorption. This is because a suspended structure was provided in the auditorium at high level for lighting purposes and baffles of 100 mm Melatech foam were placed on the underside of this structure. An acoustically transparent woven cloth material, provided by Fabritrak, was provided to those sections of foam visible to the audience.

The projection room window was constructed as a large area allowing the audience sight of the projectors inside, as the architect intended. The acoustic concerns of IMAX were overcome by constructing the window from two separately framed glazing sections, using 15 mm and 10 mm glass, and slanting the auditorium side glazing upward by around 3 degrees. The gap between the glazings varies between 100 and 250 mm typically. A small section of glazing in front of the IMAX projector has remained as single glass for projection purposes.

Subsequent tests found the sound insulation of the window sufficient to prevent the projector from being audible in the auditorium during performances. No adverse reflection effects were identified by IMAX (Sonics) during their acoustic commissioning of the loudspeaker systems.

Building Services

The auditorium is ventilated by supply air from beneath the audience seating rake. This raked structure consists of concrete treads and timber infill risers and is used as a supply air plenum. Diffusers are located beneath each seat. Air is extracted from the auditorium by grilles located in the ceiling. These grilles are connected to secondary attenuators to control the ingress of traffic noise from inside the roof void.

Conventional methods were used to control noise from building services systems generally. These include the use of primary and secondary attenuators to systems serving the auditorium, duct lagging where some sections of duct pass beneath the auditorium seating, and vibration isolation of plant items, ducts and pipework.

Plant rooms are located on the 3rd floor and 6th floor, adjacent to the rear wall of the auditorium. The walls separating these spaces are twin framed, with two or three layers of plasterboard in places on each side and a mineral wool quilt in the void.

Final Conditions in the Auditorium

As an acoustic designer, one rarely knows whether design goals have been achieved until very near the end of the contract, because conditions are not suited to sensible acoustic measurements.

It was possible to monitor out of site hours how vibration levels were varying in the structure and to compare these to design targets. A general picture of how these varied is given in Figure 3.

It is interesting to note the fall in vibration levels on the first floor slab over the period. They start at around 60 dB re 10^{-5} ms^{-2} acceleration level (at 31.5 Hz) when the springs were in place but unreleased and fall to around 42 dB on completion of the project.

It proved impossible to assess during the construction period the likely noise levels in the finished auditorium. Some guidance was obtained, however, by measuring in the roof space and the Gallery prior to completion of the auditorium and checking the measurements against predictions. Figure 4 provides this comparison and sets out the final noise levels recorded in the auditorium following completion of the project. The latter relates to when building services are operating but lighting systems in the auditorium are switched off.

Reverberation time measurements were conducted in

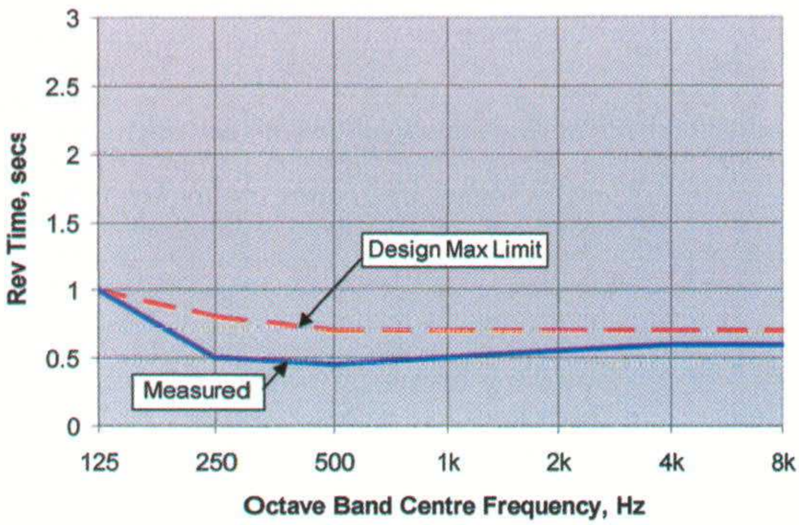


Fig. 5. RTs in the auditorium (secs)

the auditorium using the Sonics (IMAX) loudspeakers behind the screen. The results of reverberation time measurements are shown in Figure 5 where they are compared with the maximum allowable limit.

It can be seen from the above that the acoustic design criteria have been met. The above results do not unfortunately reflect the full sound insulation capabilities of the building envelope due to the presence of noise from building services systems. Tests would have to be undertaken with such systems off and this has not been possible to date.

The IMAX Cinema has been open to the public for the past three months or so. On entering the auditorium, it seems eerily quiet considering the close proximity of the passing road traffic outside. If you have not experienced a 3D IMAX film before, it is very much to be recommended.

If the question were posed why this project was successful acoustically, two points could be made, specifically: The client was prepared to employ an acoustic consultancy firm as a principal member of the design team, and pay for their continuing involvement during the feasibility, design and construction phases. Secondly, the design and construction team was responsive to input from the acoustic consultant and responded commendably to advice given.

Peter Henson MIOA is with Bickerdike Allen Partners, 121 Salusbury Road, London NW6 6RG ❖

PIONEERS OF BRITISH ACOUSTICS – 2

Edwin Barton

Edwin Henry Barton, FRS, (1858-1925) was born in Nottingham; one of three children who were left fatherless at an early age, Edwin was obliged to leave school prematurely to contribute towards the home. He was an ambitious youth who spent his spare time improving his education and he seized quickly the opportunity to attend evening classes when the University College of Nottingham was opened in 1881. In course of time he passed the London Matriculation and Intermediate Science examinations, and at the age of 32 he gave up his post of chief draughtsman in an engineering drawing office to become a day student at the University College, from which he obtained Second Class Honours in the Physics BSc (London) after only one year's work. He was awarded an 1851 Exhibition which enabled him to carry out research under Professor Rucker at the Royal College of Science (Imperial College) and under Professor H Hertz in Bonn. In 1893 he was appointed junior demonstrator in physics at the University College, Nottingham, and a senior lecturer two years later after obtaining the DSc (London) for work on electric waves. He was appointed to the Chair of Experimental Physics in 1906.

Barton's earlier research work was inspired by his experience with Hertz and was centred round electrical interference phenomena. In two of these contributions his co-worker was L Lowndes, later to become head of physics at Chelsea Polytechnic (later Chelsea College). In 1901 he turned his attention to sound and his first paper was theoretical, dealing with the refraction of sound by wind. Between 1902 and 1925 Barton with his colleagues published just over twenty papers in the Philosophical Magazine on different acoustical topics, including various aspects of string vibrations having particular reference to the nature of the vibrations of a violin in which he magnified and photographed the vibrations of the belly of the instrument using a system of optical levers. Barton also carried out an experimental and theoretical study of the range and sharpness of resonance under sustained forcing, and their variations with pitch, the results elucidating many points in the theory and practice of brass instruments. He also correlated the phenomena of inductively coupled electric circuits with the behaviour of coupled mechanical vibrations, this aspect of his work arising, one suspects, from his earlier engineering training. It was in 1917 that the first of a dozen papers in the Philosophical Magazine appeared with the name as collaborator of Dr H Mary Browning, their last joint paper appearing in the year of his death. These papers were concerned with pendular vibrations and for example the concept of Young's tricolour vision was studied with a system of three-light pendulums, the effects of stimulus on these responders being photographed and compared with the observed facts of colour vision. In another investigation a set of pendulum 'resonators' were used and their response to simultaneous harmonic forcings of different periods shown photographically; the observations were found to be in accord with the resonance theory of audition. The authors asserted therefore it was quite unnecessary to assume the existence of a larger number of separate vibrators and nerves than are actually present in the human ear.

Barton was the author of a number of texts, a text-book on *Sound* (1908), *Analytical Mechanics* (1911), *Practical Physics for Colleges and Schools* (1912 with T P Black) and *An Introduction to the Mechanics of Fluids* (1915). His text on *Sound* was noteworthy for the inclusion of an interesting section on heat-maintained vibrations.

Dr Browning speaks of Professor Barton as being a very calm and kindly person whose department at college operated very smoothly. As a lecturer he had a good voice and his presentation was clear and well illustrated. He had two sons, both of whom became physicists, Frederick, I believe went into government service but Arthur became prominent as an educationalist being headmaster of King Edward VII School, Sheffield, and later headmaster of City of London School.

Besides being scientifically interested in music Professor Barton was also an accomplished player of the trombone. He was responsible for inaugurating one of the first academic departments largely devoted to acoustics research and this subject is still a field of enquiry at Nottingham, although now in the realm of very high frequencies. In conclusion it must not be left unrecorded that Edwin Barton brought distinction to his subject by being one of the very few acousticians who have become a Fellow of the Royal Society (1916).

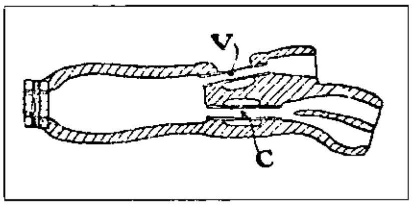
Richard Paget

The name of Richard Paget will have little or no significance to the majority of acousticians today but to those of us who were privileged to attend one of his lectures he has left a lasting memory. He was a lawyer by profession but brought to acoustics the enthusiasm of an amateur and the dexterity of a professional.

Sir Richard Arthur Surtees Paget Bart was born on 13 January 1869 and succeeded his father as second baronet in 1908. He was educated at Eton and Magdalen College, Oxford, and was called to the Bar, Inner Temple, in 1895. By his marriage to Lady Finch-Hatton in 1897 he had one son and three daughters. Paget's interests were quite wide for, besides membership of the old Physical Society and of the Institute of Physics, he was a member of the Royal Institution, a Fellow of the Royal Anthropological Society, Hon ARIBA and an Honorary Associate Member of the Town Planning Institute. He was secretary to a number of government committees, was president of the British Deaf and Dumb Association in 1953, and was a Commander of the Icelandic Order of the Falcon.

Sir Richard's participation in acoustics arose through his love of music and linguistics, and he was interested in the development of sign language for the education of those born deaf. He produced the words and music of two songs, Farmer John and The House in the Woods, whilst he also wrote the music for the Toy Band, the words of which came from H A Newbolt. Paget's direct contribution to acoustics was in his papers on the nature and artificial production of speech, which appeared in Proc Roy Soc, Nature, and in the Encyclopaedia Britannica.

In 1930 his book entitled *Human Speech* was published and, to quote the sub-title, contained 'Some observations, experiments and conclusions as to the nature, origin, purpose and possible improvement of human speech'. The book, which originally appeared in the International Library of Psychology, Philosophy and Scientific Method, was reprinted by Routledge and Kegan Paul in 1963. In his interesting introduction, Paget mentions that the nature of human speech was a subject of active discussion in the late 17th century and that John Williams, Dean of Ripon and a Founder Fellow of the Royal Society, had written an erudite and notable work in which he discussed the origin of languages and of writing, their imperfections, and the production of a universal philosophical language and language notation, and he even devised a phonetic alphabet. Paget also quotes the work of the Russian Kratzenstein which was very pertinent to his own experiments.



In 1779 Krazenstein won the prize of the Russian Imperial Academy for his work which involved the construction of a series of tubes of special form which were suggested by the observation of the form and dimensions of the human mouth when eliciting the different vowels. The tubes were 'voiced' by means of a vibrating reed fitted to each, bellows being used to 'blow the air'.

In his book, Paget describes the various forms of Plasticine models he designed for producing both vowels and consonants. The diagram shows the model he developed for producing *t* or *d* sounds which comprised three front resonators (two being in parallel and the other single) and these were connected to the common back resonator by two rubber tubes (labelled C and V in the diagram) which could be closed by pinching the rubber tubing. The *t* or *d* sounds were produced by pinching both tubes and then releasing suddenly the tube V, while blowing the larynx of the model. Apparently a high pressure produced *t* whilst a low pressure gave sounds resembling *d*; the simulation of the latter was improved by pinching the tube over a greater length. Paget found he could avoid the cracking of the Plasticine in contact with the rubber by reinforcement with string embedded in the Plasticine – a forerunner of reinforced plastics!

Sir Richard Paget died in London in 1957. His work should be an inspiration to others that astronomy is not the only field in which the amateur can still make a useful contribution to scientific knowledge.

This is the second in an occasional series of articles originally written by Dr R W B Stephens and published in Acoustics Bulletin some 20 years ago, well before most of the present members came into the Institute. ❖

MEETING ANNOUNCEMENT

One-Day Meeting

THE ACOUSTIC DESIGN OF CINEMAS AND LARGE LEISURE COMPLEXES

19th January 2000

London Venue

There has been an enormous growth in the building of large leisure complexes in recent years. These often contain a mixture of noise-sensitive and noise-producing activities, including cinemas, nightclubs, bowling, theme pubs and general retail. Resolving these potential conflicts presents the acoustic designer with a major challenge.

It is intended that the one-day meeting include a visit to the recently opened IMAX cinema at Waterloo. Topics to be discussed in the meeting could include:

- Criteria for sound insulation between cinemas
- Control of flanking sound between noisy cinemas
- Contractual strategies for dealing with inter-tenancy sound insulation and noise control
- Sound insulation and absorption from metal roof constructions
- In-situ sound insulation testing between incomplete constructions
- Low frequency sound insulation - blockwork vs plasterboard

If you would like to contribute as a delegate or presenter, please contact the organiser. Numbers for the IMAX visit will be limited, so please register your interest as soon as possible.

Meeting Organiser:
Nick Boulter,
Arup Acoustics
St Giles Hall
Pound Hill
Cambridge CB3 0AK

Tel: 01223 355033
Fax: 01223 361258
E-Mail: nick.boulter@arup.com

CONFERENCE NOTICE

2 Day Conference

(Organised by the Measurement and Instrumentation Group)

MEASURING NOISE OUTDOORS

Shuttleworth Collection and Swan Hotel, Bedford

1–2 March 2000

NOTE: change of date from the Call for Papers in May-June issue.

Environmental noise measurement is a continuing and expanding field where both legislation and the wider expectations of the individual are having an impact. Many sources of noise have to be measured outdoors, be it from a concert, from a factory, from a construction site or from traffic. Also increasingly the sound power levels from machines are required and in many cases these have to be obtained by outdoor measurements.

The challenge for the new millennium, with the ever widening capabilities of the latest generation of noise measuring instrumentation, needs to be addressed. The purpose of this Conference is to provide a mix of papers and tutorials, combined with practical measurements, to cover as many aspects of noise measuring outdoors both for the present and for the future.

The Shuttleworth Collection at Old Warden comprises mostly vintage aircraft and vehicles. Items from the Collection will be available to provide the delegates with a unique opportunity for measurement of a range of interesting sources. Delegates are therefore invited to bring along their own instruments. Companies represented on the Measurement and Instrumentation Group Committee will provide instrumentation for those unable to have such equipment present on the day.

Papers are still being sought on any aspect of measurements outdoors for inclusion in the formal parts of this 2-day Conference. Suggestions to the Meeting Organiser for the tutorials and even the workshop sessions are also welcome.

Time will be made available at the end of the practical measurements on the first day for delegates to visit the Shuttleworth Collection.

Meeting Organiser:

Martin Armstrong
Brüel & Kjær
Harrow Weald Lodge
92 Uxbridge Road
Harrow, Middlesex HA3 6BZ

Tel: 0181 954 2366
Fax: 0181 954 9504
email: martin.armstrong@bkgb.co.uk

CALL FOR PAPERS

Spring Conference

Acoustics 2000

'Research into Practice'

University of Liverpool

17-18 April 2000

The Spring Conference is the first for some time where a university venue provides a forum for both scientists and practitioners. The technical programme will be broad and will include sessions on architectural/building acoustics, environmental noise and vibration, low noise product design and structural acoustics. In addition, there will be open sessions and student sessions. Postgraduate research students will be encouraged to present papers through a reduced registration rate.

Abstracts of 200 words should be sent to the Institute of Acoustics before 26 November 1999 or to the conference organiser, Professor Barry Gibbs, University of Liverpool, School of Architecture and Building Engineering, Liverpool L69 3BX. Accepted papers, normally no more than 8 pages, must be with the Institute before 3 March 2000 in order to be included in the conference proceedings.

EDUCATION

Certificate of Competence in Sound Transmission in Buildings

Examination dates for the year 2000:

Friday 28 January 2000
Friday 22 September 2000

If you are interested in taking this programme please contact the Institute office at the address below.

A New Certificate Course

Certificate in the Management of Hand-Arm Vibration

The Institute has developed a programme for a short course certificate in the Management of Hand-Arm Vibration. It is hoped to hold the first examinations in early Summer 2000 following a market initiative in the new year.

All education institutions and training centres who are interested in running this course should contact the Institute office for details of the course syllabus and accreditation requirements.

Institute of Acoustics, 77A St Peter's Street, St Albans, Herts AL1 3BN
Tel 01727 848195 Fax 01727 850553 email ioa@ioa.org.uk Registered Charity No 267026

INSTITUTE DIARY 1999/2000

1999

21 OCT
Electroacoustics and Speech Groups Mtg: Speech Intelligibility
Manchester

22-24 OCT
Building Acoustics Group Mtg: Auditoria: The Legacy of the 20th Century and Beyond 2000
Manchester

28 OCT
Physical Acoustics 99 and AGM
IOP London

29 OCT
IOA CofC in Env Noise Measurement Exam
Accredited Centres

5 NOV
IOA CofC in W'place Noise Committee
St Albans

9 NOV
Membership Committee, PDC Committee
St Albans

10 NOV
Engineering Division Committee
St Albans

11 NOV
Meetings Committee, Publications Committee
St Albans

11 NOV
Midlands Branch Evening Mtg: Computation & Measurement - EU Noise Policy Working Group 3
Derby

11 NOV
North-West Branch Evening Mtg and AGM
Manchester

13 NOV
EAA Board Meeting
St Albans

17 NOV
London Branch Annual Dinner
London

17-18 NOV
Environmental Noise Group Conference: Environmental Noise Issues for the New Millennium
Stratford upon Avon

18-21 NOV
Electroacoustics Group Conference: Reproduced Sound 15
Stratford upon Avon

22 NOV
IOA CofC in Env Noise M'ment Committee
St Albans

23 NOV
Distance Learning Sub Committee, Education Committee
St Albans

25 NOV
Executive Committee, Medals & Awards Committee, Council
St Albans

8 DEC
London Branch Evening Mtg S'EAsy (ie Statistical Energy Analysis)
London

15-17 DEC
Underwater Acoustics Group Conference: Stochastic Volume and Surface Scattering: Recent Developments in Underwater Acoustics
Cambridge

2000

19 JAN
1-Day Meeting: The Acoustic Design of Cinemas and Large Leisure Complexes
London

19 JAN
London Branch Evening Mtg Noise Mapping
London

20 JAN
Groups & Branches Representatives Meeting
St Albans

27 JAN
Reproduced Sound 16 Committee Meeting and Electroacoustics Group AGM
St Albans

28 JAN
IOA CofC in Sound Transmission Within Buildings Exam
Accredited Centres

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

16 FEB
London Branch 1/2 Day Visit Luton Airport

24 FEB
IOA CofC in Sound Transmission Within Buildings Committee
St Albans

1-2 MAR
Measurement and Instrumentation Group Conference: Measuring Noise Outdoors
Home Counties

2 MAR
IOA CofC in W'place Noise Committee
St Albans

17-18 APR
Spring Conference Acoustics 2000
University of Liverpool

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

1 JUN
IOA CofC in W'place Noise Committee
St Albans

9 JUN
IOA CofC in Env Noise Measurement Exam
Accredited Centres

15-16 JUN
IOA Diploma Exams
Accredited Centres

6 JUL
IOA CofC in Env Noise Measurement Committee
St Albans

22 SEP
IOA CofC in Sound Transmission Within Buildings Exam
Accredited Centres

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

19 OCT
IOA CofC in Sound Transmission Within Buildings Committee
St Albans

27 OCT
IOA CofC in Env Noise Measurement Exam
Accredited Centres

2 NOV
IOA CofC in W'place Noise Committee
St Albans

23 NOV
IOA CofC in Env Noise Measurement Committee
St Albans

Non-Institute Meetings

1999

28-28 OCT
Swiss Acoustical Society Fall Meeting
Biel, Switzerland
Contact: email beat.hohmann@compuserve.com

1-5 NOV
138th Meeting of the Acoustical Society of America
Columbus, Ohio, USA
Contact: ASA, email asa@alp.org

9-11 NOV
National and International Congress on Noise and Vibrations
World Trade Centre, Rotterdam, The Netherlands
Contact: Anna Bosgode email swot-groep@apeldoorn.net

24-26 NOV
Australian Acoustical Society Conference
Melbourne
Contact: G Barnes, Acoustical Design Pty, email acousticdes@bigpond.com

2-4 DEC
ACTIVE 99, International Symposium on Active Control of Noise and Vibration
Fort Lauderdale, Florida, USA
Contact: INCE, email inceusa@aol.com

5-9 DEC
Inter•Noise 99
Fort Lauderdale, Florida, USA
Contact: INCE, email inceusa@aol.com

SOUND WAVES AND HEAT ENGINES

Anthony Atchley

The development of heat engines has been overshadowed by technological advances founded in quantum mechanics and condensed-matter physics for most of this century. Indeed, over the past few decades the prominence of classical thermodynamics in university curricula has faded to make room for more modern subjects.

However, most of the high-tech consumer products that have been made possible by advances in modern physics depend on electrical or mechanical power for their production and operation. All of the power consumed by these products, much of it generated from fossil fuels, eventually turns into heat. Improvements in the efficiency, cost and reliability of energy conversion and waste-heat removal processes are therefore extremely important to society.

Scott Backhaus and Greg Swift of the Los Alamos National Laboratory in the USA recently built a prototype of a new kind of heat engine that uses sound waves to convert heat into mechanical power. The engine has no moving parts and has a thermal efficiency of 30%, which is comparable with common internal-combustion engines [1]. This work is the latest, and perhaps the most important, improvement in the development of a type of heat engine that may fundamentally change the way that heat is converted into useful forms of energy.

The Los Alamos design is a hybrid thermoacoustic-Stirling engine. In its simplest form, a Stirling engine consists of a cylinder filled with a gas or 'working fluid' and two pistons. As the engine operates, the working fluid transfers heat to and from hot and cold heat exchangers, driving the pistons that do the mechanical work. Because this so-called Stirling cycle is a reversible one, the engine has a relatively high efficiency – a measure of how much heat can be transformed into work. However, this high efficiency is at the expense of mechanical complexity, and the high initial capital cost and recurring maintenance cost of Stirling engines have impeded their widespread use.

In contrast, thermoacoustic engines convert heat into acoustic power, and have been under development for only two decades. While other types of heat engines typically have pistons or rotating turbines, thermoacoustic devices are much simpler and have fewer moving parts. This mechanical simplicity relies on thermal conduction across a finite temperature difference to control the 'phasing' or the timing with which the gas compresses and expands so that power is produced. The disadvantage is that thermoacoustic engines have a low efficiency due to the irreversibility of this process. The Backhaus–Swift design combines the advantages of both types of engine. The result is an efficient and mechanically simple heat engine.

An important step in the development of thermoacoustics came in 1979 when Peter Ceperley of George Mason University in the USA recognized that the phasing of pressure changes in the Stirling cycle was the same as that in an acoustic travelling wave. Ceperley considered what would happen if the travelling wave in a gas propagated through a tightly packed porous medium called a regenerator. If there was a temperature difference across the regenerator, the gas would heat up and expand at one end of the device, and would cool and compress at the other end. This would amplify the acoustic wave by a factor known as the 'acoustic gain', ie, the device would convert thermal energy into mechanical energy in the form of sound.

Although it never demonstrated net acoustic gain, Ceperley built a proof-of-concept engine based on his ideas. In 1998 Taichi Yazaki and co-workers from Aichi University of Education in Japan built a travelling-wave amplifier, albeit with low efficiency.

There are two competing mechanisms in a thermoacoustic heat engine: the acoustic gain produced by converting the thermal energy stored in the regenerator into sound waves, and the energy loss due to the viscous resistance of the fluid in the regenerator.

The properties of the acoustic waves in the gas are often compared with AC electrical circuits. The ratio of the energy gain to the energy loss is linked to the acoustic impedance of the wave, which is defined as the ratio of its pressure to its velocity. The impedance of the travelling wave is low, so the ratio of the thermal gain to viscous loss is too low to produce an efficient device.

Backhaus and Swift overcame this drawback by finding a way to generate a large impedance, while maintaining the correct phasing. The Los Alamos engine comprises a quarter-wavelength acoustic resonator filled with helium gas, the pressure of which is 30 atmospheres (see Figure 1). One end of the device has a toroidal section that contains heat exchangers and the regenerator.

If sufficient heat is supplied to the hot heat exchanger, the resonator spontaneously oscillates. Part of the resulting sound wave travels through the long section of the resonator where it can be used to drive a load such as a transducer to convert sound power into electrical power. The purpose of the toroidal shape is to allow the remainder of the power to be fed back to the regenerator. The length and variations in the cross-sectional area of the torus determine the impedance of the circuit. Backhaus and Swift carefully designed the torus so that the engine has the proper phasing and sufficiently high impedance for it to be efficient. While the feedback path is integral to a successful design, it also introduced what amounted to a heat leak in the engine, which seriously degraded the performance of their first prototype. Backhaus and Swift found that they had to supply twice as much heat to the engine to maintain the sound waves as predicted. Furthermore, the temperature along the length of the regenerator did not match their computer models.

In 1997 David Gedeon, at Gedeon Associates in the USA, explained that the acoustic power flow in a closed

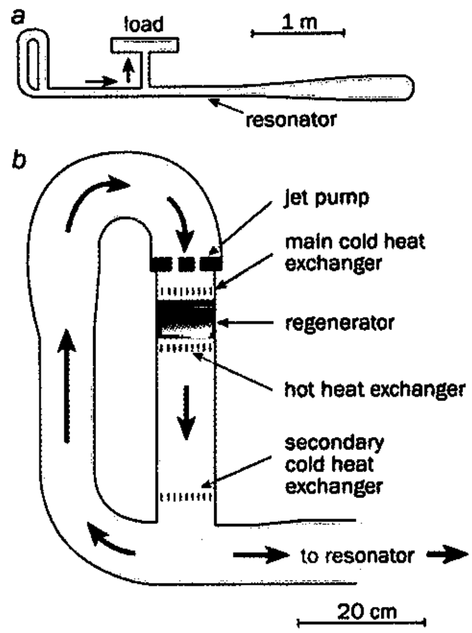


Fig. 1. (a) The thermoacoustic-Stirling heat engine, made from steel pipe, converts heat to acoustic energy which is used to drive a load. (b) A closeup view of the torus-shaped feedback loop shows the regenerator sandwiched between hot and cold heat exchangers, which serve as a heat source and heat sink, respectively. The regenerator amplifies the travelling acoustic wave via heat transfer, while the jet pump plugs any 'heat leaks'.

loop would be accompanied by a net flow, or 'streaming', of gas from the hot heat exchanger to the secondary cold one. This streaming effect 'short-circuited' the hot and cold ends of the regenerator. The Los Alamos team built a specially shaped orifice called a jet pump to cancel this streaming and create a large impedance for gas flowing in one direction, but not the other.

At its most efficient operating point, the Los Alamos engine delivered 710 W of acoustic power with a thermal efficiency of 30%. At its most powerful operating point, the engine delivered 890 W but with a slightly lower efficiency. These efficiencies are comparable to those of internal-combustion engines and piston-driven Stirling engines, but the thermoacoustic-Stirling hybrid has no moving parts.

Backhaus and Swift plan to couple the hybrid heat engine to a refrigerator to form a combustion-driven, gas liquefier that has no moving parts. However, the researchers anticipate many other applications of their technology. They also stress that this success has been achieved with their first, small laboratory prototype. They expect that further research will lead to even higher efficiencies. These improvements will make acoustic heat engines even more competitive with current technologies.

Reference

[1] Nature, 399, 355, (1999)

This article was first published in the August 1999 issue of Physics World published by the Institute of Physics.

Anthony Atchley is in the Graduate Program in Acoustics at the Pennsylvania State University, USA. ❖

COMMENTS ON TECHNICAL INITIATIVES FROM INTERNATIONAL INCE

As a Member Society of the International Institute for Noise Control Engineering (I-INCE or International INCE), the Institute of Acoustics has been asked to comment on the following proposed Technical Initiatives. We are asked, in respect of each initiative in turn,

1. Should the I-INCE General Assembly adopt the initiative ?...Yes or No.

2. Does the Institute of Acoustics (IOA) agree to participate by naming a technical expert to join any Technical Study Group set up ?...Yes or no.

3. Are we supplying written comments ?...Yes or No.

In order that IOA official representatives at the I-INCE General Assembly, to be held at Internoise 99 early in December 1999, are briefed in time, please send any comments, and offers to participate, to me by 1 November 1999, through the IOA office.

Bernard F Berry, Executive Board Member of I-INCE
Immediate Past President IOA

Proposed Technical Initiative 1 Noise of Recreational Activities in Outdoor Areas

Background

This proposed I-INCE technical initiative deals with *the noise of recreational activities in outdoor areas*. Recreational activities can be defined as those pursuits outside one's regular occupation that are usually indulged in for purposes of relaxation, or leisure-time activity after work. Noise is associated with many recreational activities. While the providers of such activities may be uninterested, unwilling, or unable to control the noise, non-participating bystanders (humans as well as animals) are sometimes exposed to relatively high levels of noise. For example, the maintaining of natural quiet in national parks and wilderness areas is considered by many to be paramount to the survival of our natural environment. But the incursion of recreational activities involving air-, land-, and watercraft in many of these reservations has greatly changed the natural environment. There are many other examples where the incursions of outdoor recreational noise create friction between the purveyors of the noise, and the bystanders who are not involved in the recreational activities – the noise of amusement and theme parks, the noise of speedways and other motor sports, the noise of small airfields, and the sounds of outdoor concerts.

Concept

This proposed I-INCE technical initiative will be concerned with the noise associated with many different kinds of recreational activities that are undertaken outdoors. Excluded will be those recreational activities and performances that are undertaken indoors with sound leakage from a building to the outdoor areas surrounding the building. In some countries, there has been much progress in limiting outdoor recreational noise, but in others a lack of knowledge and initiative has hampered progress, not to mention the opposition by many business interests to effective measures for the control of noise.

Scope

The technical report resulting from this proposed initiative is intended to study the problems posed by outdoor recreational noise on a world-wide basis, and, in particular:

- to assess what has been achieved globally to limit outdoor recreational noise,
- to compile national and international noise policies relating to outdoor recreational noise,
- to discover what regulations have been drafted or promulgated,
- to determine what methods have proven effective, and what have not, and
- to ascertain what measurement methods have been prescribed.

Action Plan

In Fort Lauderdale (1999 December), the General Assembly will be asked to make the decision whether or not to go forward with the proposed study of the noise of recreational activities in outdoor areas. If approved, it is understood that this will be a large-scale, internationally co-ordinated program to assess the problems posed by outdoor recreational noise and to determine the most effective ways of overcoming them.

Because of the magnitude of the task, the General Assembly may decide to define sub-tasks which may be assigned to a number of Technical Study Groups (TSG).

Target Date

A draft of a report, together with recommendations for future action, should be available for review by the General Assembly within two years of the initial meeting of the Technical Study Group, following the approval of this initiative by the General Assembly. At this point, the General Assembly may decide to formulate a strategic plan to achieve implementation of those recommendations agreed by consensus of the General Assembly as necessary for the public good.

Proposed Technical Initiative 2 Noise Labels for Consumer and Industrial Products

Background

This proposed I-INCE technical initiative deals with *noise labeling for consumer and industrial products*. Consumer goods are sold at retail to ultimate customers for personal or household use, indoors or outdoors. Industrial products are sold to commercial firms for a wide variety of purposes. In many parts of the world, consumer and industrial goods are sold without any noise limitations, and frequently no indication to the purchaser how noisy the products will be when installed, either to those who operate the products or to those in the vicinity. There is much work in progress to develop international and national standards for measuring the noise characteristics of consumer and industrial products, and there are testing organizations in many countries which carry out appropriate evaluations. However, the noise data available to the typical customer is frequently limited, even in those countries where there is great concern for noise at the workplace, in the home, and in the neighborhood.

Concept

This proposed I-INCE initiative will involve a study of the labeling and other forms of product information dealing with noise emissions that are furnished to the purchaser of consumer and industrial products. To provide this information, the testing laboratory follows a prescribed procedure. Hence, the technical aspects of measuring and evaluating the noise of consumer and industrial products are a part of this study. One or more I-INCE Technical Study Groups (TSG) will be constituted to carry out this study. The TSG will assemble information from the countries whose representatives are participating in the study on noise labeling methodologies. Such methodologies are intended to provide effective means for specifying the noise properties of consumer and industrial products to make it possible for the purchasers to select low-noise products. The intent is to provide information that will benefit the users of these products, and their neighbors. The ultimate goal is to make the low noise of products an important competitive factor in the sale of such products. An important aspect of this study is to develop recommendations on how and in what form labeling can be implemented to bring about people's awareness of the effects of excessive noise, and the need to reduce noise immission levels to preserve health and provide an acceptable environment.

Scope

This proposed I-INCE initiative will survey current methods for labeling and otherwise characterizing the noise emissions of consumer and industrial products. The measurement methods used by testing authorities will be included in the survey. The methodologies will be compared, and an assessment will be made of their relative effectiveness. The study of noise labeling is part of an educational program to advise on how and in what form such labeling should be implemented.

Action Plan

In Fort Lauderdale (1999 December), the General Assembly will be asked to make the decision whether or not to go forward with the proposed study on noise labeling for consumer and industrial products. As this is a very broad topic, the General Assembly may decide to assign it to two or more TSGs.

Target Date

A draft of a report, together with recommendations for future action, should be available for review by the General Assembly within two years of the initial meeting of the Technical Study Group, following the approval of this initiative by the General Assembly. At this point, the General Assembly may decide to formulate a strategic plan to achieve implementation of those recommendations agreed by consensus of the General Assembly as necessary for the public good.

Proposed Technical Initiative 3 Assessing the Effectiveness of National and International Noise Policies and Regulations

Background

This proposed I-INCE technical initiative deals with the effectiveness of noise policies and regulations around the world. During the last half of the 20th century, many countries have recognized noise as an environmental and occupational problem, and have been working to develop noise control and exposure policies. Considerable time and effort are devoted each year throughout the world to developing noise control and exposure policies for places where people work, for places where people live, and for outdoor environments devoted to leisure activities. Little is known about how effective various noise policies and regulations have been in controlling the noise exposure (noise immission) of the individuals and populations which they are intended to protect.

Concept

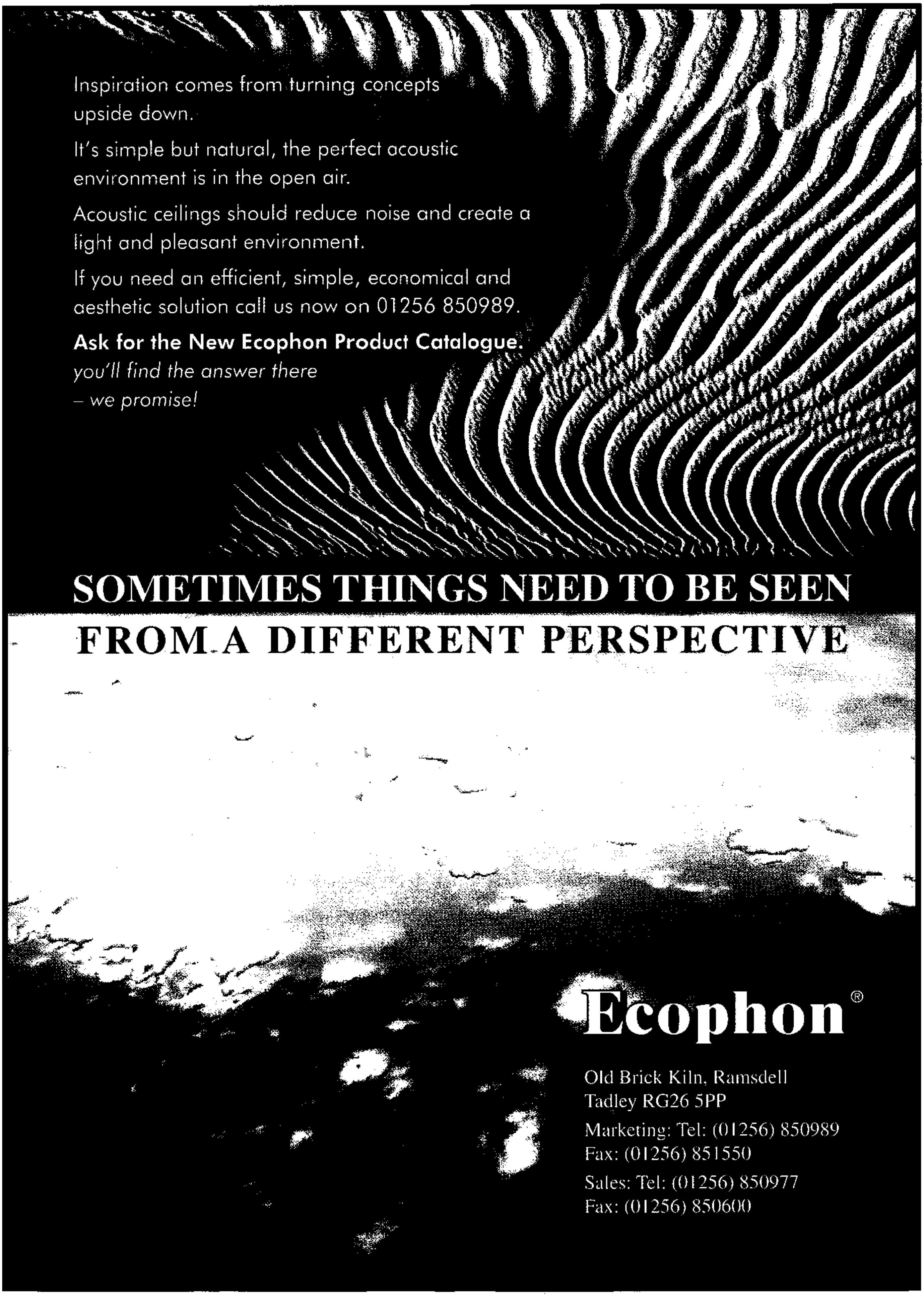
This proposed I-INCE initiative will involve a study of existing noise exposure policies and regulations in all countries which have recognized noise as a problem involving public health and welfare. The first phase will involve the collection and cataloging of as many noise exposure statements and related regulations as possible. The second phase will involve developing a baseline of noise exposure estimates for each participating country, including compliance with existing policies. The third phase will entail determination of the long-term effectiveness of these policies and regulations in controlling noise exposure by examining the changes in various noise exposure parameters over time, and the relative cost-effectiveness of the various actions.

Scope

This proposed I-INCE initiative will involve the compilation of existing noise exposure policies and the noise regulations enacted to implement these policies, estimating noise exposure in various sample community and occupational situations, and assessing the relative effectiveness of these policies in controlling noise exposure.

Action Plan

In Fort Lauderdale (1999 December), the General Assembly will be asked to make the decision whether or not to go forward with the proposed study of the effectiveness of noise control and exposure policies around the world. If approved, it is understood that this will be a large-scale, internationally-coordinated program to assess the effectiveness of noise control and exposure policies, guidelines, and regulations. The results will be documented in a formal report, including both a description of existing noise exposure levels and the long-term impacts of national and international noise control efforts. Because of the magnitude of the task, the General Assembly may decide to define sub-tasks which will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be assigned to two or more Technical Study Groups (TSG).

Target Date

A draft report, together with recommendations for future action, should be available for review by the General Assembly within two years of the initial meeting of the Technical Study Group, following the approval of this initiative by the General Assembly. At this point, the General Assembly may decide to formulate a strategic plan to achieve implementation of those recommendations agreed by the General Assembly as necessary for the public good.

Proposed Technical Initiative 4 Noise and Reverberation Control for Schoolrooms

Background

This proposed I-INCE technical initiative deals with the *control of noise and reverberation in learning spaces, particularly schoolrooms.* Good acoustics is central to verbal learning in classrooms and other learning spaces in schools, and is therefore vital in every knowledge-based society. Many countries, including Great Britain, Italy, Portugal and Sweden have taken steps to establish standards or guidelines for schoolroom acoustics. A study aimed at evaluating the methods employed in countries throughout the world to optimize acoustic environments in schoolrooms would provide helpful support to those countries for which such standards or guidelines do not exist. There are strong incentives to employ such standards or guidelines in all countries, especially in those countries where the population of school-age children is growing rapidly, and new or refurbished educational facilities are being constructed or planned. Regional differences in noise control requirements associated with differences in proximity of outdoor noise sources or outdoor air temperatures need to be identified as well as differences in the most cost-effective noise and reverberation control technologies and associated materials.

The result of the proposed study would be of substantial benefit to societies which need to improve the acoustic environment in their schoolrooms and help to remove acoustic barriers to learning that prevent students of all ages from reaching their full potential.

Concept

This proposed I-INCE technical initiative will survey the major architectural expressions of different types of learning spaces, particularly schoolrooms, in participating countries; will identify the needs of such spaces for acoustical design and noise control technology; and will include site planning, methods for ventilation, heating and cooling, and their interactions with acoustics. The survey will respect cultural differences and diversities, and the realities of the local economy.

A set of recommendations for schoolroom acoustical criteria, including practical knowledge of the costs and benefits of noise and reverberation control, will be developed. These will provide acoustical and noise control guidance to educational space designers and builders, and to those who influence national codes for schoolroom design.

Scope

This proposed I-INCE technical initiative will be concerned with those technical aspects of the acoustics of schoolrooms and other learning spaces in schools that provide opportunities for the cost-effective application of noise and reverberation control technologies to promote improved verbal learning in knowledge-based societies.

Action Plan

In Fort Lauderdale (1999 December), the General Assembly will be asked to make the decision whether or not to go forward with the proposed study of noise and reverberation control for schoolrooms. If approved, it is understood that this will be a large-scale, internationally coordinated program to assess the problems associated with the acoustics of the schoolroom. Because of the magnitude of the task, the General Assembly may decide to define sub-tasks which may be assigned to a number of Technical Study Groups (TSG).

Target Date

A draft of a report, together with recommendations for future action, should be available for review by the General Assembly within two years of the initial meeting of the Technical Study Group, following the approval of this initiative by the General Assembly. At this point, the General Assembly may decide to formulate a strategic plan to achieve implementation of those recommendations agreed by consensus of the General Assembly as necessary for the public good.

Proposed Technical Initiative 5 Noise As A Global Policy Issue

Background

This proposed I-INCE technical initiative deals with *noise as a global issue versus noise as a local issue.* There is a tendency in some countries of the world to consider noise, from the policy standpoint, as a local issue, ie, an issue that should be handled at the municipal level rather than as a federal matter to be handled at an international level.

There are several reasons for this attitude. Noise pollution has had a lower priority than other environmental problems such as air and water pollution. Noise propagates through the air over short distances (rarely more than 10 km), and it is non-persistent. In the physical sense, it could be considered a local phenomenon. However, the sources of many of the causes of environmental noise are not of local origin.

Concept

This proposed I-INCE technical initiative will consider the arguments for and against consideration of noise as a global policy issue, and will develop a strong case for considering noise at the international level. One of the important reasons is the major contribution of the international traffic system to the noise problem which cannot be controlled at the local level. It will also be demonstrated why noise may become an important non-tariff trade barrier issue.

Scope

This proposed I-INCE technical initiative will make the case that noise must be considered as a global policy issue, and any treatment of the subject on a smaller scale will be counter-productive.

Action Plan

In Fort Lauderdale (1999 December), the General Assembly will be asked to make the decision whether or not to go forward with the proposed study of noise as a global policy issue. If approved, it is understood that this will be a relatively quick study involving a few experts who have had experience in the international policy arena.

Target Date

A draft of a report, together with recommendations for future action, should be available for review by the General Assembly within one year of the initial meeting of the Technical Study Group, following the approval of this initiative by the General Assembly.

NOISE ON THE NET – PART 1

Matthew Ling MIOA

Over the past few years the development of the World Wide Web (WWW) has occurred at a rate that is difficult to keep up with. This article is the first of a regular series featuring internet sites that provide acousticians with relevant and useful information.

How Much Do You Want to Know?

The WWW provides a huge resource of information. There are, however, a number of facts to remember:

- information is not necessarily correct – there is rarely any peer-reviewing of the content of sites.
- information is not necessarily up to date – many organisations are only now getting their act together and putting their archived information on-line. As well as this, many companies forget that they need to continually up-date the information. This is especially true where offices move and phone and fax numbers change!
- information is not necessarily useful – one wise person said that '1% of the information on the internet is useful and the other 99% is rubbish'. The retort to this is that the 1% of useful information is different for each individual!

Throughout my discussions I will assume that you already have an Internet connection and an up-to-date web browser, such as Netscape or Microsoft Internet Explorer.

What Do Those Letters Mean?

At first glance a web address is confusing. It can, however, help you determine what sort of site you are about to visit and also which country the organisation is based in. For example the DETR site has the address in Figure 1.

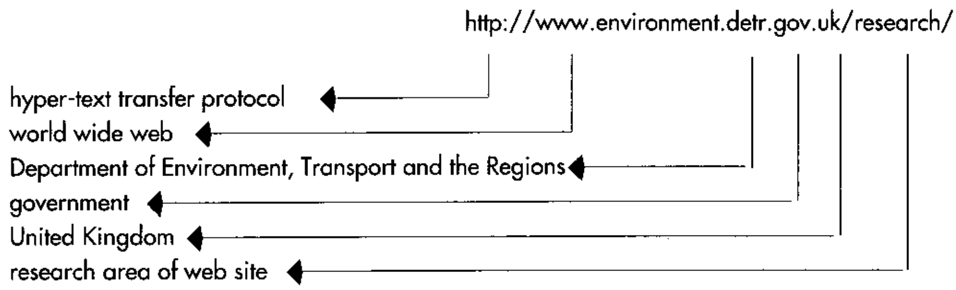


Fig. 1. Explanation of a DETR site

Other address elements commonly encountered are:

.com	company (nominally US based, or multi-national)
.org	organisation
.mil	military
.com.au	company in Australia

This does allow you some degree of guesswork when trying to find a website. For instance the Institute of Acoustics (ioa) is an organisation (.org) based in the United Kingdom (.uk). Its web site would thus logically be http://www.ioa.org.uk [1]. After a little experience, finding sites like this becomes intuitive. However problems do occur if another organisation such as the Institute of Anthropologists have registered the domain name ioa.org!

Web Bibliographic Sites

Most internet users are familiar with the conventional search engines such as Yahoo, Microsoft and Altavista. The initial difficulty is that when using a general search word such as 'noise' a hierachial search engine such as Yahoo will return you 18 categories, and 687 sites. The challenge is then to refine the search to, say, 'noise and building', which results in a dramatic reduction of your choices to 2 sites.

This process of sifting through search results and refining search words is incredibly time-consuming, so a more intelligent technique is to rely on someone else's effort! Whilst not perfect, it does enable you, in the majority of cases, to reach acoustic related organisations quicker. Some of the most useful of these web bibliographic sites are given in Table 1.

A Word of Warning

A word of warning? Well yes, time is of an essence when you're browsing on the web and once you start you won't have any left. But it can be time well spent.

And Finally...

A good place for obtaining general information is one of the search engine sites. A huge range exists, with the major ones being:

Altavista	http://www.altavista.com
Excite	http://www.excite.com
Infoseek	http://www.infoseek.com
Yahoo UK	http://www.yahoo.co.uk
UKplus	http://www.ukplus.co.uk

All these sites are useful starting points. However, once you start following links you will probably wonder how on earth you managed to arrive at the South Pole (http://www.antarcticanz.govt.nz/) when all you wanted to know was the IOA President's email address [2]!!

This is the first of a series of features written with the aim of providing you with some of the sources of information on noise and acoustics that are lurking around the Internet. If you know of sites that could be of interest to other acousticians, then send them to lingm@bre.co.uk to be featured at a later date.

[1] At present the IOA website address is http://www.essex.ac.uk/ioa

[2] ian.campbell@dial.pipex.com if you really want to know!

Matthew Ling MIOA is Senior Researcher with the Acoustics Centre, BRE, Watford

Details	Address
Acoustics and Vibrations WWW Virtual Library	http://www.ecgcorp.com/velav/index.shtml
ACOUSTICS from Douglas Nunn. Probably the most up to date listing of sites in the UK	http://capella.dur.ac.uk/doug/acoustics.html
Acoustical Society of America Links to other sites of interest. The ASA site also has on-line searching of abstracts, an introduction to acoustics, and current acoustics job vacancies!	http://asa.aip.org/links.html
Associated organisations from the IOA	http://www.essex.ac.uk/ioa/websites/websites.html
Audio and Music Links from Martin at McGill University	http://www.music.mcgill.ca/~martin/audio_links.html

Table 1. Some of the most useful web sites.

'DAT'LL BE THE DAY'

University of North London, 17 February 1999

A previous workshop run by the Measurement & Instrumentation (M&I) Group had identified that the use of DAT recorders in association with sound level meters (SLMs) for everything from noise nuisance identification to comprehensive analysis of recordings contains many potential pitfalls for the unwary. The widespread use of DAT recorders was reflected in the turnout for this One-Day Workshop, organised by John Shelton of the M&I Group Committee. A capacity 55 delegates registered to attend, attracted by the programme of presentations in the morning and hands-on workshop sessions with their own equipment in the afternoon.

The morning session began with Ian Campbell (Gracey & Associates) discussing the requirements for front ends for DAT recorders. As DAT recorders are designed for broadcast journalism and the entertainment industry, Ian demonstrated the need for instrumentation-quality microphones or SLMs, plus suitable connections to the recorder, when making recordings for subsequent analysis. The correct procedures for recording calibration tones on tape and ensuring good signal levels were also comprehensively covered.

Richard Tyler (CEL Instruments) addressed the question of whether the use of DAT recording preserves the accuracy associated with measurements made with Type 1 SLMs. CEL's calibration laboratory had tested a variety of common DAT recorders to the requirements of BS 7580 Part 1. The tests showed that the recorders' dynamic range over which Type 1 accuracy is maintained extends to at least 60 dB below the recorder's 0 VU level, when used optimally. Richard also demonstrated the adverse effects of misuse of the recorders' capabilities.

Good practice in setting up and making successful DAT recordings was demonstrated by Martin Armstrong (Brüel & Kjær (UK)). Martin used the nominal performance of DAT technology itself to illustrate the need for calibration and suitable matching of SLM and DAT recorder ranges for optimum recording of noise at various levels, and provided a reminder of the best recording procedures. The morning session concluded with John Shelton (AcSoft) discussing procedures and rules of thumb for the analysis of DAT recordings. Practical issues regarding analogue and digital output connections from DAT machines and input adaptors for SLMs were discussed, and the perils for quality of analysis of not following the rules of thumb were also illustrated.

After a delicious and convivial Korean lunch, the delegates were divided into two groups for the workshop sessions. An impressive number of delegates had brought along their own DAT recorder systems, while the workshop leaders provided equipment for other delegates to try their hands. Richard Tyler led a workshop exercise in techniques for recording, taking the delegates through the process of preparing the recorder, setting up and calibrating their system, and making recordings using suitable measurement ranges of a number of typical noise sources played into the workshop room. At each stage the delegates were encouraged to relate their hands-on experience in this workshop to the knowledge gained from the morning presentations. The second workshop was led by John Shelton, who presented the delegates with a set of identical pre-recorded DAT tapes containing a number of noise events. Delegates were asked to set up their equipment for analysis and to determine L_{eq}, L_N, one-third-octave band levels etc of each event following the best practice outlined in the morning session.

Both the morning presentations and the workshop sessions gave delegates fresh insight into the whole procedure of recording and analysis using DAT recorders combined with acoustical instrumentation, and the popularity of the event (to judge from the questionnaires returned by the delegates) reflects on the hard work put in to organise the event by John Shelton and the rest of the presenters.

Peter Hanes MIOA

GETTING A GRIP ON HAND-ARM VIBRATION

National Motorcycle Museum, 29 June 1999

The Institute only occasionally dips its arm into the realm of vibration, so it was encouraging to see a turnout of 71 delegates (including presenters) for this One-Day Meeting. Along with an exhibition by manufacturers and safety regulators, the real attraction for the delegates was the quality and breadth of the 11 presentations made during the day.

Chris Nelson (Health & Safety Executive) began the morning with an introduction to the various national and international standards that relate to both vibration exposure and emission. One significant document will be a forthcoming EN ISO 5349-1 that will draw on the better elements of existing BS and ISO standards. Paul Pitts (Health & Safety Laboratory) continued with the topic of standards by describing the proposed EN ISO 5349-2, which will contain practical advice on measurements in the workplace and guidance for new practitioners. He outlined the contents of the standard and detailed the uncertainties involved in measurements.

Iain Critchley (Peninsular Acoustics) described a hand-arm vibration risk assessment undertaken for a public water utility. This work involved recreating realistic measurement conditions to determine levels, risk evaluation in terms of a daily vibration dose, and implementing a management system and training programme to ensure that real benefits were reaped in the workplace. A similar assessment, in which a strategy for management of exposure was developed by the Council, was described by Kenneth Hill (Glasgow City Council). Kenneth also described field assessments of machines, considered the accuracy of the measurements performed, and discussed exposure guidelines based on dose values for individual machines, as they affect council employees.

Paul Pitts also presented a paper by Liz Brueck (Health & Safety Laboratory) on experiences of assessing measuring instruments against ISO 8041. Assessments of three instruments were made, and problems with the existing specifications and methods were identified: these areas are under consideration for a revision of the standard. In the final paper of the morning, Neal Hill (European Process Management Ltd) spoke of his experiences in measurement and CE marking of vibrating products. Neal used a case study on chainsaws to identify potential errors and pitfalls in the measurement process.

Mike Fillery (Chairman, IOA Education Committee) opened the afternoon session by asking the delegates whether they thought there was a need for a course on Hand-Arm Vibration. The general indication was that a course would be suitable; the Committee is now seeking volunteers for a Working Party to arrange a syllabus etc.

The conventional papers resumed with a presentation by Tim South (Leeds Metropolitan University) on the merits of frequency analysis of vibration over HA-weighted results. Tim outlined a study into the subjective effects of vibration from woodworking that had also demonstrated that frequency analysis could help provide criteria for acquisition and maintenance of tools.

Measurement of vibration from power hand tools used in the shipbuilding industry was discussed by Simon Clampton (Marconi Marine Ltd). Simon gave details of the instrumentation and measurement procedures used, presented results and recommendations for such measurements, and showed how the results had assisted the company's vibration control strategy. Richard Stayner (RMS Vibration Test Laboratory) followed with a description of vibration problems found in agriculture and forestry. He presented vibration levels, references to relevant standards, and estimated exposure limits for a series of machines, with details of some additional investigations of strimmers.

Graham Twigg and Steve Fitchett (Tecforce Ltd) presented a risk assessment exercise for hand-held pneumatic tools carried out for a manufacturer of railway rolling stock. Each step in the assessment from creating an employee exposure checklist, through investigative measurements, to the development of tool purchase and maintenance programmes was described.

To conclude the day's events, meeting organiser Richard Tyler chaired a question and answer session for the assembled presenters. Topics ranged from details of transducer mounting arrangements to differences between the various dose management systems that were described by a number of the authors. The combined expertise of those present enabled an enlightened and meaningful discussion to take place, echoing the success of the day's presentations. Many of the delegates completed evaluation forms, with the majority rating the meeting as good or excellent on most counts.

Peter Hanes MIOA ❖

ENGINEERING COUNCIL QUARTERLY ARTICLE - JUNE 1999

Malcolm Shirley

The word marketing and, to some extent, the concept itself has become somewhat abused in recent times. Abused in that people talk about marketing when that's not strictly what they mean; they often mean publicity or advertising or selling, perhaps. And abused in that, even when people use the word accurately, they can have unreal expectations of what marketing is actually able to do for them or their organisation.

Marketing is not black magic or a sure-fire recipe for instant success. It is however, when done properly, an invaluable business tool that has helped many of the world's most successful organisations to reach the top in their respective fields. Ask Ford, Coca-Cola or Microsoft about the value of marketing. Bill Gates may well be a computer genius whose innovative IT systems have revolutionised the way we work – but I feel certain Bill himself would admit that his company's all conquering position would never have been achieved without equally innovative marketing.

Marketing is an organisational function that relates to the identification and understanding of customer needs and wants and the provision of products or services to satisfy those needs at a profit – at the right time, in the right place and at the right price.

For the Engineering Council, the 'profit' we are seeking as an end product to our activities is not really financial, although we do of course need income to survive. The profit we seek primarily to derive is the enhancement of the engineering profession in the national interest and to the benefit of society. Our customers are professional engineers, the Institutions, engineering industry and society at large – as represented by the Government.

Broadly speaking, the products and services we supply are: the promotion of engineers and engineering; regulation of the profession to improve and enhance the professional standards of engineers and technicians; and the provision of a coherent focus for the development and influence of engineering policy.

By its nature, marketing touches every sphere of our organisational activity. We are learning fast that to make the contribution the profession expects from us, the Engineering Council needs to become more switched on to the needs and desires of its customers and be more creative in understanding, addressing and satisfying our markets.

The most successful organisations learnt long ago that tacking on a promotional dimension to their existing operations was not good enough. Rather, it is the building of environments in which the satisfaction of customer needs becomes the core focus of all activities at every level that really makes the difference. This then is the starting point of the Engineering Council's marketing thinking and development.

We believe strongly that both the Council and the profession – Institutions and individuals alike – will benefit greatly from successful, targeted marketing and we have, over the past couple of years, endeavoured to make marketing an integral part of our operation. We have introduced a more market driven and customer focused approach to everything we do, but our recognition of the importance of marketing has manifested itself principally in two major initiatives.

The first is the National Marketing Campaign that we have been developing with our partners the Engineering Employers' Federation (EEF), the Engineering and Marine Training Authority (EMTA) and the Engineering Construction Industry Training Board (ECITB). This is a broad, strategic campaign aimed at grabbing public attention and redefining the public perception of engineering in the UK. We believe that this umbrella campaign would provide a perfect backdrop to the engineering community's many other promotional initiatives, putting them into context and amplifying their impact.

We have received significant Government support, but in order for the campaign to become a reality we need the wholehearted backing of industry who, after all, would be the prime beneficiary of a world-class engineering workforce equipped to meet the industrial and commercial challenges of the 21st Century.

Although the industrialists we have approached agree with our definition of the problem and even our proposed solution, converting their support into funding is proving very difficult and the future of the campaign hangs in the balance. Whatever the outcome, however, the need for such an initiative remains overwhelming and – should our proposed campaign fail to materialise – some alternative means of marketing of engineering in the UK will still be essential if the brightest and best young people are ever to be persuaded to come into the profession.

Fortunately, there are no such doubts surrounding the future of the Council's second major marketing initiative – our campaign to develop professional membership and registration, on which we are about to embark in earnest. Our National Register of Professional Engineers and Technicians is by far the Council's greatest asset and accounts for the lion's share of our income. Numbers on the Register remain pretty stable, but we know that there are hundreds of thousands of eligible engineers out there who, for whatever reason, have not taken the all-important step of registering. They are our target.

Convincing them of the value of Institution membership and registration is in everyone's best interests: the Institu-

tions get more members; the Council gets more Registrants; the position of existing Registrants is enhanced because increased numbers means greater influence; and new Registrants themselves become official members of the best profession in the world. It behoves all of us, therefore, to want to see this initiative succeed.

To ensure that it does, the Council is putting significant effort and resource into the exercise. We have recently appointed a Marketing Manager, whose main priority will be to drive this project, and we will also take on specialist outside assistance where necessary.

Developing professional membership and registration, however, is not something that the Council can do in isolation. If the campaign is to have any real chance of success, it must complement the efforts of individual Institutions in this area. That is why we have involved Institution representatives in the planning stages of the campaign and will be seeking to involve all Institutions in its implementation. After all, more Registrants also means more members.

The realisation that marketing is essential to the success of any organisation came late to the Engineering Council, but we now intend to make up for lost ground. With the support of the Institutions and their members, we believe that our marketing efforts will enable the profession to go from strength to strength in the new millennium.

Malcolm Shirley is Director General of the Engineering Council ❖

Douglas Robinson HonFIOA

Doyen of Acoustics

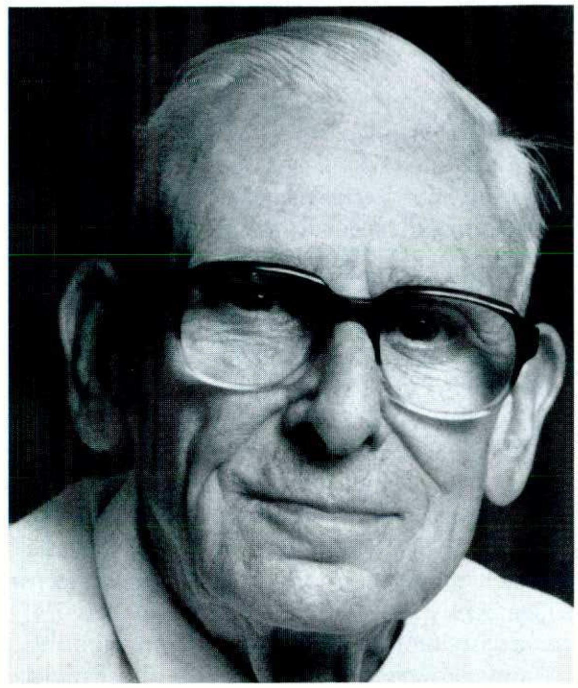
Douglas William Robinson, who has died aged 78, played a leading international role in the advancement of acoustics and scientific audiology, and was the authority behind much of the legislation now protecting society from the adverse effects of noise.

He was born on 22 July 1920 and educated as a Foundation Scholar at Owens School before graduating at Imperial College with a first class BSc(Eng) honours degree in Electrical Engineering and the award of the Henrici Medal for Mathematics. His first employment was with the Western Electric Company where he worked on a variety of topics including audiometry and the modelling of acoustic filters for ground testing of aero engines. Commissioned on entry to the Royal Air Force Volunteer Reserve in 1940 he received training in signals and intensive airborne radar before being posted to the Far East. His escape to Java from the Japanese advance on Singapore was short lived and he endured four years of privation as a prisoner of war.

After demobilisation Douglas Robinson took positions with the Rediffusion Company and then with Standard Telephones and Cables where he remained until 1950. During this time he developed the electrodynamic reference system for telephone transmission (SETED) using a quartz crystal as the absolute standard of sound pressure; and was responsible for acoustical calibration work, developing the probe microphones used in the audiometer test sets at the launch of the National Health Service in 1948.

Success in the open competition for the Scientific Civil Service led to his appointment to a post in the Acoustics Section at the National Physical Laboratory (NPL), where his first assignment was a thoroughgoing re-determination of the equal-loudness contours, completed in 1956. Research studies on loudness scaling and on audiometric standards followed, including development of the artificial mastoid. He became head of NPL acoustics in 1959.

This was an extremely busy time for Douglas Robinson and he quickly established himself as the leading UK researcher in matters relating to environmental and industrial noise. In 1961 he played a major role in organising at NPL the first ever international symposium on noise. This was concurrent with his own subjective studies of motor vehicle and aircraft noise, the results of which were subsequently used by the Wilson Committee on Noise. This was followed by the start of a major joint investigation with the Medical Research Council (MRC) on hearing and noise in industry. Further research was then undertaken on loudness, sonic boom trials and the ramifications of aircraft noise certification. In the late 1960s he turned his attention to the numerical quantification of noise in a campaign to rationalise the numerous scales and units being used to describe human reaction to noise. Thus the Noise Pollution Level came into being; the pun in the abbreviated title NPL was not entirely accidental and is credited to his wife, Joyce. He



was also involved in the establishment of various committees and working groups of the British Standards Institution (BSI), the International Organization for Standardisation (ISO) and the International Electrotechnical Commission (IEC) together with service on the International Commission on Acoustics. Douglas Robinson was promoted to Deputy Chief Scientific Officer in 1971, by which time the joint NPL/MRC investigation was complete. This led on to the Health and Safety Executive (HSE) Code of Practice (1972), the Department of Health and Social Security occupational deafness compensation scheme (1974), and a series of other studies on industrial audiometry and hearing protection.

During the 1970s, audiological standardisation returned to prominence and many significant experimental researches were carried out with co-workers. These included a study of age-related hearing loss; a determination of the normal threshold of hearing by bone conduction; the validation of the international threshold standard for hearing by air conduction and how it relates to the definition of otologically normal persons. This latter definition is still reverberating in medico-legal cases where comparison of the individual with the notional normal baseline has become a critical issue. There was also much advisory work undertaken for government departments and other institutions, principally the Noise Advisory Council and the Noise Research Committee of the Aeronautical Research Council until these bodies were abolished following the 1979 election. In 1975 he shared the last of the Wolfe Awards for outstanding contributions to research in Government science.

Douglas Robinson retired from the NPL in 1981 and took up a part-time research professorship at the Institute of Sound and Vibration Research (ISVR), at the University of Southampton. He continued to take an active part in acoustical standardisation through his chairmanship of the BSI acoustics technical committee and membership of various subcommittees. He established relationships between hearing impairment and the onset of hearing disability and handicap, sponsored by the MRC, and critically examined all the available results in the field of noise in industry out of which came a new model of the dose-response relationships for the HSE. With funding from the Ministry of Defence he then attacked the intractable problem of predicting a person's potential susceptibility to hearing loss by noise ahead of actual exposure. Finally, in a project sponsored by the Department of the Environment he quantified the annoyance of tones in noise so eliminating the need for a subjective element from the assessment of environmental noise problems. At the end of his appointment with the University of Southampton in 1992 he remained in a consultative capacity as Visiting Professor and continued to play an active role in departmental affairs until shortly before his death. His continued attention to detail and command of English and written style were memorable, and during his career he was author of over 150 erudite publications.

As a Chartered Engineer his professional career was rewarded with many academic honours and distinctions. He received the degree of DSc from the University of London in 1964 for his research in subjective acoustics and the measurement of hearing, and a DSc honoris cause from the University of Southampton in 1978. The Silver Medal of the Royal National Institute for the Deaf was awarded in 1984, the 1987 Thomas Simm Littler Prize of the British Society of Audiology, the Distinguished Service Certificate of the BSI and the University of London's George Davey Howell Memorial Prize in Otolaryngology in 1992, Honorary Fellowship of the Institute of Acoustics in 1993 and the British Occupational Hygiene Society Bedford Medal in 1999.

Those who knew Douglas Robinson will never forget him. His research judgement was never questioned and he was always respected by his peers in academia and industry alike. Deep down he had an impish sense of humour but was ever the true gentleman. On those occasions when he was able to relax the self-imposed demands of his acoustical research interests, a monumental knowledge of music and accomplishment as a pianist gave him great pleasure.

Dr Robinson is survived by his wife, Joyce, whom he married in 1946, and by his daughter Hazel of London, and his son Grant, now resident in Toronto with his wife Lori together with their two daughters.

Chris Rice FIOA

John Holmes HonFIOA

The Search for Perfection in Speech Processing

John Holmes was a leading figure in speech technology research and in the Institute of Acoustics. For 15 years he was Head of the UK Government's Joint Speech Research Unit, where he supervised important work in speech analysis, synthesis, recognition and transmission – and personally contributed a great deal in most of those fields. He was a careful, modest man who cared deeply about the people he worked with, the integrity of the technical work he was responsible for, and his duty as a civil servant.

John Holmes graduated in mathematics from Imperial College, London in 1950, and then spent two years on research in speech analysis in the College's Electrical Engineering Department, for which he was awarded the MSc Degree and the Diploma of Imperial College. In 1982 he was awarded the DSc(Eng) degree by London University for his published work on speech research.

He entered the UK Scientific Civil Service in 1952, joined the Joint Speech Research Unit (JSRU) at Eastcote on its formation in 1956, was appointed Head of the Unit in September 1970, supervised its move to Cheltenham in 1979 and resigned in January 1985. For about 2 years, he then worked part-time at PA Technology (near Cambridge). Then he became a fully fledged independent technical consultant and, more particularly, continued with his speech research.

Dr Holmes was a Fellow of the Institute of Acoustics, the Institution of Electrical Engineers, the International Society of Phonetic Sciences and the Acoustical Society of America. He was also a Senior Member of the Institute of Electrical and Electronic Engineers. Most of his professional institution activities were with the Institute of Acoustics. He was instrumental in the formation of the Institute's Speech Group in 1976 and was its first Chairman, for four years. He was on the Institute's Council for most of the 1980s, and was a Vice President for three of those years. He was elected an Honorary Fellow of the Institute of Acoustics in 1994.

Both during and since his time at JSRU John Holmes kept in close touch with speech research groups in other countries, with frequent attendance at international conferences and visits to other research laboratories. In particular these visits included many in the USA, such as AT&T Bell Laboratories, MIT, ITT, Texas Instruments, etc. In 1960-61 he spent four formative months in the Speech Transmission Laboratory of the Royal Institute of Technology, Stockholm, funded by an OEEC Senior Visiting Fellowship.

He published about 50 papers at conferences, in journals, etc, many of them as sole author, the earliest in 1954 and the last in 1998 at a conference in Australia. Much of his published work was concerned with understanding how voiced speech signals are generated by the interaction between glottal excitation and vocal tract resonances, and developing methods for analysing and synthesizing speech in these terms. He developed a formant-based speech synthesis system and by the early 1970s had demonstrated that it was capable of reproducing extremely good approximations to natural speech. The Holmes formant synthesizer uses a parallel arrangement of formant resonances with control of centre frequency and of amplitude. (Most formant synthesizers use a series configuration, but his papers on the subject explain why the parallel arrange-

ment, as he implemented it, can be preferable.) The Holmes formant synthesizer also includes carefully thought-out control of the excitation, and its interaction with the formant resonances, based on his long and careful studies of excitation phenomena. This work is recorded in his monograph Speech Synthesis, published in 1972.

An early version of the parallel formant synthesizer was used in one of the world's first speech synthesis-by-rule systems, which constructed speech patterns from a specification of the sequence of phonemes. It was described in a landmark paper published in 1964 with John Shearme and Ignatius Mattingly, and has been developed since then in several ways. (My own recent work on speech modelling for automatic speech recognition was inspired by this work.)

Having shown that his formant synthesizer could be made to copy human speech so well that people could hardly tell the original and the copy apart, a logical goal was fully automatic analysis. John explored several alternative approaches to formant analysis over the years, most of them concentrating on the short intervals just after glottal closure, when the vocal tract is in its simplest state and is also most full of resonating acoustic energy. He also worked on novel methods for efficiently encoding control parameters for a formant synthesizer for storage or transmission, making use of the non-uniform density of acoustic events by using a variable-frame-rate scheme. In the 1990s he developed a novel approach to formant analysis for automatic speech recognition, which was capable of delivering useful information even when presented with degraded signals. It was unusual in that it could deliver more than one interpretation of the speech pattern, which could then be disambiguated by the automatic speech recognition system.

He was a pioneer in the use of digital computers for speech processing, using an Elliot 803 for speech synthesis, and developing his own approach to digital filters. In the 1970s when general-purpose computers were not suitable for significant real-time speech processing he supervised the development of a series of special-purpose digital machines for speech synthesis, cepstrum analysis, and spectrographic analysis.

Although his first degree was in mathematics, and he could use mathematical techniques effectively, he was not very comfortable with the modern trend in speech technology research to use large amounts of sometimes rather intimidating mathematics. He preferred to see and listen to the speech phenomena that he was dealing with. A good example of his approach is his 1991 Eurospeech paper, *Use of phonetic knowledge when designing and training stochastic models for speech recognition.*

His book *Speech Synthesis and Recognition* published in 1988 was used widely by younger researchers and was recommended reading on many degree courses. Recently, he had been concentrating his efforts on writing the second, expanded, edition of the book, and was spending a high proportion of his time on this task right up until shortly before he died. Unfortunately the book is not yet finished, but his daughter Wendy, with whom he collaborated several times, is still working on it and hopes it will be published early in 2000.

After his retirement, John Holmes concentrated more on automatic speech recognition and did further work on formant analysis and degree of voicing analysis – as always, looking in detail at what was going on and modifying simplistic if mathematically elegant approaches to fit the real world of speech signals. He developed an unconventional approach to connected word recognition which was capable of giving speaker-independent recognition of varied regional accents while still being economical computationally.

It was my privilege to work under John Holmes at JSRU from 1971 until 1985. I learnt not only an enormous amount about speech and speech processing, but an attitude to deep understanding of the field and great care with presentation. For him, excellence was intrinsic. He had a precision of thought and a precision of expression to go with it. His view of scientific and business ethics was strong too; he would not tolerate a risk of misleading others, by carelessness, mis-emphasis or omission of material fact. He expected us to have these high standards too. He was never unkind, but let us know directly when we were wrong and that it was necessary to put it right. Today I am often aware of the standards he would insist on, even when I know I do not meet up to them myself.

John Holmes delighted in scientific work, had great competence and diligence. For those of us who worked with him, he is a delightful example and a strong formative and continuing influence.

My thanks to Wendy Holmes and Nigel Sedgwick for help in preparing this text.

John Bridle FIOA ❖

Hansard

21 July 1999
(Airport Noise)
Mr David Taylor (North-West Leicestershire): I want to draw to the attention of the Minister and the House the urgent need for more effective ways to control the major problem for those who live near airports and airfields – aircraft noise, particularly at night.

In my brief time in the House, there have been several debates about the need for action on behalf of those communities enduring chronic night noise from local airports. I want to make my own contribution and suggestions for a possible way ahead. Earlier this year, early-day motion 533, tabled by the hon Member for Richmond Park (Dr Tonge), summarised the impact of aircraft noise on nearby communities. As it said, night noise has adverse social consequences and may have a damaging effect on the health of those who live close to airports.

Civil aviation is powering ahead, fired by open access policies. Published air traffic predictions show an annual growth trend of 6 per cent, which will double the number of flights every 12 years and could dramatically upset the delicate balance between economic expansion and environmental restraint.

Airlines and airports say that aircraft are becoming quieter, and indeed they are. The phasing out, under international agreements, of the noisier chapter 2 aircraft by 2002 is welcome, but it should be noted that, already, 80 per cent or more of UK-registered large jets are of the more modern and theoretically quieter chapter 3 type. Despite the progressive introduction of those quieter engines, overall noise is escalating because of the greater number of larger aircraft involved, so Government intervention is absolutely necessary.

Last July, the Secretary of State for the Environment, Transport and the Regions published a transport White Paper which stated, among other things, that the Government would enact legislation to enable local authorities to enforce noise mitigation measures for airfields and airports. That legislation and those enforcement powers cannot come soon enough. Noise is a very important issue for those whose homes are near airports or under flight paths.

My particular interest in this matter arises from the presence of East Midlands airport in my constituency. The airport's origins were very much rooted in the local authority consortium that developed it, managed its operations and liaised effectively with nearby residents if problems arose. Since its sale to the private sector some years ago, the airport's fortunes have taken off rapidly.

The airport is now a major employer for our area: 5,000 jobs are located in and around the airport. It is a major regional asset in the provision of scheduled and charter passenger flights. It is a major player in the air freight market. It is the latter point that can produce problems for those living near the airport.

The airport is surrounded by many villages in Leicestershire's border region with Derbyshire and Nottinghamshire. My hon Friend the Member for South Derbyshire (Mr Todd) and I recently attended a meeting of the parish councils from those villages, who have formed an umbrella group called the Association of Airport Related Parish Councils, or AARPC. Each parish council itemised to us a litany of concerns about the airport, but in every case the core worry was that of night noise, either from over-flying, or ground running.

AARPC is urging the local planning authority to protect the well-being of communities near the airport by imposing appropriate restrictions on airport operations. What it is seeking appears to me to be a good template for the extra environmental powers that central Government should consider giving to local government. I shall give two brief examples.

First, AARPC says, flight paths should be agreed so as to minimise the over-flying of residential areas, particularly at night. Secondly, the group is pressing for a regulatory framework that can ensure that ground running and the older chapter 2 or comparable freight aircraft are not a feature of night operations.

It is not only local parish councils that protest long and loud to me. I have a sizeable postbag of complaints from individuals, particularly from the large village of Kegworth. I see a continual stream of constituents at my advice sessions. I have spoken at public meetings called to discuss airport noise. At least three independent community groups are lobbying hard for environmental improvements to the airport. They are Save Aston Village Environment, or SAVE, People Against Intrusive Noise, or PAIN, and Wings.

Two criticisms frequently surface in my discussions with residents and protest groups. The first is their belief that airport authorities are not policing the flight paths of user aircraft as closely as they might, especially at night. Secondly, residents and protest groups believe that local authorities should monitor aircraft noise at a range of locations in the affected communities. The data from that comprehensive array of survey points would firmly establish the shape and size of the noise contours within the overall noise footprint. The results of the survey should be subject to systematic audit by an independent body before being brought into the public domain and being fed into the planning process when further development is being sought by airport operators, or for enforcement action if appropriate or necessary.

To be fair to East Midlands airport, I must point out that its development policy recognises that it has a duty to minimise and manage the impact of its business on the environment and local villages. Indeed, the first key issue spelt out by its development policy document is tackling the noise associated with planned increases in air traffic movements, which will be linked to two projected extensions to the runway.

Within the obvious and paramount requirements of airport and aircraft safety, the airport has a duty to minimise the noise generated by its operations, but more has to be done if local communities are to be satisfied and noise levels are to be acceptable.

I shall now move briefly from the particular difficulties of our regional airport to the general lessons that can be learned from our experience and applied to the national scene. There is an increasing demand in a fast-moving world for rapid distribution of goods. That in itself puts enormous pressures on air freight services, which can translate into a serious environmental impact on airport communities, binding their quality of life tightly to the operational characteristics of their commercial neighbour. Airport communities badly need a control framework that resident and environmental organisations agree is so lacking at present.

Environmental limits must be set for existing and new or extended airports. Those limits would be permanent criteria that would have to be observed at all times. Their range and type would of course vary to reflect local geography and circumstances, but a number of core limits would apply to all airports. Those would include a cap on the number of air traffic movements, a restriction on types of aircraft to be operated, approved tracks for aircraft related to runway configuration and controlled times of operation.

The limits would also specify noise contours to be observed. They would control overnight running of engines or ground power units, the location of public safety zones and a good deal more. The overall aim is to fix limits on air traffic and noise levels permitted at an airport and to define a physical area beyond which further development will not be sanctioned.

An unquestioning attitude to demand-led projections for airport growth is entirely inconsistent with any concept of sustainable development with which I am familiar. In an ideal world, there will be no need for national noise legislation. Indeed, the White Paper specifically encourages airports to enter into voluntary noise mitigation agreements with their local authorities, and planning policy guidance 24 spells out how best planning authorities can use powers to minimise noise impact by specifying conditions and criteria for permitting noise sensitive and noise-generating developments.

However, the Government will need to legislate to give new powers to airports and local authorities – to airports so that they can take action against, for instance, non-compliant airlines, and to local authorities so that they can enforce noise mitigation agreements.

Hon Members on both sides of the House are well aware of the major economic benefits associated with the United Kingdom's network of airports. That commercial success need not be, indeed will not be, jeopardised by a better regulatory framework for noise control. Our Government must not turn a deaf ear to the clamour of concern expressed by airport communities about the night noise that they must endure. It is imperative that there is early legislation to allow both airport shareholders and airport neighbours to get a good night's sleep.

22 July 1999
Road Noise

Mr Pike: To ask the Secretary of State for the Environment, Transport and the Regions what guidance his Department has issued in respect of the use of whisper concrete or asphalt for road construction and resurfacing projects in (a) rural areas and (b) urban areas; and if he will make a statement.

Ms Glenda Jackson: This is an operational matter for the Highways Agency. I have asked the Chief Executive, Mr Lawrie Haynes, to write to my hon Friend.

Letter from Lawrie Haynes to Mr Peter Pike, 22 July 1999: The Transport Minister, Glenda Jackson, has asked me to reply to your recent question about guidance issued in respect of the use of whisper concrete or asphalt for road construction and resurfacing projects in either rural areas or in urban areas. Guidance on the use of both whisper concrete and asphalt for use in trunk road construction and maintenance is contained in two separate publications.

General guidance over surfacing alternatives is given in the *Design Manual for Roads and Bridges*, Volume 7, HD 36/99. While specifications for these materials is included in the *Manual of Contract Documents*, Volume 1 and 2. No distinction is made between their use in rural and urban areas as the choice of surfacing is based on the particular requirements for each road. Both documents are published and available in the House of Commons library.

If you require further information I suggest that you contact the Agency's Group Manager responsible for road surfacing, Graham Bowskill. He can be contacted on 0171 921 4746 and is familiar with both whisper concrete and asphalt road surfaces.

Mr Pike: To ask the Secretary of State for the Environment, Transport and the Regions what assessment his Department has made of the impact of noise from motorways and high speed roads in (a) urban areas and (b) rural areas; and if he will make a statement.

Ms Glenda Jackson: The Government have been well aware of concern about the level of traffic noise arising from motorways and other high speed roads. Our proposals for dealing with the problem arising from those roads for which the Secretary of State has responsibility were explained in *A New Deal for Trunk Roads in England.* We announced the annual budget which was being ring-fenced for this purpose on 22 March 1999, Official Report, columns 50-51, together with criteria which would target the most serious and pressing cases. The Highways Agency has assessed a number of locations where traffic noise had been a particular cause for concern against the sift criteria.

The Agency will shortly be undertaking detailed studies of those locations meeting the criteria where there are no immediate plans to replace the existing road surface with a quieter one. The studies are necessary to discover the most appropriate means of dealing with the problem. There has been no differentiation between urban and rural areas, but the studies will take into account the proximity of housing to the road. The Agency has also made good progress in the use of lower noise surfaces when maintenance is due on existing roads. Approximately three quarters of maintenance contracts undertaken since last year have used these new surfaces.

27 July 1999
Motorway Noise
Mr Bill O'Brien: To ask the Secretary of State for the Environment, Transport and the Regions what proposals he has to assist residents who suffer from excessive noise from motorways; and if he will make a statement.
Ms Glenda Jackson: I will write to my hon Friend and place a copy of my letter in the Library.
Mr Bill O'Brien: To ask the Secretary of State for the Environment, Transport and the Regions if he will make a statement on the responsibility for measuring and monitoring noise levels at properties where motorways have been built.
Ms Glenda Jackson: There is no requirement for noise levels to be monitored after a road has been built. But within six months of the final offers of noise insulation under the legislation applying to new or substantially altered roads, residents living within 300 metres of such a road who had not been offered insulation have an opportunity to appeal for the assessment to be reviewed. In such cases, it is not general practice to undertake noise measurements, but to calculate the statistical level of noise required by the Regulations from the flow of traffic and other relevant factors.
Mr Bill O'Brien: To ask the Secretary of State for the Environment, Transport and the Regions what studies his Department has carried out to identify high and unreasonable noise levels in properties where motorways were built before 1988; and if he will make a statement.
Ms Glenda Jackson: Following our announcement on 22 March 1999, Official Report, columns 50-51, of a ring fenced budget for the Highways Agency to undertake noise mitigation measures in the most serious and pressing cases on existing roads, a large number of locations where concern has been expressed about noise have been assessed against the stated criteria. Detailed studies are now required to determine the feasibility of providing measures at locations meeting the criteria where there are no plans to provide a quieter road surface as part of routine maintenance operations.
Mr Bill O'Brien: To ask the Secretary of State for the Environment, Transport and the Regions what proposals he has to assist people living near motorways on which there has been a significant increase in the volume of traffic above that forecast when the motorway was built.
Ms Glenda Jackson: The Government announced its proposals for dealing with the problem of noise arising from those roads for which the Secretary of State has responsibility, which include the majority of motorways, in *A New Deal for Trunk Roads in England*. We announced the annual budget which was being ring-fenced for the provision of noise mitigation measures on 22 March 1999, Official Report, columns 50-51, together with the criteria which would target the most serious and pressing cases, including locations affected by unexpectedly high levels of traffic growth.

Extracts provided by Rupert Taylor FIOA

BSI News

New and Revised British Standards

BS 8233:1999 Sound insulation and noise reduction for buildings – Code of Practice. Supersedes BS 8233:1987

BS ENs Implemented by Amendment

BS EN ISO 389: Acoustics – Reference zero for the calibration of audiometric equipment.
BS EN ISO 389-3:1999 Reference equivalent threshold force levels for pure tones and bone vibrators. Implementation of European standard EN ISO 389-3:1998 by amendment to BS ISO 389-3:1994. Note: This amendment renumbers BS ISO 389-3:1994 as BS EN ISO 389-3:1999.
BS EN ISO 389-4:1999 Reference levels for narrow-band masking noise. Implementation of European standard EN ISO 389-4:1998 by amendment to BS ISO 389-4:1994. Note: This amendment renumbers BS ISO 389-4:1994 as BS EN ISO 389-4:1999.

Amendments to British Standards

BS ISO 389: Acoustics – Reference zero for the calibration of audiometric equipment.
BS ISO 389-3:1994 Reference equivalent threshold force levels for pure tones and bone vibrators. Amendment No 1. Note: This amendment implements EN ISO 389-3:1998 and renumbers BS ISO 389-3:1994 as BS EN ISO 389-3:1999. Updated standard.
BS ISO 389-4:1994 Reference levels for narrow-band masking noise. Amendment No 1. Note: This amendment implements EN ISO 389:1998, and renumbers BS ISO 389-4:1994 as BS EN ISO 889-4:1999. Updated standard.
BS EN ISO 8662: Hand-held portable power tools – Measurement of vibrations at the handle.
BS EN ISO 8662-10:1998 Nibblers and shears. Amendment No 1. Updated standard.
BS EN ISO 11200:1996 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. Amendment No 1. Updated standard.
BS EN ISO 14163:1998 Acoustics – Guidelines for noise control by silencers. Amendment No 1. Updated standard.

British Standards Reviewed and Confirmed

BS 4196: Sound power levels of noise sources.
BS 4196:1981 Precision methods for determination of sound power levels for sources in anechoic and semi-anechoic rooms.
BS 5727:1979 Method for describing aircraft noise heard on the ground.
BS 6655:1986 Specification for pure tone air conduction threshold audiometry for hearing conservation purposes.
BS EN ISO 9614: Acoustics – Determination of sound power levels of noise sources using sound intensity.

BS EN ISO 9614-1:1995 Measurement at discrete points.
BS EN 21683:1994 Acoustics – Preferred reference quantities for acoustic levels.

Updated British Standards

BS EN 1032:1997 Mechanical vibration – Testing of mobile machinery in order to determine the whole-body vibration emission value – General. Amendment No 1.

British Standards Proposed for Withdrawal

BS 4813:1972 Method of measuring noise from machine tools excluding testing in anechoic chambers. Obsolete.
BS 7025:1988 Method for preparation of test codes of engineering grade for measurement at operator's or bystander's position of noise emitted by machinery. Obsolete.

British Standards Withdrawn

BS ISO 389: Acoustics – Reference zero for the calibration of audiometric equipment.
BS ISO 389-3:1994 Reference equivalent threshold force levels for pure tones and bone vibrators. Superseded by BS EN ISO 389-3:1999.
BS ISO 389-4:1994 Reference levels for narrowband masking noise. Superseded by BS EN ISO 389-4:1999.

New Work Started

EN 352: Hearing protectors – Safety requirements and testing.
EN 352-1 (Revision) Ear muffs.
EN 352-2 (Revision) Earplugs.
EN 352-3 (Revision) Ear muffs attached to an industrial safety helmet.

Drafts for Public Comment

99/203058 DC Draft IEC 61094-1 Measurement microphones – Part 1: Specifications for laboratory standard microphones (Document No 29/439/CDV) (Possible new British Standard).
99/203190 DC IEC 61094-5 Measurement microphones – Part 5: Methods for pressure calibration of working standard microphones by comparison (IEC Document 291440/CD) (Possible new British Standard).
99/562773 DC ISO/DIS 12124 Acoustics – Procedures for the measurement of real-ear acoustical characteristics of hearing aids.
99/710061 DC ISO 1925/DAM 2 Mechanical vibration – Balancing – Vocabulary (Amendment 2).

ISO Publications

ISO 3822: (Edition 3) Acoustics – Laboratory tests on noise emission from appliances and equipment used in water supply installations.
ISO 3822-1:1999 Method of measurement. Will be implemented as BS EN ISO 13822-1, and will supersede BS 6864:1987.

This information was announced in the July & August 1999 issues of BSI Update.

Book Reviews

Marc Leman (Ed)
Music, Gestalt and Computing. Studies in Cognitive and Systematic Musicology.
ISBN 3-540-63526-2
524pp, price £37.50
Springer-Verlag (1997)

Musical acoustics is a field that superficially might to be regarded simply as a physical science, but if their work is to have any relevance anyone studying this topic must be aware of the wider world in which musical instruments have to perform. Because of this, the musical acoustician should be informed by all matters related in any way to music and musical instruments and, in particular, views emanating from the more esoteric fields such as cognitive musicology might well prove fruitful. This is the promise offered by *Music, Gestalt and Computing*.

This book contains a revised and reviewed selection of papers presented during the Joint International Conference on Cognitive and Systematic Musicology, held in Brugge in September 1996. Its aim is to present a coherent state-of-the-art survey of the subject area, and it is devoted to the relationships between acoustics, human information processing and culture.

The papers included in the book are organised in chapters according to topics, although the first chapter is concerned with general topics related to theoretical, historical and programmatical issues. The other chapters deal with problems, or solutions to problems, in domains related to pitch, perception, harmony, rhythm, organisation, expectancy, timbre, texture, expression, and application oriented issues such as hybrid computational architectures and interactive computer systems. The book comes with a CD providing sound examples for various chapters, and these are described in an appendix at the end of each chapter. At the end of the book a complete list of all sound examples is given, along with a comprehensive name and subject index.

Unfortunately, however, for this reviewer at least, the book did not fulfil its promise. It does contain much of relevance to musical acoustics, but it really is very hard going and the useful information can only be reached by the most thorough and careful reading. The problem is the writing style, and although it claims to contain introductory sections accessible to the non-expert reader, these are amongst the worst culprits.

As an example, one page opened more or less at random (p45) contains 17 lines of footnotes out of a total of 40, whilst of the actual text a good third is made up of references. Overall the style is along the lines of 'so and so said this' and 'so and so argued that', becoming at times just a list of names without seeming to contain any information or reach any conclusions.

This is all rather sad. The book does have its good points, and becomes almost lucid when discussing more tangible concepts, as in the sections dealing with computer systems. However, the acoustician should not expect to learn much at a casual reading. The CD sound examples, on the other hand, are worth listening to. They are interesting and do convey the intended message without the listener having to rely on imagination as often happens with such examples. But not many people of my acquaintance could justify paying the price asked these days for a specialist book just to get hold of an interesting CD.

Peter Dobbins FIOA

Environmental Noise Barriers: A Guide to their Acoustic and Visual Design
By Benz Kotzen & Colin English
Publisher: Routledge
Price: £50 (hardback)

This is an interesting and very readable book on a subject which is of immense importance to all those whose work involves road and rail transport and the environment. Concerned citizens in all walks of life should also read this book because the widespread use of environmental noise barriers in the UK will affect virtually everyone either in their homes or as drivers or passengers in vehicles. Noise consultants may be disappointed that noise barriers for industrial applications such as sand and gravel quarries are not allocated a section in this useful book.

There are 148 photographs illustrating the wide range of designs and materials which are now used in America and many structures which will cost millions of pounds to manufacture and erect. Because the UK has followed a compensation policy for property value depreciation and sound insulation, we have lagged many years behind the rest of the developed world in using noise barriers. This means that our industries which could develop and manufacture noise barriers have a lot of catching up to do. It could be a huge market.

It is predicted that by 2011 there could be twenty-eight million cars in Britain. The mind boggles! Most noise barriers must have a forty year life. Should we be devoting more resources to electrically powered vehicles in anticipation of a world crisis when oil and gas prices escalate when supplies run out? Will we be able to generate enough electricity to meet the soaring world demand?

Our standards for state supplied sound insulation and compensation are based on the controversial percentile level of 68 dBA which is the arithmetic average of the values of L_{10} hourly dBA for each of the eighteen one-hour periods between 0600 and 2400 hours. Why do we not comply with the World Health Organisation's guideline limits for day and night time noise of 55 and 45 dBA, L_{Aeq} for a one hour period? Compliance with these rules would accelerate the investment of resources to reduce tyre noise, to improve public transport services, to make more use of rail transport and to develop high acoustic performance noise barriers which are not visually offensive.

My sympathies are with the minority in the UK who do not own a car. They have to put up with excruciating noise and other environmental pollution without having the tremendous personal advantages of a private car for their own use. Read this book and think deeply about this crucial subject.

Ian Watson ❖

Noise & Health – A New Journal
and the
Noise Research Network

A new Journal, *Noise & Health,* commenced publication in 1998 with Deepak Prasher as Editor-in-Chief and Dr Manjula Patrick as Editorial Manager, based at the Institute of Laryngology & Otology, University College London, 330 Gray's Inn Road, London WC1X 8EE e-mail: m.patrick@ucl.ac.uk.

The editorial board comprises 57 individuals from 19 countries, few of whom would be familiar names to most UK members of the Institute, suggesting a large representation from the medical side. Bernard Berry, Immediate Past President of the IOA, and Professor Peter Wheeler, a former president, are clear exceptions on the list.

In association with this a Noise Research Network is being formed. Its stated aims are to (1) Facilitate multi-disciplinary research. (2) Provide a means of finding potential collaborators (3) Pool expertise (4) Increase subject-base (5) Integrate and disseminate information (6) Raise awareness of research in other associated areas. The Network is gathering information from individuals working in the field which covers noise, its measurement and control, auditory and non-auditory effects and other related areas. The database of research personnel is to be made available as a searchable database on a web site. Interested individuals submit their general career details which should include research areas and publications.

A member of the database may take a subscription to the journal for £45; other individuals pay £60 and institutions £120. Copies of recent issues of the journal are available for inspection in the Institute library.

Those interested should contact Dr Patrick at the above address.

Editor

New Products

FULCRUM SYSTEMS

Rear-Mirror Microphone Boosts Clarity and Safety

New from acoustic specialists Fulcrum Systems Ltd is the VMM16 Rear-View Mirror mounted vehicle microphone.

The microphone has been acoustically designed for voice critical applications and offers significant acoustic and safety benefits over 'A' Pillar mounted products and is already in use with the emergency services.

The VMM16 features exceptional speech clarity in a high background noise environment, strongly rejecting wind and road noise. A design combination of acoustics and mechanics for the mirror mounting has enabled excellent high-speed 'windows open' performance.

The mirror-mounting concept was developed by Fulcrum re-addressing the problems of vehicle mounted microphones and applying up-to-date acoustic and mechanical techniques to provide optimum performance.

With the mirror correctly aligned to the drivers' eyes, the microphone is always correctly acoustically positioned for the mouth. Safety is enhanced, as there is no temptation for the driver's eyes to leave the road ahead when speaking – the mirror-mounted microphone is within normal driving vision.

Sound files of the actual 70 mph (110 kph) performance of the VMM16 with the windows open and closed can be found at website www.fulcrum-system.co.uk showing a striking comparison against an industry standard product.

The product is available as an OEM product or through Fulcrum's network of distributors in most countries which can provide local support.

The VMM16 is a plug-in replacement for most electret-based vehicle microphones used with GSM and PMR Hands-Free with 3.5 mm plug. Each microphone is supplied boxed with a full installation pack and instructions.

For more information contact Bob Andrews, Fulcrum Systems Ltd, Hillbottom Road, Sands Industrial Estate, High Wycombe, Bucks HP12 4HJ Tel: 01494 437575 Fax: 01494 473324 email bob.andrews @fulcrum-systems.co.uk

MICROSTAR LABORATORIES

PC-based PCI Data Acquisition Board with On-board Processor

Microstar Laboratories has announced a new top-of-the-line PCI-based Data Acquisition Processor (DAP™) board optimised for real-time data acquisition and control.

The 14-bit resolution DAP 5200a/526 has an AMD K6-2 300 MHz onboard processor to provide local intelligence, enabling functions in data acquisition and control to be completed on the DAP board in high speed/real time and the results passed to the host PC for display and further processing.

The board provides 14-bit A/D resolution for its 16 onboard analogue inputs, and 12-bit D/A resolution for its 2 onboard analogue outputs. The analogue input channels sample at an overall 800k samples per second, and the digital input channels at an overall rate of 1.67M words per second. The two onboard analogue output channels update at an overall 1M updates per second, and the 16 onboard digital output channels update at an overall 1.67M words per second.

32MB of onboard DMA memory is provided as a data buffer; DMA bus mastering is used to transfer data to the PC, protecting an application from random operating system and network delays. DAPL 2000, a full 32-bit implementation of DAPL, a multitasking real-time operating system, is shipped with the board. DAPL is fully compatible with all industry-standard interfaces such as DASYLab, DIAdem, HP VEE and Lab\VIEW. The DAPL operating system contains over 150 standard commands and new commands can be written by developers in C/C++ and run on the DAP Board.

External expansion in 19 inch industrial racks allows a total of up to 512 analogue inputs and up to 66 analogue outputs connected to a single DAP5200a. Rack-mountable option cards expand 16 onboard digital inputs to up to 128 digital inputs, and 16 onboard digital outputs to up to 1024 digital outputs.

Further details from Microstar Laboratories (UK) Ltd, Westminster House, 77-79 High Street, Egham, Surrey TW20 9HE Tel: 01784 471313 Fax: 01784 471919 website http://www.mstarlabs.com

FERROFLUIDICS LTD

New Audio Grade Fluids

Ferrofluidics has recently introduced two new hydrocarbon based audio grade fluids which are direct replacements for the current APG 800, APG 900 and APG 1000 series.

The new APG 2000 and APG E series have greater thermal stability and therefore a longer life than the fluids they are replacing. For example, APG 2036 has a gel time of 100 hours at 175°C compared with gel times of 75 hours for APG 936 and 50 hours for APG 836.

The APG E series are closer to the APG 900 series in their chemistry but have better colloidal stability which makes them of interest for compression drivers and similar high magnetic flux speakers.

For further details contact Ferrofluidics Ltd, Talisman Business Centre, Bicester, Oxon OX6 0JX. Tel: 01869 363200 Fax: 01869 363201 e-mail: enquiry @ferrofluidics.co.uk. Internet:http:// www.ferrofluidics.co.uk.

PROSCON ENVIRONMENTAL

New Model 706 Personal Noise Dosimeter from Larson Davis

ProsCon Environmental Ltd announce the release of the new Larson Davis Model 706, stated to be an extremely powerful and flexible integrating and profiling noise exposure meter. The Model 706 is based on the Model 705 NoiseBadge™ but with a much-improved dynamic range and the addition of a LCD display. The lightweight Model 706 weighs 200g and is ergonomically designed to be unobtrusive when worn in the pocket or on the belt for long periods of time.

The custom graphic screen on the Model 706 uses easily understandable symbols for indication of mode, interface activity, battery power and memory status. Additionally, measured data are displayed clearly in large numbers. The GUI navigates the user through a variety of set-up and measurement parameters giving the user power and flexibility to perform virtually any personal noise exposure measurement without the need for peripheral equipment.

With the standard 1 megabyte of memory, the Model 706 will measure user defined time histories and give 16 hours of 1 second intervals including L_{eq}, L_{min}, L_{max} and Peak (C or Un-weighted).

The microphone preamplifier cable has a high quality LEMO™ connector that removes the need for factory return should the microphone ever become damaged, thus reducing down times and subsequently providing added cost savings.

Under normal operating conditions the Model 706 has extremely low power consumption typically providing 80 hours of measurement with two low cost AA alkaline cells. High speed data transfer to the Windows™ based PC software (included with the Model 706) is by infra-red technology thus removing the need for interface cables.

The BLAZE computer software allows set-up and control of the instrument, archiving, graphical presentation and analysis of down loaded data. Presented data includes dose, projected dose, TWA, time history based on exchange rate, criterion and threshold levels: each one modified for easy recalculation for 'what if' scenarios. Other measurement parameters include sound exposure, minimum and maximum sound pressure levels and peak.

Further details from David Neil of ProsCon Environmental Ltd, Abbey Mill, Station Road, Bishops Waltham, Southampton SO32 1GN Tel: 01489 891853 Fax:01489 895488 e-mail: drpclark @enterprise.net.

CAMBRIDGE CONTROL

MATLAB Toolbox

Cambridge Control, the MathWorks UK subsidiary, has launched the Process Data Analysis and Modelling Toolbox for faster and simpler data analysis. The toolbox, created in conjunction with software developer Datanacon, analyses historical data and enables trends to be identified and models built with MATLAB.

The Process Data Analysis and Modelling Toolbox has been extensively beta-tested by a number of British blue-chip companies, s ·ch as ICI, Shell UK and Pilkington Glass.

The toolbox allows captured data to be analysed and manipulated in a quicker, more intuitive way than with off-the-shelf data processing packages. This will enable users, particularly in the financial and retail markets, to study cause-and-effect relationships, multivariate linear/non-linear correlations and create models with the data.

The Process Data Analysis and Modelling Toolbox includes a powerful neural networking technology to identify trends in data and discard out-of-boundary readings which could distort the final report. The cleansed data, model calculations and modelling results can then be exported seamlessly into Excel for further analysis and manipulation. The product utilises a 100% Graphical User Interface which enables rapid familiarisation with the software's functionality.

For further information contact Cambridge Control Ltd, Newton House, Cambridge Business Park, Cowley Road, Cambridge CB4 0WZ Tel: 01223 423200 Fax: 01223 423289 e-mail info @camcontrol.co.uk website http:// www.camcontrol.co.uk.

NEWS

PROSCON ENVIRONMENTAL

Sole UK Distributor

ProsCon Environmental Ltd have announced that with effect from 1st August 1999 they are appointed the sole UK distributor for the entire Larson Davis product range.

This announcement follows the procurement of Larson Davis Acoustics (USA) by PCB Group of New York, and after much thought for the customers within the UK a decision was made to revert to a one dealer agreement for the UK.

ProsCon Environmental Ltd have already represented Larson Davis since March of 1998 dealing primarily with the real time analyser and vehicle passby systems markets, as well as environmental systems for both short, and long term monitoring.

ProsCon Environmental Ltd continue to offer a calibration service for all Larson Davis instruments and other manufacturers' sound level meters as well as repairs, replacement microphones and a full hire service of the most popular sound level meters and environmental kits. For further details contact ProsCon Environmental Ltd as previous.

MILLENIUM AWARDS

Concert Hall Acoustics Exhibition

Bridget Shield of South Bank University and Trevor Cox of Salford University have been awarded a grant for the design of an exhibition on concert hall acoustics. The project is funded through the Royal Society and British Association Millenium Awards Scheme, financed by the Millenium Commission. The aim of the scheme is to encourage people's understanding of science, engineering and technology. Bridget and Trevor are working closely with Catherine Sutton of the Royal Festival Hall education department. Concert hall acoustics is an ideal subject for promoting public understanding of science: the exhibition can reach out to music lovers, of whom most will be familiar with some of the effects of good and bad room acoustics; and the subject lends itself to eye catching exhibits with aural demonstrations.

The exhibition will initially be shown at the South Bank Centre in London, where, in addition to concertgoers, it is hoped to attract the many tourists and visitors who pass through the South Bank Centre every day. The exhibition will also be used in school visits to the Royal Festival Hall, to give children some understanding and insight into the behaviour of sound and the importance of acoustics in concert hall design. The exhibition will be held in the main foyer of the Festival Hall (near the bar!) and is expected to open towards the end of January 2000. It is hoped that it will be possible to transfer it to other venues at a later date.

For further information, please contact Bridget at shieldbm@sbu.ac.uk or Trevor at t.j.cox@salford.ac.uk.

ENDEVCO AND BRÜEL & KJÆR

Joined forces

Endevco and Brüel & Kjær Sound & Vibration have decided to join their expertise. It is stated that this will provide improved distribution, access to all major measurement technologies as well as enhanced manufacturing competence and will make available:

- The broadest line of accelerometers and precision microphones serving all applications, unmatched by any other company in the world.
- An extensive line of analysing systems for both sound and vibration analysis scaleable from 1 to 2000 channels.
- A well-trained service and support organisation with expertise based in the United Kingdom offering a technical hot line, calibration services and software upgrades.
- Coordinated research and development to enhance innovation and new product offers.
- Improved manufacturing competence by consolidating over the next two years all accelerometer manufacturing at Endevco.
- Numerous short courses and technical seminars in English.
- The manufacturing expertise and quality of the two largest providers of sound, shock and vibration components and systems in the world.

For further information contact Brüel & Kjær, Harrow Weald Lodge, 92 Uxbridge Road, Harrow Weald, Middx HA3 6BZ Tel: 0181 954 2366 or Endevco (UK) Ltd, Melbourn, Royston, Herts SG8 6NA Tel: 01763 261311.

Brüel & Kjær are Key Sponsors of the Institute.

CIBSE Guide B12: Sound Control

Revision

The section of this guide relating to sound control, Section B12, is currently being revised. This is part of a two year project to update the acoustics and cooling and ventilation sections and is part funded by the Department of the Environment, Transport and the Regions under the Partners in Innovation Scheme. The work on section B12 is being led by Dr Geoff Leventhall.

The first stage of the project entails reviewing the existing material and identifying the most appropriate structure for the new edition of the guidance. CIBSE is keen to obtain comment from practitioners, and has asked Bridget Shield to liaise with the Institute of Acoustics, giving members an opportunity to have an input to the revision, and to keep them informed of progress of the revision.

CIBSE have designed a questionnaire for distribution to interested parties, to assist them in providing their views on various aspects of Section B12. The questionnaire is available on the IOA website, or may be obtained direct from the CIBSE Research Manager, Dr Hwyel Davies, on 01234 351269 (telephone and fax) or at hwel@gec.org.uk.

There is also a half day workshop on the afternoon of Monday 29 November to discuss the proposed revision of these sections of Guide B. Some time will be devoted to small group sessions on particular issues, one of which will be section B12. Any IOA member who wishes to contribute to the discussions are welcome to attend, and should contact Dr Davies for details.

For information about the revision contact Dr Davies and for technical queries Dr H G Leventhall FIOA at vy27@dial.pipex. com.

HSE

Guidelines for its Research Programmes

The Health and Safety Executive (HSE) has published new guidelines which set out the business context for its research activities. They describe the health and safety issues that have been identified as priorities and that will require research. They also outline some of the key influences which will impact on HSE's business needs and on its research programmes, over the next few years.

The Guidelines for HSE's Research Programmes provide a link between HSC/E's annual Strategic Plan and HSE's annual Mainstream Research Market publication, which provide information on business programmes and research activities, respectively.

Copies of Guidelines for HSE's Research Programmes are available free of charge from Lee Collins at HSE, Seventh Floor South, Rose Court, 2 Southwark Bridge, London SE1 9HS Tel: 0171 717 6489 Fax: 0171 717 6955.

Copy for the New Products section only should be sent to John Sargent MIOA, Oak Tree House, 26 Stratford Way, Watford WD1 3DJ. ❖